YEARBOOK

OF THE

UNITED STATES

DEPARTMENT OF AGRICULTURE.

1897.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1898.

GRASS GARDEN ON GROUNDS OF U. S. DEPARTMENT OF AGRICULTURE

(Buffalo grass, or curly mesquite, in the foreground.)

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[PUBLIC—No. 23.]

AN ACT providing for the public printing and binding and distribution of public documents.

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Section 73, paragraph 2:

The Annual Report of the Secretary of Agriculture shall hereafter be submitted and printed in two parts, as follows: Part one, which shall contain purely business and executive matter which it is necessary for the Secretary to submit to the President and Congress; part two, which shall contain such reports from the different bureaus and divisions, and such papers prepared by their special agents, accompanied by suitable illustrations, as shall, in the opinion of the Secretary, be specially suited to interest and instruct the farmers of the country, and to include a general report of the operations of the Department for their information. There shall be printed of part one, one thousand copies for the Senate, two thousand copies for the House, and three thousand copies for the Department of Agriculture; and of part two, one hundred and ten thousand copies for the use of the Senate, three hundred and sixty thousand copies for the use of the House of Representatives, and thirty thousand copies for the use of the Department of Agriculture, the illustrations for the same to be executed under the supervision of the Public Printer, in accordance with directions of the Joint Committee on Printing, said illustrations to be subject to the approval of the Secretary of Agriculture; and the title of each of the said parts shall be such as to show that such part is complete in itself.

PREFACE.

Under date July 14, 1897, the Secretary of Agriculture, in calling upon the chiefs of bureaus, divisions, and offices of the Department of Agriculture for contributions to the Yearbook of the Department for 1897, used the following language:

> It is my earnest wish that the Yearbook shall be of such a popular character and of such value to practical agriculture as to justify the enormous edition issued by Congress. Every one contributing to it should be fully impressed with the fact that every page contained in the Yearbook costs the country $500, and is designed to be distributed to half a million persons. As the reputation of the Department is assuredly a matter of pride to every one of its officers and scientific workers, I feel confident of the hearty cooperation of each one of you in making this book the best book of its kind ever issued. As soon as the subjects upon which you propose to submit papers are presented to me for consideration, I shall indicate which of them will be acceptable, that the work of preparation may be undertaken as promptly as possible.
>
> The editing of the Yearbook for 1897 will be confided, as in the case of the other publications of the Department, to the Chief of the Division of Publications, under the personal direction of the Secretary.

This expression by the head of the Department affords a clew to the principles which have controlled the preparation of the Yearbook. Moreover, from the titles of the articles submitted by the several chiefs as available, the Secretary of Agriculture himself made the selection. In addition to the miscellaneous articles thus selected, the Secretary called upon each chief in charge of a special branch of the Department work not purely administrative for an article setting forth the character of the work done by him for the farmer. The precise nature of the article desired is indicated in the Secretary's call as follows:

> * * * * in addition to such other suitable articles as may be necessary, the forthcoming Yearbook, 1897, should contain an article from each chief of bureau, division, and office outside of those that are purely administrative, which shall set forth in plain terms the relation of the work of his bureau, division, or office to the farmer. The existence of the Department is justified precisely so far as it aids the farmer to be a successful farmer, and my desire is that the article called for should present clearly to the reader just how the division of the work in your charge achieves that purpose. * * * *

Thus it will be seen that the Yearbook for 1897 has been constructed on lines laid down by the present head of the Department.

The practical carrying out of the work as thus outlined has called for a subdivision of the book into four main parts. The first, as usual, consists of the annual report of the Secretary of Agriculture for the fiscal year 1897, and its publication fills the requirement of the law (see paragraph on page 2) that the Yearbook shall "include a general report of the operations of the Department."

The second part contains the papers setting forth the work of the several bureaus and divisions and bears the general title "Work of the Department for the Farmer."

In the papers in this second part considerable diversity is shown, the several chiefs differing widely in the manner of presenting the nature of the relation of their branch of the work to the farmer, but the majority incline to an historical account of the division itself. By direction, considerable latitude was allowed to each chief in telling his story, hence the variety of forms referred to; but those who are interested in knowing what service the Department undertakes to render to the farmers of this country, and the methods by which it seeks to accomplish it, will certainly find this information here.

The miscellaneous papers in the third part, eighteen in number, were, with a single exception, prepared by the chiefs of the bureaus and divisions and their expert assistants. This part fairly illustrates the extent and variety of the scientific work and, with the account given in the second part of the character of the work undertaken, should serve to remove the not infrequently incorrect impression conveyed as to the nature of the duties devolving upon the scientific staff of the Department, owing no doubt to the inappropriate title of "Chief of Division" by which most of those composing it are officially designated.

The fourth part, the "Appendix," contains information which should be available to every farmer and which is of value to all who are interested, even indirectly, in agriculture. Beginning with an extended presentation of the organization of the Department, a list of the agricultural colleges and stations in the several States, and a list of the Department publications for the year, it includes data on feeding, fertilizers, fungicides, a list of one hundred of the most valuable trees in the United States, with their characteristics and uses and their preferred environment; tables showing the number and value of farm animals, the acreage and value of the principal crops, the imports and exports of agricultural products, transportation rates, and a record of the weather condition throughout the year. The several bureaus, divisions, and offices of the Department have been drawn upon to supply this collection of agricultural facts, and it has not been found necessary or feasible to credit each particular one with every item contributed by it, except in case of statistical tables and meteorological information, the authority for which it has been deemed best to indicate.

GEO. WM. HILL,
Editor Yearbook.

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YEARBOOK

OF THE

U. S. DEPARTMENT OF AGRICULTURE.

REPORT OF THE SECRETARY.

To the President:

The Secretary of Agriculture has the honor to submit his annual report of the work of the Department for the fiscal year ending June 30, 1897.

OBJECTS OF THE DEPARTMENT.

The Department of Agriculture was organized to help farmers to a better knowledge of production and its tendencies at home and abroad, so as to enable them to intelligently meet the requirements of home and foreign markets for material that may be profitably grown or manufactured on American farms. It was also intended that the Department should organize a comprehensive system of means by which the sciences that relate to agriculture should become familiar as household words among our farmers.

SCOPE OF THE DEPARTMENT WORK.

The endowment of agricultural colleges by Congress in 1862 and the appropriations for experiment stations in 1887, for education in agriculture and for supplying correct information to farmers along the lines of their life work, are probably the most effective and far-reaching ever devised by the government of any people. Cultivators are becoming more familiar with the soils they manipulate and the climates of their respective localities, the plants adapted to their conditions, and the live stock that those conditions will best develop. The work done in each State along lines of agricultural investigation by experiment stations is to some extent local in its character, while much of it has general application. The Department of Agriculture designs giving wide circulation to everything of general interest, so that the farmers of all the States and Territories may get the benefit of good work done in each State.

ANIMAL PRODUCTS AND FOREIGN MARKETS.

The science of dairying is spreading from the agricultural college centers, resulting in greatly increased and improved production. The Department of Agriculture is seeking markets in foreign countries by making their people familiar with the superiority of our goods.

We produce meats of superior quality more cheaply than any other nation can put them on the world's market, owing to the cheapness of our grains and grasses. The State experiment stations are giving feeders information regarding the best methods of nutrition, which will result in more economic practices. The Department of Agriculture inspects live animals and dressed meats for export and certifies to their freedom from disease, supervises their condition through agents in foreign markets, and is the advocate of exporters where discriminations are laid upon the movement of live stock and meats in foreign countries. The Department will in the future endeavor to help producers to find markets for surplus productions, by getting and spreading information concerning them and concerning what foreign markets require.

EXPERIMENTS WITH SUGAR BEETS.

The Government spends money freely in distributing seeds and plants among the people. The policy of the Department of Agriculture in the future will be to encourage the introduction of what will enable our people to diversify their crops and keep at home money that is now sent abroad to buy what the United States should produce.

Seven tons of imported sugar-beet seeds were distributed last spring in 27 States, among 22,000 farmers, through the experiment stations of those States, to ascertain where the sweetest beets can be produced. Samples are now being analyzed at the experiment stations, and where they are not prepared to do the work the beets are forwarded to the laboratory of the Department at Washington. There is abundant encouragement to lead us to conclude that our country will within a few years produce what sugar it requires. The Department will collect all the facts regarding the work of this season and publish them for general distribution. The pioneer work will be pushed energetically during the next year.

OPPORTUNITIES FOR NEW INDUSTRIES.

The United States paid $382,000,000 the last fiscal year for sugar, hides, fruits, wines, animals, rice, flax, hemp, cheese, wheat, barley, beans, eggs, tea, etc., $6,000,000 for chicory, castor beans, lavender, licorice, opium poppy, sumac, etc., and $2,000,000 for bulbs, nearly all of which could be grown and prepared for use at home. The Department of Agriculture will encourage the growing of these articles by the introduction of seeds and by sending out Farmers' Bulletins giving information concerning them.

An American farmer can grow horses as cheaply as he can grow cattle; we have a heavy and profitable export trade in cattle, and may have an export trade equally heavy and profitable in horses. The Department is gathering facts regarding our horse industry at home and the requirements of purchasers abroad, so that our farmers may learn what foreign buyers demand.

ADVANCE IN SEED DISTRIBUTION.

We are endeavoring to get information from foreign countries with which we compete in the markets of the world regarding crops and prices. We are also taking steps to ascertain what crops are grown on different thermal lines, so that seeds and plants may be intelligently brought to this country to assist in the diversification of our crops and add to their variety. Agents are sent into foreign countries to make selections suitable to our various latitudes. All this work is done at a disadvantage and at considerable expense, which limits seed and plant importation. A scientist has been appointed in the Department to have charge of seed and plant importation. He will correspond with American representatives abroad, with scientific associations, investigators, seed houses, and the like, so as to get information concerning plant life in different latitudes and along the life zones that control plant growth. The Department requires the history as regards soil, climate, and antecedents of every seed or plant it imports. This is very difficult to get in many cases. None of the countries of the Eastern Hemisphere have a corps of scientists in every locality as the United States has. Our country has profited by introducing new seeds and plants, but much of this work has been done in the dark.

NEED OF QUALIFIED AGENTS IN FOREIGN COUNTRIES.

There is a necessity in every foreign country to which we send representatives for American agents who have been educated in the sciences relating to agriculture. The agricultural colleges endowed by Congress are educating men along these lines. Such men can now be had who are competent to report intelligently on the productions of countries where man has lived by tilling the soil for thousands of years, and they could keep the farmers of the United States informed regarding crops, markets, and their tendencies much more accurately than agents not scientifically educated.

GRASSES AND FORAGE PLANTS.

Much of our country is comparatively new; few of our native grasses or legumes thrive in connection with systems of rotation that are necessary to maintain fertility. They are fast disappearing as grazing and cultivation are adopted. It is a task worthy a nation's effort to replace them with grasses that form sod and replenish the soil with humus or legumes that fix free nitrogen in the soil and that provide the most valuable part of animal food. Both considerations demand the attention of the Department of Agriculture, and efforts have been made during the past season to procure suitable grasses and legumes from the semiarid countries of Asia, through agents of the Department, for trial in the Western and Southwestern sections of our country.

THE DEPARTMENT SCIENTISTS AND THEIR WORK.

The Department has a thoroughly competent corps of scientists occupying places in the front ranks of their specialties, conducting research into all fields of inquiry where practical farmers need their help. They cooperate with the scientists of the several experiment stations in investigations of more than local interest, and keep in touch with observers and experimenters throughout the United States and in foreign countries. Reports of their work are distributed as the secrets of nature influencing agricultural production are revealed.

THE WORLD'S MARKETS FOR FARMERS.

The markets of the world are now in close, sympathetic touch. Their sources of supply are affected by the weather, by insect depredations, by military commotions, by transportation facilities, and by the intelligence of producers. The Department of Agriculture intends, through its bureaus, offices, and divisions, to carry information to the home of every farmer, and thus enable him to direct his efforts intelligently as changing conditions suggest.

EXPERIMENTAL EXPORTS OF BUTTER.

Early in the year it became apparent that a considerable surplus of butter of the higher grades would appear in our domestic markets. This had never before occurred, and it was plain that if such a condition prevailed for any length of time the price of fine butter would decline; and should this happen with the best quality, values would be depressed through all grades of this commodity. Before midsummer the best of creamery butter was offered in almost unlimited quantities in our largest markets at a price lower than ever known (14 and 15 cents), and no material change occurred for several weeks. I therefore decided to make a series of experimental exports of fine American butter, for the purpose of promoting an increased foreign demand for this article, and in order to get more exact information as to facts and conditions attending such exports than was otherwise obtainable.

GROWTH AND CONDITION OF OUR BUTTER TRADE ABROAD.

The export of butter from this country is nothing new. It began even as early as the year 1747, and exceeded 1,000,000 pounds annually a hundred years ago. Then it increased to 35,000,000 pounds in 1863, and, dropping to 2,000,000 in 1870, rose to almost 40,000,000 in 1880. Since that time the quantity exported has been as low as 5,000,000 pounds a year (1894) and as high as 31,000,000, the latter for the fiscal year ending June 30, 1897. New York City reports, for the commercial years ending with May, butter exports of 643,000 packages (about 60 pounds each) for 1880, 292,000 for 1890, 24,000 for 1895, 199,000 for 1896, and 320,000 for 1897. Since May 1, 1897, the exports from New York have been about 12 per cent greater than for the same months in 1896; but prior to the last year or two the butter exported was of low grade as a rule, and made not so much with a view to establishing a regular trade as to take advantage of special and transient conditions of the markets at home and abroad, and to make profits on these occasional business ventures. The result has been to give foreign merchants, especially in Great Britain, the impression that the butter of this country was poor in quality, and that no regular supply could be depended upon.

TESTING THE LONDON BUTTER MARKET.

Shipments of butter were therefore begun early in the season, under the supervision of the dairy division, and have since been continued at intervals of three or four weeks. The butter has been obtained from selected creameries in the leading dairy States, prepared with special reference to the ascertained requirements of foreign buyers, and thus far all has been consigned to a representative of the Department at London. It has been disposed of under his supervision, special efforts being made to test the demands of the London market and obtain the opinions of wholesale dealers, tradesmen, and consumers as to the merits of the butter thus sold and its relative position, present and prospective, in that market.

IMPROVEMENTS IN TRANSPORTATION OF BUTTER.

Much attention has also been given to the matter of transportation, with a view to shortening the time, improving the accommodations, and avoiding detentions and exposures, so as to make the conditions as nearly perfect as possible all along the line, from the producer, perhaps in our far West, to the consumer in England or on the continent of Europe. It was at first found that although satisfactory facilities were provided by refrigerator cars and quick transit while on the rail, and by cold compartments on the steamships while at sea, there were points of necessary transfer where delays occurred, with the butter often exposed to high temperatures and the packages marred and injured by careless handling. Serious detentions at interior points of transfer and hours of needless exposure upon platforms and in terminal sheds at New York and other points have been located and arrangements made for preventing them. The railroads of this country and the special transportation lines operating over them appreciate the necessities of the case, and are prepared to perfect their arrangements for receiving butter in all the large producing districts and delivering it unimpaired to vessels at any suitable port to any extent demanded by the development of this traffic.

COLD STORAGE OF BUTTER ON STEAMERS.

Suitable accommodations for cold storage of butter on ocean steamers were very imperfect and uncertain prior to the present year, and are not yet satisfactory at all points. But refrigerators have been available at New York almost every week during this season, and it is now evident that the demands of trade in this respect will be met sufficiently at that point and promptly provided for at other ports on the Atlantic and also on the Gulf. (These important provisions will apply as well to other perishable farm products, and encourage the extension of markets in that direction also.) At English ports there has been much complaint of detention and careless handling. An agent of the Department has given particular attention to this subject at Southampton, and reports the conditions there as much improved. A good deal remains to be done, however, to secure satisfactory facilities for transfer and prompt forwarding of butter and similar merchandise at those ports and proper accommodations on the freight trains to the interior markets of Great Britain. Refrigerator cars, such as are in common use all over this country, are as yet practically unknown in England.

BETTER REPUTATION FOR AMERICAN BUTTER.

The shipments made have served the double purpose of securing useful information for those of our own people, whether producers or dealers, who wish to sell abroad, and of aiding to establish a better reputation for butter from the United States among prospective customers. Leading English merchants have been thus convinced, as never before, of the excellence of butter obtainable in this country and the feasibility of delivering it fresh and unimpaired to British buyers.

In the endeavor to have all the butter included in these trials plainly marked and made known as the product of the United States, and thus presented to the English consumer, extraordinary prejudice has been met in London at every point. Merchants insisted that no good butter could come from America, made various unjust and absurd criticisms of the butter offered them, and even when convinced of its merits, against their will, they offered to pay much less for it than they gave for butter of no better quality from other countries and sources of supply. Once in the hands of the trade, our butter was repeatedly sold as English, Canadian, or Australian, and special efforts were required to get any of it into the hands of consumers, under its true name, through the usual commercial channels.

FACTS ABOUT AMERICAN BUTTER.

It is too early now to formulate all the lessons taught by these experimental exports, but certain facts have been already determined. Butter from the most remote creamery districts of the United States, when properly made, can be so transported as to be delivered in prime condition to consumers in England or on the continent of Europe fifteen or twenty days after making. The quality of selected American butter is quite equal to the best offered in London from any other country, although our supply, as a whole, is not so uniform in character as that from some other sources, notably Denmark. Despite allegations to the contrary, the butter exported by the Department has been proved to contain less water and a greater proportion of pure butter fat than any butter for sale in the London market.

The products of the United States and of Denmark have been found to be the only absolutely pure butter imported into England; all others, including the product of British colonies, contain more or less injurious ingredients, used as preservatives. Notwithstanding the prejudices of London merchants, and the maintenance of comparatively low quotations for "States" butter, the creamery product of this country is now commonly retailed at the highest market price, on a perfect equality with the best English, Danish, and French butters. And English customers are so well pleased that, whether knowing it to be American butter or not, they frequently make special efforts to get more of that particular kind, and are disappointed on finding the supply to be insufficient and uncertain. The retail price obtained for butter exported by the Department during the summer has been from 24 to 28 cents per pound.

BUTTER PACKAGES FOR THE LONDON MARKET.

The London market objects to salted butter in small packages. There are indications that with some effort print butter and small packages for family trade might be successfully introduced, especially in the suburbs of the city. But consumers, as a rule, buy in small quantities, often daily, and prefer to see the quantity they want cut from a large body, like the contents of a box or tub, weighing 50 pounds or more. For this reason mainly the retailers, and consequently the larger merchants, demand large packages, and decidedly favor, because of convenience, the cubical box of 56 pounds, or a half hundredweight, known as the Australian package. Nevertheless, butter of established reputation sells in London, as elsewhere, at the best market rates, with little regard to the form of package. The best Danish butter, which still holds first place in English markets, is always found in kegs or firkins of different and irregular sizes. And although when the Department sent over early in the season exactly the same butter in boxes and tubs, the former sold for a cent or two more per pound than the latter, subsequently, upon recognition of the quality of the article, the offerings made by the Department, in boxes and tubs, sold at the same price.

COLOR AND FLAVOR OF BUTTER.

English markets seem to differ as much as those in America in the matter of taste as to the degree of color and salt in butter. It is an easy matter to provide for meeting the requirements of any locality or market in these respects. At present London buyers want butter of a light lemon or straw color, even less yellow than our natural June grass butter, and lightly salted, having, in the finished product, about one-third of an ounce to the pound, or 2 per cent, of salt. A mild and even flat flavor seems to be preferred to the quicker and more decided flavors so highly esteemed in this country.

CONDITIONS AFFECTING EXPORTS OF BUTTER.

From the present outlook, the whole matter of future foreign markets for American butter depends upon the question of price. English merchants are rapidly learning, and those of other countries can be similarly taught, that they can get all the butter they want from the United States, and of a quality unsurpassed, if they will pay enough for it. But the supply of fine butter in this country is irregular in quantity and our home demand fluctuates, so that the highest grades are at times obtainable at prices which offer a tempting margin for export, and a few months later the same grade of butter sells for about as much in Chicago and New York as it would in London. While these uncertain conditions exist, no regular export trade of importance is likely to be established. Neither merchants nor consumers like change of kind in their supply of butter. A reliable supply of uniform quality is an essential condition to a regular trade. It costs 2 or 3 cents a pound, and sometimes more, to carry butter from an American creamery and sell it in Liverpool or London.

A comparison of market quotations in England and the United States month by month will show that at times there are strong inducements for exporting butter and none at all at other times. In July last the wholesale price of the best creamery butter in New York was 15 cents, while at the same time butter of equal quality was worth 20 to 21 cents in London. From that time to the present writing butter has advanced over 50 per cent in value in this country, while in London the advance during the same period has been only 20 per cent.

CONTRACTS ABROAD FOR ENTIRE BUTTER PRODUCTS.

A private dairyman often finds it to his advantage to contract the butter product of his farm to a good customer at a fixed price for the year. Sometimes he gets less than he might obtain temporarily elsewhere and sometimes more, but the year's average is satisfactory. Others, including creamerymen as well as dairymen, are quite contented to follow the regular market price if their customer will take the entire product, week by week. From the investigations already made, it is evident that American creameries which do not find a sufficiently regular and satisfactory market for their butter product throughout the year, but are willing to accept ruling market prices, can arrange for disposing of their entire output to foreign merchants on terms quite as advantageous as those obtainable in this country.

FURTHER EXPERIMENTAL EXPORTS OF BUTTER DESIRABLE.

As already stated, the trials made the present season have been confined to the London market. The results obtained thus far seem to make it desirable to continue these experimental exports of butter, enlarging the field of operations to include other points in Great Britain which present peculiar local features, as well as selected markets on the continent of Europe.

It may become expedient to make similar efforts to extend the markets for other perishable commodities, the products of American farms, such as poultry, eggs, and fruit.

THE PROBLEM OF THE FARMER'S HOME.

Among the educational movements which in recent years have engaged the attention of the public none has been received with greater favor than the attempt to introduce into schools for girls and women some systematic teaching of the arts which are practiced in the home. Many of the colleges of agriculture and mechanic arts, together with scientific, technical, and industrial schools, now maintain a department of domestic science. Cooking and sewing are quite commonly taught in the public schools, and cooking schools for women have been organized in numerous places. While useful instruction in these lines is imparted, it is generally recognized that much remains to be done before the teaching of domestic science can assume its most effective form.

NEED OF THOROUGH HOME TRAINING.

In this, as in other branches of instruction which have a vital relation to the arts and industries, the student should learn not only the best methods of doing the things required by the daily needs of home life, but also the reasons why certain things are to be done and others avoided. In other words, this teaching needs a scientific basis if it is to be thoroughly useful. In this respect domestic science is in the same category with medicine, engineering, and agriculture. It is not so very long ago that medicine and engineering were very largely empirical arts, and the schools of medicine and engineering were principally engaged in teaching men the things they were to do when they became doctors or engineers. To-day no doctor or engineer is considered fitted to pursue his profession until he has drunk deep at the fountains of science and knows well the principles on which successful practice must be based. In agriculture it is coming to be clearly seen that teaching the boy how to plow or to perform any other farm operation is not the most important service which the school can render. There must be added to this, definite and careful instruction in the principles on which agricultural practice is based. The farmer must be taught to think in the lines where science has shed light upon his art if his practice is to be most thoroughly successful. Fortunately, science has already much to tell the farmer which is most useful to him, and every year sees an increase in the great store from which the agricultural student can safely draw.

THE TEACHING OF DOMESTIC SCIENCE.

Now, what has been done for the boy in agriculture and engineering needs to be done for the girl in domestic art and science. And already the beginnings of a far-reaching effort in this direction have been made. The teachers of domestic science are not content to follow a dull routine of household drudgery in their teaching. They are appealing to the scientist and specialist in lines which touch the home life to explain the principles on which home practices should rest and to show them how intelligent taste and skill can make the home a pleasant place to live in, and how scientific knowledge can enable the home keeper to maintain the health and generally promote the physical well being of those committed to her charge. Some progress has been made in formulating the replies which science is now able to give to inquiries relating to domestic science and in undertaking investigations with a view to greatly broadening our knowledge of these matters in the days to come.

THE DEPARTMENT'S WORK FOR THE HOME.

In the great work of helping the women of our land, nearly half of whom are toiling in the homes upon our farms, this Department, it is believed, has a large duty to perform. For, whatever will be effective in raising the grade of the home life on the farm, in securing the better nourishment of the farmer's family, and in surrounding them with the refinements and attractions of a well-ordered home, will powerfully contribute alike to the material prosperity of the country and the general welfare of the farmers. The investigations which the Department has undertaken on the food and nutrition of man have already been of much service to the teachers and students of domestic science, and it is hoped that these investigations will hereafter be still more helpful in establishing a scientific basis for the teaching and practice of human nutrition. Through its close relations with the agricultural colleges and other institutions for industrial training of the youth, the Department may incidentally aid the movement to educate women in the rational practice of the arts of the home.

PROPOSED HELP IN THE TRAINING OF WOMEN.

But beyond this, it is much to be desired that the Department may be afforded an opportunity to undertake some definite enterprises which will enable it to extend much more material assistance to those who are engaged in the noble task of giving practical training to the future wives and mothers of our farmers and to that vast army of faithful women who are bearing the heavy burdens of keeping the farmers' homes pure and sweet and rearing the future masters of our vast agricultural domain.

BUREAU OF ANIMAL INDUSTRY.

MEAT INSPECTION.

The appropriation at the disposal of the bureau has not been sufficient to enable it to inspect all the animals slaughtered in the United States designed for interstate and foreign commerce. The force engaged in this work has been enlarged from time to time, and the number of animals inspected has increased each year. During the past year all the beef exported to Europe, and a great part of the pork and other meat products, have been inspected in accordance with the law, but the bureau has found it impossible to inspect the large amount of meat slaughtered for interstate trade. The force now used in the inspection is competent and efficient, and it should be extended sufficiently to meet the intent of the law looking to the inspection of all the meat entering into interstate and foreign trade. The persons obtained by certification from the eligible list of the civil service, as a rule, have been more competent and efficient than those obtained before the force was brought within the classified service.

The work of inspection was in operation at 128 abattoirs and packing houses located in 33 cities.

The following table shows the number of ante-mortem inspections made in the stock yards and at abattoirs, with the number condemned:

Ante-mortem inspection.

Animals.	For official abattoirs in cities where the inspection was made.	For abattoirs in other cities and miscellaneous buyers.	Total inspections.	Condemned at abattoirs.	Rejected in stock yards.
Cattle	4,289,058	3,960,967	8,250,025	195	24,951
Sheep	5,179,643	2,864,712	8,044,355	757	10,503
Calves	259,930	189,053	448,983	56	2,597
Hogs	16,813,181	8,753,563	25,566,744	12,858	40,287
Total	26,541,812	15,768,295	42,310,107	13,866	78,338

The following table shows the number of post-mortem inspections, giving the number of animals rejected, with the number of carcasses and parts condemned as unfit for human food:

Post-mortem inspection.

Animals.	Number of inspections.			Carcasses condemned.			Parts of carcasses condemned at abattoirs.
	At abattoirs.	On animals rejected in stock yards.	Total.	At abattoirs.	Stock-yard inspections.	Total.	
Cattle	4,242,216	11,634	4,253,850	6,618	3,725	10,343	10,290
Sheep	5,209,161	4,733	5,213,894	3,086	1,652	4,738	1,213
Calves	273,124	787	273,911	238	311	549	42
Hogs	16,808,771	30,263	16,839,034	a41,562	12,929	54,491	b37,750
Total	26,533,272	47,417	26,580,689	51,504	18,617	70,121	49,295

a Includes 3,243 condemned on microscopic examination.
b Includes 10,082 condemned on microscopic examination.

The meat-inspection tags or some other mark of identification were affixed to 14,510,662 quarters and 863,248 pieces of beef, 5,161,927 carcasses of sheep, 231,879 of calves, 524,556 of hogs, and to 314,947 sacks and pieces of pork.

The following table shows the number of animals inspected before slaughter, for abattoirs having inspection, from 1891 to 1897, inclusive:

Animals inspected for abattoirs having inspection, fiscal years 1891–1897.

Fiscal year.	Cattle.	Calves.	Sheep.	Hogs.	Total.
1891	83,891				83,891
1892	3,167,009	59,089	583,361		3,809,459
1893	3,922,174	92,947	870,512		4,885,633
1894	3,862,111	96,331	1,020,764	7,964,850	12,944,056
1895	3,752,111	109,941	1,344,031	13,576,917	18,783,000
1896	4,050,011	213,575	4,710,190	14,301,963	23,275,739
1897	4,289,058	259,930	5,179,643	16,813,181	26,541,812

MICROSCOPIC INSPECTION OF PORK.

In the microscopic inspection for trichinæ, 1,881,309 specimens were examined. The number of samples found infected was 13,325, of which 3,243 were from carcasses and 10,082 from pieces of pork.

The number of pounds exported was 43,572,355, of which only 1,001,783 pounds went to countries not requiring a certificate of microscopic inspection.

Amount of pork microscopically inspected, fiscal years 1892–1897.

Fiscal year.	To countries requiring inspection.	To countries not requiring inspection.	Total.
	Pounds.	*Pounds.*	*Pounds.*
1892	22,025,698	16,127,176	38,152,874
1893	8,059,758	12,617,652	20,677,410
1894	18,845,119	16,592,818	35,437,937
1895	39,355,230	5,739,368	45,094,598
1896	21,497,321	1,403,559	22,900,880
1897	42,570,572	1,001,783	43,572,355

The cost of this inspection was $111,669.30, an average per specimen examined of 5.94 cents, or an average of 0.256 cent for each pound of microscopically examined meat exported.

INSPECTION OF VESSELS AND EXPORT ANIMALS.

The number of inspections of domestic cattle for export was 845,116; number tagged, 410,379; number rejected, 1,565; number of inspections of domestic sheep, 348,108; number rejected, 189. The number of Canadian cattle inspected was 13,136; number rejected, 12; Canadian sheep inspected, 23,289; number rejected, 72.

The number of domestic animals exported under the supervision of inspectors consisted of 390,554 cattle, 184,596 sheep, 22,623 horses, and 100 mules.

The number of certificates issued for cattle was 1,563; the number of clearances of vessels was 954.

The percentage of loss in export animals during the year 1894 was 0.37; in 1895 it was 0.62, and in 1896 it was 0.32.

The cost of inspection of export animals, the Texas fever work, and the inspection of animals imported from Mexico was $102,555.16.

Cattle and sheep inspected for export.

Fiscal year.	Cattle.				Sheep.		
	Number of inspections.	Number rejected.	Number tagged.	Number exported.	Number of inspections.	Number rejected.	Number exported.
1897	845,116	1,565	410,379	390,554	348,108	189	184,596
1896	815,882	1,303	377,639	365,345	733,657	893	422,603
1895	657,756	1,060	324,339	324,299	704,044	179	350,808
1894	725,243	184	360,580	363,535	135,780		85,809
1893	611,542	292	280,570	289,240			

SOUTHERN CATTLE INSPECTION.

During the quarantine season of 1896 there were received and yarded in the quarantine divisions of the various stock yards 42,869 cars, containing 1,154,235 cattle; 43,529 cars were cleaned and disinfected.

The supervision and control of the movement of cattle from the district infected with Southern, or splenetic, fever involves the placarding of cars and the stamping of waybills, the proper yarding of Southern cattle so that they will not come in contact with susceptible animals, and, when reloaded at one station, the notification of the inspector at the point of destination or at intermediate stations. In the noninfected area in Texas 220,543 cattle were inspected and permitted to be moved to other States by trail and railroad for grazing.

INSPECTION OF IMPORTED ANIMALS.

The number of animals imported from Mexico and inspected at the ports of entry along the boundary line was as follows: Two hundred and ninety-two thousand four hundred and seventy-nine cattle, 43,393 sheep, 12 hogs, and 171 goats.

An experiment is now in progress in Page County, Iowa, to determine to what extent and at what cost hog cholera can be prevented or controlled by sanitary regulations. The legislature at its last session passed a special act giving authority to destroy animals and to enforce necessary quarantine regulations. The funds available for this experiment are not sufficient, but it is hoped that the work may be sufficiently thorough in a part of the county to indicate what may be accomplished by the enforcement of such regulations. Experiments are also being made to learn what may be accomplished by killing only the plainly diseased animals and treating those exposed with hog-cholera antitoxin. It is yet too early to form an idea of the results that will be obtained through these experiments further than to state that the antitoxin evidently has a beneficial effect. The laboratory and experiment station are now engaged upon investigations looking to the production of an antitoxin of greater protective power and at less expense than has been possible heretofore.

PROPOSED EXTENSION OF MEAT INSPECTION.

The most pressing work of the Bureau of Animal Industry for the coming year is the extension of meat inspection to abattoirs engaged in the interstate business, which has not yet been included in the service. Until all the establishments which kill for shipment to other States have been included, the object of the law in preventing the sale of diseased carcasses for human food will not be accomplished, and there will be a discrimination in favor of those who have received the inspection and against those who have not been able to obtain it. There is also a demand for increased microscopic inspection, which is necessary to permit the marketing of American pork products in the principal countries of continental Europe. The exports of these products fluctuate largely from year to year, according to the condition of the market, and consequently it is impossible to foresee the expenditure which will be necessary to properly provide for the trade. There should either be an emergency fund which can be drawn upon for this purpose or the Department should be authorized to charge a reasonable sum—say 5 cents—for each specimen microscopically inspected, and the sum so collected should become additional to the appropriation, so that any demands made might be complied with.

PAYMENT FOR MICROSCOPIC INSPECTION.

While I believe the general inspection of meats for sanitary purposes should be made by the Government, without charge to the slaughterers, the microscopic inspection to a great extent is a commercial inspection, and the cost of it could be more legitimately assessed against the trade which it benefits. If the packers paid the cost of the inspection, there would be no longer any reason for declining to extend it to all who apply for it, and the inspection could be applied to as many small pieces of pork as might be deemed necessary or advisable. At present inspection is demanded of pieces weighing only from 1½ to 3 pounds, and on account of the cost of inspecting such small pieces a limit of weight has been set (5 pounds), which is more or less unsatisfactory to the trade.

The inspection of export animals must be continued in order to certify to their healthfulness and maintain the market which has been secured for them in other countries. At present our live animals are shut out from most of the countries of continental Europe, and it is only by inspection and certifying to their healthfulness that we can hope to have these markets reopened.

INSPECTION AND QUARANTINE OF IMPORTED ANIMALS.

The inspection and quarantine of imported animals must also be continued in order to prevent the introduction of contagious diseases. While much progress has been made in the control of contagious diseases in European countries from which our stockmen import live animals, yet most of these countries are now affected with either pleuro-pneumonia or foot-and-mouth disease, or both. The prospects are that there will be more importations from Europe during the coming year than for several years past, and consequently the cost of this inspection must be somewhat increased.

INSPECTION CERTIFICATE TO INCLUDE MILK PRODUCTS.

It is suggested that an extension of the Government system of inspection and certification at present applied to meats and meat products for export to include butter, cheese, and condensed milk would be advisable and may perhaps be necessary in order to maintain the standing of our products in foreign markets. If a trade in pure butter or pure cheese is built up under existing conditions, it may at any time be ruined through the shipment by unscrupulous persons of adulterated products or those which have been preserved with agents generally considered harmful. No doubt a certification limited to products which would grade above a certain fixed and arbitrary standard would be a great benefit and aid in building up and maintaining a greatly increased trade in such products.

CATTLE AFFECTED WITH TEXAS FEVER.

The inspection and quarantine of cattle from the Texas fever district is an extremely important branch of the service, and it needs constant attention to prevent the infection of the central stock yards and the widespread dissemination of the contagion. When we consider that the quarantine line separating the infected from the uninfected district of the country extends from the Atlantic coast on the east to the

Pacific on the west and is over 4,000 miles in length, the difficulty in preventing violations of the regulations and the unlawful movement of infected stock can be appreciated. During the present year there have been more violations of the quarantine than for several years, owing, no doubt, to the increased demand for stock cattle. It will be necessary to take increased precautions during the next year to prevent the movement of cattle contrary to the regulations, or great damage to the domestic and export trade and a heavy loss of stock will result. The force during the present year is not sufficient to properly guard this line.

DESTRUCTION OF CATTLE TICKS.

Probably the most important work which the pathological division has had in charge has been the experimental study of the effect of the different substances in destroying ticks which spread the infection of Texas fever. It has been found recently that a petroleum product known as paraffin oil will destroy the ticks without greatly irritating the skin of the animals to which it is applied. It is thought by dipping the animal twice in this oil, with an interval of a few days, all the ticks will be destroyed, and the animals, even from the infected district, may hereafter be shipped with safety to any part of the country. If this hope is fulfilled, the dipping of cattle from the infected district must soon become general and will save millions of dollars to the Southern States and more thoroughly protect Northern cattle.

BLACK LEG.

An effort is being made to prevent the losses from the disease known as black leg, or symptomatic anthrax, by distributing to the owners of herds where such losses occur a vaccine that will produce immunity. Some localities report losses from this disease ranging from 8 to 14 per cent. Heretofore the methods used in this country required two vaccinations, with an interval of ten days or more. The trouble and expense of a double vaccination, added to the cost of the vaccine, has deterred many stock owners from adopting this method of prevention. The pathological division is experimenting with a vaccine prepared by a special method which produces sufficient immunity to resist the disease with one vaccination.

RABIES.

Many investigations of reported outbreaks of this disease have been made and a considerable number of tests made of animals supposed to be infected with rabies. A great variety of opinions have been expressed concerning the existence of rabies and the extent to which it prevails in this country. There are few institutions which are prepared to make scientific tests of animals supposed to be infected with this disease, consequently the work of the pathological division in this direction is of great importance. A considerable number of undoubted cases of the disease have been discovered, and it has been found that some apparently unaccountable outbreaks of disease among cattle were really attributable to rabies.

ERADICATION OF SHEEP SCAB.

The design of the Department is to entirely eradicate sheep scab, and every effort will be made to bring this about. The work should be done on the ranch and on the farm. In many instances sheep owners have undertaken the complete eradication of this disease and succeeded. There is always more or less opposition when outside interference is brought to bear upon private management, but the general welfare of the sheep owners all over the United States requires that this disease should be eradicated. Intimate relations now exist between the sheep-breeding grounds and sheep-feeding grounds of the Northwest. Sheep are moved in large numbers from west of the Missouri to the grain fields east of it. The sheepmaster on the breeding grounds can obtain better prices for his stock by eradicating this disease, and much loss will be prevented to the feeder when he can buy healthy sheep.

HOG CHOLERA AND TUBERCULOSIS.

Experiments are also being made to determine the best methods of treating and controlling hog cholera and tuberculosis. The losses from these diseases are extremely serious, and every effort should be made to reduce them. In order to accomplish this, it is plain that the Department must exercise fuller control over the movement of animals from one part of the country to another and prevent the dissemination of contagion by stock cars in which diseased animals have been transported. It is probable that more legislation should be enacted, giving the Department greater power in the stock yards that are used for interstate shipments, and that more positive authority should be granted for compelling the disinfection of cars and stock pens.

WORK OF THE BIOCHEMIC DIVISION.

This division has manufactured and distributed to State authorities sufficient tuberculin to test 57,000 cattle for tuberculosis and sufficient mallein to test 1,400 horses for glanders during the past year. This division has also succeeded in manufacturing an ink which is of great assistance in branding carcasses and pieces of inspected meats. Such branding answers the purpose of identification in many cases as well as seals and tags, and where used results in a great saving of money, since it can be applied much more rapidly and costs for material very much less.

WORK OF THE ZOOLOGICAL LABORATORY.

With a view to determining the value of German microscopic examination of pork for trichinæ, the various outbreaks of trichinosis in that country from 1881 to 1895 have been studied.

It is a remarkable fact that with all these cases of trichinosis which are laid at the door of German inspection and German pork, there was not a single case in Germany during the fifteen years referred to which the German sanitary authorities have been able to show was due to American pork.

The zoological laboratory has prepared for the use of the bureau inspectors a bulletin on certain animal parasites found in meats, with special reference to their direct or indirect transmissibility to man.

For about two months the attention of this laboratory was occupied with a study of the parasites of the fur seal, undertaken at the request of the Treasury Department. An extensive report on this subject has been submitted to the United States Seal Commission for publication.

NEED OF AN ANIMAL EXPERIMENT STATION.

The work of this bureau requires the use of an experiment station where a considerable number of experimental animals can be constantly kept. This is needed partly for the diagnosis of diseases met with in the inspection of meat and in the investigation of outbreaks of disease in various parts of the country, and also in the investigation of the nature of diseases and the best methods of treating them. The station which has heretofore been occupied by the bureau has become insufficient for the purpose, and a change has therefore been made to a point farther from the city of Washington, and where more land can be obtained. The importance of continuing such investigations and of pressing them forward as rapidly as possible can not be overestimated, and no doubt the necessity for such work will continue for many years to come. I would therefore recommend that suitable grounds for such an experiment station be purchased, thus avoiding the necessity of moving from place to place and abandoning the improvements which must necessarily be made where this work is being conducted.

GREATER LABORATORY FACILITIES NEEDED.

I also invite attention to the importance of providing a fireproof building for the scientific laboratory. The building now occupied is unsuited for housing the valuable working material which has been accumulated during the thirteen years that the bureau has been in existence. In the study of animal parasites, for instance, there has been intrusted to our zoologist the type specimens from the principal collections of the world. If these specimens were destroyed, it would be an irreparable loss to science and to practical agriculture. So, in each division of the work there are specimens, literature, indexes, and working material of all kinds which represent years of labor and which could not possibly be replaced.

This laboratory is a practical workshop, which aims to make constant and immediate returns to the farmers for the full amount expended for the scientific work of the bureau. It is accomplishing this by the distribution of tuberculin, mallein, and black-leg vaccine, by bringing out the best methods of treating diseases, by determining and informing stock raisers as to the nature of diseases which affect their stock, by perfecting methods for making cattle insusceptible to Texas fever, and for killing the ticks which are the means of spreading the disease. These lines of work are worth millions of dollars to our farmers, and they should not only be encouraged, but put beyond the danger of interruption and ruin by fires and other avoidable accidents.

THE WEATHER BUREAU.

The extension of the scope of the Weather Bureau and its increase in usefulness are well known to the American people. In 1883 weather maps were not issued except at the central office in Washington, D. C. During the last fiscal year 4,315,000 maps were issued at 81 stations outside of Washington, D. C., and there has been an increase of 686,000 copies within the last two years to meet the constantly increasing demands of the public. In 1883 forecasts and warnings were sent to 8,094 places by mail, no other method of distribution, except through the daily press and the railroad train service, being then in use. During the last fiscal year daily forecasts and warnings were sent to 51,694 places by mail, telegraph, and telephone, and there has been an increase in the number of places receiving forecasts in the last two years of nearly 30,000.

CLIMATE AND CROP BULLETINS.

In 1883 no information was collected respecting the weather as influencing crops. Now climate and crop conditions are reported from about 8,000 places, and the results are summarized in the weekly climate and crop bulletins which are issued at each State center and republished by practically the entire press of the country, both rural and urban. There were in that year less than 300 voluntary observers in cooperation with the bureau, and no systematic publication of their reports was made. Now there are about 3,000 voluntary observers making daily readings of standard Government thermometers and rain gauges, the daily readings being collected and neatly printed in tabular form at 42 State centers.

STORM-SIGNAL STATIONS.

In the year mentioned (1883) there were 41 stations on our seacoast and the Great Lakes where storm signals were displayed for the benefit of mariners. Now there are 253 stations where these signals are displayed, at each of which, in addition to displaying signals, telegraphic bulletins giving the location, intensity, and probable movement of the storms, are distributed to vessel masters within one hour after the information is dictated by the forecast officials.

EXTENSION OF WEATHER SERVICE.

For the fiscal year ending June 30, 1884, the weather service cost $993,520. The appropriation for the current year is $883,772, which is $109,748 less than in 1883, while the work performed and the benefit derived by the public are much greater. The appropriation for the current fiscal year, however, is inadequate to meet the demands made by the people, either directly to the bureau or through their Representatives in Congress, for a material extension of the benefits of the weather service. It is necessary to establish and equip new stations at important centers of population. The amount now appropriated is barely sufficient for the actual working force at the meteorological stations, leaving no opportunity for the extension of the present system or the establishment of new stations. It is only with the utmost care, and by requiring from nine to twelve hours' work every day in the year, including Sundays and holidays, at a majority of our stations, that the important duties of the service can be performed. Every mail brings urgent requests from Representatives in Congress, farmers, mariners, merchants, and professional men for extensions which it is impossible to make.

MONEY NEEDED FOR NEW WEATHER BUREAU STATIONS.

An increased appropriation of $160,348 in the estimates for the Weather Bureau for the next fiscal year has therefore been asked for. This increase contemplates the establishment of several stations in the Southwest of our country, where an extensive area is not now included in the domain covered by meteorological observations. This unprotected region includes large portions of Nevada, Utah, Arizona, New Mexico, and southeastern California. Four or five additional stations should be established in this territory. The weather conditions which cause frost in the orange and raisin sections of California drift in a southerly direction from the north and northeast. The giving of accurate frost warnings for the extensive fruit interests of southern California requires the additional stations above referred to.

SHELTERS REQUIRED FOR INSTRUMENTS.

The estimates include an item of $10,000, over and above the amount allotted for the present fiscal year, for the purpose of purchasing instrument shelters for issue to voluntary observers of the Weather Bureau, who number about 3,000 at the present time. These shelters will enable the bureau to obtain more accurate climatic observations, since the thermometers will be so exposed as to have free circulation of air, and yet will be protected from sunlight, rainfall, and radiation from surrounding structures. Many employees are now engaged in collating and publishing these reports for the purpose of establishing the climatic features of every portion of each State in the Union. It is an unwise economy that does not provide for the taking of accurate observations upon which so much subsequent time and labor are expended.

An item of $5,000 is included for the purpose of erecting a small brick and stone building on the Government reservation between the two canals at Sault Ste. Marie, Mich. The average number of vessels passing through these canals in the season of navigation is 80 per day. The Weather Bureau office at that point is maintained chiefly in the interests of shipping, and its location should be on this Government reservation, where it can be of the greatest service to vessel masters.

LOCATION OF WEATHER BUREAU OFFICES.

It is of great importance that offices be located with a view of securing several advantageous conditions. Nearness to the press, the telegraph office, and, if at a lake port, proximity to the harbor are important conditions in securing prompt and effective distribution of storm warnings and weather information. Besides providing for these, the proper exposure of meteorological instruments must not be overlooked. It is apparent that economy in expenditure should not induce the Government to locate its meteorological observatories in other than the most advantageous surroundings. Under no circumstances should the accuracy of the meteorological readings be subordinated to the desire to secure quarters rent free.

NEW WEATHER BUREAU STATIONS FOR CITIES.

Additional stations are also needed to meet the demands of many cities which, though not so situated geographically as to furnish the bureau useful observations for its storm warnings, are still so important in their manufacturing, marine, and other industries as to render it advisable to establish complete meteorological stations in their midst, to preserve a record of the prevailing atmospheric conditions. Such a record would be exceedingly useful in the development of their industries, and would make it possible to have a more complete system of distribution of storm warnings than obtains at present. There are to-day over fifty cities having a population of over 50,000 with no Weather Bureau station. The storm-warning service long ago outgrew the experimental stage. It has demonstrated its usefulness to such an extent that only the most efficient appliances should be used for conveying its warnings to mariners.

THE MISSISSIPPI FLOOD OF 1897.

There was an extensive flood last spring in the Lower Mississippi River region. Fifteen million dollars' worth of farm products and live stock were found by this Department to be within that region. Successful forecasts were made weeks and days in advance, to the great profit of the residents of the flooded area. The river service is composed of 22 sections, each with a central office receiving reports from a definite area and each making local forecasts for the river district under observation. In the case of an impending disaster, such as was imminent last spring, the central office at Washington dictates important warnings for distribution by the section center. During recent years a very thorough reorganization and systematization of the river and flood service has been effected. From the local observers who measure rainfall and gauge river heights to the trained meteorologists who are in charge of the river center, from the latter officials to the forecast officials at the central office, and from these to the chief of the bureau the organization has been slowly strengthened, until it is believed that the bureau is able to serve the public efficiently during an emergency.

EFFECTIVENESS OF STORM WARNINGS.

No one of the ten West India hurricanes which swept our Atlantic and Gulf coasts during the past few years reached any harbor without danger signals being displayed well in advance. The extensive truck gardens of the South Atlantic States received full warnings of frosts of marked severity, and all cold waves of any considerable extent were successfully forecast in the interests of shippers of perishable produce and manufactures.

Gratifying success attended the warnings issued for the benefit of the fruit industry of Florida, the sugar interests of Louisiana and Texas, and the truck-growing districts of the Eastern seaboard.

The rain warnings issued from the San Francisco office for the benefit of the raisin industry during the drying season, and on the accuracy of which that industry is greatly dependent for success, were in every instance verified. The official in charge of the San Francisco office states, in reference to the work of the bureau in this particular, that during the last three years not a single rain occurred in the raisin-drying region without warning, and in only one instance was an unnecessary warning issued.

GROWTH IN VALUE OF THE WEATHER SERVICE.

These facts testify to the great value of the Weather Bureau. It has far outgrown in accuracy and usefulness the largest anticipations of its founders, and has fully demonstrated the wisdom of the American scientists whose investigations make such a service possible.

Its warnings save many millions of dollars annually to the agricultural and marine interests of the country, and the numerous demands made by those interests for an extension of the service should be honored by a material increase in the appropriations for the support of this valuable Government institution.

STANDARD DANGER SIGNALS DESIRABLE.

During the period mentioned (1883 to 1897) the danger signals displayed at lake and ocean ports have increased in number from 41 to 253. These danger signals, notwithstanding they are a great aid to navigation and result in the saving of thousands of precious lives annually, are in many cases made by old and obsolete appliances. The signals are of such value as to justify an appropriation of funds that will equip these stations with the most improved appliances for conveying danger warnings to mariners. While the saving of life should be our first consideration, I am informed that conservative estimates made by those interested in shipping, indicate that one hurricane sweeping the Atlantic Ocean unannounced by signals would cause a damage to floating craft of two to four million dollars. Therefore commercial interests would be subserved by equipping in the most efficient manner each station with such mechanical appliances as have, by recent experiments, been adopted as standards.

EXTENSION OF METEOROLOGICAL SERVICE.

Twenty-seven years ago the meteorological stations of the Weather Bureau were established. Since that time many cities have grown to greater proportions than the cities in which the original stations were located. I am informed that it will be necessary to discontinue some stations at less important cities for the purpose of establishing observatories in the more important places, unless provision is made for the extension of the service. The fact that in no case has a city given up its local meteorological service without vigorous protest, is sufficient evidence that such local service should be maintained and that like service should be extended to cities of equal importance.

STUDY OF THE UPPER AIR WITH KITES.

The work of the preceding year in regard to obtaining observations in the upper air by means of kites has been continued. The object of these observations will be to further studies in regard to the mechanics of storms, and to prepare synoptic charts from simultaneous readings taken in the free air at an altitude of not less than 1 mile, with a view to increasing the percentage of forecasting accuracy. Many improvements have been made in these kites during the past fiscal year, and the results attained seem to justify a considerable extension of the work during the ensuing year, the preparations for which are now well under way.

DIVISION OF VEGETABLE PHYSIOLOGY AND PATHOLOGY.

Valuable work has been continued by this division in the study of diseases affecting forest and shade trees; diseases affecting plants under glass, a matter of much interest to a great many of our people; diseases of the Bermuda lily, caused by methods of propagation and handling; diseases of the rose, violet, and chrysanthemum, and diseases of Southern watermelons. Diseases affecting cotton, cowpeas, market-garden crops, and pomaceous and allied fruits have also been studied.

Experts are detailed continually to make a study of the diseases affecting fruits and other crops of the Pacific Coast. The English walnut is rapidly becoming an important industry in California, and treatment of a bacterial disease affecting it has been successful over large areas. Bacterial diseases of tobacco have also been studied during the past year.

Publications have been prepared treating of the apple canker of Washington and Oregon, fig fermentation, black rot of the navel orange, diseases attacking the raisin crop, etc.

The division has also engaged in field experiments of wheat to test the resistance of the different varieties to rust and other diseases, and to obtain facts regarding their value to the different wheat-producing regions of the country, in cooperation with the Kansas Experiment Station. It has continued the study of the nutrition of plants grown under different conditions, and in connection with this the study of conditions of soil, climate, and other important factors affecting plants in the different parts of the country.

The new problems presented where irrigation is practiced are receiving earnest attention.

BIOLOGICAL SURVEY.

Two principal lines of work are carried on by the Biological Survey—a study of the geographic distribution of animals and plants, with a view to determining the boundaries of the natural life zones and their subdivisions, and the study of the food habits of birds and mammals, for the purpose of ascertaining the economic relations of our native species. Work along both of these lines has been continued.

During the past fiscal year fieldwork has been done in Washington, Oregon, California, Nevada, Utah, Wyoming, Nebraska, Kansas, Indian Territory, West Virginia, Mexico, and western Canada.

A special effort has been made to ascertain the boundaries of the life zones of the various species of plants and animals in the northwest corner of the United States, particularly in Oregon and Washington.

ZONES FOR CORN, WHEAT, AND OATS.

Investigations are being made with a view to determining results of previous studies on geographic distribution and making them immediately available for practical agriculturists. The first investigation had for its object the determination of the varieties of corn, wheat, and oats which should be most profitably cultivated in each of the natural life zones of the United States. This work is being done in conjunction with Prof. C. S. Plumb, of the Indiana Experiment Station. Information regarding the different varieties of cereals has been collected from more than 1,000 grain growers, located in different parts of the United States and the Canadian Provinces.

The work of the Biological Survey is a prime necessity, in order that the Department may have a correct knowledge regarding the localities to which imported seeds and plants should be sent

ECONOMIC RELATIONS OF MAMMALS AND BIRDS.

Studies of the economic relations of the various mammals and birds have been continued during the year, and special effort has been made to obtain a sufficient number of birds' stomachs to complete investigations already begun on the food of certain species. More than 3,000 birds' stomachs have been added to the collection, and 2,342 have been examined. This work will result in giving correct information to the agriculturist as to which birds are his friends and which are his enemies.

The main object of the work of this division is the collection and dissemination of information regarding the geographic distribution of birds and mammals, particularly those of economic importance.

FIBER INVESTIGATIONS.

A ton of flax straw grown in the Puget Sound region of Washington, under the direction of the Office of Fiber Investigations, was sent to a firm of famous flax manufacturers in Lisburn, Ireland, to be scutched and retted in order to determine the grade of the flax so produced. A very superior quality of straw was produced, resembling the straw of the famous Courtrai region of Belgium. With the Irish report was received a large assortment of flax samples, the best scutched fiber of which is valued therein at $350 per ton; but out of the lot sent from Washington, fiber was hackled worth $500 per ton. This experiment also demonstrated conclusively that it is possible to obtain good fiber and good seeds from the same plant. The success of the experiment has stimulated experiments in other parts of the Pacific Coast, and in Oregon, particularly, considerable fiber flax is being grown this season.

Interesting experiments are being conducted in the ginning of Egyptian cotton.

HEMP AND RAMIE MACHINES.

Large quantities of hemp are grown in Nebraska. It is intended to arrange for an official trial of hemp machines next season in connection with the forthcoming Omaha Exposition. The interest in new ramie-decorticating machinery continues, and several new machines are ready for test. A trial of these machines was to have been held this fall, but a proper growth of ramie could not be assured, owing to the converting to other use this season of the ramie tract at the point where the Government trials are held. A new French machine now turns out raw fiber approaching in quality the China grass of commerce, though the capacity of the machine has yet to be tested before the Department can make any authoritative statements regarding its ability to turn out fiber in paying quantity.

All our figures of the relative yield of ramie fiber per acre are based on foreign tests or on mere estimates put forth by those interested in machines. It is the purpose to secure, if possible, a ton or more of Southern-grown ramie ribbons, which will be stripped and dried under the direction of the Department, and afterwards treated for the spinning fiber by Department chemists, and, at the same time, by spinners in the United States who are contemplating manufacture, and who control commercial degumming processes. It is important to settle the question of absolute yield.

DIVISION OF CHEMISTRY.

The character of the work carried on in the Division of Chemistry is shown in the following summary:

STUDY OF TYPICAL SOILS.

The value of the study of the typical soils of the United States has been enhanced by securing from the celebrated experiment station at Rothamsted, England, samples of a few of the soils whose history has been carefully noted at that station during the past fifty years. These samples were kindly furnished by Sir J. Henry Gilbert, who, in conjunction with Sir John Bennet Lawes, has had charge of the experimental work at that station for the past sixty years.

A direct comparison has been instituted between these soils, whose history has been known for so long a period, and the typical soils which have been secured from various parts of this country.

The character of the work has not varied greatly from that of previous years, but some important changes in the details have been instituted. During the previous years the amount of moisture in the soil at any given time was determined chiefly by an inspection of the surface, with occasional weighing of the pot containing the sample of soil being tested. This method, under constant supervision of an expert, is capable of securing the best results. Often, however, it happens that this supervision of the work, which has been under the immediate direction of the chief of the division, is interrupted by reason of his absence. In such a case it has been deemed advantageous to have a more rigid control of the quantity of moisture present. To this end weekly weighings of the pots have been made, so that the quantity of moisture which has been evaporated during the seven days is directly determined. Knowing the quantity necessary to produce complete saturation of the soil, a simple calculation will show the amount to be added in order that the amount of moisture in the soil shall be between 60 and 70 per cent of the total quantity necessary for its complete saturation.

IMPROVED METHODS OF EXPERIMENT WITH SOILS.

The method of weighing has been improved by an ingenious mechanical device which renders it possible for one person, without assistance and without undue physical exertion in the way of lifting the pots, to weigh the whole number, viz, 176, in about four hours.

Important improvements in the method of applying the moisture have also been inaugurated, which have been the result of the experience of the past few years. The use of glass measuring vessels has been discarded, and a large number of tin vessels of conical shape, holding 2 pounds of distilled water, have been employed. By these improved means it is quite possible to add one portion of water to each of the pots in the course of two hours.

The general control of the crops growing on these soils has been continued as in previous years. Oats and beans are grown during the first half of the season in duplicate samples of typical soils. After the harvest of these crops the soil in the pots is again prepared for planting and a crop of buckwheat grown thereon. By this method two crops are secured during each season, thus increasing the value of the experimental work by duplicating the data obtained.

PROPOSED PRELIMINARY REPORT ON SOIL CONSTITUENTS.

A careful study is made of the total amount of dry matter produced in each pot, and the quantity of nitrogen, phosphoric acid, and potash removed from the soil by each crop is determined. The data of four seasons are now at hand, and while it is not claimed that these data are sufficient to establish all the points in question, they are at least sufficiently extended to warrant the preparation of a preliminary report, which is now under way. This report will contain statements in regard to the composition of the soils, their physical character, their water-holding capacity, their content of humus, and the percentages of nitrogen, phosphoric acid, and potash contained therein, both as regards total content and in respect to the quantities removed by different solvents.

These data will be illustrated not only by analytical tables, but also graphically in such a way as to show in the most evident manner the relation which exists between the physical and chemical composition of the soil, its content of moisture, and the quantity of dry organic matter produced.

STUDY OF FOODS.

Cereal products have been studied during the past fiscal year. The composition of the different varieties of flour, meal, and the by-products of milling has been carefully established by elaborate chemical investigations. Valuable data in regard to the heat-giving properties of foods have thus been secured, and it has been ascertained that the combustion is a valuable check on the accuracy of the chemical analyses. The work of investigating these food products has been particularly complicated. It has covered the whole range of flours, meals, and milling by-products of every description carried on since 1883. The report will soon be ready for publication.

COOPERATION OF THE ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS.

The excellent results which have been obtained by the active cooperation of this Department with the Association of Official Agricultural Chemists have been recognized and acknowledged in all quarters of the world. Especially in the United States have these results been of inestimable value in unifying and coordinating the methods of analyses employed in the various experiment stations and other laboratories of the country. A comparison of the methods of procedure at the present time with those which were in vogue fifteen years ago would serve as an unanswerable argument in favor of the continuation of the cooperation which has been so harmoniously established and maintained.

In the active work incident to this cooperation the Division of Chemistry has taken a prominent part. All of the subjects which are assigned for investigation by the Association of Official Agricultural Chemists are fully and patiently studied by the chemists of the Department. The contributions which have been made in this way from the Division of Chemistry have done much to secure the high standard of analytical work which now obtains in the United States among our agricultural chemists. So firmly has this standard been established and so excellent have been its merits, that it has commanded the approval and support of commercial chemists and those engaged in original investigations.

PROPOSED CHEMICAL INVESTIGATIONS.

By reason of the restricted appropriations afforded the Division of Chemistry for the fiscal year ending June 30, 1898, it will not be possible to extend the scope of investigations much beyond the plan followed in the previous fiscal year. The investigation of foods will be continued, the special subject under consideration being the composition and character of infants' and invalids' foods. This subject is of such a wide scope that it will be all the work which it will be possible to do in this line during the year.

The work in the typical soils of the United States will be continued along the lines already followed for the purpose, either of ascertaining new facts in regard to the relation of soil to crop, of confirming the results of investigations already made, or of correcting them in order to make them conform to the new discoveries which may be made.

SUGAR-BEET INVESTIGATION.

The work in the investigation of sugar-producing plants contemplates the analysis of samples grown by farmers in different parts of the country from seeds furnished by the Department. From arrangements which have already been made by these farmers, it is indicated that 5,000 or 6,000 samples of beets will be sent to the Department for analysis during the months of September, October, and November. Preparations have been made for the accomplishment of a large amount of chemical work, and it is hoped that valuable information may be secured thereby in regard to the quality of soil and climate in different localities where beets can be produced with a high content of sugar. A study of the composition of beets grown from high-grade seeds, under the direction of the Division of Chemistry, will also be conducted. These beets have been grown at six of the experiment stations of the country, so distributed as to represent a wide range of climatic conditions.

In the miscellaneous work of the division it is also proposed to continue the investigations which have been undertaken, and not concluded, regarding methods of determining starch in cereals and other starch-containing plants. This is one of the most difficult operations in analytical agricultural chemistry, and has been the subject of wide discussion in all parts of the world.

INQUIRY AS TO USE OF STREET SWEEPINGS.

An investigation of the disposition which is made of street sweepings and other refuse of cities has been undertaken by this division, and will be prosecuted vigorously during the coming year. The division has placed itself in communication with all the cities of the United States having a population of 10,000 and over. It has also perfected arrangements for obtaining information in regard to disposition of street sweepings and sewage in the largest cities of Europe. The importance of this work is twofold—first, from a hygienic and economic point of view, in regard to the best method of disposing of this refuse; and, second, from a manurial point of view, in regard to the value of these materials for fertilizing purposes. In cases where garbage and street sweepings are burned, a study of the resulting ashes will be made for the purpose of determining their fertilizing value. It is hoped that a material advantage will accrue from this investigation, both to the cities, in respect of the method of disposing of the refuse, and to the farmers, in respect of securing a new fertilizing material at a low price.

DIVISION OF ENTOMOLOGY.

The work of the Division of Entomology may be classified under the following heads:

Investigations upon specific injurious insects or groups of insects, experiments with insecticides and insecticide machinery, determination of species sent in by the entomologists of the State experiment stations and by other workers, general investigations of the life histories of injurious insects, bibliographic work, and the work of preparation of circulars and publications.

SPREAD OF THE SAN JOSE SCALE.

Investigations have been made supplementing the report made in 1896, regarding the spread of the San Jose scale. While the State experiment stations have shown great interest in this work and have undertaken the investigations with energy, it seems proper, nevertheless, that the records should be kept in the office of the Department, so that at any time a supplementary bulletin may be published. Many entomological experts, as well as fruit growers, find great difficulty in distinguishing between the San Jose scale and several closely allied species which occur on fruit trees.

The office of the Entomologist in the Department is kept busy by the requests from persons for the examination of scale insects in order to decide their identity. A bulletin has been prepared covering these points.

STUDY OF THE MEXICAN COTTON-BOLL WEEVIL.

An agent was sent to Mexico in the spring of 1897 to study the Mexican cotton-boll weevil in its original home, for the purpose of ascertaining whether parasites exist there which could be imported into Texas with benefit, and the occurrences and spread of the species during the present year in Texas have been studied with care.

FOREIGN INSECT PESTS.

The division has devoted some time during the year to the consideration of the dangers of the importation of new insect pests from abroad. The Entomologist prepared and delivered an address before a convention of horticulturists, nurserymen, and entomologists held in Washington, D. C., in March, 1897, on the subject of the desirability of an inspection system against foreign insects, and an article in the Yearbook of the Department for 1897 will give further information on the same important subject.

MISCELLANEOUS INVESTIGATIONS.

During the past year the Division of Entomology has been conducting experiments with new and old insecticides with regard to their effects on the foliage of different plants under varying conditions.

General investigations of the life histories of injurious insects are carried on in the "insectary" building and adjoining garden plat. During the fiscal year notes were recorded upon 502 species which had never before been studied in the insectary.

Investigations in the general subject of insects injurious to shade trees in cities and towns have been continued; also investigations of insects affecting stored foods.

ENTOMOLOGICAL PUBLICATIONS.

A great demand exists for some of the bulletins of this division, especially for those treating of insects in the household and insects affecting domestic animals. Owing to legal limitations, the editions of some of the bulletins most frequently called for are small, and many applicants have to go unsatisfied. A bulletin treating of the degree of temperature at which certain insects affecting household goods and foods remain inactive affords information especially valuable to cold-storage companies, and may result in a reduction in the charges of cold-storage companies during the summer months.

Publications have been issued by the division relative to insects affecting stored vegetable products; also a Farmers' Bulletin on insects injurious to stored grains.

ENTOMOLOGICAL INVESTIGATIONS IN CONTEMPLATION.

By special direction of Congress this Department was authorized to conduct, during the fiscal year 1898, an investigation of the ravages of the gipsy moth. Accordingly the work was laid out for the beginning of this fiscal year, so that a report on the subject might be prepared as early as possible.

The work along certain general lines indicated in the foregoing sections will be prosecuted. The Mexican cotton-boll weevil will be carefully watched, and further efforts will be made to obtain Mexican parasites. The investigation of insects injurious to shade trees, insects affecting stored foods, insects affecting citrus fruits, geographical distribution of injurious insects in this country, bibliographical work, and experimental work with insecticide machinery will all be continued. Another investigation will be made upon the injurious grasshoppers of the far West. It is obviously impossible to anticipate the special subjects for investigation which it may at any time become necessary to undertake. The beginning of nearly every season brings some injurious species prominently to the front, and when this species has not already been investigated, new work must be begun. There has long been need of a complete practical bulletin on the subject of the Hessian fly. It is planned to prepare such a bulletin. A similar work relating to the chinch bug will also be prepared during the coming year. Experimental work in apiculture comes properly under the head of "Entomological investigations," and will be resumed under capable supervision. The honey-producing industry is a large and growing one, and deserves some slight encouragement at the hands of the Government.

SEED DISTRIBUTION.

The appropriation of $150,000 for the distribution of seeds for the fiscal year ending June 30, 1897, provided that $130,000 must be expended for the purchase of seeds, leaving $20,000 for putting up and mailing the same. The seeds were purchased already put up in packages and mailed from the different cities where the contracts were held. The appropriation for the present fiscal year is $130,000, of which amount $110,000 must be expended in the purchase of seeds. The conditions of the law will require contracting with the smallest possible number of seed houses. The purchase of bulbs, plants, cuttings, etc., must be paid from the remaining $20,000.

The spirit of the law requires that the seeds, plants, bulbs, etc., be rare and valuable. Efforts are being made by the present Secretary of Agriculture to spend the appropriation for seeds, plants, etc., by purchases through agents and representatives abroad, through seed houses and scientific associations. The Old World contains many things that would be valuable to the New World. All this work, however, must be paid for out of the $20,000 appropriated and not required to be expended for the purchase of seeds. The distribution of imported seeds and plants to the several experiment stations throughout the country and otherwise must be paid for out of the $20,000 fund. This will necessarily circumscribe efforts in this direction. It is desirable that more of the appropriation given for seeds should be available for the introduction of what is new and rare.

SECTION OF FOREIGN MARKETS.

The Section of Foreign Markets was instituted March 30, 1894, under a clause in the act of appropriations for the Department of Agriculture setting aside $10,000 for the purpose of making "investigations concerning the feasibility of extending the demands of foreign markets for the agricultural products of the United States."

This appropriation has been expended chiefly in the preparation of a series of bulletins and circulars designed to convey information regarding such opportunities as exist for the extension of our export trade in American farm products. During the period beginning with the organization of the section in 1894 and ending June 30, 1897, eight bulletins, relating to as many different countries, and 17 circulars, devoted to special topics, were given to the public.

PUBLICATIONS RELATING TO CERTAIN COUNTRIES.

The countries treated of in the bulletins already issued are (1) the United Kingdom of Great Britain and Ireland, (2) the German Empire, (3) France, (4) Canada, (5) Netherlands, (6) Belgium, (7) Norway, and (8) Sweden. Each country is considered with a view to its possibilities as a customer for the products of American agriculture. To ascertain what these possibilities are, it is important, first of all, to be informed as to the agricultural resources of the country under consideration. A full account, therefore, is given of the extent and character of the principal crops grown, and also of the number and varieties of stock raised. This is followed by a careful review of the country's foreign commerce, and more particularly of its import trade in agricultural produce, the purpose being to show how far the national requirements exceed the home supply, making it necessary to import from other countries. Official statistics are presented as to the quantity of the various products annually imported and the different sources from which they are received; and these facts are accompanied by such information regarding customs duties and regulations, equivalents of foreign moneys, weights and measures, rates of exchange, etc., as may be of service to American producers in quest of a foreign market.

Each bulletin is supplemented by a series of reports received through the medium of the State Department from our consular representatives stationed in the particular country concerned. The object of these reports is to set forth such facts regarding the several consular districts as are likely to assist in creating there a larger demand for our products. With this end in view, they frequently give important information as to the nature and quality of the goods preferred, methods of sale, prices paid, means of transportation, etc., enhancing thereby the practical value of the bulletins.

OFFICE OF ROAD INQUIRY.

During the past fiscal year many important meetings have been held in the several States and considerable information has been collected for distribution. The literature of the office now numbers 20 bulletins and 15 circulars of information, which have been in much demand. During the present spring and summer experiments have been made, in conjunction with several of our experiment stations, under the direction of the Director of the Office of Road Inquiry, with such materials as were found in the localities where the experiments were conducted. Many localities in the United States have not the materials fit for making permanent roads, and for this reason the office has endeavored to promote experiments in steel roadbeds. Two sections of roads were built at the Agricultural College experiment station in New Jersey during the month of June. A piece of road 1½ miles long was also built at Geneva, N. Y., connecting the experiment station with the city.

In response to circulars sent to the principal steel manufacturers in the United States, various plans of construction have been offered. It has been well demonstrated that a well-designed steel trackway can be successfully built and profitably maintained, especially in localities where other materials are scarce. The considerable expense involved in preparing special shapes of rails has prevented much experiment in this direction heretofore; one company, however, is disposed to aid in the matter whenever a definite order for 1 mile of road shall be received. The cost of material for a mile of road will be $3,500. Heretofore the Director of the Office of Road Inquiry has succeeded, by the expenditure of a minimum amount of Government money, in inducing local representatives to contribute considerable amounts to these road-building experiments.

DIVISION OF AGROSTOLOGY.

The work of this division, as authorized by Congress, is the investigation of grasses and forage plants, embracing all points relating to their natural history, geographical distribution, uses, and adaptability to special soils and climates. The law also authorizes the establishment and maintenance of experimental grass stations and the employment of necessary labor and purchase of supplies for carrying on the work. There are two grass gardens maintained by the division. One is located on the grounds of the Department of Agriculture and the other at Knoxville, Tenn. During the past fiscal year between 400 and 500 varieties of forage and grass plants were sown on the grounds of the Department, furnishing an interesting object lesson to the people and an opportunity for study by scientists. The seeds were procured through the collections of field agents and by exchanges with foreign countries.

The grass garden at Knoxville embraces about 7 acres of ground, and cultures there are conducted upon a more extensive scale. More than 200 varieties were grown in this garden during the past year. The design of the Knoxville garden is to obtain information which will be useful to the Southern States relative to grasses for pastures and meadows.

FORAGE PROBLEMS IN THE CATTLE RANGES.

There is especial necessity for the study of forage problems throughout the southwest portion of the United States, including the States of Texas and Kansas, and the Territories of New Mexico and Arizona, giving special attention to the native grasses and forage plants, their abundance and value, their preservation and the possible methods to be employed in restoring the grazing value of those regions which have become valueless through overstocking or other causes.

The Division of Agrostology has placed itself in communication with such parties as are interested in improving the forage conditions of the Southwest for the purpose of gaining, first, a more definite idea of the present conditions, and second, how best to improve these conditions. There is a deep interest among the people of the Southwest in this work. More than 1,000 answers have been received from circulars sent out, seeking information regarding actual conditions. The division has also given attention to similar conditions in the Dakotas, Wyoming, Colorado, and adjoining States. Cordial cooperation is had in the States mentioned with the scientists of the experiment stations.

GRASSES FROM DRY REGIONS OF THE OLD WORLD.

The demand for new and improved forage plants which will grow and thrive on the farms of the Southwest and Northwest is continually on the increase. The Secretary of Agriculture is now making efforts, through agents in the Old World, to introduce grasses from regions which are semiarid and that grow under other conditions that may make them suitable for these localities. A system of exchange is being carried on with scientists in Australia, Algeria, northwest India, and with the botanical gardens of several of the countries of the Old World.

Careful study is given to the adaptability of certain plants to special soils and climates throughout all the States. Propagation of sand and soil binding grasses, those best suited for the formation of turf in numerous places along our seaboard and Great Lakes, which will prevent the movement of drifting sands, is a subject that has received the attention of the division.

GARDENS AND GROUNDS.

The collection of plants in the conservatory proper is mostly of those having economic value, and serves as a nucleus from which selections are made of such as appear to merit propagation for experimental purposes and introduction as industrial plants, if a suitable climate can be found for their growth.

Attention is given to the growth and propagation of the pineapple, the citrus family, olive trees for the production of cuttings, and for other similar purposes. About 20,000 various ornamental plants are propagated annually to supply the flower garden and flower beds on the Department grounds.

DISTRIBUTION OF PLANTS.

The distributions during the last fiscal year consisted mainly of 36,500 strawberries, 7,000 native and foreign grapes, 3,900 olive plants, 2,900 camphor trees, 4,000 fig cuttings, and a large number of plants such as guavas, cinnamon, pepper, citrus, vanilla, coffee, etc.

The United States imports large quantities of plants and plant products that might be produced in our own country. As many of these as possible will be propagated under the direction of the Superintendent of Gardens and Grounds and distributed, in order to contribute to our independence in this regard.

CAMPHOR AND OLIVES AS NEW CROPS.

The camphor plant may be taken as an example of the introduction of a new crop. For more than twenty years the Department has been distributing this plant in the extreme Southern States, first as a shade tree and as a shelter to orange groves, and more recently as of very promising industrial value. After all these years planters are now taking a special interest in its culture, trees are in great demand, and their value as economic plants will be properly tested.

With regard to future work exclusive of ordinary care of the grounds and glass houses, the propagation of such economic plants as may seem advisable will be continued. At present the olive is the leading factor in propagation, as it is considered desirable to fully introduce and encourage olive culture in such of the Southern States as seem suited to its profitable growth.

DIVISION OF SOILS.

The most important lines of work carried on during the past year have been an investigation of the soils of Florida; a continuation of the investigations of the principal tobacco soils of the United States; the perfection of the electrical methods of determining the moisture, temperature, and salt content of soils; the study of the moisture content of a number of the important soil formations of the country; a continuation of the investigations of the physical properties of soils; and the devising of methods for the practical study of soil conditions.

REPORT ON FLORIDA SOILS.

A bulletin is in course of preparation on the preliminary study of the soils of Florida, particularly those adapted to tobacco, truck, and pineapples. A large amount of fieldwork was done in Florida in the early spring and a great many soil samples were collected there that have since been examined to determine their physical texture; a few chemical analyses have been made by the Division of Chemistry to throw light upon some of the problems presented. Records have also been kept of the amount and daily fluctuation of the moisture in typical hammock, high pine, and scrub land in the State during the season, and the results throw an important light upon the agricultural value of the different soil formations of the State and the local distribution of the native vegetation.

THE SOILS COLLECTION.

The soils collection of the Department amounts now to over 3,000 samples, from various parts of the United States and several foreign countries, representing many of the most important soil areas of the world. About one-half of these have been carefully examined. Many of the results have been published, while others await the collection and examination of more material, in order to develop special lines of investigation or to write up the soils of special agricultural areas or industries.

WATER CONTENT OF SOILS.

Much time has been given, as heretofore, to the study of the water content of various soils, to determine the normal quantity in soils of different formations and of different agricultural areas as well as the normal variation which may occur in the water content without detriment to the plants. The importance and bearing of this work can only be really appreciated by seeing the relation of the soil moisture to the general economy of plant growth.

Under ordinary circumstances the temperature of the air is a prime cause of the evaporation or loss of water by plants; the relative humidity of the air, together with the general atmospheric movements, controls the evaporation, while the moisture of the soil supplies loss due to evaporation. For a steady and continuous growth of plants there must be a certain relation therefore between temperature, which is the cause of evaporation, relative humidity, which is a controlling factor, and soil moisture, which supplies the loss. It has been possible to determine from the field records what may be called the line of drought for a number of the important soils of the country. This is the minimum amount of water which the soil must contain under ordinary conditions of temperature and humidity in order that the crop shall not suffer. This line of drought depends, of course, upon the texture of the soil as well as upon the temperature of the air, the kind of plant, and the stage of development. The texture of the soil has an influence on this, because in a soil of fine texture, made up mainly of clay and fine sand, the movement of water is quite slow, and there must be a large quantity of water in the soil to insure an adequate supply moving up to the roots of the plant to replace that lost by evaporation. This explains the well-known fact that a plant may thrive in one soil with 5 per cent of water, while it would perish in another soil containing 15 per cent.

RECORDS TO ESTABLISH DROUGHT CONDITIONS.

The temperature and relative humidity of the air affect this line of drought, because with a low temperature and a high relative humidity there is comparatively little loss of water and a smaller supply in the soil may be ample, while with a high temperature, unless this is balanced by a very high humidity, there will be a greater evaporation from the plant and a larger amount of water will be needed in the soil to insure an adequate supply to the plant. The kind of crop and the stage of development will obviously affect the location of the line of drought for any soil, as different plants require different amounts of water, and this differs again according to the stage of the development. The water supply of the soil is, therefore, a very important factor in climatological studies. It is clearly possible to establish approximately for any soil and for any crop the relation which must at all times exist between the temperature, the relative humidity of the air, and the amount of moisture that must be present in the soil to maintain the balance. To this end records have been kept of the amount of moisture in a number of the principal soil formations of the country, some of the records extending over three or four seasons, accompanied with careful notes of the daily condition of the soil and of the plants.

MEASUREMENT OF SOIL MOISTURE.

The electrical method of moisture determination already described in a bulletin issued by the division has been still further perfected. Sixteen stations have been equipped with these electrical instruments in various parts of the country and in several important types of soil. Records have been kept at these stations for periods varying from two to four months, and it has been found that the method can be used by anyone with ordinary care. As a result of these field records, I feel perfectly satisfied with the operation of the method, and equally satisfied that it will prove of great value in soil investigations, as well as of practical and commercial value. One great value of the method is that the electrodes are permanently buried in the field at any depth desired and the field can be cultivated or cropped as usual. The electrical resistance between the electrodes is read off from a scale, and this resistance varies according to the square of the water content. By once thoroughly standardizing the electrodes, therefore, and by the use of tables which are furnished by the division, the moisture content of the soil can be determined at any time from the electrical resistance of the soil.

INFLUENCE OF CULTIVATION ON WATER CONTENT OF SOILS.

Having perfected this method of moisture determination, in which the moisture can be rapidly and readily determined successively at the same point without any disturbance of the soil, it is possible to study in a very satisfactory way the influence of different methods of cultivation, of fertilization, and of irrigation upon the water content of soils. This is a line of very practical work, made possible only by the perfection of such a method as this. Plans are now under consideration for an exhaustive study of the influence of methods of cultivation, fertilization, and cropping upon the water content of the soil in different parts of the country.

PHYSICAL PROPERTIES OF SOILS.

Investigations are also being vigorously pushed on the physical properties of soils and on practical methods of determining these in the field. Some very important results have just been attained, explaining more fully than ever before the real cause of the capillary movement of water in soils. It has been found that this is due to the curvature of the water surface between the grains of soil. In fine-grained clay soils and in dry soils generally the curvature of the surface of the water between the grains is very great. On account of the great curvature of the surface there is a pressure outward, and a tendency for water to be drawn into the spaces between the grains from any other part of the soil where there is more water and where the curvature of the surface of the water between the grains is less. This is the practical cause of the capillary movement of water in soils, upon which plants depend for their current supply. Methods of cultivation and of fertilization have an influence on this, and investigations will be continued along these lines to see the extent of the influence of tillage upon the movement of the moisture in the soil.

DIVISION OF FORESTRY.

There is one economic question closely related to the general welfare of our future rather than our present, which, I fear, has not received adequate attention by our people or by Congress—the forestry question.

It has become apparent that sooner or later a large line of manufacturing industries employing at present capital to the amount of more than one billion of dollars, employing labor of more than one million workers, and producing nearly $2,000,000,000 of value annually, will be more or less hampered for lack of suitable supplies because of the absence of rational use and systematic reproduction of our forest resources. In addition, our agricultural interests in the hill country and mountain districts are bound to suffer, indeed are beginning to suffer from the same cause, just as they have suffered in other countries.

NEED FOR EXTENSION OF FORESTRY INVESTIGATIONS.

The Department of Agriculture, through the Division of Forestry, has with scanty appropriations endeavored to secure and disseminate technical information needful in rational forest management. It has also experimented on methods of tree planting with a view to an extension of forest areas into the forestless regions which need the shelter and protection of forest growth, and has increased our knowledge of the properties of our timbers which might lead to desirable economies in the future.

A more liberal consideration of this line of work by the Government would seem justified by the magnitude of the interests involved, especially since with the establishment of forest reservations from the public domain the need of technical knowledge in their management has become a necessity.

It is well known that the agriculture of the far West is directly dependent upon irrigation, the water of which is secured from the forest-covered mountains. One of the chief purposes which the reservations were designed to serve is the protection of this water supply.

OFFICE OF EXPERIMENT STATIONS.

The agricultural experiment stations, now in operation in every State and Territory except Alaska, continue to carry on a large amount of scientific and practical work giving results of great value to American agriculture. They enjoy more largely than ever the support and confidence of farmers and horticulturists. A number of the States have liberally supplemented the funds appropriated by Congress for the maintenance of the experiment stations. During the past year the revenues of the stations aggregated more than a million dollars, of which $720,000 was received under the act of Congress of March 2, 1887.

URGENT DEMANDS UPON EXPERIMENT STATIONS.

No country equals the United States in the liberality with which it maintains institutions for agricultural research and in the thoroughness with which the results of their work are disseminated among the people in whose interests they were established. So great has been the success of our stations and so urgent have been the demands for the information which they are able to give, that the calls upon station officers for the preparation of popular bulletins and the delivery of addresses at farmers' meetings have in many cases been more than it was possible for them to meet without endangering the success of the original investigations which it was their first business to conduct.

DIFFICULTIES IN STATE STATION WORK.

While the farmers of the country may well congratulate themselves on having such numerous and important agencies for the discovery of new truths and the dissemination of useful information regarding the practice of their art, they should not relax their efforts to aid the stations in advancing the efficiency of their work and securing the greatest benefits to agriculture which can be obtained with the resources at their command. Many of our experiment stations are doing all that could reasonably be expected of them with the means and facilities at their command, but in some cases, as the investigations made by this Department have shown, the stations are hindered in their work by causes which might easily be removed. Some of the difficulties which the stations encounter grow out of the fact that the people are not sufficiently alive to their interests in this matter to insist that the station work shall be performed in accordance with a consistent and permanent policy. It is obvious that thorough agricultural investigations can not be made if the plans and personnel of the station are being constantly shifted. This fundamental fact has been too frequently overlooked by appointing officers and boards of control. Fitness and ability to carry on successful investigations should be the fundamental qualifications for station officers, and when competent men are once obtained, they should be made secure in their positions and supported in their efforts to plan and carry out thorough experiments.

PROPER USE OF EXPERIMENT STATION FUNDS.

The funds appropriated by Congress for the experiment stations are intended solely for the carrying on of agricultural investigations and the publication of the results. The stations are by law made departments of the land-grant colleges, but it was not intended that any part of the station funds should be used for the payment of the salaries of the teaching force or for any other general college purposes, nor that the expenses attendant upon the management of farms or dairies for other than experimental purposes should devolve upon the stations. It is evident that in some cases the college has encroached upon the station, and there is still need of greater care in this matter. It is the duty of all institutions receiving the benefits of the land-grant and Morrill acts to make ample provision for the maintenance of the courses in agriculture without in any way diminishing or diverting the funds which should be devoted to the experiment stations.

The stations should confine their operations to such lands and herds as are actually required for the carrying on of experimental inquiries in a few lines determined upon as best adapted to promote the interests of agriculture in their respective States

EXPERIMENTS FOR ALASKA.

Recent events have greatly augmented the importance of active measures to develop the agriculture of Alaska. The information recently received from unofficial sources, as well as that previously gathered by officers of the Government, seems to make it clear that it will be practicable to develop the agriculture of that region so that it may furnish food supplies and beasts of burden for a considerable population. The development of agriculture in this region, as elsewhere, can undoubtedly be greatly promoted by experimental inquiries conducted systematically under the supervision of expert officers. I would therefore urge that the appropriation for investigating the agricultural resources and capabilities of Alaska be continued and that provision be made for carrying on experiments in that region in case the official inquiries now in progress there seem to make this desirable.

WORK OF THE ALASKA COMMISSION.

In obedience to an act of Congress, a commission consisting of Mr. Benton Killin, a member of the board of regents of the Oregon Agricultural College, and a man thoroughly familiar with the agricultural conditions on the Pacific Coast, and Dr. W. H. Evans, botanical expert of the Office of Experiment Stations, was dispatched to visit the coast and island region of Alaska from its southern boundary as far north as Unalaska. They were instructed to observe the agricultural conditions existing in places visited, the possibilities of further extensions of arable land, and the native plants used for food and forage; to make collections of soils, and of food and forage plants, and to determine as far as practicable what localities are suitable for experiments in agriculture and what kind of experiments seem immediately feasible and desirable.

This commission started for Alaska about the 1st of June, and brief preliminary reports thus far received indicate that it is successfully prosecuting its work. It is definitely expected that a report of its findings can be prepared so as to be transmitted to Congress during its coming session. Through the courtesy of the honorable Secretary of the Interior and the Commissioner of Education, the services of Dr. Sheldon Jackson, superintendent of Government schools in Alaska, were secured to investigate the agricultural capabilities of the Yukon Valley. Dr. Jackson is to perform this service in connection with the annual inspection of the Alaska schools, in which he is now engaged, and his report may be expected at the same time as that of the commission.

BOTANICAL INVESTIGATIONS.

At least $6,000,000 is paid annually to foreign countries for miscellaneous agricultural plant products which are grown in a temperate climate. A systematic attempt has been begun to give our farmers full information how to grow such products and where to sell them. Many of these small crops should prove valuable additions to the resources of our farming people, especially in sections where there is an overproduction of staple crops, or where farm labor is cheap. The success of similar enterprises in the past demonstrates that they may be made into profitable local industries, and a rational prosecution of this line of investigation is expected to show that in a country of such varied climatic conditions we can match the requirements of almost any cultivated plant of the temperate zone.

INQUIRIES FOR NEW CROPS.

Judging from the large number of letters received by the Department asking for information about the cultivation of new or little known crops, the farmers of the country are ready, in view of the generally lessened profits on staple farm products, to follow any promising suggestions made by the Department in this direction. As the beginning of an effort to meet this demand, an investigation has been undertaken of the subject of chicory cultivation. This country imports about $250,000 worth of chicory root per annum, which is used as a coffee substitute and adulterant. There is now every prospect that chicory will be made a profitable farm product in the United States and that this amount of money will go into the pockets of American instead of European farmers.

In connection with seed distribution two important series of experiments are in progress. First, a practical test of scientific purity and vitality by which the high quality of all the seeds sent out is assured, and second, a field test of the new varieties offered to the Department by which their value and standing as new and important introductions into agriculture may be definitely ascertained before large purchases are made.

DIVISION OF POMOLOGY.

The correspondence which devolves upon this division in relation to the adaptability of varieties for planting, methods of propagation, planting, pruning, and cultivating fruit trees and plants and marketing their product consumes a large portion of the time of the Pomologist or his assistant and prevents much work of original investigation in relation to the fruit industry which is highly important. A large part of this correspondence grows out of the receipt of specimen fruits sent by growers for examination or identification, and its value to the fruit growers of the country is recognized. Provision should therefore be made for its continuance without encroachment upon work which is more strictly scientific and progressive.

Descriptions of more than 550 fruits have been added to the files of the division during the year and 175 water-color paintings, 100 photographic negatives, and about 200 wax models of fruits have been made.

EXPERIMENTS WITH FIGS.

Large sets of fig cuttings from the collection furnished to this Department in 1894 by the Royal Horticultural Society of England have been placed in 10 of the Southern States for testing. Small trees of "Corsican" citron have been placed with more than 100 fruit growers in California and Florida, and 350 seedling trees of Chinese persimmon, grown from seeds obtained from Peking, were distributed to growers who gave them a careful test. Scions of 18 varieties of apples of New Zealand and Australian origin, received through the kindness of the Pomologist of New Zealand, were distributed in June, 1897, to a number of growers for testing. Seeds of the "rough lemon" of Jamaica, valued in that island as a stock for orange trees, were also distributed.

Work on the Descriptive Card Catalogue of Fruits has been continued during the year, and the usefulness of the catalogue as a work of reference has been fully demonstrated.

TEST OF METHODS OF ROOT GRAFTING.

The nursery period of a comparative test of methods of root grafting the apple was completed during the year. The trees resulting from it were distributed to experiment stations and private planters in several States, where they can be kept under observation during the orchard period, to determine the effect of the methods of propagation upon vigor, productiveness, and longevity.

In addition to work already under way, it is important that a systematic effort in the preparing of maps which will show the areas where the principal fruits grown in the country are capable of being commercially produced shall be begun, and that certain fruit-producing species, which are believed to be adapted to cultivation here, either as stocks or for their fruit, shall be introduced from foreign countries.

PUBLICATIONS.

By the organic law creating the Department of Agriculture one of the chief duties of the Department was defined to be to "diffuse among the people of the United States useful information on subjects connected with agriculture in the most general and comprehensive sense of the word." It is evident that to realize to the fullest extent the benefit of the continued and diligent research and investigation of the scientific questions affecting agriculture, which occupy the time of a large portion of the officers and employees, the information thus obtained must be promptly and widely diffused, and it is my earnest desire to fully comply with the law in this regard.

INADEQUACY OF PUBLICATIONS FOR GROWING DEMAND.

The publication work of the Department has attained extraordinary proportions. The number of publications issued during the past fiscal year is 424, aggregating over 6,500,000 copies. This is over 100 per cent more publications and over 100 per cent more copies than were issued in 1894, and yet, notwithstanding great improvements in the method of distribution by avoiding duplication and by placing the various publications, as far as possible, in the hands of those only by whom they are chiefly needed, the increased supply is found quite inadequate to meet the increased demand. Thousands upon thousands of persons earnestly desirous of procuring the information these publications are designed to convey have to remain ungratified. The growing demand for the publications of this Department is strikingly manifested in two important particulars—on the one hand by the large sale of the Department publications by the Superintendent of Documents, under the provisions of the law providing for the printing and binding, approved January 12, 1895, the number of publications of this Department so sold amounting to 13,000, an increase over the year previous of more than 10,000; on the other hand by the increased demand by Members of Congress for publications of this Department to distribute to their constituents.

GROWTH IN NUMBER OF PUBLICATIONS DISTRIBUTED.

Of the total number of copies of all publications issued by the Department during the five years ending June 30, 1897, and amounting to over 23,000,000, over 6,500,000 have been turned over to Senators, Representatives, and Delegates in Congress for distribution by them; and of this vast number, 5,500,000 were so turned over in the past three years and nearly 2,500,000 of that number, or about 45 per cent, during the last fiscal year.

Number of publications issued during five years ending June 30, 1897.

Year.	Publications.	Farmers' bulletins.	Total copies issued.	Distributed to Members of Congress.
1893	210	....	2,689,084	989,468 (1893–1894)
1894	205	278,500	3,169,310	
1895	254	1,567,000	4,100,660	1,385,770
1896	376	1,891,000	6,561,700	1,816,695
1897	424	2,387,000	6,541,210	2,467,237
Total	1,469	6,123,500	23,061,964	6,659,170

CALL FOR AN INCREASE OF APPROPRIATION.

With the exception of the sum allowed for the printing and distribution of Farmers' Bulletins, there has not only been no increase in the total appropriations for the Division of Publications during the period of five years covered in the foregoing table, but the amount available is actually less now than then, notwithstanding the fact that between the first and last years of that period the number of publications issued was more than double and the total number of copies issued had increased by nearly 4,000,000. A large amount of extra work—that is, work performed outside of the usual office hours—has therefore devolved upon the division force; while, in order promptly to distribute the enormously increased number of publications without any adequate provision for an increase in the force, it has been necessary to constantly draw upon the force of other divisions. While this may be justified on the ground that all divisions are interested in this work of the distribution of documents and are served by its efficient performance, it interferes seriously with a systematic arrangement of the clerical force and tends to interrupt the regular work of other divisions. A large increase has therefore been asked for in the appropriation for the work of publication, both of the regular printing fund and also for Farmers' Bulletins and for the distribution of bulletins, reports, and other documents for the ensuing year.

CONGRESSMEN'S QUOTAS OF BULLETINS REDUCED.

The want of adequate appropriations for the current fiscal year has compelled me regretfully to reduce the number of Farmers' Bulletins available for Members of Congress, notwithstanding the continued demands made upon the Department for an increase in this direction. The figures above given, showing the large proportion of publications distributed through Members of Congress and the rapid increase in the number distributed through this channel in the past three years, afford ample evidence that it is only by greatly enlarging our facilities in this respect that Congress will enable me to supply the urgent demand of its own Members.

DISPOSITION OF FUNDS DERIVED FROM SALE OF DOCUMENTS.

The large increase in the sale of the publications of this Department by the Superintendent of Documents, and the frequent calls made by that officer for additional copies of publications of which his sales have exhausted the supply, suggest that the moneys received by him for the sale of our publications should be made available for the reprinting of such as are thus exhausted, and for which the demand still continues. So far as possible, the Superintendent of Documents has been supplied in such cases with a limited number taken from the small reserve for official use at the Department, authorized under the law of January 12, 1895, and whenever a reprint has become necessary for our own use a certain number of the reprinted copies have been placed at his disposal, but it does not seem right that from a printing fund barely adequate to supply our wants money should be taken to pay for additional copies to be sold by the Superintendent of Documents, and the proceeds handed over to the Treasury. I therefore earnestly recommend that the law of January 12, 1895, providing for the public printing and binding be so amended as to provide for the setting aside of the moneys so received for Department publications, subject to the joint order of the Secretary and the Superintendent of Documents for the reprint of Department publications for sale.

HURTFUL RESTRICTIONS REGARDING PUBLICATIONS.

Other amendments to the law of January 12, 1895, are very urgently needed. The provision under section 89, by which the discretion of the Secretary of Agriculture as to the number of copies of the reports and bulletins he desires to print is restricted to "reports and bulletins containing not to exceed 100 octavo pages," and which limits the editions of all publications exceeding that size to 1,000 copies in any one fiscal year, should be promptly abrogated. This limitation conflicts directly with the organic law creating the Department, providing for the diffusion of the information it acquires for the benefit of agriculture. In that respect this Department differs materially from other Departments of the Government whose publications are issued largely for official use. When it is remembered that this Department is compelled to maintain an exchange list with many hundred scientific and educational institutions in foreign countries, to distribute its publications freely to all agricultural colleges and experiment stations, and to the specialists engaged in these institutions, and that every division, other than those engaged in purely administrative work, is obliged to maintain a corps of scientific and expert correspondents, most valuable coadjutors in carrying on our work, but receiving no pay and getting no acknowledgment except in the distribution to them, free of charge, of the publications in which they are specially interested, it will be readily understood that there is not a single publication of this Department of which we do not need more than 1,000 copies, even when the circulation thereof is not extended beyond what may be termed official use. Cases have occurred where the number of persons supplying valuable information and responding at the cost of no little time and trouble to circulars of inquiry addressed to them by the Department has largely exceeded 1,000, and these have, therefore, been deprived of the simple courtesy of a copy of the publication to which they had themselves so cheerfully and largely contributed. In nearly every case where this limitation has been imposed upon us the value of the work has occasioned a considerable call upon the Superintendent of Documents from parties perfectly willing to pay for the book, but whom it has, of course, under this embarrassing limitation, been impossible to gratify.

REPRINTS FOR PRIVATE INDIVIDUALS.

One other restriction now imposed under the law of January 12, 1895, should also be withdrawn. This is the limitation prescribed in section 42 of the act in question, which limits the number of copies of any bulletin which the Public Printer may furnish to applicants giving notice before the matter is put to press to "250 to any one applicant." It has frequently happened that the work of the Department in promulgating useful information would have been widely supplemented by various organizations interested and without expense to the Government had this limitation not existed. In other cases a little deception has defeated the purpose of the law, as it is only necessary for a party desiring 1,000 copies to send in four orders under different names for 250 each. It is earnestly to be desired that this limitation should be withdrawn, and that it should be left to the discretion of the Public Printer to decide what number of copies he can supply under certain circumstances, providing the request of the applicant be indorsed by the head of the Department from which the desired publication is issued.

INCREASE DESIRED IN DEPARTMENT QUOTA OF YEARBOOKS.

As far back as 1888, when there were but one bureau and eleven divisions reporting to the head of the Department, then Commissioner of Agriculture, and when only 400,000 copies of the Annual Report were printed, 30,000 copies were set aside for the use of the Department. In 1889 the Department quota was reduced from 30,000 to 25,000, and remained at the latter figure until 1892, when the total number of copies of the Annual Report was increased from 400,000 to 500,000, and the Department quota was restored to the former figure of 30,000. Since that time these figures have remained unchanged. In the meantime the far more popular form of annual report, viz, the present Yearbook, has been adopted, and the correspondents and coworkers of the Department have greatly increased. The agricultural experiment stations have been established throughout the country with a special officer representing their interests in the Department, whose requisition for Yearbooks to supply the colleges and stations and the specialists engaged therein and corresponding institutions abroad, covers over 1,800 copies of this publication. In place of one bureau we now have two, the added one—the Weather Bureau—calling for over 3,000 Yearbooks to supply its voluntary weather observers alone, and both bureaus having largely increased their sphere of work and the number of their correspondents. In place of eleven divisions reporting directly to the head of the Department there are now eighteen, and one of these alone, namely, the Division of Statistics, has quadrupled the number of its correspondents. The foreign exchange list of the Department has also more than doubled since 1888. Under these circumstances, I am compelled to recommend most urgently that the Department quota of the Yearbook be increased to 50,000 copies, at least.

DIVISION OF STATISTICS.

The preparation of monthly reports concerning the condition, acreage, and production of certain products of the soil and the number and value of farm animals has been the principal work of this division during the year. These reports have been based on returns received from a corps of 56,700 regular correspondents, reporting monthly, and 140,500 special correspondents, reporting at particular seasons of the year.

In addition to the monthly crop reports, the number of copies of which ranged during the year from 172,500 to 200,000 per month, special reports to the number of 325,000 copies were also published.

IMPROVEMENT IN CROP REPORTING.

I am impressed with the extreme cumbrousness of the system of crop reporting that has been in use in this division during the last few years. Instead of conducing to completeness and accuracy, it would appear from the report of the Statistician to in some measure defeat its own object by its unwieldiness and by the fact that the indefinite multiplication of crop reporters weakens the sense of individual responsibility. I strongly favor the making of some slight pecuniary acknowledgment of the services of a carefully selected corps of correspondents located mainly in the principal agricultural States, and that reliance be placed upon the State statistical agents for information regarding the States of minor agricultural importance.

So marked is the geographical concentration of agricultural production in the United States that twenty-five States, or just half the total number, produce 98 per cent of the cotton, 95 per cent of the corn, 95 per cent of the barley, 93 per cent of the oats, and from eight-tenths to nine-tenths of the wheat, rye, buckwheat, tobacco, potatoes, and hay produced in the entire country.

NEED OF QUALIFIED AGENTS IN EVERY STATE.

It is clear, therefore, that the making of satisfactory provision for crop reporting in twenty-five States would leave only a very small part of the total production of the principal crops to be reported upon exclusively by State agents.

That the Department should have a principal statistical agent in each State in place of the present unsatisfactory plan of State groupings is, it seems to me, an obvious requirement. It has been the rule of the Department until within the last two or three years to have a separate statistical agent in each State, in order that it might have the advantage of his superior local knowledge. The Department's increased dependence upon these officers renders it doubly important that they should possess all the qualifications necessary to the proper performance of the duties required of them, and unless the best men are selected, the Department's crop-reporting system will be weakened instead of strengthened by their appointment.

DISTRIBUTION OF CROP REPORTS.

In this, as in every other branch of the work of the Department, the question how the farmer may be made to receive greater benefit than heretofore from the collection of information designed primarily for his use is being carefully considered. The printing and distribution of the monthly crop reports have been considerably expedited within the last three months, and it is hoped that within a short time they will reach the farmer still more promptly.

As a further means of placing him in possession of important information at the earliest possible moment, it is suggested that brief reports as to the general condition of crops and the state of the markets at home and abroad may be displayed in rural post-offices. It has been ascertained that this can be done at a very small expense, and such an arrangement is in contemplation.

ACCOUNTS AND DISBURSEMENTS.

Including the sum of $720,000 for agricultural experiment stations, Congress appropriated to the Department of Agriculture for the fiscal year ending June 30, 1897, $3,168,532.

While the appropriation for the agricultural experiment stations is included in the act making appropriations for the Department, the money is paid quarterly directly to the 48 experiment stations, as provided by the act approved March 2, 1887. The expenditures from this fund are, therefore, not considered in the following statement of Department expenses.

Of the amount appropriated for the fiscal year 1897, $2,146,044.23 was disbursed prior to July 1, 1897. There remained on that date unpaid bills aggregating $184,000. When these shall have been paid, the total expenditures from the appropriations for the year 1897 will be, in round numbers, $2,330,000, leaving a final balance to return to the Treasury of about $118,000. The total amount paid out during the year was $2,306,365.36, including $1,488.10 for supplemental accounts of 1895 and $159,836.57 for those of 1896.

CONCLUSION.

This brief summary of the work of the Department will give producers an outline of the comprehensive scope of its efforts to help observers and investigators where ways and means for prosecuting research into nature's unknown secrets are beyond their reach. It is in sympathy with the colleges and experiment stations endowed by Congress, endeavoring to help and encourage, while avoiding all appearance of dictation or meddling. The Department is now the most comprehensive repository of scientific facts regarding agriculture in all its relations to mankind, and a publisher of this kind of information more extensive than is found anywhere else. The work of the Department grows with the diversification of production and manufacturing on the farm; as the extension of commerce by improved and cheapened transportation brings our people into competition with new countries and new conditions; as the magnitude of our crops, seeking new markets, increases and our flocks and herds multiply and enter into home and foreign commerce. It advocates the interests of the American farmers when their exports are discriminated against in foreign countries, and endeavors to serve them from a national standpoint whenever occasion requires or opportunity presents.

The time is auspicious for pushing the work of the Department of Agriculture. The people's President, now executing the laws of the Republic and guiding its policies, sympathizes with those who toil in the field, the factory, the forest, and the mine. He is solicitous that the Department become useful to all sections of our country, to the end that the greatest possible assistance may be given rural home makers.

I am glad to testify that the spirit of improvement and progress is more general among American farmers than ever before; that the necessity of education along lines pertaining to economic production is more fully recognized, and that the farmer's home is becoming more and more the seat of comfort, the center of intelligence, virtue, and happiness, the source of strong men for all vocations, and the sure safeguard of the Republic.

JAMES WILSON,
Secretary.

WASHINGTON, D. C., *October 28, 1897.*

MICROSCOPIC INSPECTION OF PORK AT CHICAGO, ILL., BY THE BUREAU OF ANIMAL INDUSTRY.

WORK OF THE DEPARTMENT FOR THE FARMER.

The papers in this section of the Yearbook were prepared by special direction of the Secretary of Agriculture in accordance with the instructions contained in the following letter, a copy of which was addressed to the chiefs of the various bureaus, divisions, and offices "outside of those that are purely administrative:"

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., September 18, 1897.

SIR: It is my desire that, in addition to such other suitable articles as may be necessary, the forthcoming Yearbook, 1897, should contain an article from each chief of bureau, division, and office outside of those that are purely administrative, which shall set forth in plain terms the relation of the work of his bureau, division, or office to the farmer. The existence of the Department is justified precisely so far as it aids the farmer to be a successful farmer, and my desire is that the article called for should present clearly to the reader just how the division of the work in your charge achieves that purpose. Let it be such a paper as you would prepare to present to a body of farmers of average intelligence, or before a committee of Congress inquiring into the purpose, character, and practical utility of your work.

* * * * * * *

Very respectfully,

JAMES WILSON, *Secretary.*

THE WEATHER BUREAU.

By WILLIS L. MOORE, *Chief.*

INTRODUCTION.

The work of the Weather Bureau of the Department of Agriculture in its relation to practical agriculture may be divided, for the purpose of description, into the following classes:

(1) The forecast service for predicting storms, cold waves, and frosts.

(2) The river and flood service for predicting floods.

(3) The climate and crop service for recording and presenting the details of climate and the weekly and monthly conditions of crops.

In his first and second annual reports (1862 and 1863) the first Commissioner of Agriculture, Hon. Isaac Newton, dwelt on the vital importance of the weather and climate to the community at large and especially to the agriculturist. But it was not until February 9, 1870, that Congress was induced to inaugurate a tentative weather service. For twenty years after that date the work was carried on by the Chief Signal Officer of the Army as the meteorological division of his office. Finally, by the act of October 1, 1890, the Weather Bureau, as such, was officially recognized and was transferred to the Department of Agriculture, the general details of its organization being defined in that act.

The Weather Bureau now has 150 fully equipped meteorological stations, with from one to ten employees each; 253 stations especially equipped for the display of danger warnings to mariners; 261 stations for the making of daily telegraphic reports of temperature and rainfall in the cotton, corn, and wheat regions; over 3,000 stations where volunteer observers make daily records of temperature and rainfall with standard instruments, and about 10,000 crop correspondents who report weekly to State centers.

To give notice of the approach and force of storms seems to have been especially in mind by those who in 1870 framed the act of Congress defining the work. All the other details have been added year after year, until now the weather service has probably five times as many employees as during the first year of its establishment, and does twenty times as much work annually as was done then.

THE STORM-WARNING AND FORECAST SERVICE.

PROGRESS OF PRACTICAL METEOROLOGICAL SCIENCE.

While the practical application of meteorological science to the making of weather forecasts can never reach the degree of accuracy attained by theoretical astronomy in predicting the date of an eclipse or the return of a comet, yet such substantial progress has been made during the last century as to seriously engage the attention of thoughtful man and cause him to make special effort to use the knowledge already gained for the benefit of agriculture, commerce, and the general industries of the world.

Practical meteorology is to some extent a tentative work. It may be placed upon a plane with the theory and practice of medicine and surgery. The forecaster is in a great degree guided in his calculations by symptoms, and he is able to diagnose, by means of the daily meteorological chart, the atmospheric conditions with about the same degree of accuracy that the physician is able to determine the bodily condition of the patient. He is able to forecast changes in the weather with rather more certainty than the skilled physician can predict the course of a well-defined disease.

THE SYSTEM OF COLLECTING OBSERVATIONS AND MAKING FORECASTS.

The system by which the Weather Bureau collects meteorological observations and makes weather forecasts may be briefly described as follows: At 8 o'clock in the morning, Washington time (which, by the way, is about 7 o'clock at Chicago, 6 o'clock at Denver, and 5 o'clock at San Francisco), the observers at about 150 meteorological stations, scattered throughout the United States, all thoroughly equipped with standard instruments, take an observation of all of the elementary conditions of the air at the bottom of the great aerial ocean in which we live, which, by its variations of heat and cold, sunshine, cloud, and tempest, affects not only the health and happiness of man, but also his commercial and industrial welfare.

By 8.25 a.m. the necessary mathematical corrections have been made, the observations have been reduced to cipher, and each has been filed at the local telegraph office. During the next thirty or forty minutes these observations, having the right of way over all telegraph lines, are transmitted to their destination, each station contributing its own report and receiving in return, by an ingenious system of telegraphic circuits, such data from other stations as it may require. The observations from all stations are received at Washington, Chicago, New York, and other large cities; and nearly all cities having a Weather Bureau station receive a sufficient number of reports from other places to justify the issue of a daily weather map.

When the observations have been received at the central office in Washington and their results charted, showing the location of the storm centers, the high-pressure or cold-wave areas, the regions of rainfall during the past twelve hours, the areas of high and low temperature, the fluctuations in pressure and the changes in temperature, and the direction and motion of upper and lower clouds, the forecast official gets a bird's-eye view, not only of the exact conditions of the air over the whole country at the moment of taking the observations one hour before, but of the changes which have occurred in those conditions during the preceding twelve hours. A discussion of the general principles which guide the forecaster in arriving at his conclusions, however, is reserved for the concluding part of this paper.

UTILITY OF FORECASTS TO THE FARMER.

A knowledge of the weather on the morrow is of undoubted advantage to all persons engaged in outdoor pursuits.

The farmer, by familiarity with all kinds of weather, naturally becomes somewhat expert in foretelling, by a few hours at least, the approach of rainy weather. Left to his own resources, he is by no means a bad weather prophet.

The local rains of summer frequently surprise him with his hay down, where possibly a little extra exertion would have housed the crop. The information that local rains for his State or district are probable, together with the indications that every intelligent farmer can read from the appearance of the sky, should serve to put him on his guard against loss by rain.

The general farmer probably has less occasion to consult the forecasts than the truck grower or those who may be engaged in the production of a single crop, such, for example, as cotton, tobacco, sugar cane, etc.

The region devoted to the production of fruits and vegetables embraces a large portion of the Middle and South Atlantic seaboard and the Gulf States. In this large territory accurate warnings of killing frost in the late fall and early spring are of very great value. It is also important to know, especially after February 1, when there is likelihood of the temperature of nighttime falling to 40° F. The Weather Bureau performs a valuable service in distributing information in this respect.

The cranberry districts, though comparatively small, also receive valuable aid from the Weather Bureau in times of frost and cold weather.

Sugar cane is often killed or severely injured by frosts in October and November. Warnings of expected frosts enable planters to cut the canes and pile them in rows, so that the leaves of one tier cover the butts of another, in which condition the canes will keep for several weeks without injury.

In the tobacco-growing districts warnings of heavy rains and high winds are valuable after transplanting. So also, warnings of frost during September and October will frequently enable planters to save themselves from financial loss.

METHODS OF PREVENTING OR MINIMIZING INJURY FROM FROSTS.

Mr. W. H. Hammon, forecast official, has made an intelligent study of the methods of preventing or minimizing injury from frost. In his report, from which several ideas are copied in this paper, it is stated, among other things, that "radiation takes place more rapidly when there is nothing to obscure the sky. Clouds or any other obstruction act as a screen to retard it. It takes place more rapidly from the surfaces of plants, etc., than it does from the air above them, so that on still nights these surfaces are frequently cooled several degrees below the temperature of the surrounding air, and frost may form on vegetation although the air a foot above be several degrees above the freezing point.

"One important principle to be considered in the study of the conditions under which frost forms is the increased density of the air as its temperature is lowered. Owing to this principle the air, on calm nights, arranges itself in accordance with its density. The heavier cold air rests on the surface and surrounds the plants and trees, thus increasing their liability to injury. Frequently a thermometer close to the ground will read 5 or 10 degrees lower than one 8 or 10 feet higher. This principle causes the air on slopes, as it becomes chilled by radiation, to flow down into the valleys, where it accumulates, thus frequently causing severe frosts in the lowlands while the hillsides remain uninjured. It is for this reason that frost does not so readily occur on windy nights, since the wind mixes the air to a more uniform temperature throughout and causes that near the ground to be warmer than it otherwise would be.

"In selecting locations for orchards or gardens, avoid so far as possible placing the tenderest plants on low ground, especially in the bottoms of narrow valleys with high hills on either side. In addition to the loss of their own heat by radiation, these valleys will become filled on frosty nights with the air that has been cooled on the slopes and has then flowed downward into the bottoms. Bottom lands opposite the mouths of canyons should be especially avoided for the same reason. The converse of this is true, that plants on gentle slopes are less liable to injury than those on bottom lands.

"Slopes facing the south are preferable to northern slopes, because they receive the rays of the sun more directly and for a longer period. Slopes facing the west are to be preferred to those with an eastern exposure, since they receive heat longer in the afternoon; and being shaded for a time in the morning from the direct rays of the sun, the frost disappears more slowly and seems to be less injurious. The fact that frosted plants are more seriously injured by being suddenly warmed in the dry air than when the frost disappears more slowly seems well established.

"Moist soil, or localities that can be easily flooded for the purposes of protection, are to be preferred to dry sections of otherwise similar location, for the evaporation of the moisture from the soil on dry cold nights will tend to raise the dew-point of the air and thus diminish the probability of frost."

Mr. Hammon believes that "one of the most effective means of protection against frost is to diminish radiation by obscuring the sky with the smoke of smudge fires, but that this method is not so successful in the narrow valleys of a hilly country, for, while it retards the radiation of heat in the valley, the smoke bank is usually of low elevation, and radiation proceeds uninterruptedly from the hillsides, whence the cool air flows down into the valley, beneath the smoke, and chills the plants." Damp straw, tar, turpentine, old hay, or anything that will produce the greatest amount of smoke will serve as fuel for these fires. The fuel should be on the ground in advance, and the fires started while the temperature is several degrees above the danger point. It is believed that decidedly better results will be obtained if damp fuel is used or if the fire be sprayed with water, for this will add vapor to the air, which, in condensing, will assist in checking radiation by obscuring the sky with fog or cloud, and at the same time the dew-point will be raised.

In the case of smudges, the fire warms and expands the air near it, causing it to rise. This establishes an upward current of warm air from the fire, and a space is warmed beyond that needing protection, and cool air flows in from the sides to take its place. Thus, the heat of the fire has but little effect in diminishing the intensity of the frost, almost the entire protection being gained by the blanket of smoke produced. By spraying the fire, on the other hand, much heat is consumed or lost in converting the water into vapor, which on rising is quickly condensed as it comes in contact with the surrounding air. The heat of condensation thus becomes manifest in the lower air, and is in a measure distributed along the lower stratum of the air, and greatly aids in protecting the plants. Every quart of water thus evaporated and again condensed in the surrounding air contains heat sufficient to raise the air temperature 1° F. throughout a space about 50 feet square and 50 feet deep.

A modified form of water protection, which is valuable in orchards, is to spray the trees with water. This plan is probably more valuable in protecting citrus fruits and other plants which are not injured until the temperature has fallen several degrees below the freezing point. In places where irrigation can be practiced it will be found of great value in giving protection. Anything that will seriously interfere with the rapid loss of heat after nightfall will tend to prevent the formation of frost. If the soil be well charged with moisture, it partakes greatly of the stable temperature of water, and cools but little, if any, below the temperature of the superincumbent air, and no frost will occur even though all other conditions of clearness, gentle winds, and cool air obtain. Even a small amount of moisture, say one-half inch rainfall, will often give protection if well distributed and precipitated within twenty-four hours previous to the coming cool conditions.

When severe drought conditions prevail, injurious frosts may occur when the general air temperature 10 feet above the earth is above 40 degrees. Under such conditions, in order to avoid a deposit of frost, it is necessary that the temperature of the top soil and that of vegetation be reduced to the freezing point. This is accomplished by conduction and radiation of heat, which will take place more rapidly from the soil and vegetation than from the lower stratum of air. The degree of heat to which vegetation has been subjected immediately before the frost condition, and the temperature under which it has made its growth, will in a great measure determine the extent of damage by frost. If the spring be uniformly cold, fruit buds will remain undeveloped; winter cereals and all other vegetation will develop slowly, and their fiber will be tough and wiry. Such vegetation will pass uninjured through a late spring frost which may be sufficiently heavy to be considered "killing;" but when the growth has been rapid under abnormally high temperatures the blade and stalk are tender, and serious damage may result from a very light frost.

It may be said that the most effective means of securing immunity from damage by frost is to place yourself in telegraphic connection with the official charged with the distribution of Weather Bureau frost warnings, and then be prepared to flood, spray, or cover with screens, straw, or other material, or else to start smudge fires. Of course, these means are only effective for the protection of limited areas.

Frost warnings are succeeded in the late fall by warnings of severe cold waves. The latter are valuable to the farmer in case he is a shipper of his own produce.

COLD-WAVE WARNINGS.

Cold-wave warnings would be of great practical utility if they could be distributed to stock raisers, whether on the farm or ranch. The ideal distribution of warnings is, of course, by telegraph or telephone. If, therefore, the stock grower is within reasonable distance of a telegraph or telephone station, it would be well to make inquiry of the nearest Weather Bureau official in regard to obtaining notice of severe cold waves.

GENERAL DISTRIBUTION OF WEATHER FORECASTS.

In the general distribution of weather forecasts, 1,821 places are served daily at the expense of the Government by telegraph or telephone, while occasional warnings of unusual character, such as cold waves, frost, and hurricanes, and in California special rain warnings are also telegraphed at Government expense to over 4,000 points. In addition to this paid service, more than 31,000 addresses are served daily with the weather forecast by telegraph, telephone, mail, and railway train service, without cost to the Government except for stationery, etc.

FORECASTS OF RAIN IN CALIFORNIA.

Forecasts of rain in California are of signal service in preventing injury to raisins exposed to the air in the drying process. In October, 1897, a general and rather unseasonable rain occurred in the great interior raisin district of California. First reports indicated that several million dollars worth of raisins had been destroyed, but when the later returns were gathered it was found that the damage was but slight, owing to the rain warnings extensively distributed through the telephonic systems connecting the principal vineyards. On account of the peculiar topography of California, such warnings can be made with a high degree of accuracy.

THE RIVER AND FLOOD SERVICE.

With our many thousands of miles of navigable rivers, flowing through one of the most extensive and fruitful regions of the world, warnings of floods are often worth many millions of dollars to navigators and to agriculturists having movable property on low grounds contiguous to the streams. Such warnings are issued when the precipitation is so heavy as to indicate the gathering, during the next two or three days, of flood volumes in the main streams. The feasibility of making accurate forecasts as to the height of water several days in advance at any station is no longer questioned. The forecaster at each of the twenty-two river centers considers the rainfall, the temperature, the melting of snow, if there be any, the area and slope of the watershed, and the permeability of the soil. From a study of floods in former years he knows the time necessary for the flow of the water from the tributaries to the main stream and the time required for the passage of the flood crests from one place to another.

The principal streams included in the river system are the Allegheny, Monongahela, Ohio, Kanawha, Wabash, Illinois, Tennessee, Cumberland, Mississippi, Missouri, Arkansas, and Red rivers of the central valleys; the Columbia, Sacramento, and San Joaquin, of the Pacific Coast; and the Hudson, Susquehanna, Potomac, Savannah, Chattahoochee, and Alabama rivers of the Atlantic and east Gulf coasts.

Each forecaster in charge of a river center has a definite section of the river system assigned to him. He receives the necessary telegraphic reports of rainfall over the watersheds tributary to his river district, and also the necessary telegraphic data as to gauge readings nearer the source of the main river than his own station, and the gauge readings of many of the tributary streams.

Some idea of the vast destruction of property due to floods may be gathered from the statement that the floods of 1881 and 1882 caused a loss of not less than $15,000,000 to the property interests of the Ohio and Mississippi valleys. There was also a loss of 136 lives. In 1884 the region about Cincinnati alone suffered a loss of over $10,000,000 in property.

It would be impossible to estimate the value of live stock and movable property saved by flood warnings during the great flood of the spring of 1897 in the lower Mississippi, but certainly the saving amounted to many millions of dollars. Many days before the river overflowed its banks the areas threatened were warned of the coming flood. The report of the Statistician of the Department indicates that there was in this flooded district $15,000,000 worth of stock and movable property, the greater part of which was carried to places of safety mainly as the result of the thorough dissemination of information relative to the coming flood. When the Mississippi River at New Orleans was at the highest stage ever known, warnings were sent to that city that within five days the gauge reading would show an increase in the height of the water of over one foot. The water reached the height predicted exactly on the day, but the levees had been strengthened and raised to meet the impending danger.

THE CLIMATE AND CROP SERVICE.

During the crop season this service collects weekly returns from several hundred voluntary crop correspondents. The returns thus received are carefully studied by the director having charge of the section or district, at whose headquarters educated and practically trained meteorologists, crop writers, printers, and messengers are on duty, fully equipped with the most improved instruments and mechanical appliances for performing their various functions. Each section director issues on Tuesday morning during the crop-growing season several thousand copies of a neatly printed bulletin, 9 by 12 inches in size, giving detailed information concerning climate and crops in every county in his State. The State bulletins are published by nearly the entire rural press of their respective States. The section director in each State telegraphs to Washington each Tuesday morning, in a message of sixty words or less, the pith of his weekly bulletin, and this message forms a part of the national climate and crop bulletin. The latter is prepared from the telegraphic reports from section directors and the meteorological records of about one hundred and fifty stations. It contains, in addition to the foregoing, charts showing the actual rainfall, the departures from normal temperature and rainfall, and the temperature extremes of the week.

At the end of each month the section directors also collect by mail and publish in eight or twelve page quarto reports tables of daily rainfall and temperature from about one hundred sets of Government instruments in the hands of intelligent voluntary observers in each State, thus presenting the complete climatological and crop data of the month in convenient form for reference or study. Some idea of the magnitude of the crop work done by the climate and crop service of the Weather Bureau may be gleaned from the simple statement that in one month of four weeks there are printed 168 different State crop bulletins, 4 national crop bulletins, and 42 monthly climate and crop bulletins. It may also be well to mention that about three hundred observers in the wheat, the corn, and the cotton belts measure the rainfall and temperature and telegraph their reports to certain section centers, whence the reports are placed upon telegraphic circuits and thus distributed to the produce, commission, and commercial exchanges of the country. These 300 reports are in addition to the usual meteorological observations telegraphed from 150 regular Weather Bureau stations for the purpose of forecasting. Even these latter reports, on account of their value in showing crop conditions, are promptly charted on large blackboard maps before every important board of trade in the country before they are used in the making of forecasts.

During the winter months there is published at the central office on Tuesday of each week a snow and ice chart, showing the portions of the country covered with snow and the thickness of the ice at the regular Weather Bureau and selected voluntary stations.

The Weather Bureau of the Department of Agriculture, with its vast ramifications extending into every part of the country, is, in fact, the most extensive and most efficiently equipped machine anywhere in the world for the accurate collection and rapid dissemination of climate and crop information.

The great fund of climatological information collected by climate and crop services serves not only to show the effect of untoward weather conditions upon growing crops, but also to determine the agricultural possibilites of each State, the weather conditions under which insect pests thrive, and other problems of interest in connection with the general science of meteorology.

WORK OF THE VOLUNTARY OBSERVER.

In this connection, there is introduced here an account of a most important part of the extensive machinery of the Weather Bureau, the work of the voluntary observer, by means of which this great fund of climatological information and permanent weather record is obtained. Mr. James Berry, the chief of the climate and crop division, has, under instruction from the writer, prepared that portion of this paper relating to the work of the voluntary observers in determining the detailed climatic features of each State.

THE PAID METEOROLOGICAL STATIONS.

The paid meteorological stations of the Weather Bureau, 150 in number, distributed over the United States—exceeding in area 3,600,000 square miles—afford an average of but 1 station for each 24,000 square miles of territory, and while telegraphic reports from a larger number of stations would supply more complete data upon which to base the weather predictions of the Weather Bureau, and thereby tend to increase their accuracy, the data furnished from these 150 stations have, in past years, afforded information sufficient for successfully foretelling the occurrence of violent storms, cold waves, etc., and announcing the daily current weather changes from twenty-four to forty-eight hours in advance of their occurrence.

While it has been possible for the Weather Bureau to satisfactorily conduct its most important work of forecasting weather changes with this comparatively small number of stations, it is obvious, when considering that there are as many as eight States with areas of less than 24,000 square miles, that the records of the 150 telegraphic stations afford very meager information upon which to determine the local climatic features of many sections of the country.

THE VOLUNTARY OBSERVER.

The voluntary observer, therefore, must be looked to for data to ascertain the detailed characteristics of the climate of the various sections of the country. Under the liberal policy of the Government weather service in recent years it has been possible to vastly augment the number of cooperating voluntary stations. In 1880 the number of voluntary observers was less than 225; in 1885, about 275; in 1890, nearly 1,500; in 1895, nearly 2,500, and since 1895 the number has been further increased until at present there are no less than 3,000 voluntary observers in the United States taking daily observations of the extremes of temperature and recording measurements of precipitation, including rain, snow, hail, sleet, etc., much the larger number of these observers being provided with standard instruments. With this number of voluntary stations, together with the regular paid stations of the Weather Bureau, we have an average of 1 station to each 1,200 square miles of territory.

VALUE OF THE DATA SUPPLIED BY THE VOLUNTARY OBSERVER.

The value of the data supplied by the records of the voluntary observer, both to the locality in which the observations are made and to the national weather service, can not easily be overestimated. These records are valuable not alone to the meteorological student and investigator, but they afford the farmer a valuable means of studying the effects of meteorological conditions upon crops, and enable him to determine the conditions under which certain crops may be successfully grown, as well as to ascertain just what the meteorological conditions were under which abundant or deficient crop yields were produced, while the observations of a series of years afford data upon which to compute normals for a basis of comparison with current conditions. The direct bearing of weather conditions upon the production of crops renders argument unnecessary to show the practical value of a careful study of these subjects, and that intelligent conclusions may be easily drawn by comparison of yields of crops with the meteorological conditions under which they are produced. A diary showing the time of planting and the progress of crops from seedtime to harvest, with the acreage and yield of the several crops, would prove of the greatest interest in the study of this subject.

The voluntary observer's record, besides being valuable in determining the adaptability of the climate of a section to the cultivation of crops, supplies information of incalculable worth to engineers in the construction of aqueducts, reservoirs, bridges, culverts, etc. Millions of dollars are annually expended in such work, and without foreknowledge of the frequency, duration, and amount of rainfall in the several sections of the country to enable those in charge of these enterprises to determine the capacity of sewers, culverts, etc., that will prove adequate to carry off the amount of rainfall, disastrous mistakes are liable to occur. The medical profession also utilizes the data in ascertaining localities possessing climatic conditions best suited for their patients, and the records often have great bearing in legal cases, in which it may be important to prove the existence of certain meteorological conditions at a given time.

PUBLICITY OF THE OBSERVATIONS OF THE VOLUNTARY OBSERVER.

By the present system of cooperation between the Weather Bureau and its voluntary observers the records of observations are made in triplicate, one copy being retained by the voluntary observer, the other two going, respectively, to the central station of the climate and crop section, in which the observer is located, and to the central office of the Weather Bureau at Washington City. The observations are published in detail in the monthly reports of the climate and crop sections, and a summary, showing the extremes and averages of temperatures and total rainfall, are published in the National Weather Review. Many observers also supply local newspapers with copies of their records for publication. It will thus be seen that the observations are given wide publicity through the local press and official publications of the Weather Bureau, the latter having extensive circulation in all parts of the United States as well as in foreign countries.

REFORM IN METHOD OF PUBLISHING OBSERVATIONS OF VOLUNTARY OBSERVERS.

Early in the administration of the present Chief of the Weather Bureau he undertook to institute a much-needed reform in the method of publishing the detailed observations of voluntary observers in the monthly reports of the various climate and crop sections. While the great desirability of publishing these observations in detail and arranging the data in convenient form for future reference had long been recognized, there seemed no adequate means by which such an end could be accomplished. The difficulties which lay in the way of publishing the data in a uniform manner and after an approved method, however, have been largely overcome. At the present time 34 of the 42 sections into which the climate and crop service of the bureau is subdivided are issuing quarto-monthly reports in practically uniform style. These publications give the extremes of temperature for each day of the month, daily rainfalls, climatological tables showing how the current temperature and rainfall compare with normals for the corresponding period, and charts graphically illustrating the distribution of temperature, prevailing wind directions, and total precipitation. The several meteorological elements are summarized, comparison made with normal conditions, and abnormal conditions discussed.

On the temperature chart, which accompanies the monthly report of the climate and crop section, it is possible, with the large number of reports, to trace isothermal lines for each degree of mean temperature, while on that accompanying the National Weather Review this is not practicable, the mean isotherms being 5 degrees apart. The same may be said of the precipitation charts of the publications mentioned. Those of the climate and crop sections illustrate the distribution of rainfall much more in detail than is possible with the chart issued with the National Weather Review, the base map for which is of a scale much smaller than that of the section publication. These climate and crop service publications, therefore, contain sufficient material to admit of determining in detail the meteorological conditions prevailing throughout the year in all sections of the country.

BENEFIT OF RECORDS OF VOLUNTARY OBSERVERS TO THE COMMUNITY.

Voluntary observers' records increase in value as the period they cover is lengthened, and they never cease to be of interest in the community where the observations are taken. They afford effective means of frustrating aims of those given to extravagant statements with regard to present or past weather conditions. By careful perusal of the instructions the voluntary observer receives from Weather Bureau officials, he becomes acquainted with the best methods of exposure of instruments, and his observations being taken, with standard instruments, tested by Government experts before their issue, are accepted as authoritative.

FACILITIES OF THE VOLUNTARY OBSERVER.

It is the opinion of the writer that the voluntary observer has facilities for the exposure of meteorological instruments, more particularly thermometers, rain gauges, and wind instruments superior to those found in the larger cities, in which most Weather Bureau stations are located. It is evident that the interior of the larger cities do not afford an exposure representing the true air temperature of the surrounding country. The combustion of enormous quantities of fuel in cities and the storage of the sun's heat in walls and pavements necessarily must affect very sensibly the thermometer, and cause its readings to be materially higher than if given an exposure free from such influences. As an illustration of this may be cited the records of the weather bureau in Philadelphia and those of the voluntary station in the immediate vicinity in the suburbs of Camden, N. J. The instruments at the latter place have an excellent exposure, and the observations are taken by a most competent and painstaking observer. A comparison of the records at these places, covering a period of four years, from 1893 to 1896, inclusive, shows an average daily difference of 1.2° F. the year round, while in some months the difference is not less than 2.5° F., being greatest in calm weather.

EFFECT OF LIBERAL POLICY ON ACCURACY OF RECORDS OF VOLUNTARY OBSERVERS.

Undoubtedly many of the old records of voluntary stations, some of which antedate the establishment of the national weather service by half a century or more, valuable as they are, were made from instruments of doubtful accuracy. The liberal policy of the national weather service in recent years in providing voluntary observers with reliable instruments, carefully tested before issue, insures records of far greater accuracy than it has hitherto been possible to procure with the cheap and unreliable thermometers which many faithful observers from necessity used. A correction card, showing the error of the thermometers at various temperatures, now accompanies each instrument issued by the Weather Bureau. This enables the observer to ascertain the true temperature at any degree of heat or cold and to make his records absolutely correct. It therefore may be confidently stated that never before the present time has such careful and general attention been bestowed upon the matter of instrumental equipment and exposure. The records now being kept will afford the future investigator more trustworthy and accurate information with respect to climate than it has been possible to obtain in the past.

LOANS OF INSTRUMENTS TO VOLUNTARY OBSERVERS.

The Weather Bureau loans to voluntary observers when eligibly located, upon condition that observations be taken and records furnished, a set of meteorological instruments, consisting of self-registering maximum and minimum thermometers and standard rain gauges, and provides him with appropriate blanks for keeping records. The limited supply of instruments renders it necessary to use caution in the selection of stations, in order to guard against a practical duplication of records and to secure observations that will prove of value. Many applications for instruments from competent and trustworthy persons are declined on account of the proximity of their location to existing stations. The gradual increase in the number of stations has materially reduced the distance limit, formerly fixed at 50 miles, in determining eligibility of a proposed station, so that the bureau is now enabled to equip stations much nearer to those already established than heretofore. Except under unusual conditions, however, it is the policy not to issue instruments to stations within 20 miles of one already established.

PRINCIPLES OF WEATHER FORECASTING.

In the section following of this paper brief reference is made to some of the general principles of weather forecasting from synoptic charts.

THE STUDY OF THE CHARTS BY THE FORECAST OFFICIAL.

A synoptic chart is one that shows the weather conditions existing at the same instant of time over a wide extent of territory.

In addition to the synoptic charts, the forecast official has before him other charts showing the changes in temperature, pressure, etc., that have occurred during the preceding twelve hours. Here, for example, throughout a great expanse of territory all the barometers are rising, that is to say, the air has cooled, contracted, become denser, and now presses with greater force upon the surface of the mercury in the cisterns of the instruments, thereby sustaining the mercury columns at a greater height. Over another considerable area the barometers are falling, as increasing temperature rarefies and expands the volume of air, causing it to press upon the instruments with less force. The winds, too, blow in general conformity to the system of pressure gradients, as will be subsequently explained. Occasionally the reports from a station show high cirrus clouds composed of minute ice spiculæ moving from one direction, lower cumulo-stratus clouds composed of condensed water vapor moving from another direction, and the wind at the surface of the earth blowing from still a third point of the compass. When such erratic movements of the air strata are observed it is almost a sure premonition of rain and high winds within two or four hours; sometimes sooner. The readings of all barometers shown on the forecast official's charts are reduced to sea level, so that the variations in pressure due to local altitudes may not mask and obscure those due to storm formation.

EXPLANATION OF THE CHARTS.

On the weather charts used for the forecast official's study, and also on those published for general distribution, the word "high" is written at the center of the region of greatest air pressure and the word "low" at the center of the region of least pressure. Under the influence of gravity the air presses downward and outward in all directions, thus causing it to flow from a region of great pressure toward one of less. The velocity with which the wind moves from the "high" toward the "low" depends largely on the difference in air pressure. To better illustrate: If the barometer reads 29.5 inches at Chicago and 30.5 inches at Bismarck, N. Dak., the difference of 1 inch in pressure would cause the air to move from Bismarck toward Chicago so rapidly that, after allowing for the resistance of the ground, there would remain a wind at the surface of the earth of about 50 miles per hour, and Lake Michigan would experience a severe "northwester."

The arrows shown on the charts fly with the wind, and almost without exception move toward the "low," or storm center; the wind moves from the regions marked "high," where the air is abnormally heavy, toward the "low," where the air is lighter. As the velocity of water flowing down an inclined plane depends both on the slope of the plane and on the roughness of its surface, so the velocity of the wind as it blows along the surface of the earth toward the storm center depends upon the amount of the depression of the barometer at the center and on the resistance afforded by surfaces of varying degrees of roughness.

Now, picture in the mind the fact that as the air moves inward it rotates about the storm center in a direction contrary to the movement of the hands of a watch, and you have a very fair conception of an immense atmospheric eddy.

Anyone having watched the placid waters of a deep-running brook must have observed that where it encounters a projecting crag little eddies form and whirl along downstream. Atmospheric storms are simply great eddies in the air which are carried along by the general easterly movement of the atmosphere in the middle latitudes of the Northern Hemisphere. But they are not deep eddies, as was once supposed. The word "low" on the weather map marks the center of an atmospheric eddy of vast horizontal extent as compared with its thickness or extension in a vertical direction; thus, a storm condition may extend from Washington, D. C., to Denver in a horizontal direction and yet extend upward but 4 or 5 miles. The whole disk of whirling air, 4 or 5 miles thick and perhaps 1,500 or 2,000 miles in diameter, is called a low-pressure area, or storm area. It is important that a proper conception of this fundamental idea be had, since the weather sequences experienced from day to day depend almost wholly on the movement of these traveling eddies, cyclones, or, as they are more commonly called, low-pressure areas.

FACTS USED BY THE FORECASTER IN HIS DEDUCTIONS.

The forecaster knows that high and low pressure areas drift across the country from the west toward the east at the rate of about 600 miles daily, or about 37 miles per hour in winter and 22 miles per hour in summer; that the "highs" are attended by dry, clear, and cooler weather, and that they are drawing down, by a vortical action of their centers, the cold air from great altitudes above the clouds and causing it to flow away laterally along the surface of the earth in all directions from the center, and that the high-pressure areas as they move eastward sometimes become so intense in their vortical motion as to draw down such vast volumes of cold air that we call them cold waves.

In the downward movement of the air in cold waves we must concede that the loss of heat by radiation through a cloudless atmosphere is much greater than that dynamically gained by compression, or else we must assume that the air possesses such intense cold at the elevation from which it is drawn that notwithstanding the heat gained by compression in its descent it is still far below the normal temperature of the air near the surface of the earth.

The forecaster knows, too, that although these intense high-pressure areas first appear in the extreme northwest territory, they do not depend on the land of their birth for the cold they bring to us, and that cold waves are not simply immense rivers of air which have been chilled by flowing over the great snow and ice fields of the Arctic regions, as was once thought. He is also familiar with the fact that in the low-pressure areas the conditions of the air and its various movements are exactly the reverse of what they are in the high; that the air is much warmer and moister, and that it is drawn spirally inward from all directions instead of being forced outward, as in the high; that it ascends as it approaches the center of the depression, sometimes causing rain or snow as it cools by expansion during its ascent, or as it encounters and mixes with air strata of lower temperature than its own.

We know that while our atmosphere extends upward to an altitude probably of 60 miles it is so elastic and its expansion is so rapid as it recedes from the earth that half of its mass lies below the 3-mile level, and that our storms and cold waves are simply great swirls or eddies in the lower stratum of probably not more than 5 miles in thickness; that the air above the 6-mile level probably flows serenely eastward in these latitudes without being disturbed by our most severe storms.

The forecaster is further aware of the fact that our high-pressure areas, with their clear, cool weather, and our low-pressure areas, with their warmer and often rainy weather, alternately drift eastward in periods that average about three days each; that they are not in any sense the product of chance, but are part of that great divine economy which provides for seedtime and harvest, for by the action of the "lows" the warm, vapor-bearing currents are sucked inland from the Gulf and the ocean and carried far over the continent, so that their moisture is condensed and scattered over the plains, rendering them tillable and suitable for the habitation of man; that the high-pressure areas, in drawing down the cool, pure air from above, scatter and diffuse the carbonic-acid gas exhaled by animal life and the fetid gases emanating from decaying organic matter; that the cold waves created by these high-pressure areas are among the most beneficent gifts of nature, for their clear, dense air not only gives us more oxygen with each inspiration of the lungs, but the abnormally high electrification that always accompanies such air invigorates man and all other animal life; that the cold north wind, if it be dry, as it usually is, brings physical energy and mental buoyancy in its mighty breath; that four-sevenths of all our storms come from the north plateau region of the Rocky Mountains and pass from this arid or subarid region easterly over the Lakes and New England, producing but scanty rainfall; that the greater part of the remaining three-sevenths of the number of storms have their inception in the arid region of our Southwestern States, and that as they move northeastward they can nearly always be depended on to give bountiful rainfall, and that many of them cross the Atlantic and affect the continent of Europe, and that a few, and by far the most severe, wind and rain storms that touch any portion of our country originate in the West Indies and travel in a northwesterly direction until they touch our Gulf or South Atlantic Coast, when they recurve to the northeast and sweep along our Atlantic Seaboard with hurricane intensity.

During the prevalence of droughts in the great central valleys all the low-pressure or storm conditions form in the middle or north plateau region of the Rocky Mountains. When such droughts are broken, it is usually accomplished by "lows" that form in Arizona, New Mexico, or Texas.

From many years spent in daily watching the formation, progression, and dissipation of storms the forecaster well knows that at times, by an accretion of force not shown by observations taken at the bottom of the ocean air, storms suddenly develop dangerous and unexpected energy or pursue courses not anticipated in his forecast, or that the barometer at the center of the storm rises without any premonition and gradually dissipates the energy of the cyclonic whirl.

These are a few of the generalizations of which the forecaster takes cognizance and which guide him in his deductions. In brief, he carefully notes the developments and movements in the air conditions during the preceding twenty-four hours, and from the knowledge thus gained makes an empirical estimate of what the weather will be in the different sections of the country the following day.

HOW TO BECOME A FORECASTER.

By preserving the weather charts each day and noting the movements of the "highs" and "lows" any intelligent person can make an accurate forecast for himself, always remembering that the "lows" as they drift toward him from the west bring warm weather and sometimes rain or snow, and that as they pass his place of observation the "highs" following in the tracks of the "lows" will bring cooler and probably fair weather.

DIVISION OF CHEMISTRY.

By H. W. Wiley, *Chemist.*

FUNDAMENTAL CHARACTER OF CHEMICAL RESEARCH.

The foundation of scientific agriculture rests upon agricultural chemistry. Before the time of Liebig, agriculture was only an empirical science. No exact information was at hand concerning the composition of crops, the nature of the soil, or the functions of fertilizers. Certain facts which had been learned by long experience were made use of in practical agriculture, but in a blind sort of way, without definite knowledge of the processes which took place, and necessarily without economical application of labor and materials.

PRIMARY RELATIONS OF CHEMISTRY TO AGRICULTURE.

The first work of agricultural chemistry has been to determine the nature of the crops produced and the relations which they bear to the soil in which they grow. The first great fact established by this investigation was that almost the whole weight of a crop is formed by direct combination or synthesis from elements preexisting in the air and soil, or in parts of the soil; in other words, the greater part of the weight of every crop is the product of the synthesis which takes place between carbonic acid and water. The soil and the atmosphere must be regarded, then, as the environment most favorable to the production of organic matter, and the crowning practical work of agricultural chemistry is the study of those conditions which favor the largest production of organic matter in any given instance. These conditions are evidently those of temperature, moisture, and mineral plant food.

The most direct contact which the work of this division has with practical agriculture is in the study of the composition of soils and of the crops which grow in them. Heretofore this study has been chiefly accomplished in field experiments, where the conditions have been hard to control. In order to check, so far as possible, all the results which have been obtained in such a study of the relations of the plant to the composition of the soil in which it occurs, this division has for the past four years conducted a series of studies in which an absolutely perfect control of the conditions has been possible. To this end, typical soils from different parts of the United States and from the celebrated agricultural experiment station at Rothamsted, in England, have been collected and placed in pots where all the conditions attending the growth of the plants can be supervised.

CHIEF OBJECT OF SOIL STUDIES.

The primary object in the study of these typical soils, from the practical agricultural point of view, is to determine by cultures of various crops the maximum amount of organic matter which can be produced under given circumstances. This is done in connection with a most minute study of the chemical and physical properties of the soil, so that definite information can be secured respecting the relations which exist between chemical and physical composition and crop production. All soil studies, to be of value to the farmer, must in this way be connected with the actual experiments in determining the producing value of the soil. When these studies are made without such an adjunct they have great theoretical and scientific value, but lack that practical quality which permits of their use directly in the advancement of agriculture. Providing that a favorable climate exists, the soil is the first problem which the practical farmer must consider. Other things being equal, in the purchase of a soil it is found that those soils which have the highest available fertility are the ones that bring the highest price.

IMPORTANCE OF PRESERVING SOIL FERTILITY.

To preserve and increase this fertility should be one of the chief objects of the practical farmer, because if he allow the fertility of the soil to decrease he will place himself on the road to financial failure. Good farming is not only evidenced in the fact that the farmer is able to pay his bills, to live comfortably, and to accumulate a moderate amount in the savings bank, but it is also shown, with an equal degree of certainty, by the improvement in the fertility of his farm. One of the chief characteristics of the work of the Division of Chemistry therefore is the investigation of those problems respecting soil fertility which bear directly on this great economic work of the practical farmer. To this end the Division of Chemistry studies the origin of soils, the composition of the rocks from which they are derived, the transportation to which they are subjected by the action of water, ice, and wind, the methods in which they are deposited and held in position, and the character of the crops which are best suited to soils of different origins and compositions.

QUANTITY OF PLANT FOOD.

The Division of Chemistry studies also the amounts of plant foods removed in different crops and searches for the most economical means of replacing the waste. It is through such chemical studies that the farmer has learned the causes of the impoverishment of his soil and the sources from which it can be recuperated.

CHEMISTRY AND FERTILIZER DEPOSITS.

Chemical studies have made it possible to open the potash mines of Stassfurt, and have led to the discovery and operation of the quarries of mineral phosphates which exist in many parts of the world, especially in the United States. It was through chemical studies that the farmer was led to import the deposits of guano which had been stored for many thousand years in the arid islands of the Pacific. Through chemical studies the opening of the nitrate beds of Peru and Chile was made possible, and the mining and importation of vast quantities of nitrate of soda secured.

NITRIFICATION.

Through chemical studies of the soils and the operations which go on therein, there has been revealed to the practical farmer the nature of those minute processes which go on in the soil through the action of microorganisms by means of which inert nitrogen is made available for plant food. The nature of the processes of the decay of nitrogenous bodies placed in the soil has thus been clearly revealed, and in addition to this it has been shown that certain classes of crops, in conjunction with bacterial activity, are able to oxidize and make available the free nitrogen of the atmosphere. In this way the most costly of all fertilizing materials has been thoroughly studied, and the practical farmer has been instructed in regard to the means of supplying it at the least possible outlay of money. It is thus due directly to chemical studies that the growing of leguminous crops, such as clover, peas, and beans, has been so widely practiced. In like manner the best methods of preserving the nitrogenous manures of the stable and barnyard have been developed, so that the maximum fertilizing influence of such manures is secured.

ECONOMY IN THE USE OF FERTILIZERS.

While chemistry does not claim the faculty of making the farmer entirely independent of the nitrogenous fertilizers which have been stored for his use, it has already accomplished much in diminishing the expense to which he has been subjected in purchasing the whole of such fertilizers employed in his agricultural work. The chemical studies of the Division of Chemistry have also indicated the most economical manner in which the principal fertilizing materials, such as phosphoric acid, nitrogen, and potash, can be applied, and the particular combinations of fertilizing ingredients which are calculated to produce the maximum result in any given locality. In view of this fact, the great practical utility of the study of the chemical composition of the soil is at once apparent. It leads not only to a more intimate knowledge on the part of the farmer of the environment in which his crops grow, but also points out the steps necessary to secure the maximum result from the action of fertilizing materials with a minimum expenditure of money. Abstruse science and practical agriculture are thus intimately linked together, and the methods in which they most harmoniously work are developed from year to year by the studies which are carried on by the Division of Chemistry of this Department and similar laboratories in other parts of the country and of the world.

DEVELOPMENT OF NEW AGRICULTURAL INDUSTRIES.

Many of the agricultural industries are largely dependent upon chemical studies for their proper development and expansion. This is particularly true of the sugar industry, to which the Division of Chemistry has devoted a large part of its time during the past fifteen years, and to which it is still giving the most earnest attention. The development of sugar-producing plants, such as cane and the beet, is only possible under rigid chemical control. The work of the division has been highly fruitful in this particular. For eight years it conducted a station for the growth of sorghum as a sugar-producing plant, during which time the percentage of sugar in the field crops of this plant was raised from 9 to 14 per cent. Similar stations for the improvement of the sugar beet have been established and are still in operation. One of the chief functions of the Division of Chemistry at the present time is the study of the practical conditions on which the successful introduction of the sugar-beet industry into this country must depend. To this end, beets grown in all parts of the United States under the most varied conditions of climate and soil are sent to the division for analysis, and from the analytical data thus obtained it will be possible, sooner or later, to determine the localities in this country best suited to beet culture.

IMPORTANCE OF PROPER LOCALITIES.

When the vigorous competition in sugar production is considered, it is easy to see how it is necessary that those localities where soil and climatic conditions are most favorable should be defined as soon as possible, so that the development of the industry in this country may go on uninterruptedly under the most favorable conditions. Without the cooperation of the Division of Chemistry and other agricultural laboratories in the United States it would not be possible to locate these areas, except by long and costly experience. The direct saving of capital and energy which these studies make possible can only be measured by large sums of money. The work of the division, therefore, not only points out with unerring certainty the proper course for capital to pursue, but what is equally important, utters a word of caution in regard to investments in unfavorable localities. It is quite certain that if intending investors in this industry study carefully the data which are collected, they will not make the mistake of investing their funds in regions where failure is almost certain to occur.

PRODUCTION OF HIGH-GRADE BEETS.

Among the most valuable means of securing the establishment of the sugar industry are those which relate to the production of beets of high sugar content. This is only possible under such control as the work of the Division of Chemistry has inaugurated and still conducts. The beets which are preserved for seed production are selected, not only from their shape and size, but especially from their content of sugar. In the scientific production of seed, each beet which is originally reserved for the production of seed is subjected to analysis, and only those which reach a certain standard are propagated. In cooperation with some of the agricultural experiment stations, and independently also, the Division of Chemistry is conducting work of this kind in various quarters of the United States, for the purpose of indicating the best varieties of beets of the highest percentage of sugar and illustrating the way in which the methods whereby the improvement of the sugar beet can best be secured can be practically followed on a large scale. It is only when such a course is followed that we can hope to compete with Europe and the Tropics in the production of sugar.

BENEFITS TO GENERAL AGRICULTURE.

The practical benefits to American agriculture which will accrue from the application of the results obtained in the Division of Chemistry in this particular can only be properly comprehended when the vast imports of sugar into this country are considered. The object of the work is to give to American agriculture the activity, the industry, and the profits which are now found in Europe and tropical sugar-producing countries. If scientific means be followed under careful technical and business control, the establishment of an indigenous sugar industry is certain, and the benefit which will accrue to American agriculture in the near future can only be measured by hundreds of millions of dollars.

COMPOSITION AND ADULTERATION OF HUMAN FOODS.

Of almost equal importance with the character of the work outlined above, from a practical point of view, are the researches which are being conducted in the Division of Chemistry in respect to the composition and adulteration of human foods. It is most important that the actual composition or nature of human foods be carefully ascertained and that the adulteration thereof be prevented. The work of the division is therefore directed to the study of the composition of foods of all classes and to the investigation of the nature of the adulterations which are practiced whereby the farmer is deprived of a portion of his justly earned profits. It requires no argument to show that if cheap and inferior foods, or if substitutes for foods, be sold under the guise of pure and wholesome articles the farmer is the first who must suffer, from a financial point of view. In addition to this, the danger to public health must not be forgotten when impure or debased foods are offered for sale and pass into general consumption. A large part of the work of the Division of Chemistry is therefore devoted to a study of the composition of human foods from a purely scientific point of view. The character and extent of the adulterations which are practiced with our common foods are also made the subjects of research, and numerous reports have already been published, both upon the composition of human foods and their adulterations. This work is still vigorously pushed forward, and it is a matter of pleasure to know that the farming public of the United States has fully appreciated the efforts of this division to secure for honest foods an honest market. The whole range of human foods will finally be covered by these investigations, and the results which will ensue therefrom can not fail to be of the utmost practical benefit to the agricultural public. Not only is the farmer protected by these studies in the market which is open for his wares, but he also receives a further protection in the guaranty of the good quality of the purchases which he makes. For instance, the coffees, sugars, and teas which are mostly used by our agricultural population are purchased at the groceries, and not produced upon the farm. The frauds which can thus be practiced upon the agricultural public in the sale of adulterated, debased, or impure foods of the character named are prevented by the control which is exercised over these foods, based upon the data obtained by the work of the Division of Chemistry. The pure-food laws which are enacted in many of the States are based upon these data, and it is hoped that through the efforts of the friends of pure foods, aided by the efforts of this division, a national pure-food law will soon be enacted, governing the sale of foods in the District of Columbia and the Territories and interstate commerce in all food products.

MISCELLANEOUS WORK.

The miscellaneous work of the division is also of the highest practical value to agriculture. This may be illustrated by citing some of the subjects of a miscellaneous nature which are now under investigation. The study of the composition of the sunflower was undertaken two or three years ago, and is now almost completed. The economical aspects of this study are of the greatest interest. Not only has it been shown that a most delicious salad oil can be made from the seeds of the sunflower, but that the resulting cake is of the highest nutritive value for cattle feeding. The character of the pith has also been investigated, and the nature of the stalk—in fact, the whole plant—has been subjected to careful chemical examinations, and it is hoped that, based upon the data which will be contained in the bulletin to be issued, this industry may obtain a foothold in the United States and expand to a much greater extent than ever before. Heretofore the sunflowers have been grown for their seeds alone, which have been used for feeding birds and sometimes for cattle and horses. The data which have been obtained in the studies, now almost completed, show a wide possibility of development in this industry alone.

USE OF BASIC PHOSPHATIC SLAGS.

The character of the miscellaneous work may be further illustrated by another example of an investigation which is now in progress and near completion. This example also shows the intimate relation which may exist between agricultural and manufacturing interests. In the manufacture of iron the presence of phosphorus has always been regarded as a serious drawback. The presence of a very small quantity of phosphorus in iron renders it brittle and unfit for most purposes. In this country, as in Europe, there are vast bodies of iron ore which contain such large quantities of phosphorus that it is impossible to use them under any of the old processes. A few years ago a process was invented by means of which practically all the phosphorus can be extracted from the pig iron by a simple chemical operation. In this operation the phosphorus is made to combine with lime, and large quantities of slags containing great quantities of phosphorus are produced. For many years these slags were regarded simply as refuse and of no value. When studied by chemical means, however, it is found that the phosphorus contained in these slags has a far higher availability for plant food than the natural phosphates—in fact, an availability which is almost equal to that of dissolved phosphates or ordinary acid phosphates. Under the stimulus of this chemical discovery, these slags have been used for fertilizing purposes with the greatest success. In this country one factory has already commenced the manufacture of iron from ores rich in phosphorus. The Division of Chemistry has therefore undertaken a thorough study of the relations of basic slags to the crops which are produced in the United States. In the prosecution of this study the localities in Europe where basic slags are manufactured were visited by the Chemist for the purpose of obtaining all the available information on the subject. The factory in this country was also thoroughly studied and samples of the phosphate slags made in the United States secured and compared with those made in Europe. These data are now almost ready for publication, and the collection of them and the research necessary to securing the information desired illustrate in a striking manner the practical relations of chemical work not only to agriculture, but to metallurgy.

COOPERATION OF SCIENTIFIC INVESTIGATORS.

It is not necessary to adduce further illustrations of the intimate practical bonds which unite chemical studies to the operations in the field. It is, of course, understood, without further reference, that the Division of Chemistry of the Department of Agriculture makes no claim to be the sole representative of investigators of this nature. The illustrations which have been given above serve only to show, citing the Division of Chemistry as an example, the intimate relation which scientific research bears to agriculture everywhere. Hundreds of chemists in the United States are engaged in similar researches, as well as equal numbers in Europe. It is important, however, that the farmer should from time to time be reminded of the debt which agriculture owes to chemistry. We are apt to forget the steps of the ladder by which we rise, and the chemist is often held in low esteem by practical men who owe the whole of their success to the investigations which he has made. A striking illustration of this fact has lately come to the notice of the writer in the prospectus for a beet-sugar factory, where the manager is put down for a salary of $5,000 a year and the engineer for $2,500, while the chemists are modestly put off with salaries of from $700 to $1,000 per annum. While agricultural chemistry laid the foundations which have made scientific agriculture possible, it does not arrogate to itself by any means the whole field of scientific research in regard to agriculture. The agricultural chemist welcomes most heartily his brother scientists who with equal zeal and equal success pursue those investigations which, although abstract and scientific in their nature, have in their final results the greatest practical value for the improvement and development of agricultural interests. While the agricultural chemist was first in the field, he realizes that the vast number of subjects which are open to research requires the collaboration of every branch of science, and all are entitled to equal rights and equal privileges in the investigation.

DIVISION OF ENTOMOLOGY.

By L. O. Howard, *Entomologist.*

Summed up in the fewest possible words, the work of the Division of Entomology is entirely directed toward answering the question, How may the farmer and fruit grower avoid damage to their crops by insects?

The work which the division is doing toward answering this question is both direct and indirect. Its direct functions may be summed up as follows: It is a correspondence bureau; it is an investigating bureau; it is a publishing bureau.

CORRESPONDENCE OF THE DIVISION.

It is in the exercise of the first of these functions—correspondence—that the office comes perhaps into closest contact with the farmer and fruit grower. The division holds itself ready to answer, so far as possible, all questions as to the nature of any insect which may damage crops and as to the best remedies to be used. Ten years ago this division was almost the only place in the United States where such inquiries could be satisfactorily answered. The offices of the State entomologists in Illinois and New York were the only other public offices of similar nature, although there were entomologists connected with a few of the leading agricultural colleges, such as Cornell, Michigan, and Iowa. With the recent establishment of one or more agricultural experiment stations in almost every State in the Union, it would seem that this correspondence would be, to a large extent, diverted from the national department. This has not been the case. The correspondence of the division has steadily increased. The experiment stations have stimulated farmers to take advantage of the opportunities offered by public institutions, and more than twice as many inquiries are now received at the division as before the establishment of experiment stations. At this date (October 1, 1897), for example, over 5,000 letters of inquiry requiring written answers have been received since January 1 (nine months), and many others have been answered by printed circular. Moreover, many farmers who live in the vicinity of Washington, D. C., or who are in the habit of visiting the city, have been given desired information by word of mouth.

The work entailed in answering one of these requests for information varies greatly. In the great majority of cases the inquiry relates to some well-known insect, and full information can readily be given either in circular or letter form. Frequently, however, something new or rare presents itself or some difficult question is received requiring hours of investigation before a satisfactory reply can be returned. Some insect not before known as especially injurious may come in any day with an account of serious damage from its work, and such cases frequently mean an investigation, not of hours, but of months. So that, when we say that something over 5,000 letters of inquiry have been answered in nine months, it must be understood that it means far more in the way of work than it does to a business man, for example. In fact, a considerable part of the time of the Entomologist, four assistants, and two clerks is occupied in this correspondence work. There can be no doubt that it is a most important branch of the work, and that it is productive of very considerable good to those agriculturists who avail themselves of it. Appreciative letters are frequently received from farmers and fruit growers who have gained information of much positive value through this correspondence.

INVESTIGATIONS OF THE DIVISION.

As an investigating medium the Division of Entomology is, as it must be, very active. It is a cardinal principle in remedial work against insects that the more one knows about the habits and life history of a given species the better are the chances of ascertaining a cheap and efficient remedy. Many insects can be successfully attacked only in the active feeding condition; with others the eggs are the easiest destroyed, and with others the insect in the quiescent overwintering stage. We must know not only how to recognize it in its different stages but must know just how long it remains in each stage and just how it comports itself in each. Specific insects might be mentioned to illustrate these points, but it will probably not be necessary in this paper. Each new insect which becomes prominent must be studied throughout its life round before we can say that we know best how to fight it. Moreover, even at this late date, careful investigation is constantly bringing to light new facts about old and supposedly well-known injurious insects.

For ordinary purposes, many of these studies of life history are made in the greenhouse attached to one of the buildings occupied by the division, and which, since it was built especially for insect study, is known as the "Insectary." By careful observation in confinement the main facts of the insect's life can be discovered. The accuracy of these observations as related to the normal development must, of course, be tested, where possible, by outdoor observations. The farming country around the city of Washington, therefore, is utilized for such observations, and studies are constantly being made in the large park in which the buildings of the Department are situated.

In the case of insects which will not flourish in the climate of the District of Columbia, careful field studies in the locality of injury are necessary. Formerly the division had field agents in different sections of the United States. With the establishment of the State experiment stations, however, the continuance of these field agents was considered unnecessary, since almost every State now has its official economic entomologist. Some States, however, are still unsupplied, and members of the office force of the division are frequently sent out into these States to investigate insect outbreaks which seem to need urgent investigation.

As illustrative of these two forms of investigation we may mention the San Jose scale and the Mexican cotton-boll weevil. The presence of the San Jose scale in the East was first recognized by the present chief of the division in 1893. During the following year a careful study of its life history was made in the "Insectary" at Washington, D. C., and for the first time its complete life round was carefully investigated. The history of the insect was so fully displayed that there has been no necessity for State entomologists to spend any time on this part of the extermination problem. This work was all done in the immediate vicinity of Washington, D. C.

The Mexican cotton-boll weevil, however, is known only in the State of Texas. Texas, although it has an agricultural experiment station, has no official entomologist. It became necessary to investigate this insect on the spot, and during the past three years four experts connected with the division have at different times studied the species in portions of Texas.

The number of insects requiring especial study of this kind is somewhat surprising. During the past sixteen years about 8,000 species have been studied with regard to their life history in this way. This means a total of 500 species new to the notebooks each year, additional notes being made each year upon species which have already received some study, so as to bring the total of species studied annually to an average of about 1,000.

REMEDIAL INVESTIGATIONS.

As will be inferred, the object in view in all of this study is to see how the insect can best be handled and the injury which it does prevented, so, together with this study of the life history, or, rather, supplementary to it, there is carried on experimentation from a remedial standpoint. Remedies are constantly being tested, and new insect-destroying substances are being experimented with. Such substances are tested not only as to their effects under varying conditions upon the insects themselves, but also as to their effect upon the plants upon which the insects feed, and as this effect frequently varies in warm weather and in cold weather, in wet weather and in dry weather, and even at different times of the day, a large amount of experimentation is involved in this branch of the work. Apparatus for the distribution of insect-destroying substances are also being tested. In former years much experimental work in the devising and construction of such apparatus was done and at least one result of lasting value was reached, viz, the invention of the cyclone or eddy-chamber system of nozzles, which has since come into general use in all parts of the world for the distribution of insecticide and fungicide mixtures. Of late years, however, the rapid increase in the use of spraying machines among farmers and fruit growers has attracted private enterprise to this field, and many business firms are engaged in the building and perfecting and sale of such apparatus. Within the past year, however, the division has had a gasoline motor spraying apparatus constructed for experimental work, which seems admirably adapted for community spraying of orchards and for work against shade-tree insects in cities and towns.

MORE GENERAL INVESTIGATIONS.

This investigating work is not entirely haphazard emergency work; that is to say, the division does not confine itself to investigating the specific insects which are brought to its attention as prominently injurious in this or that locality. Time is frequently saved by investigating groups of insects, or by investigating the whole subject of the insects which affect a certain agricultural product. Thus, studies have been made of the group of insects which in their larval state are known as cutworms, no matter what crop they may affect; so, also, with the scale insects. Then again, the entire subject of the insects affecting the orange has received investigation; also insects affecting cotton, insects affecting live stock, insects affecting cabbage, etc.

PUBLICATIONS OF THE DIVISION.

As a publishing bureau, the division issues a series of bulletins of general interest to farmers, some of them confined to one specific topic, such as the manual of apiculture, the bulletin on the San Jose scale, the bulletin on household insects or the bulletin on insects affecting live stock, and others containing a variety of shorter miscellaneous articles. It has also issued from time to time large reports dealing with some topic of greater scope, and other such reports are in process of preparation. Further, with the view of reducing the labor of correspondence, a series of circulars was undertaken, of which 26 numbers have been published. Each of these circulars gives an illustrated, condensed, practical account of some one prominent injurious insect. With the gradual growth of this series of circulars the Department will eventually have in print what will amount practically to a compendium of practical entomology for the United States.

The publications of the division are circulated as extensively and as freely as the terms of the law governing the printing and binding of Government publications and the funds at the disposal of the Department for that purpose will permit.

"INDIRECT" WORK OF THE DIVISION.

The work of the division which may be termed "indirect," as opposed to these perfectly obvious efforts to answer the question proposed in the opening paragraph of this paper, is, perhaps, quite as important as that which has already been discussed. This work is mainly connected with assisting the farmer, not directly, but through the economic entomologists of the United States, and, to a lesser extent, of foreign countries. It consists mainly in the preparation of bibliographies and of technical bulletins, in naming specimens sent in by these entomologists, and in giving them information about the literature. Thus, there has recently been printed a bibliography which gives the titles of all articles on American economic entomology published down to the year 1888. Together with the titles is given a short abstract of the contents of each article, and the work is cross indexed in such a way that any person by its use can learn in a moment's time exactly what has been published upon any given injurious insect. There is now completed in manuscript a supplementary bibliography, bringing our published writings on American economic entomology down to the close of the year 1896, and it is proposed hereafter to publish annual supplements.

The work in the naming of insects, for experiment station entomologists principally, is greatly facilitated in Washington by the presence of the great collection of insects in the U. S. National Museum, which was built up largely through the Department of Agriculture, and of which the Entomologist of the Department has charge, and forms another extensive branch of this indirect work. Many thousands of species are thus named each year for outside workers. The possession of a fairly extensive library also enables the division to give references to literature and to look up for outside workers matters published in books inaccessible to them.

There is, further, a class of work which, while direct in its ultimate bearings, is still indirect as regards immediate results, and concerns the entomologists of the different States. This work is connected with investigations covering a wide extent of territory. Such work, for example, is the study of the geographical distribution of injurious insects, the ascertaining of the boundary lines of such species, the study of the spread of imported pests, the bringing together of all facts relating to differences in life history and habits which depend upon differences in geographic situation, climate, precipitation, etc. In such work the division is assisted by the entomologists of the different States and the results are of reciprocal benefit. It is hoped eventually, for example, that the study of localities of injurious abundance of the principal injurious species will be carried to such a point as to enable the economic entomologist to determine with accuracy of any given locality that such and such an injurious insect will or will not affect such and such a crop in that locality.

Thus, the Division of Entomology occupies to a certain extent the position of a central consulting office for the numerous State offices and for other entomologists interested in the practical application of the study.

The correspondence of the division with the economic entomologists of foreign countries is very extensive and is of reciprocal benefit. The principal crop pests in foreign parts, which are at all times liable to be introduced into the United States, become thus known to the division, new methods in the way of remedial work are thus ascertained, and there is an occasional interchange of beneficial insects. It was by such foreign correspondence that the former chief of the division learned of the probable existence of some efficient natural enemy of the white, or fluted, scale in Australia, and was induced to send an assistant in search of it, an act which saved the orange and lemon industries of California from probable extinction, and at this time the present chief is sending, by the aid of the California State Board of Horticulture, natural enemies of the same destructive insect to Egypt and Portugal. Activity in America in the study of injurious insects has been so great of recent years, and legislative encouragement has been so steady, that the United States has achieved a very prominent position in investigations in economic entomology. The officers of the division are therefore constantly appealed to for advice by the officials of other countries, and at the same time returns are made in the way of information along the lines just indicated.

DIVISION OF BOTANY.

By Frederick V. Coville, *Botanist.*

INTRODUCTION.

In the organic law creating the Department of Agriculture, enacted in 1862, provision was made for scientific officers of three classes, namely, chemists, entomologists, and botanists. It was not, however, until 1869 that a Division of Botany was actually organized. In the twenty-eight years since the division was established three men have held the position of botanist: First, Dr. C. C. Parry, who occupied the position for two years, and whose principal achievement was the formation of a National Herbarium; second, Dr. George Vasey, who was botanist of the Department from 1872 to 1893, and whose lasting works were the building up of the National Herbarium and the diffusing of information relative to the agricultural grasses of the United States; and, third, the present incumbent, under whom a diversity of botanical work, to be described in detail hereafter, has been developed.

The history of the Division of Botany has been the history of the application of a technical knowledge of botany to the plant problems of agriculture. At first the application was hesitating, remote, and of questionable or slight utility; but little by little the real problems have come to be more clearly apparent and the manner and means of attacking them better understood. The American botanist of a generation ago was supposedly a man fully informed on every branch of botanical science, and from whom was expected, accordingly, a ready and authoritative decision upon every new plant problem. The American botanist of to-day is a man who approaches a new, difficult, and important problem in the attitude of a student, his first duty being to grasp every detail of the problem, his second to conceive and elaborate the solution, and his third to lay it clearly before the public. Formerly botanical science was considered something apart from practical affairs, a subject to be studied for its inherent interest only; now it is recognized that the public is the court of final appeal, and that investigations productive of real and fundamental knowledge, most intimately connected with human progress, are those chiefly to be pursued.

It is not to be expected that the history of the Division of Botany will show an unbroken series of problems presented, elaborated, and dismissed. The earlier conditions did not render so smooth a course possible. Much of the energy expended was doubtless unproductive. But the fact remains that a large proportion of the successful investigations in American agricultural botany were initiated in this division, some of them being carried to completion within it, others developing such importance as to have been deemed worthy of separation into distinct divisions. It is not possible in a brief sketch to give a detailed account of all the work done by the Division of Botany, but it is possible to cite a sufficient number of examples to give an idea of the whole.

THE NATIONAL HERBARIUM.

When the Division of Botany was established, in 1869, the Smithsonian Institution already had in its possession the botanical collections of several Government expeditions, and the Commissioner of Agriculture, Hon. Horace Capron, recognizing that a herbarium was a necessary part of the equipment of the new division, made an arrangement with the Smithsonian Institution, through its secretary, Joseph Henry, by which these collections were placed in the safe-keeping of the Division of Botany, though still remaining the property of the Institution. The result of this arrangement was that the Department of Agriculture had from the start a large reference herbarium, to which additions were made constantly both by the Department itself and by the Smithsonian Institution until the herbarium finally reached such dimensions that its maintenance became a financial burden to the Department. In 1896 the Smithsonian Institution again assumed its custody. At the time of this retransfer the herbarium was estimated to have a value of $150,000 to $250,000. It should always be remembered that to the Department of Agriculture, and specifically to the Division of Botany, is due chiefly the credit for the building up of this great series of collections. The herbarium is still in daily use by the Department in its various botanical investigations, and as indispensable a part of its equipment as a library or experimental grounds. Under the present arrangement the Department has the use of the herbarium without the expense of its maintenance.

FORAGE PLANTS.

As early as 1874, Dr. George Vasey, the Botanist of the Department, began his work on the improvement of the forage supply of the United States. At that time the hay product of the country amounted to about 25,000,000 tons per annum. In the Northeastern States the forage problem was already, in the main, solved, but in the South and in the West there was a deplorable lack of suitable forage plants. New England and New York had brought their grasses and clovers from Great Britain, and owing to a general similarity of climate had found them satisfactory. Their use had extended also to the middle West with equal success. With the increase of stock raising in the cotton country of the South, however, it was found that the old and well-known forage plants must be replaced by others better suited to the warmer climate. During the next decade, following the rapid depletion of the wild forage supply of the far West and the establishment of homesteads throughout that region, the similar discovery was made that the common forage plants of the East could not withstand the dry climate there prevailing. For many years the Botanist by correspondence brought together every particle of information available along these two lines, and in 1884 put it together in the form of a book entitled "The agricultural grasses of the United States." It was this report that the late Representative Hatch, of Missouri, long chairman of the Committee on Agriculture of the House of Representatives, declared to be, in his opinion, the most valuable report up to that time issued by any of the scientific divisions of the Department of Agriculture. This report was very widely distributed, and a second and revised edition was issued five years later.

In the year 1888 the lump-sum appropriation for botanical investigations and experiments was increased from $2,000 to $20,000, and the establishment of forage experiment stations was authorized. The principal station established under this act was at Garden City, in western Kansas, a situation typical of the subarid area known as the Great Plains. A large number of grasses, both native and foreign species, were cultivated at the station without irrigation. At the end of the five years' lease, in 1893, after the various species clearly not adapted to the region had been thrown out year by year, the experiment resulted in the demonstration that two forage plants, Hungarian brome and red Kafir corn, and one grain, Jerusalem corn, were the crops best suited to cultivation in those portions of the southern Great Plains where irrigation was impracticable. A few other plants, notably Colorado bluestem, gave promise of success, and their cultivation has since been followed up in other portions of the plains. The most important of the contributions of this Garden City station to the progress of agriculture, however, was to demonstrate that the grain-producing varieties of Kafir corn, particularly the variety known as Jerusalem corn, was of all known grains the best adapted to the region. Both maize and wheat were in most years a failure, on account of the scant rainfall, and had not this new grain been introduced the nonirrigable lands of the region would have lapsed into their original uncultivated condition. The station was an object lesson to thousands of despairing farmers. It showed them that Kafir corn could produce a good crop when everything else was killed by the drought; that Kafir corn was the equal of maize for fattening hogs and feeding farm stock, and that it could be made into good bread. Thousands of bushels were distributed among the farmers, and they found the grain as successful on their own farms as at the station. At the end of the five years' life of the station Kafir corn was very generally cultivated, the shipment of fat hogs had shown a marked increase, and the farmers were making a far more comfortable living than before. Since that time Kafir corn has become the leading grain crop in western Kansas and western Oklahoma, and its cultivation is now thoroughly established.

In the Southern States, also, the betterment of the forage product was undertaken by means of the same appropriation that made the Garden City experiments possible. Collaboration with the experiment stations was effected in the States of Louisiana, Mississippi, Florida, Georgia, and North Carolina. Grasses and other forage plants to the number of 508 were tried, experimentally, and about 35 were found successful. About 12 of these fill the practical requirements of the South, covering the different soils and the different seasons of the year. To show the enormous benefit resulting from these experiments it is only necessary to cite statistics relative to the yield of hay in the five States in which the experiments were conducted. According to the census returns for 1880 this yield (per acre of hay in these States) averaged 0.86 ton, the average for the whole United States being 1.14 tons. The report of the Division of Statistics for November, 1893, the year in which the experiments were completed, so far as the Department of Agriculture was concerned, shows that in that season these five States had increased their yield to 1.66 tons per acre, while the average for the entire country had increased to only 1.32 tons. At the beginning of the fiscal year 1895–96 a new division, the Division of Agrostology, was established, which assumed the work of forage investigations. To this division that portion of the corps of the Division of Botany previously engaged in such investigations was transferred.

FUNGOUS DISEASES OF PLANTS.

In his annual report for the year 1872, the Botanist touched upon the subject of the fungous diseases of plants, quoting an account of a valuable piece of work that had been done on the plum and cherry disease known as black knot. No reference to investigations in this line are found in the annual reports thereafter until 1885, in which year the report of the Botanist contained a preliminary notice of several diseases under examination. The investigations in this direction were pushed for several years. In the case of two diseases, the downy mildew and black rot, both of the grape, effective remedies were announced and means for their economical application were devised. As a result, an industry which was before liable to enormous losses in unfavorable years was transformed into one that could be regularly depended upon to produce substantial results. There are no statistics which show the amount in dollars thus saved to our fruit growers, but unquestionably losses which would have aggregated hundreds of thousands of dollars have been prevented in the few years since these discoveries were made and published. At the present time an application of these remedies when the diseases threaten to break out is as much a part of the raising of good grapes as the use of a hoe or cultivator is a part of the tilling of ordinary farm crops. In course of time (1889) this branch of the work was confided to an independent division, now known as the Division of Vegetable Physiology and Pathology.

PURE SEED.

One of the first measures taken in 1893 toward a reorganization of the Division of Botany was to establish and equip a laboratory for testing the quality of commercial seeds. In the spring of 1895, after the seed intended for distribution by the Department had already been purchased, it was decided for purposes of general information to test them. The tests showed that some of the seed was of very poor quality, and that in a few cases deliberate fraud had been perpetrated. For the first time in the history of the Department did its authorities know the real quality of the seeds they had distributed. The following year there was a revision of the seed-purchasing methods of the Department, and year by year these methods have been improved, until now the Department not only knows exactly the quality of the seeds it distributes but pays only for the good seed. The five firms furnishing seed for the distribution of 1897 were under contract, in case any seed fell below a specified standard of purity and germination, to pay back to the Department a proportional amount of the contract price. The total drawback collected by the Department under its contract and based on the tests made by the Division of Botany amounted in this one season to $3,397.86.

Reputable seed dealers handle good seed, but a great deal of trash is placed on the market by irresponsible firms. The Division of Botany in order to point out more forcibly the existence of such poor seed has tested a large number of samples purchased in the open market or sent in by correspondents. It has examined seed sent out as "extra-cleaned Kentucky blue grass" that contained only 26 per cent of Kentucky blue grass seed. It has examined samples named Rhode Island bent grass that contained only 2 per cent of the seed of that grass. Such seed may cause the almost total failure of a crop, but seed of a considerably higher percentage of purity often does harm of a different character. A sample of timothy seed of the 1897 crop offered for sale at the Chicago board of trade and rejected was sent to the Department to be tested. It contained 29.8 per cent of impurities, consisting chiefly of the seeds of two weeds, one at the rate of 288,000 seeds per pound, the other at the rate of 450,000 per pound. Recently the division received from a Maryland farmer a sample of clover seed about which he wanted an opinion. It was found that, though it looked like high-grade seed, in reality 36.7 per cent consisted of the seed of yellow trefoil, a weed the seed of which so closely resembles that of clover as to be readily distinguished only by an expert. There is every reason to believe that this was not an impurity of the ordinary sort, but a deliberate adulteration. A similar case occurred in a lot of grass seed purchased by the Department two years ago for general distribution. A sample of supposed yellow oat grass which cost $50 per hundred pounds was found upon critical examination to contain 74.4 per cent of impurities, mostly consisting of the seed of wood hair grass, worth about $10 per hundred. It was ascertained that this adulteration had originated in Europe, and that the American importers had themselves been deceived.

The importance of good seed to successful farming has become so generally appreciated within the past few years among agriculturists that the Association of Agricultural Colleges and Experiment Stations recently appointed a committee to devise a uniform system of seed testing. The Division of Botany was represented on this committee, and a report, following in the main the system the division had already tried and found successful, was adopted. Thus, the results of the work are becoming widely disseminated throughout the United States, and can not fail to be productive of the highest good.

WEEDS.

The subject of weeds is one that has always been prominent in the correspondence of the Division of Botany. The questions received are often difficult to handle, but the Department has nevertheless investigated many of them, and has published information which would enable an intelligent and industrious farmer so to deal with particular weeds as to destroy the greatest number with the least expenditure of labor. The Russian thistle, which came prominently before the public on account of the widespread damage caused by it in the Northwest, furnishes an illustration of Department work in this line. An assistant botanist was sent to the Dakotas in 1892 and again in 1893, and the whole life history of the plant was worked out. It was found that by cutting the weed at a certain season, August 1 to 20, the formation of seed could be prevented. On the basis of this knowledge the method of dealing with the weed in the Northwest was chiefly established. Exactly how much actual gain these enlightened methods of handling the weed have brought to the farmers of the Northwest it is impossible to estimate, but there can be no doubt that they constituted a vast improvement over earlier ineffectual methods of procedure. Various other weeds have been taken up in a similar manner, and descriptions of their vulnerable points published.

One direction in which the Division of Botany has been in many cases conspicuously successful in the handling of weeds is in preventing their introduction into uninfested portions of the country. Through a large number of correspondents in all parts of the United States the division is kept informed as to the distribution of our worst weeds, and maps showing at a glance their present range are constructed and kept on file. When information is received that one of these weeds has been found far beyond its known limits the local authorities are advised of the fact and the importance of promptly destroying it suggested, together with means by which this destruction can be accomplished. In the case of the Russian thistle this plan has been pursued with success. The authorities in California, for example, were notified by the Department of Agriculture that the Russian thistle was growing at a certain railway station in that State and were advised to root it out. The State authorities thereupon employed an agent to traverse the railroad lines and wherever the Russian thistle was found to exterminate it. This has been done successfully, and, while it is quite possible that the Russian thistle may ultimately become established in California, such establishment will be postponed for many years, and the enormous damage to the wheat crops warded off for just that period. It was estimated that in 1893, a season favorable to its growth, the Russian thistle damaged the wheat crop of the West to the extent of $3,000,000 to $5,000,000.

The woolly mullein, a European weed, was discovered a few years ago by one of the correspondents of the Division of Botany at a certain point in the State of Kentucky. An assistant was sent to examine into the case. It appeared that the weed was likely to prove a bad one, but that only a small area had been infested up to that time. The authorities at the State experiment station were notified, and in due time the division was informed by them that the infested area had been carefully cleaned and that it was believed the weed had been exterminated. Had the same thing been done with the Russian thistle ten years ago an amount would have been saved the wheat growers of the Northwest sufficient to pay the cost of maintaining the whole Department of Agriculture for many years to come.

A study of the means of dispersion of weed seeds has been made, and it appears that most weeds are introduced first in impure seed from abroad, that when once introduced they are rapidly carried from point to point and from State to State through the various channels of trade, particularly in commercial seed, in grain, and in the litter of cattle cars, the most important lines of dispersion being the railroads of the country. The railroad companies have been very quick to respond to suggestions that their right of way be kept clear of weeds.

The State legislation relative to the destruction of weeds has been examined into by the Division of Botany, and it is found that almost all the State weed laws are inoperative, either because they are not explicit or because their execution is too cumbersome and too expensive. A compilation of all the State weed laws has been made, and a model weed law based on the investigations of the Department has been prepared and published. Recent legislation by some of the Western States has followed closely this model law proposed by the Department.

POISONOUS PLANTS.

In the year 1894, on account of numerous inquiries received relative to poisonous and medicinal plants, an assistant with the necessary botanical and chemical education was secured and set at work upon the study of those plants which were the most common sources of poisoning in animals and man. The original investigations up to the present time have been confined principally to laurel and related plants which contain the principle known as andromedotoxin, a poison often fatal to sheep, cows, and sometimes to other farm stock. A widespread demand for information about those poisonous plants which are a menace to children has temporarily taken the place, however, of special chemical and physiological researches, and a Farmers' Bulletin and other publications of a similar nature on our common poisonous plants have been prepared. While, therefore, the investigations of poisonous plants have not as yet reached the point at which their value to the farmer in telling him how to prevent the death of his animals from eating poisonous plants can be expressed in dollars and cents, nevertheless a large amount of valuable general information has been published which the public is very glad to get and could not get in any other way.

NATIVE PLANT RESOURCES.

The early transcontinental expeditions and surveys carried on by the Government were usually accompanied by a naturalist, a part of whose duties was to do botanical work. The report written by this officer or based upon his collections customarily consisted of a systematic enumeration, sometimes with descriptions, of the plants collected on the expedition, but it was seldom that any real economic deductions were drawn from these researches. Most of them constituted what may be called pure scientific work. For many years there has been a demand, particularly in the far Western States, for fuller information regarding our flora. The Division of Botany, therefore, several years ago undertook a systematic exploration of the least-known parts of our country, cataloguing the plants collected, discussing the natural agricultural areas as outlined by the extent of particular plant formations, enumerating all the known local uses of plants, especially among the aborigines, and drawing various economic conclusions. Among these reports the one entitled "Botany of the Death Valley expedition" enunciated the principles of plant distribution, particularly as illustrated in the Southwestern United States. The "Flora of the sand hills of Nebraska" pointed out the peculiar conditions under which the vegetation of the region has been differentiated, and drew therefrom some pertinent conclusions. A third paper of the same class was entitled "General report on a botanical survey of the Cœur d'Alene Mountains in Idaho."

Another report entitled "Notes on the plants used by the Klamath Indians of Oregon" is an account of the aboriginal uses of plants by one of our native tribes. It contains a number of facts which are very suggestive in the direction of taking up in our own agricultural economy, for food or other purposes, some of the plants used for centuries by the native tribes of the United States. One of the plants mentioned several years ago in the annual report of the Botanist as in use among the aborigines and as giving promise of importance as an agricultural product is canaigre. This was employed by the Southwestern Indians as a native dye and tan. Its cultivation has proved in recent years to be thoroughly practicable and a marked commercial success. It is undoubtedly true that other plants used by the American aborigines will fill places in civilized agriculture in the same manner as maize, the potato, the tomato, canaigre, and others have already done, and it is to make a record of all the facts that are likely to be suggestive in this direction that the Division of Botany is conducting these investigations. The sum total of miscellaneous investigations brought together by this method after a period of several years forms a valuable record.

NEW AGRICULTURAL CROPS.

Within the past year the Division of Botany has devoted its attention to the investigation of certain agricultural crops which are now imported in large amounts and which could probably be grown in the United States with profit. The value of these miscellaneous imports amounts to $8,000,000 or $10,000,000 annually. The first one taken up for investigation was chicory, the dried root of which is imported for manufacture into a coffee substitute, the total imports for this purpose amounting to $250,000 per annum. Investigation has shown that this crop can be grown successfully, and there is no doubt that it can be grown with profit. It is believed that experience will show that within ten years practically all the chicory used in this country will be grown within the United States, should the present trade relations continue.

As illustrating what can be done in the direction of miscellaneous crops, may be cited the case of pyrethrum, the plant from which insect powder is manufactured. The following statement shows how the imports of the powder manufactured from pyrethrum and similar plants have decreased during the past ten years from $129.783 to $2,134:

Value of imports of insect powder.

1887	$129, 783
1888	127, 913
1889	89, 429
1890	46, 298
1891	23, 698
1892	17, 691
1893	15, 765
1894	16, 027
1895	786
1896	2, 134
Total	469, 524

This means that the experimental cultivation of pyrethrum in California about fifteen years ago has proved a success, and that we are now able to grow all of the product we need. Our investigations relative to new agricultural crops have practically only just begun, and it is impossible to point out actual results in dollars and cents. Such results will not be evident to their full extent until the introductions favored by our reports have been attempted by farmers and their practicability substantiated or otherwise.

DIVISION OF VEGETABLE PHYSIOLOGY AND PATHOLOGY.

By B. T. Galloway, *Chief.*

INTRODUCTION.

It is written in nature that all living things must die, and plants grown by man for food and raiment are no exception to this law. Long before plants were cultivated they were subject to diseases, which at times carried off many forms, and these, in the constant struggle in which all nature takes part, gave place to others better adapted to the surrounding conditions. As time progressed man found it necessary to increase his food supply, and to do this certain plants were brought together and made to grow out of nature's usual way. Thus was born the art of agriculture, and from the few simple practices followed at first there have developed the infinite complications and variations in the methods known to-day. But man in his desire to make all nature subservient to his will was not to escape the penalty of changing the usual course of nature, so it followed that when he began to grow plants and to introduce new forms from time to time he also introduced the diseases which have prevailed among such forms in their wild state.

The introduction of diseases, however, was not the only problem brought forward by the efforts of man to keep pace with his own wants. By the removal of forests, the tilling of the fields, and the causing of crops to grow in widely extended and often compact groups the equilibrium in nature, which in a wild state is at least approximately attained, was severely disturbed, and thus in many cases better opportunities for development were afforded the foes of cultivated plants, for they had more material to work upon and the resistance to their attacks was naturally less.

It is not strange, therefore, that references to the diseases of plants are found in the earliest literature. The destructiveness of blights and mildews was known and appreciated in ancient times, and ceremonies were offered to the gods and other practices followed for the purpose of keeping these pests in check. As knowledge increased and experience opened new fields of thought, a better understanding of the nature of many of the diseases was acquired. Even at the present time, however, the matter is often bewildering to the husbandman, owing partly to the obscure nature of many of the diseases and the difficulty of understanding questions which only long and special study can make entirely plain. The perplexities connected with the subject are often made greater by the very fact that the disturbances which brought various diseases into activity in the past are still at work in a more intensified form than was the case even a comparatively few years ago. Man himself is the prime factor in bringing about this state of affairs, and so long as he continues to change the habits of his plants (to strive to improve them, in other words) just so long will he, by this very action, keep them in a state of unbalanced equilibrium, and very little disturbance in any direction will often completely upset them, and in the end cause them to succumb to their foes in one way or another.

Thus, it appears that diseases have been in existence as long as plants, that they will continue their destructive work in various ways and under varying conditions, and that they are likely to be particularly bad so long as man continues his work as a disturbing element. That the scope of the work about to be described may be more clearly understood, it may now be well to consider briefly what is actually meant by disease.

DISEASE AND ITS VARIOUS FORMS.

It may seem easy at first thought to define disease, but when we come to consider the various questions involved we find the matter complicated in a number of ways. Strictly speaking, a plant or other organism may be considered diseased when from any cause its functions become abnormal. If this definition is accepted, however, it will be seen that there are numerous cases where plants ordinarily considered healthy are in reality diseased. Thus, many plants are incapable of propagating themselves, and but for the care of man would disappear. In such cases certain functions are deranged, and in this sense the plant is in reality diseased. From the standpoint of the grower of such plants, however, they are not looked upon as diseased, unless in some way their value to him is lessened or entirely curtailed. The term, in other words, is a relative one.

FACTORS CAUSING DISEASE.

Disease, then, as the farmer, gardener, and fruit grower understand it, may be brought on by a great many causes, and it will be understood that these causes are often exceedingly complicated and difficult to unravel. In so far as we are at present concerned it may be said that diseases of plants are due to two sets of factors: (1) The influences of the inanimate world, such as unfavorable soil, too much or too little moisture, excessive heat or cold, too much or too little food, etc., and (2) the action of living organisms, principally insects and minute plants known as fungi. With insects we are not concerned, as they properly belong to another branch of the Department. The fungi are a great group of plants, which for the most part are so minute that they can be seen and studied only with the aid of the microscope. Thousands of forms are known, and there is scarcely a crop that is not subject to attack from one or more. It is not necessary at this point to go into detail as to how these minute organisms live, grow, and reproduce themselves. Suffice it to say that in the main they can not obtain their food from the air and soil, hence they must look elsewhere for it, and in the crops we grow they find it already prepared. Upon these crops they fasten themselves and proceed to rob them of their nourishment, and the plants thus attacked gradually become weak and die unless by some means the power of the fungus to do its work is checked. It must be remembered, however, that no sharp line can be drawn between the diseases due to unfavorable conditions and those in which fungi take part. In every case where the matter is carefully studied, it is found difficult to say where the effects of one factor or set of factors begin and those of another leave off. An example or two will make this matter plain and at the same time indicate the general lines followed in making investigations.

EXAMPLES OF DISEASES.

From the examples following a fair idea may be formed of some of the diseases with which the grower of plants has to deal. Only a bare outline of the simplest facts are given, however, as it is neither necessary nor desirable to go into details in the present paper.

Root diseases.—It is not uncommon to find fruit trees and other plants gradually losing vitality, the leaves becoming small and yellow, and the entire growth more or less stunted. A study of such plants and their surroundings may reveal the fact that the roots have been slowly killed, and the plants being unable to get proper food and water have died of starvation, complicated, it is true, with other troubles which necessarily accompany the destruction of the roots. The death of the roots may have been due to lack of air in the soil, this being the direct result of the size and arrangement of the soil grains. Soils of this kind, and they are not uncommon, are quickly made wet, and as soon as the water between the grains exceeds a certain amount circulation of the air is stopped, the activity of organisms necessary to the life of the soil is checked, the roots are slowly suffocated, and a long train of other changes follow, and as a final result the plant dies. Of course, it must be understood that the mere yellowing of the leaves of a plant, accompanied by a dwarfing of growth, is not always brought on by the conditions described. Other surroundings may produce similar results, and it is on this account that the questions involved are often so perplexing. In the case just described neither fungi nor insects have played any important part, although it is not uncommon to find certain forms present in advanced stages of the disease. These, however, are to be looked upon more in the nature of scavengers, as they play no important part in the real death of the plant.

Changes brought about in plants by man.—We may now consider a second example, in which changes in the functions are inadvertently brought on by man, and as a result of these changes a fungus, which under normal conditions could not obtain a foothold upon the plant, comes in and carries destruction and death with it. It is occasionally the practice in orchard work and in cases where trees are grown for shade and ornament to severely prune them. Sometimes this is done to top graft with other varieties and sometimes merely to remove what is considered an excessive growth of wood. Frequently the cutting away of large branches throws the functions of the tree entirely out of balance. The plant has grown with a certain relation between the development of its roots and branches, and if a considerable number of the latter are removed a corresponding portion of the roots, if left, must eventually die, for the top of the tree will not be able to support them in health. In the various destructive changes which take place at such a time the whole tree may become involved. The partly decaying roots bring about changes in the food supply, and this in time causes an imperfect development of all the tissues above ground, the leaves, branches, and trunk becoming more or less weakened and consequently less able to resist the attacks of outside organisms. Under such conditions the tree is often attacked by a fungus which slowly kills the living wood of the trunk and larger branches. Eventually the trunk may be entirely girdled by this organism, and the tree will in consequence die. As long as the tree performs its functions normally the fungus is unable to gain a foothold, although perhaps present at all times. Were it not for the action of the fungus the tree would doubtless have eventually adapted itself to the changed conditions, and with proper care would have recovered.

Fungous diseases.—Now, turning our attention to an example where the fungus itself takes the aggressive part from the start, we may cite the case of the well-known potato blight, or downy mildew, which in past years has been the cause of a loss of millions of dollars in this and other countries. Potato fields which throughout the season have been green and vigorous, when attacked by this disease suddenly turn brown in July and August, and within a few days the plants become a rotten, foul-smelling mass. An examination of the foliage of the diseased plants soon after they commence to turn brown reveals little to the eye. Here and there tufts of a whitish, downy growth may be seen scattered over the surface of the leaves, but without the aid of a microscope it is impossible to make anything out of them. When that instrument is brought into use, however, it is seen that the downy, frost-like growth consists of a miniature forest of delicate, whitish threads, branched and rebranched like the limbs of a tree. Upon the ends of the delicate branches minute, egg-shaped, colorless bodies are seen, and they break off easily if slightly disturbed. By proper manipulation of the microscope it will be seen that the little tree-like growths send their delicate threads down into the tissues of the leaf, and that wherever they come in contact with the tissues they rob them of their nourishment and use it in building up their own structures. The small, egg-shaped bodies described are for the purpose of reproduction, fulfilling the same office as the seed of higher plants. Rain or dew or slight currents of air cause these bodies to break from their delicate supports. Many are lost or destroyed, but many others reach healthy potato leaves, and there, in the presence of the proper amount of moisture and heat, they germinate and produce the same kind of delicate threads as those from which they originated. In this way the disease is rapidly spread, only a few days being necessary for each successive crop of reproductive bodies to develop, and as millions are produced on each leaf, it will be seen that the fungus may, under proper conditions, be quickly disseminated.

LOSSES CAUSED BY DISEASE.

It would be difficult to give a fair idea as to the number of plant diseases and the damage they cause in the aggregate. So many factors come into play and so many complications are involved that only approximate statements can be made. It is probable that the loss in the United States from the diseases affecting cereals, such as smuts and rusts, will alone amount to $25,000,000 or $30,000,000 annually. Cotton, tobacco, potatoes, and other staple crops are correspondingly damaged, and the same is true of many similar crops. While the losses are sorely felt by farmers as a whole in such cases as have been mentioned, they are particularly noticeable and are felt with striking severity where intensive lines of work are followed and certain crops grown as specialties. In such cases it is the individual who has tangible evidence as to the actual amount he is out of pocket as a result of the attacks of certain diseases. A case in point is found in the growing of oranges, lemons, and other citrus fruits in Florida, where, judging from carefully collected data, it appears that the loss in one year from diseases which have been studied was more than $450,000. This loss, falling as it did upon a comparatively few individuals, was of course felt all the more severely. When other fruits, vegetables, and the many plants grown for ornament and for flowers are considered, the injuries become more and more striking. Probably it would not be overestimating the loss from plant diseases as a whole in this country to place it at $150,000,000 to $200,000,000 annually. We will now see in what way the Department is endeavoring to help the husbandman in this matter, and will point out as clearly as possible a few of the results.

METHODS OF CONDUCTING INVESTIGATIONS.

NECESSITY OF A THOROUGH KNOWLEDGE OF PLANTS.

From what has been said, it will be understood that, generally speaking, to arrive at any definite conclusions in regard to the treatment of a disease a knowledge of the cause or causes must first of all be obtained. Empiricism in such matters can not long avail, although it may be and is sometimes followed with more or less beneficial results, and moreover no rational understanding of a disease can be obtained without first knowing how the plant behaves in health. The very foundation of all work on the diseases of plants, or vegetable pathology, therefore, should be a study of the normal life processes, or vegetable physiology; in other words, to fully appreciate the changes which are taking place in a diseased plant and the conditions surrounding it, a thorough knowledge must be had as to how the healthy plant behaves and its relations to soil, air, heat, moisture, and other environmental conditions. As will be seen, the complications involved lead off into numerous difficult and perplexing questions, and the aid of many branches of science must be called in before definite conclusions can be reached. The men, however, who grow plants for the money there is in them are not concerned with these details, as the main point of interest to them is how the knowledge obtained by such work enables them to grow better crops and to realize from them greater profits.

OBJECT OF THE INVESTIGATIONS.

Briefly, then, the plant pathological work of the Department is planned to obtain, first of all, as thorough a knowledge as possible of the behavior of plants in response to disturbing influences. It is in such cases that careful laboratory, greenhouse, and field experiments must be made and investigations requiring great care and patience carried on. Let us take an example that will appeal to thousands of fruit growers, namely, the fire blight, or, as it is sometimes called, twig blight, of the pear. Following the line of investigation that has been carried on in the case of this disease, it will be seen in a general way how the Department's work is conducted and how it is all made with a view of practical application in the end.

STUDY OF BLIGHT.

In the laboratory it has been found that blight is invariably accompanied by a minute organism, a bacillus, allied to those which cause such dangerous diseases as tuberculosis and typhoid fever in man.

These minute germs have been found in countless millions in the delicate cells of the plant, but to prove that they were the actual cause of the disease it was necessary to separate them from the pear tissues and all other organisms present, to grow them wholly apart and in an absolutely pure state, and finally to bring them again into contact with healthy pear trees and produce the disease. This has been done. The germs of pear blight, free from all other organisms, have been made to grow on potato, on various kinds of gelatin, and on other media, just as the farmer grows a crop of corn on a soil free from all other plants. The germs grown in this way, when pricked into the delicate tissues of a young pear shoot, multiply rapidly, and in a few days there is a well-developed case of the disease. The cause of the disease being thus definitely determined, it remained to find out how it was spread from tree to tree, and how, after seemingly disappearing in late summer, it would break out again the following spring. The work was now transferred from the laboratory to the orchard itself. Here it was found that insects, particularly bees, play an important part in disseminating the disease. One very destructive form of blight occurs in the blossoms, and the bees in visiting these for honey carry the germs to healthy flowers. Thus, from one center a whole orchard may soon become infected, and with what results will be easily understood by those familiar with the way the blight works.

While bees were found to be a really serious factor so far as the spread of blight was concerned, the work brought out a fact heretofore unknown, but of vast importance to fruit growers, namely, that many varieties of pears will not fruit at all unless bees have access to them—in other words, their own pollen is not potent, and they require the pollen from some other variety in order to set fruit. This fact explains why large blocks of certain varieties are unfruitful, and suggests a way of overcoming the difficulty.

Coming back to blight, the studies in the orchard further revealed the very important fact that while the branches killed during the summer usually contain no living germs after a few weeks, in a certain small proportion of them, at the point where the diseased part merges into the healthy, they do remain alive, and also that these germs pass the winter in a partly dormant condition. As soon as spring opens, the germs in these few "hold-over" cases again start into active life and in a short time become so numerous that they ooze from the wood in gummy masses. Insects are attracted to this more or less sweetish gum, and by visiting it and then going to other trees, especially to the blossoms, they redistribute the organism. So much, therefore, for what has been developed by a long and careful study of this disease. It now remained to apply the knowledge in a practical way, which was done by what has come to be known as the winter method of combating blight. This consists simply in a careful inspection of the orchard in the fall or early winter and a cutting out of every branch showing any sign of the hold-over blight. Not only is it necessary to cut out these branches, but it is important that they be completely destroyed by fire. Following this practice carefully, it has been found practicable to eradicate blight not only from the orchard, but also from the nursery, where the conditions for spreading are much better, owing to the way the trees are planted.

FUNGICIDES.

Other diseases, of course, must be studied and treated in an entirely different manner. For instance, in many cases it has been found practicable to prevent serious injury to crops by the application of preparations known as fungicides. The efficacy of these fungicides in particular cases and their effects on the plant and on man himself must all be considered. Then, too, there are important questions in mechanics that demand attention; for instance, a fungicide may be cheap and effective, and yet unless it can be applied in actual field-work in an economical way it will have to be discarded. All this work involves the art of spraying plants, which has been developed practically within the past ten years, but which has now reached a point where it is regarded to be as necessary as pruning or the cultivation and fertilization of the soil.

PLANT BREEDING.

There is a phase of the work which is fully as important, if not more so, than any thus far enumerated, namely, a study of plants and plant life for the purpose of establishing the conditions necessary for that development which will make them most profitable to the grower. Every plant must be regarded as capable of attaining a certain ideal development, and if it does not do this something is wrong either with it or the surroundings in which it is forced to grow. It will be seen, therefore, that there is an important field in studying the conditions under which our crops attain their highest development and in pointing out the principles which will enable the grower to not only modify his conditions to suit the plants, but to modify the plants to suit the conditions. This involves the important work of plant breeding, a subject which can not well be considered apart from plant physiology and pathology.

The importance of such work is shown by some recent investigations carried on by the division in California on the raisin grape. Owing to an inherent weakness in the vine the flowers "blast" at blooming time, and as a result it is not uncommon for the whole crop to be lost. Some seasons this loss exceeds a million dollars or more, and it is therefore of the utmost importance to find a means of preventing it.

While blighting is influenced by climatic conditions, it is unquestionably due to a constitutional weakness of the vine, in which insects and fungi take no part. Certain varieties do not have this weakness, but they are not suited to the purpose for which the other varieties are grown. It is here that breeding has come into play, with every prospect of success. The choice varieties noted for their tendency to drop the flowers have been crossed with other less desirable ones known to be free from this trouble. Thousands of seedlings have been produced by these crosses, and some give promise of having all the hardiness of one parent and the desirable qualities, so far as fruit is concerned, of the other. Thus, by crossing, by selection, and in other ways the value and usefulness of plants to man may be increased, from the fact that they are made not only to more properly fit certain conditions, but that by being adapted to these conditions their health is maintained and a better development reached in every way.

SOME PRACTICAL RESULTS OF THE WORK.

GROWTH OF THE SCIENTIFIC TREATMENT OF PLANT DISEASES.

In the whole history of agricultural practice no phase of it, probably, has made such rapid strides in so short a time as the investigation and treatment of plant diseases. Less than fifteen years ago this subject was rarely referred to in print, and it was seldom that there was any discussion bearing on the matter at agricultural, horticultural, and other meetings. There were but few experiment stations then in the country, and such work as those in existence were doing was along the lines of chemistry, feeding, etc.

WORK FOR THE BENEFIT OF THE GRAPE GROWER.

Twelve years ago the Department began the work on plant diseases in a small way, its efforts at first being devoted to a few of the more important diseases of fruits. In the beginning the investigations were confined to the laboratory, it being recognized that before any practical results could be secured in the field, knowledge must be obtained as to the nature of the diseases it was intended to combat. A special effort was put forth to discover the cause and best means of preventing the serious loss to grape growers through the ravages of several widespread diseases. At the time this work was undertaken the growing of grapes for market was being abandoned in many sections, it being no longer possible to obtain a crop on account of one disease in particular—namely, black rot. The work of the Department showed that this disease was due to a fungus. Furthermore, it showed how the fungus lives from year to year, and how part of the time its growth is confined to the living berries on the vine and part of the time to the old, dried, and shriveled fruits which fall to the ground. The latter, it was found, furnish the means of again starting the pest another season, and thus the more the rotten berries accumulate on the ground the more danger there is of infections the next year. Possessing these facts and many others, the details of which need not be mentioned here, it remained to discover some means of protecting the grape from the parasite in a way that would be sufficiently cheap and practical to warrant its adoption by grape growers themselves. The only way to accomplish this object or to determine whether it could be accomplished was by work in the vineyards, conducted so as to leave no doubt as to the results. This work was inaugurated, and eventually it was proved that by the proper use of various solutions sprayed upon the vines the latter would not be injured in the least, but the attacks of the fungus would in large part be prevented. To reduce the operation to a practical basis, many difficulties had to be overcome. The question of suitable apparatus was a difficult one, as few manufacturers were willing to put a machine on the market without some assurance that there would be a demand for it. That these obstacles were overcome, however, and that the work was a success is shown by the widespread application of the results obtained. For the first few years, despite the widely published statements concerning the work, it was difficult to get growers to undertake it. Men were actually paid to spray their vines in order that the results might be utilized as an object lesson for others. Five years after the first successful treatment of black rot, however, carefully collected data showed that there were over fifty thousand grape growers treating their vines in accordance with the directions issued by the Department. The industry, which for years had languished or been abandoned in many sections, was revived, and, as was stated by the viticultural expert connected with the Eleventh Census, the work of the Department of Agriculture has practically revolutionized grape culture in many sections.

Figures showing the actual money value of such work are always difficult to obtain, yet they serve as convincing argument, and hence the desirability of having them. For the purpose of getting such figures in reference to the effects of treatment on grape diseases, arrangements were made at one time with about three hundred grape growers to so plan their work as to obtain as definite facts as possible in regard to the actual money value of the operations carried out under the directions of the Department. It was found that the treated vines yielded on an average 80 per cent more fruit than the untreated, and that the actual gain as a result of the work ranged all the way from $20 to $150 per acre. The aggregate gain, as estimated by the entire three hundred growers, was something over $20,000, while the expense, including labor and cost of all materials used, did not exceed $2,000. In other words, this experiment and many others made afterwards showed beyond question that at an expenditure of, approximately, 1½ cents per bearing vine seven or eight years old or more from 10 to 25 cents gain followed in the fruit production alone.

Since the facts here given were obtained the practice of spraying grapes has extended throughout this and many foreign countries, and it would probably be difficult to find a grape grower at this time in the United States who has not in some way profited by the work.

WORK FOR THE BENEFIT OF THE NURSERYMAN.

Another line of work in which important practical results have been obtained is the treatment of nursery stock for the various diseases to which it is subject. Millions of apple, pear, cherry, plum, quince, and other trees are grown in this country, the industry being one of the most important of all horticultural pursuits. Pears, cherries, plums, and quinces are particularly subject to a disease generally known as leaf blight, which causes the leaves to fall early in the season, thereby shortening the period of growth, and thus not only stunting the tree, but in the case of seedlings preventing the insertion of buds—an operation necessary in order to obtain the desired varieties. Several years ago the Department began an investigation of the diseases of nursery stock, inaugurating experiments which extended through several seasons. The work was intended primarily to determine the possibility of preventing the diseases, the cost involved, and the actual gain in the growth of the tree, if any, as measured by dollars and cents. Over a hundred thousand trees were used in the experiment, and it was shown that the cost of the work was 25 cents per thousand the first season and the same the second year. The third year it was 40 cents, making the total cost for three seasons' work 90 cents per thousand trees. The net profit, as determined by the nurseryman who dug the trees and sold them, ranged from $1 to $40 per thousand, the average being $13, or about 1,400 per cent on the actual money expended.

WORK FOR THE BENEFIT OF THE ORCHARDIST.

The same diseases which cause serious loss in the nursery also attack pear, cherry, plum, and quince in the orchard. Here also important practical results have been obtained. At an expenditure rarely exceeding 15 cents per tree it has been shown conclusively that the marketable product can be increased from 25 to 50 per cent. Reference has already been made to the work of the Department in California, Florida, and other sections. It has been proved that to make such work thoroughly practical and of the greatest value to the farmers and fruit growers of any region, investigations must be carried on in such a way that all local conditions of climate, soil, etc., can be carefully watched. To do this the men engaged in the work must be on the ground, where the various phases in the development of a disease can be closely watched and the effects of treatment carefully noted. It may be well to give an example of the work of the Department carried on under the conditions mentioned by an assistant on the Pacific Coast.

For the past two years experiments have been carried on with a view to finding a means of preventing peach-leaf curl, a very serious disease, which in one orchard alone, containing a hundred acres, caused a loss in two years of about $25,000. In 1895 in this orchard 345 trees were sprayed with a view of preventing curl. As a control, or in other words, as a means of determining the effect of the treatment, 229 trees in the same orchard were left unsprayed. The treated trees gave an average yield of 317 pounds of fruit each, while the untreated yielded only 97 pounds. There was therefore a gain of 220 pounds of fruit on each treated tree, or a total gain of 75,900 pounds on all the trees sprayed. This fruit sold by the car load for 1½ cents per pound, so that the total value of the fruit saved in this case was $1,138.30. The net profit from 345 trees was $1,104, it having cost 10 cents per tree for treatment. As a result of this work the whole orchard was sprayed the present year, and at least 2,000 acres of bearing trees in other parts of the State were also treated. In this one orchard the owners estimate that the saving to them through the work will be $20,000, that is, there was a clear gain of 450 pounds of fruit per tree on those treated. Figuring on this basis, and taking all the work done in the State, there was a gain of, approximately, $450,000 to the growers of California who adopted the treatment recommended by the Department. The work was also carried on extensively in Michigan, New York, and other States, and from the facts at hand in regard to the results, it is believed that a safe estimate of the total value of this work would be three-fourths of a million dollars.

INVESTIGATIONS IN PROGRESS BY THE DIVISION.

Cases of the kind mentioned might be multiplied, but it is believed enough has been said to show the value of the work from the standpoint of dollars and cents. It must be remembered, however, that the value of a large share of the investigations can never be determined on such a basis. The discovery of a principle and the ability to get it applied may often require years of patient work, and yet in the end the actual money value in such a case can be only approximately estimated.

A better knowledge of the laws that govern plant growth is necessary before we can control any particular phase of it with the greatest economy and profit. The primary aim of the work of the division in this line is to obtain this knowledge and bring about its practical application to agriculture. The work now under way includes a study of the principal orchard fruits (apples, pears, quinces, peaches, and plums) and of the various citrus and other subtropical fruits (oranges, limes, lemons, pineapples, guavas, etc.). A study of the diseases of trees, especially those used for shade and ornament, is being pushed as rapidly as possible. Winterkilling, especially of evergreens, in certain parts of the West; the injuries which occur during winter where irrigation is practiced; asphyxiation of roots in certain soils; and the dissemination of the germs of certain parasitic diseases by irrigation are all being investigated. Among the small fruits, grapes are receiving special attention. Much time is being devoted to a study of the problems connected with wheat culture, with a special view to securing varieties not only rust resistant, but also best suited to the various conditions of soil and climate in the wheat-growing regions.

The diseases of truck and garden crops are receiving a great deal of attention. The growing of crops under glass, an industry which represents many millions of dollars in the United States, is receiving careful consideration. Until recently little was done in the way of careful, scientific study of the difficulties and diseases to be contended with in the growth of these crops, but such studies are now being pushed vigorously.

Our knowledge of the relation of nutrition to growth, productiveness, and health of plants, being as yet quite meager, a thorough study of the fundamental principles of plant nutrition is planned. Extensive experiments in the selection and breeding of oranges, pineapples, grapes, wheat, oats, and the various crops grown under glass are being conducted with a view to obtaining varieties more resistant to disease, better suited to the various conditions under which they are grown, and of greater commercial value. This work is based on the principle that where the conditions of a region in which it is desirable to grow a certain crop are not naturally or can not easily be made favorable, the crop must be changed by breeding and selection within certain limits, to meet the conditions.

All phases of this work are being pushed as rapidly as time, funds, and thoroughness will permit.

DIVISION OF POMOLOGY.

By G. B. Brackett, *Pomologist.*

INTRODUCTION.

In the not very remote past the time was when fruits were regarded as delicacies and luxuries which only a few households could afford to place on their tables daily in fresh condition just from the orchard and garden, and when canned fruits were hardly known. The old style of curing fruits in the sun's heat was in vogue, and around dwellings in rural districts might be seen long boards and portions of the roof of the house and sheds covered with sliced apples, peaches, pears, etc., exposed to the sun's rays; and oftentimes the walls of the kitchen were festooned with long strings of prepared fruits curing for family uses during the winter and spring months, and sometimes for market.

"Paring bees" were common in all neighborhoods where orchard fruits were grown, and at these the young folks had their tasks to perform, and right gleefully did they participate in the enjoyments and festivities which such occasions afforded.

The pioneer on frontier settlements had to be content with native wild fruits, and his frugal housewife prepared for dessert purposes the native crab apple, plum, grape, and berries, all of which were preserved or made into jams, jellies, etc. Fruits were then considered as luxuries, and not as necessary articles of food. Meats, cereals, and vegetables constituted the main diet of the people of town and country.

In those days the farmer planted but few orchard trees, and the vine and small fruits were seldom grown. A man who would have ventured to plant a commercial orchard of any considerable size would have been regarded as wasteful of his time and money. Fruit plantations were considered and treated as secondary in importance as a farm crop, and when planted were generally left to take care of themselves.

Seedling trees and sprouts which had sprung up around older trees constituted mainly the stock that was planted for orchard purposes. Grafting and budding were but little practiced, and it is not surprising that the product was generally of poor quality.

INCREASE IN THE SUPPLY AND USE OF FRUIT.

The above gives a fair idea of the condition of the pomological industry in the United States a little over fifty years ago. What is its present condition? The products of orchards, vineyards, and small fruit plantations are so abundant that all the markets are full and often so glutted that all effort in trade channels, together with heavy foreign shipments, does not entirely dispose of the abundant supply. Fruit is so cheap that people of the poorer classes are able to provide an abundance for daily family use, and a menu without it in some form would be regarded as notably lacking in completeness. It is no longer considered a luxury, but a necessary health-giving food, supplying in a measure the chemical elements absolutely essential to a hygienic diet.

The canning of fruits of all kinds has become an extensive industry, which places the product in every household at very little cost to the consumer, as well as in a most attractive and wholesome form.

Fruits evaporated by artificial heat, aided by highly improved machinery, have taken the place of fruits formerly cured by the sun's rays. The magnitude of this industry as carried on in the United States is immense; it employs both millions of dollars of capital and large forces of laborers. The cost of the canned product has been reduced to a minimum, and all classes can now provide this product for their families. Jellies, jams, butters, etc., are manufactured in such large quantities and are so cheap, that they also come within the reach of the masses for daily use.

In view of the radical changes which have occurred in the pomological conditions of this country in the cultural as well as the dietetical views of the people under the influences of a higher civilization, it may be truly said Americans have become fruit eaters in the fullest sense of the word; the old régime has passed away, and no articles of food seem so inviting and are so much craved by the child, the adult, or the aged, as those which the pomological industry offers.

Encouraged by such changes and the demands of trade, millions of dollars are invested, the industry has grown to be one of great commercial interest, so that single orchards, vineyards, and small-fruit plantations of hundreds of acres are common in the land.

The interesting question arises, What agencies have been instrumental in bringing about a change so radical and beneficial? In reply, the following statements are presented:

The constant and increased agitation through hygienic and horticultural journals, aided by the public press, the strong arm of National, State, and local pomological and horticultural organizations, assisted by private efforts, have led the people into a greater appreciation of the intrinsic value of fruits. Through these constant and intelligent efforts, also, have been given to the people fruits of such high character and excellence as are now found in abundance and at a low price in the markets and upon the tables of millions of householders.

ORGANIZATION OF A DIVISION OF POMOLOGY A NECESSITY.

In 1884 the pomological industry of the United States had developed to such magnitude as to demand the recognition and support of the General Government for its further advancement and success, it having outgrown the ability of private organized effort. It had assumed such national importance that its necessities commanded the efforts of pomologists and statesmen in its behalf, and Congress came to its relief by organizing the Division of Pomology as a part of the newly established Department of Agriculture. Passing from the important event of its organization to the present status of the division, the question, How does the division benefit the farmer? is often presented for attention. In considering any attempt to answer this question, the public must bear in mind that the field of the division's operations covers a wide area of country, extending from the Atlantic to the Pacific and from the Gulf of Mexico to the Great Lakes, having a climate varying from temperate to tropical, and with a soil and environment equally variable. The general benefits only will be stated, though the extensive details connected with its work are also highly important; but much valuable material, owing to a lack of funds, remains unpublished in the office of the division.

BRANCHES OF WORK OF THE DIVISION OF POMOLOGY.

(1) The division's equipments and facilities, though these are not commensurate with its requirements, reach out into every State in the Union and into foreign countries, searching for information and material of a pomological character which gives promise of substantial aid to the culturist.

(2) The division publishes in pamphlet form a catalogue of fruits adapted to the various fruit districts of the country, which is revised as occasion may require in cooperation with the American Pomological Society.

(3) The division endeavors to add by collection or recommendation to the already valuable list adopted by the American Pomological Society other valuable sorts of fruit, found at home or in foreign countries, for trial in the United States.

(4) Every means at the command of the division is used to correct the frequently erroneous names of varieties of fruits submitted, and to establish a correct and uniform nomenclature throughout the country.

(5) A large correspondence receives prompt and careful attention. The division is frequently called upon to impart such information as it is prepared to give in all lines of pomological interest to correspondents from all sections of the country.

(6) Specimens of new fruits of merit are constantly submitted to the division for examination and for determining their valuable qualities, and the conclusion reached is promptly forwarded to the sender. To facilitate and encourage this important line of work, the division furnishes boxes and franks on application for mailing such specimens without cost to the parties sending them.

(7) Bulletins are issued as occasion requires, which contain practical and scientific information that results from the careful and thorough investigations of important questions pertaining to the highest interests of American pomology.

An annual report is compiled from each year's work of the division. It contains a summary of the most valuable matter of the period covered, and this, as well as the bulletins, is freely distributed to all parties interested in fruit culture, as far as the law governing the public printing and the funds available for this purpose will permit.

CONCLUSION.

The Division of Pomology was organized for the benefit of all citizens of the United States directly or indirectly interested in fruit growing, and, so far as the provision by Congress will permit, its every effort will be given to promote the material prosperity and advancement of the pomological industry throughout the United States. The fact should be borne in mind that it must have the cooperation, confidence, and the aid of pomologists generally to enable it to reach the highest point of usefulness and to render valuable service to the American fruit grower.

BIOLOGICAL SURVEY.

By C. Hart Merriam, *Chief.*

INTRODUCTION.

The Biological Survey aims to define and map the natural agricultural belts of the United States, to ascertain what products of the soil can and what can not be grown successfully in each, to guide the farmer in the intelligent introduction of foreign crops, and to point out his friends and his enemies among the native birds and mammals, thereby helping him to utilize the beneficial and ward off the harmful kinds.

No fact is better recognized by thoughtful students of our resources than the need of diversifying our agricultural products, with a view not only to remedying the present unequal apportionment of standard crops throughout the United States, but also with a view to the introduction of new kinds. This is the more important because of the varying market values of standard crops from year to year, prices frequently falling so low as barely to cover cost of production, bringing hardship if not financial ruin to the producer. In order to obviate so far as possible the disastrous effects of such years it would seem the part of wisdom to be prepared with two or more crops, so that if one fails by reason of unsuitable seasonal conditions or low price the other can be depended on for sufficient revenue to bridge over the period of loss from failure of the first.

Farms so favorably situated that absolute reliance can be placed on a single crop, or so little diversified that all parts are equally fitted for this crop, are few and far between; and even in such cases there is danger of overproduction. As a rule, if the major part is well adapted for corn, wheat, cotton, sugar, or tobacco, the crop chosen is subject to material fluctuations in yield and value, and minor areas are better fitted for some other use.

NEED OF DIVERSIFICATION OF CROPS.

The Statistician of the Department, in his last report to the Secretary, calls attention to the marked geographic concentration of agricultural productions, and points out that "twenty-five States, or just half the total number, produce 98 per cent of the cotton, 95 per cent of the corn, 95 per cent of the barley, 93 per cent of the oats, and from eight-tenths to nine-tenths of the wheat, rye, buckwheat, tobacco, potatoes, and hay produced in the entire country." This certainly is an unfortunate state of affairs, and one which, in the light of present knowledge of crop adaptations, seems unnecessary. At the same time it is well to keep in mind the distinction between crops raised for home consumption and those raised for export. If, for instance, the twenty-five States and Territories now producing collectively less than 5 per cent of the total output of cereals can, by selecting proper varieties, grow enough for their own use, they may be able to raise for export fruits or other crops far more valuable to them than an excess of cereals.

For several years prior to 1897 the price of wheat in the North and West was so low as hardly to cover the cost of harvesting, while in the Southern States not enough was raised for local consumption, and the price was correspondingly high. Thus, in 1894 the price of wheat on the farm in the Dakotas, Oregon, and Washington ranged from 39 to 46 cents per bushel, while in South Carolina, Alabama, and Georgia it brought from 76 to 87 cents, and in Arizona $1. If a wheat can be found which may be depended upon to mature a good yield on suitable soils in the Southern States great benefit to the people should accrue therefrom. Recent investigations carried on in the Biological Survey by Prof. C. S. Plumb show that Fultz wheat and the spring or May wheats (including red May, early May, late May, big May, and others) may be grown successfully, except in the lowlands, in what is known as the Austroriparian zone, a belt which covers the greater part of South Carolina, Georgia, Alabama, Mississippi, Louisiana, and central Texas; and that Sonoran and Australian wheat do well in the Lower Sonoran belt in Arizona and southern California. Similarly, oats, in the main a Northern crop, have been found to do well in the Austroriparian belt of the Southern States if proper varieties are chosen; and these varieties are the Burt and Red Rust Proof. In the case of corn, Moseby's Prolific, Golden Dent, and White Gourd Seed seem well adapted to the same belt. So there appears to be no reason why cereals can not be grown in the Southern States in quantities more than sufficient for local consumption.

Cotton is the staple crop of the South, far exceeding all others in money value. But during 1897 the price of cotton was so low as to yield no profit, while at the same time wheat was so high that if a fair division of acreage had been made between the two, the Southern planters would have realized handsome profits instead of suffering financial distress. Attention must be called also to the fact that in the face of the very large crop and extreme low price of cotton in 1897, when our export amounted to $212,640,769 (and similarly in 1894, when we exported $210,000,000 worth), enormous quantities were imported from Egypt. This, while inferior to our Sea Island cotton, is of higher grade than our ordinary product and is used "for goods requiring smooth finish and high luster. It gives to fabrics a soft finish somewhat like silk." During the fiscal year 1896 the value of the Egyptian cotton imported into this country was more than $5,000,000. This brings up the important question whether we can not, with the aid of irrigation, raise these high-grade varieties in certain parts of the arid Southwest—in southern Arizona and the desert region of southern California.

SEA ISLAND AND EGYPTIAN COTTON FOR NEW SECTIONS.

The history of Sea Island cotton is interesting, as showing how the intelligent introduction and cultivation of choice crops in suitable climatic areas may yield rich returns. Dr. Walter H. Evans states that the Sea Island cotton, whose fiber is so highly prized, "is indigenous to the Lesser Antilles, and probably to San Salvador, the Bahamas, Barbados, Guadaloupe, and other islands between 12° and 26° north latitude. By cultivation it has been extended throughout the West Indies, the maritime coast of the Southern States, Central America, Puerto Rico, Jamaica, etc., southern Spain, Algeria, the islands and coast of western tropical Africa, Egypt, Island of Bourbon, East Indies, Queensland, New South Wales, etc. It may be cultivated in any region adapted to the olive and near the sea, the principal requisite being a hot and humid atmosphere; but the results of acclimatization indicate that the humid atmosphere is not entirely necessary if irrigation be employed, as this species is undoubtedly grown extensively in Egypt."

Although the area in which Sea Island cotton is produced in the United States is very small, and although a large quantity is manufactured in our country, still the value of the crop exported amounted in 1894 to nearly $3,000,000 and in 1896 to $3,816,216. It is quite probable that both Sea Island and Egyptian cotton could be cultivated with profit in parts of southern California and southwestern Arizona.

PROFITABLE CROPS FOR DIFFERENT CLIMATES.

But wheat and cotton are not the only crops to be grown with advantage in the South, for the list of fruits, fiber plants, and other agricultural products fit for the climatic conditions of the Austroriparian belt is a long one, and a wise selection with reference to home consumption and convenient markets is bound to place agriculture in the Southern States on a very different plane from that it now occupies.

In northern New York and Wisconsin[1] the dairying industry is one

[1] In 1890 New York produced 48.3 per cent and Wisconsin 21.3 per cent of the total output of cheese for the country. The New York output in that year was 124,086,524 pounds.

of the chief sources of revenue, and cheese is a staple product. In years like the present, when cheese sells at the factory for 8 or 9 cents—and still worse a few years ago, when it sold for 4—the farmer is left at the end of the season without return for his labor. Yet, most of the lands now devoted almost exclusively to dairying are situated in the sugar-beet belt, and are also adapted to several excellent varieties of wheat and other crops to which little or no attention is now given.

WHAT THE FARMER NEEDS TO KNOW.

The farmers of the United States spend vast sums of money each year in trying to find out whether a particular fruit, vegetable, or cereal will or will not thrive in localities where it has not been tested. Most of these experiments result in disappointment and pecuniary loss. It makes little difference whether the crop experimented with comes from the remotest parts of the earth or from a neighboring State, the result is essentially the same, for the main cost is the labor of cultivation and use of the land. If the crop happens to be one that requires a period of years for the test, the loss from its failure is proportionately great.

The cause of failure in the great majority of cases is climatic unfitness. The quantity, distribution, or interrelation of heat and moisture may be at fault. Thus, while the total quantity of heat may be adequate, the moisture may be inadequate, or the moisture may be adequate and the heat inadequate, or the quantities of heat and moisture may be too great or too small with respect to one another or to the time of year, and so on. What the farmer wants to know is *how to tell in advance* whether the climatic conditions on his own farm are fit or unfit for the particular crop he has in view, and what crops he can raise with reasonable certainty. It requires no argument to show that the answers to these questions would be worth in the aggregate hundreds of thousands of dollars yearly to the American farmer. The Biological Survey aims to furnish these answers.

MAPPING AGRICULTURAL REGIONS.

From a study of the geographic distribution of our native animals and plants it has been learned that the United States may be divided into seven transcontinental belts and a number of minor areas, each of which is adapted to particular associations of animal and vegetable life. It has been found also that each of these belts and minor areas, except the coldest, is adapted to the needs of particular agricultural products, and that the distribution of native animals and plants may be coordinated with the successful distribution of cultivated crops. In other words, the study of the geographic distribution of our native or indigenous fauna and flora has resulted in the establishment of a number of agricultural belts, each of which comprises several minor divisions fit for particular varieties of fruits, cereals, and breeds of live stock.

Through the intelligent efforts of man the slow processes of nature have been hastened, so that most fruits and cereals have been made to yield varieties adapted to a diversity of climatic conditions. The happy outcome of this artificial selection is that, while certain varieties of wheat, oats, corn, apples, pears, grapes, and so on thrive only in certain limited areas, different varieties thrive in other areas, a very large proportion of crops having varieties fit for each of the natural agricultural belts of the country. The same is true, though perhaps in less degree, of poultry and live stock.

The Biological Survey is engaged in tracing with as much precision as possible the actual boundaries of these belts and areas, in preparing lists of the native or indigenous species, and of the fruits, grains, vegetables, and other agricultural products that are adapted to each. In this undertaking it aims to point out such exotic agricultural and horticultural products as, from their importance in other lands, are likely to prove of value if introduced on fit soils and under proper climatic conditions. In view of the fact that all of the climatic life zones of the world, except the humid tropical, are represented in our own country, there can be little doubt that an intelligent study of the agricultural products and adaptations of distant lands will result in the discovery of fruits, vegetables, fibers, farm crops, and breeds of stock which may be introduced into the United States not only with profit, but which by diversifying our products and leading to the development of new industries will render our agricultural resources more stable and certain.

The colored maps prepared by the Biological Survey furnish the first rational basis the American farmer and fruit grower has ever had for the intelligent distribution of seeds, and the only reliable guide he can find in ascertaining beforehand what crops and fruits are likely to prove successful on his own farm, wherever it may be located. These maps, in connection with the work of the Entomologist, show also the belts along which noxious insects are likely to spread, forewarning the husbandman of impending danger.

In studying crops with relation to the zones or areas in which they may be most profitably cultivated considerable progress has been made. An investigation of the zone adaptations of several hundred varieties of fruits and nuts is far advanced, and by cooperation with Prof. C. S. Plumb, director of the agricultural experiment station at Lafayette, Ind., a similar study of the varieties of corn, wheat, and oats has been completed and will soon be published.

DEVELOPMENT OF AGRICULTURE IN CALIFORNIA.

The history of the development of agriculture in California affords an excellent example of the changes in staple products that come with increased knowledge as to the fitness of particular areas for particular crops. In the early days California was distinctly a grazing

State, and hides and wool were the chief exports. Then wheat came to the front and soon formed the staple product. Later it was learned that large areas were particularly well suited to the needs of fruits, and the fruit industry rapidly grew until at the present time it exceeds even the wheat crop in money value. But the fruits from which so large a revenue is now derived are only in part those first introduced. Fifteen years ago wine grapes were perhaps the most important fruit; now they are of secondary consequence. For a time deciduous fruits were the principal ones deemed worthy of attention; now citrus fruits are of even greater value, the output of oranges and lemons in 1896 being 3,780,000 boxes. Almonds, walnuts, olives, and raisins have also come to be important crops. Twenty-five years ago all our raisins were imported; now California produces annually from 90,000,000 to 100,000,000 pounds.

The development of the prune industry is instructive as an illustration of a common class of cases where products worth hundreds of thousands of dollars annually to a single State have been introduced by chance rather than as a result of scientific study. The first prune cuttings are said to have been brought from France, along with cuttings of grapes and other fruits, by a Frenchman who settled at San Jose about the end of 1856. For some years little was thought of this introduction, and it was not until 1880 and 1881 that serious attention was given the cultivation of prunes. But from 1893 until the present year the annual output in dry fruit has ranged from 44,780,000 to 64,500,000 pounds.[1]

It is hard to resist the temptation to dwell on the marvelous expansion of the fruit industry that has taken place in California since the climatic adaptations of her various agricultural belts began to be understood; but for present purposes a statement of the exports of a few of her many products for the year 1895 will suffice to give a fair idea of the magnitude this industry has attained. In 1895 California shipped 6,625 car loads of fresh deciduous fruits; dried fruits, 6,132 car loads; raisins, 4,638 car loads; canned fruits, 3,129 car loads; citrus fruits (mainly oranges), 11,582 car loads;[2] nuts, 1,333 car loads; wine and brandy, 8,056 car loads.[3]

THE ARID REGIONS.

While considerable progress has been made in ascertaining what agricultural products are adapted to the climatic conditions of southern California and southern Arizona, this has been done at great cost, and nothing like a complete knowledge of the subject has been attained. Before this will be possible the life zones and their subdi-

[1] Statistics from California Fruit Grower.

[2] Figures from Fifth Biennial Rept. California State Board of Agriculture, 1896.

[3] From California State Board of Trade.

visions must be accurately mapped and corresponding arid areas in Africa, Arabia, Persia, India, Chile, and Australia must be studied with reference to agricultural productions which might be introduced with profit in proper zones in our arid Southwest. Nature has not been over generous in the distribution of water in this part of our country, but she has been lavish in her gifts of soils and climates. The fruit growers of California were long in finding out that their State comprises all of the agricultural belts of America except the tropical, and that its different areas are naturally adapted to a great diversity of agricultural and horticultural products. Even at the present day few realize that in the southern half of the State hundreds of farms might be so laid out with reference to the mountain slopes that each would embrace sections of all the agricultural belts, enabling the fortunate husbandman to produce not only early and late crops of small fruits and garden vegetables, but also an astounding diversity of crops, from the apples, cherries, potatoes, and hardy cereals of the upper Transition and lower edge of the Boreal belts to the oranges, lemons, almonds, olives, and cotton of the Lower Sonoran zone, and in certain localities the pineapple, date, and citron of the arid Tropical zone. It is probably not too much to say that an accurate map of the agricultural belts of California in the early days would have saved the State in the aggregate millions of dollars that have been expended in finding out what crops are best adapted to particular areas, and although much has now been learned by persistent and costly experiments, such a map would still be of very great value.

So far as this phase of practical agriculture is concerned, the work of the Biological Survey ends with mapping the natural life zones and their subdivisions and pointing out the products best fitted for the climatic conditions of each.

STUDIES OF FOOD HABITS OF BIRDS AND MAMMALS.

The bulletins on birds and mammals published by the Biological Survey correct widely prevalent errors as to the economic status of species that affect agricultural interests, and demonstrate the inefficiency and wastefulness of bounty laws, under which millions of dollars have been expended by the various States and Territories without accomplishing the object for which they were intended.

Birds are the farmers' most valuable aids in his life-long battle with the insects that prey on his crops. How important, therefore, that he should not destroy those that do him greatest service. In the case of hawks and owls the division has shown, by the examination of the stomach contents of about 3,000 of these universally hated and persecuted birds, that only six out of the seventy-three kinds inhabiting the United States are injurious, and three of these are so rare they need hardly be considered, leaving only three to be taken into account as enemies of agriculture. The others prey upon mice, insects, and other vermin, and rank among the farmers' best friends.

Since its establishment in 1885, the division has examined the stomach contents of nearly 15,000 birds belonging to 200 species and subspecies, and has published information on the food habits of 140 kinds, mainly hawks, owls, crows, jays, blackbirds, sparrows, thrushes, flycatchers, swallows, shrikes, wrens, woodpeckers, horned larks, and cedarbirds.

DIVISION OF SOILS.

By Milton Whitney, *Chief.*

INTRODUCTION.

The Division of Soils was established in the Weather Bureau, by order of the Secretary of Agriculture, on February 15, 1894, under a clause of the act making appropriations for the Department of Agriculture for 1894 providing for the investigation of the relation of climate to organic life. In the appropriation act taking effect July 1, 1895, the division was recognized as an independent division in the Department of Agriculture, charged with the investigation of certain broad, general subjects.

OBJECT OF THE WORK OF THE DIVISION.

The primary object in the organization of the work of the division was to study the relation of the climatic conditions of moisture and temperature under the surface of the ground to the local distribution of crops. This was to supplement the work of the Weather Bureau. The fact was recognized that the rainfall does the crops little or no direct good until it enters the soil. The soil then offers a resistance to the descent of the water and holds a portion of it back for the use of crops during the period between rains. This water supply varies according to the texture of the soil, and thus arises the need of classifying the soils according to their water-holding capacity as shown in their natural condition in the field.

RELATION OF SOIL MOISTURE TO TEMPERATURE AND HUMIDITY.

The water supply of the soil is thus shown to be an important factor in climatology, and to bear a distinct and obvious relation to the temperature and relative humidity of the atmosphere, and to form an important element of the climate of any locality.

Tersely stated, an increase in the temperature of the air tends to increase evaporation from plants. The relative humidity of the atmosphere, together with the velocity of the wind, controls this evaporation, while the moisture in the soil supplies the loss of water due to it. For a continuous growth of vegetation there must be a certain definite relation, constant within fixed limits, between the temperature of the air, the relative humidity, and the soil moisture. With any great departure from the normal in any one of these conditions there must be a corresponding change in one or both of the other conditions or the crop is liable to suffer. If, for example, the temperature rises above the normal, there must either be a proportional rise in the relative humidity, in order that there shall not be an excessive evaporation from the plant, or there must be an increase in the water supply of the soil to meet the increased demands made upon it by the plant. If the soil is moderately dry, little harm may occur to the plant, provided the temperature is low or the relative humidity is very high.

There is, of course, no sharp line determining the exact relations of these factors, for there are many gradations of conditions from the most favorable for plant growth to such as render it impossible for plant life to be sustained. The decisive factor may be either temperature, relative humidity, or soil moisture.

SOIL MOISTURE AND LOCAL DISTRIBUTION OF VEGETATION.

Under the conditions prevailing over most of our country it is believed that the moisture supply of the soil has more to do with the local distribution of vegetation than either of the other factors. It is important, therefore, to determine what water content of the different types of soil gives the most favorable conditions for plant growth under the normal conditions of temperature and relative humidity, and then to determine the variation which may occur in this water content without serious injury to the crop. This has been done in a number of cases. When the facts in this connection are once established they will furnish a reliable basis for the intelligent application of water through methods of irrigation or for improved methods of cultivation in order properly to conserve and regulate the water supply in the soil.

KNOWLEDGE OF INTENSIVE FARMING NECESSARY FOR THE EASTERN FARMER.

Different classes of crops require different climatic conditions for their best development. The relation between temperature, humidity, and soil moisture most favorable for one kind of crop will not necessarily be favorable for another kind. As soils differ greatly in their relation to water, we have here the basis for the classification of soils in regard to their adaptation to crops—a classification necessary for the intensive farming which is being forced upon the Eastern section of the country.

A broad and comprehensive study of the country as a whole shows that the interest in soil investigations is not the same in all sections. Our Eastern farmers have been forced, through competition from the

West and from other parts of the world, to specialize in agriculture and horticulture, and they are fast adopting an intensive system of cultivation. The reason for this depends upon certain economic and social principles which need not be considered here. Eastern farmers can no longer grow wheat as a staple crop on all farms, as was formerly done. They must select only the most favorable locations of soil and climate in order to produce the crop economically, and the areas upon which this can be done grow smaller each year. This is only one of many instances in which the old staple crops are being abandoned for more profitable specialization along rather narrow lines.

As before stated, the basis for this specialization and intensive cultivation must be a thorough knowledge of the soils and soil conditions. This can only be obtained through a careful study and classification of the soils, the final result of which should be the preparation of soil maps showing the location and area of different types of soils adapted to certain classes of plants. The Eastern farmer is therefore now ready to use intelligently reliable soil maps of his locality.

GENERAL FARMING STILL POSSIBLE IN THE WEST.

In the West this necessity for specialization and intensive cultivation has hardly arrived. On the broad level or rolling prairies and in the fertile valleys of the West the rocks themselves are more uniform and there are vast areas of uniform soil conditions. Furthermore, owing to the comparatively dry climate of the West, the soils derived from the different rocks are more uniform as the decomposition of the rock has not, apparently, gone so far as in the more humid climate of the East. Many of the rocks in the West have disintegrated and fallen apart, leaving the minute grains of sand still composed of the several minerals constituting the rock, and making not only very uniform conditions over large areas, but very uniform conditions to very great depths. As a rule, there is little or no difference between soil and subsoil down to a depth of many feet. In the more humid climate of the East the rocks, on the contrary, have gone beyond disintegration and have decomposed so that many of the minerals have been entirely changed in their chemical composition and have been broken down in their physical texture; hence the greater uniformity in the soils of the West. There is not so great a variety of distinct types, and they can be cultivated much more cheaply. Over much of the Western area there is only a small and variable rainfall, but with 18 or 20 inches of well-distributed rainfall crops can be successfully grown. This is only equal to about half of the rainfall in the East, and there is but a narrow margin to work on. In the semiarid region the rainfall is so uncertain that a good crop can only be expected about two years out of five. The staple crops can be economically produced if the season is favorable, and the most important question is proper methods of cultivation which will conserve for the use of crops the small amount of water which actually falls. This is a vital problem over a large part of our country to-day, and the study of the movement of water in soils and methods of cultivation and treatment to conserve this moisture are matters of vital interest to the farmer.

PROBLEMS OF THE ARID REGION OF THE FAR WEST.

In the arid region of the far West, with a rainfall not exceeding 8 or 9 inches per year, and on the soils generally which require irrigation for the production of crops, methods of applying water to the land, the proper quantity to supply for the several classes of crops, methods of cultivation to conserve this water, and the treatment of the alkali problem, are the most important and really vital problems to be considered. Large areas of land in the West are being injured by the excessive application of water through improper methods of irrigation, and lands are being abandoned on account both of the excessive amounts of water they contain and of the alkali which accumulates near the surface, when too much water is used and improper or insufficient methods of cultivation are adopted.

THE CLASSIFICATION OF SOILS.

The preceding remarks outline the broad general interests involved in soil investigations in this country at the present time, and a brief statement of what has been done and what there is to do along these lines will now be given.

The classification of soils should be based, where possible, upon the geology of the region. Soils are derived from the disintegration of rocks. These rocks have been formed under peculiar conditions which determine to a very large extent their physical characteristics. They may be sandstone, limestone, shale, granite, or basalt, each of which usually covers large and well-defined areas. The soils derived from their decay will have certain physical characteristics, which will serve as a basis for their classification. There will be more or less sand, silt, or clay, according to the physical nature and chemical composition of the rock. A variation in the relative amounts of these constituents will have an important bearing upon one feature of the climatic conditions, namely, the water supply; for, as already pointed out, the available water supply for plants is only dependent upon the rainfall in so far as the water is held back by the soil.

TEXTURE OF SOILS.

The soil in its natural state appears very compact and continuous; but, as a matter of fact, on an average only 50 per cent by volume of the space is occupied by the solid grains, leaving an equal volume to be occupied by air and water. The rain descends through the soil in the minute spaces between the soil grains. The fewer grains—that is, the coarser the soil—the fewer of these spaces there will be; each space will be correspondingly large and there will be comparatively but little resistance to the downward movement of water. On the other hand, in a fine-grained soil the space is divided up into an infinitely greater number of very much smaller spaces, and as the rainfall moves down through such a soil much more resistance is offered to its movement and a larger quantity is held back for the use of crops. It is for this reason, together with the difference in the capillary power, that under the normal rainfall of our Eastern States a light sandy soil will maintain on an average only about 7 per cent of water, while a heavy clay soil will maintain on an average 20 per cent of water.

STRUCTURE OF SOILS.

It is not alone the texture of the soil which determines its relation to the rainfall. This depends likewise upon the structure of the soil, or the arrangement of the soil grains. A soil having a given texture may be rendered very impervious to water by improper methods of cultivation, especially when the soil is wet. It becomes important, therefore, to study not only the texture but the structure, and as there are no suitable methods of determining the relative arrangement of the soil grains, it is necessary to make actual moisture determinations and so determine directly the relation of the soil to moisture in its natural condition in the field.

WHAT THE CLASSIFICATION OF SOILS DEPENDS UPON.

The classification of soils depends, therefore, first upon the geological formation to which the soil belongs; then upon the texture of the soil, as determined by separating the grains into different groups according to their size; then upon the relative moisture contents which in connection with the texture will indicate the relative arrangement of these soil grains; and lastly upon the character of the vegetation furnishing a key, or rather a final measure, of the value of the soil conditions.

VARIETY OF SOILS IN THE EASTERN STATES.

In Bulletin No. 4 of this division the method of collecting the samples, of making the mechanical analysis, as well as the determination of the moisture content of the soils in the field is described. Since then an electrical method of moisture determination has been perfected which has given very satisfactory results. In Bulletin No. 5 a classification of certain soils is described and the texture of a large number of distinct types of soil is illustrated by a number of plates. It is shown in this bulletin that the texture of the early truck soils along the Atlantic coast from Maine to Florida is very uniform.

The wheat and grass soils of the Atlantic Coast States have also marked characters, but the most striking example of the influence of the physical properties of soils upon distribution of crops is seen in the study of the soils of the tobacco districts of the United States. The texture of the soils adapted to the bright yellow tobacco of the South is quite uniform wherever it is grown successfully. The Northern cigar tobacco soils are also distinct in their physical properties. The characteristic soil for a cigar wrapper from the Connecticut Valley is a light, sandy loam similar in texture to the truck soils of the Atlantic Coast. The soil of Pennsylvania and Ohio, adapted to the finest grade of filler, is a strong limestone clay soil similar to the wheat and grass lands of Pennsylvania, Virginia, Ohio, and Kentucky. These two types are as opposite as can be. The wrapper soil has, on the average, less than 5 per cent of clay and maintains throughout the season about 7 per cent of moisture. The filler soil, on the other hand, has from 25 to 40 per cent of clay and maintains on the average about 20 per cent of moisture.

The export tobacco soils of Kentucky and Tennessee are very uniform in their physical characters, and their product is unsuited to our domestic needs, but adapted to the uses of different foreign countries. Each of these countries requires slightly different characteristics, and these are determined by differences in the character of the soil conditions of different districts, together with the climatic conditions and proper methods of cultivation and treatment of the crop. Large areas of land which were formerly used for tobacco have been abandoned on account of the specialization of the industry and the necessity of supplying the market with tobacco of peculiar properties adapted to special needs.

A very satisfactory system of classification of soils has thus been worked out by the division, and it is quite possible to determine the areal distribution of soils adapted to certain classes of crops. It would be perfectly feasible at this time to map the areas devoted to the early truck crops and to the different classes and types of tobacco. From what has already been stated it is very evident that there is a great variety of very different soil formations in the Eastern States, and that the farmers are ready for the specialization of their industries, and are in a condition to appreciate and use such soil maps as a basis for their specialization and intensive farming.

RELATION OF SOILS TO WATER.

Probably one of the most important functions of the Division of Soils is the study of the relation of soils to water. This has importance from two points of view. The statistical value of the records is very great. The amount of moisture in the soil is one of the important factors in the climatic conditions of any locality, and a statistical record of the fluctuations in the water content is quite as important as the record of the fluctuations of the temperature and relative humidity of the air. It is more important than the record of the fluctuations in the rainfall. Good localities should, therefore, be selected in the regions of the important types of soils in the United States, and continuous records should be kept of the actual moisture conditions in the soil, in connection with the records of temperature, relative humidity, rainfall, and all other meteorological records of the Weather Bureau. These statistical records might not perhaps be of great use to individual farmers, but they would be of great value in the estimation of the crop yield, as well as in furnishing a basis for the introduction of new crops and the modification of existing conditions for the improvement of the crops already grown.

NORMAL CONDITIONS AND NORMAL VARIATIONS OF MOISTURE OF SOILS.

In the work already carried on by the Division of Soils it has been possible to find out and record normal conditions of moisture for some of our soil formations, and to determine the maximum and minimum quantities, or the normal variation, in the moisture content which can occur without marked injury to the crop. It has been found as a general rule that the fluctuation may amount to one-fourth of the normal. For example, if the normal or average water content of the soil is 20 per cent by weight of the dry soil, the water content may rise to 25 per cent, for a limited period at any rate, without injury to the crop, and may fall to 15 per cent, but this will reach the line of drought, and with less water than this in such a soil crops will suffer in proportion as the percentage of water is less. These limits may be called, therefore, the line of drought and the line of excess of water.

Such records will give an important basis for the introduction of improved methods of cultivation; for the water supply in the soil should never be allowed to fall below the line of drought if it can be prevented. And by a proper system of cultivation it is probable that the rainfall can be so conserved that the danger from drought in most soils can be reduced to a minimum, thus giving a very satisfactory assurance of a crop.

MODIFICATION OF METHODS OF CULTIVATION FOR IMPROVING SOILS.

There is reason to hope and believe that it will be possible to work out a scientific basis for the practical modification of the methods of cultivation, for changing and improving the conditions maintained by the soil; in other words, that we shall understand the causes which determine the difference in the relation of soils to water, and shall be able to control these to a certain extent by recognized methods of cultivation. If this is accomplished it will be possible, if the actual conditions in the soil are known, to prescribe certain methods for their control, instead of blindly trying all methods, as must be done at present.

That soils differ greatly in their relation to water can not be doubted, and the variation found in nature is so great as to warrant the belief that, if the underlying principles are understood and can be controlled, it will be possible to very materially influence crop production through new methods of cultivation.

COMPARISON OF THE SOILS OF THE EASTERN AND WESTERN UNITED STATES.

In the Eastern States we have on an average about 40 inches of rainfall a year. Half of this leaches down through the soil and runs off into the streams, and so is lost to vegetation. There is thus left about 18 or 20 inches of rainfall available for crops. There are large areas in the West where 18 or 20 inches of rainfall is ample. Not only so, but if this rain all falls in the winter months and the ground becomes well moistened, it is possible to mature crops without any rain during their period of growth if the soil is carefully cultivated so as to prevent an excessive loss of water through evaporation. On certain kinds of soil, particularly on some of the alkali soils and in certain artesian basins, a rainfall of only 8 or 9 inches per year, falling during the winter months, is sufficient to produce crops of wheat, corn, tobacco, and fruit without irrigation. In the far West only about 2 per cent of the entire rainfall is recovered in the streams, and much of this is from surface run-off. As a rule, therefore, the rainfall does not extend down to the underground water and the whole of it is available to the crop, since it must all evaporate from the surface of the ground or be transpired by the growing plants. When the soil has once been supplied, therefore, with the annual rainfall the water is held at the disposal of crops and is continuously supplied at the surface according to the ability of the soil to draw it up. The surface of the ground becomes quite dry and often dusty, and a complete mulch is thus provided, which protects against evaporation.

In the Eastern States the character of the soil is different. There is nearly always a layer of heavier subsoil immediately under the surface, through which the movement of water is slower than in the top soil. Evaporation goes on constantly at the surface of the ground, and on account of the difference in texture, when there is any sudden demand upon the plant, the movement of water through and out of the soil is relatively much faster than the movement in the subsoil. There is furthermore a continuous loss of water from below, due to percolation—a loss about equal to the amount lost from the surface of the ground by evaporation. Under these conditions of difference of texture and of double loss of water from the soil, the crop begins to suffer in two or three weeks unless the moisture supply is replenished by rain. Rain is needed on an average about every three or four days, or for two or three successive days followed by an interval of ten days of fair weather. The latter is the more usual condition. If the period of fair weather is prolonged to three weeks, crops suffer, as a rule, and if the drought continues for four or five weeks, no matter how much rain had fallen up to the beginning of this period, it means usually a disastrous drought and failure of the crop.

Contrast this with the ability of the soil of some of our far Western States to support vegetation in an active condition for five or six months without rain, and one will see that soils have the power of conserving the water and holding it at the disposal of crops for a very long period; so that, if we can only understand and control the conditions, instead of fearing drought the excessive wetness would be the only condition to be feared, and this could be controlled by underdrainage.

CAUSE OF THE MOVEMENT OF WATER IN THE SOILS.

Considerable work has been done in the division in the study of the underlying principles of the relation of soils to water. Much of this is really technical work and must continue to be so. The most important result has been the determination of the actual cause of the movement of water in the soils, a subject which had never before been thoroughly understood. It had been known that it was due to surface tension, or capillarity, as it is usually called, which depends upon the tendency of a surface of water to contract. It was, therefore, understood that it was the contractile power of the film of water around the soil grains that caused the movement of water to the plant. It appears now, from a minute study of this problem, that the movement is dependent upon the curvature of this film rather than upon the total area of its surface. In a moderately dry soil the curvature of the film will be very great, as the water is held in the minute spaces between the grains. In a fine-grained clay soil, where the spaces are small, the curvature of the films of water around the grains will always be very great, greater than in a sandy soil. With a surface of such great curvature there is a pressure outward, the surface tends to straighten itself, and there is a tendency for water to be drawn into the space between the grains, so that the surface of the film may approach more closely the form of a catenoid, which is a surface of no pressure. An account of this work has been published in Bulletin No. 10 of this division. Investigations are being continued along this line to see what control can be exercised over the curvature of the films in the soil, as well as to determine their mean thickness in soils of different textures and of different water content, and the way in which water is transported through them from place to place in the soil. It is absolutely necessary that the mechanics of the soil moisture be worked out and thoroughly understood before the most intelligent methods of cultivation and fertilization can be devised for the control of the soil moisture. Other lines of investigation into the physical properties of soils are being carried on. These are second in importance only to the investigation of the mechanics of the film of water just mentioned.

DETERMINATION OF MOISTURE BY THE ELECTRICAL METHOD.

The electrical method of moisture determination, described in Bulletin No. 6, has given very great satisfaction during the past season. Fourteen sets of instruments, with an aggregate of fifty-eight sets of electrodes, were placed in the hands of farmers in different sections of the country for use in very different types of soil.

In this method a set of electrodes is buried at any depth in the soil, and an alternating electric current is sent through the soil from one electrode to the other. A temperature cell is mounted between the electrodes and so connected as to compensate for the effect of temperature upon the electrical resistance of the soil. Each electrode has to be standardized by determining accurately the amount of moisture in the soil at any particular time and taking the resistance carefully. The resistance will subsequently vary according to the square of the water content, and a very simple calculation will give the water content for any particular resistance of that electrode. As this same relation holds throughout the season, a card can easily be constructed showing exactly the amount of moisture for any resistance of the electrode.

This form of instrument can be very conveniently used in the field. Where the electrodes are to be buried at a considerable depth they are inserted in auger holes in order that the subsoil shall not be disturbed from its original condition. The auger hole is subsequently filled with melted pitch. Lead-covered cables are attached to these electrodes and are carried underground as far as necessary and brought up into a measuring box. The cable is buried at a sufficient depth so that the ordinary operations of plowing and cultivation can be carried on without any disturbance of the apparatus.

In the case of electrodes at a depth of less than 6 inches they are buried in the same way that a plant is set out, the cables connecting them running underground, as in the case of deeply buried electrodes. With these shallow electrodes a little stick must indicate their position, and cultivation around them must be carefully done, as in the case of handling a tender plant. They can conveniently be put in the row with plants, or near an individual plant, if the field is set out in hills. This apparatus as at present used is rather complicated and expensive for the individual farmer to use in his field. However, a much simpler form of instrument is being devised, which will cost but little and which can be easily installed.

As before stated, continuous records of the moisture conditions in the most important soil formations should be kept throughout the growing season for their statistical value. Further than this, the method is capable of being used to great advantage in studying the relation of soils to water as a basis for improved methods of cultivation and of cropping. If the modified and cheaper instrument is perfected it should be capable of being used to great advantage by the individual farmer in the cultivation of his crops where intensive farming is being done. The condition of his soil as regards moisture should be as carefully observed as the temperature in a greenhouse, for it is frequently possible, through methods of cultivation or of irrigation, to check the too rapid transpiration of the moisture from the soil.

EXCESSIVE USE OF WATER BY IRRIGATION INJURIOUS.

The lines of drought and excessive water content of several types of soil have been established as a result of the moisture determinations of the past three years. Where these lines are established for any soil and for any crop a farmer should use all possible means at his disposal to prevent a change in the moisture conditions of his soil greater than is shown to be safe by the record of normal variation. Where irrigation is possible, either in the West or in the East, the application of water should be so made as to prevent the water content from approaching, or from falling below, the line of drought.

This method of moisture determination is particularly applicable where irrigation is practiced. If the normal water content of a soil is known and the variation which may occur without injury to the plant, it will give a basis for the intelligent application of water. In the present empirical method of irrigation there is a tendency to use entirely too much water, and great damage is being done in many parts of the extreme West by the excessive use of water. Indeed, in many parts of the irrigated districts of the West there is as great a necessity now for underdrainage as there formerly was for irrigation. In several of the older regions of California irrigation is no longer necessary, and with only 8 or 9 inches of annual rainfall, occurring during the winter months, such quantities of water have been added to the soil that wells can be dug throughout the district and standing water found at depths of from 2 to 6 feet. No irrigation is necessary, except that the main canals be allowed to run throughout the season. If these canals are even a mile apart, they are believed to furnish the water needed for the entire section, and it is the general opinion that if they are not allowed to run the crop would suffer. It seems incredible that the lateral movement of water in these soils should be sufficient to maintain the supply for a distance of half a mile on either side of the canal, but such appears to be the fact.

In some of these older irrigated districts in California and in Utah considerable areas of land have been abandoned or have been greatly reduced in value on account of the excessive wetness of the soil and the impossibility of producing any of the staple crops under such unfavorable conditions.

Another objection to the excessive use of water in the irrigation of soils of the arid regions is the danger from alkali. Excessive quantities of seepage water in moving through the soil carry along the soluble salts which have accumulated through the disintegration and decomposition of rocks. The water finally comes to the surface, first in the lower valleys and "draws," and then creeps up onto the higher lands. As the standing water approaches the surface of the ground, it is strongly impregnated with the salts, and as it evaporates in large volume from the surface of the soil it leaves the soils often with an incrustation of alkali on the surface. Such an accumulation of salts is fatal to most if not all of our agricultural plants, and many fine fields have been abandoned on account of this "rise of alkali." Not only does this affect crops of the person who applies the water, but the main trouble being from seepage water the injudicious methods used by one person may damage a neighbor some distance away who is on a lower level and in the path of the flow of the seepage water. The remedy for this is thorough underdrainage and thorough cultivation, but the prevention is through the judicious and economic use of water. It is safe to say that two or three times the area of land now being irrigated could be thoroughly watered with the quantity of water at present being used, without any detriment whatever to the existing fields. On the contrary, decidedly better and surer crops could be grown through the smaller application and more judicious use of the water. A convenient method of moisture determination, such as the electrical method described, if used as a basis for the application of water to the soil, would be the means not only of conserving the water so that larger areas could be irrigated, but where it was used irrigation could be carried on much more intelligently, to the great benefit of the crop and the conservation of the fertility of the soil.

This investigation of the control of the soil moisture and the conservation of the rainfall, together with the application of water through the method of irrigation, is of vital interest to the farmer in the West; and as competition is growing stronger he feels the need of all the light that can be thrown upon the subject, and is ready to use any means which may be placed at his disposal for the control of soil conditions.

SALT DETERMINATION IN THE SOILS.

The electrical method, upon which the moisture determination is based, can also be used under proper conditions for the determination of the relative salt content of soils. This is a matter of comparatively slight importance to the farmers in the East, but of the greatest importance in the arid regions of the West.

The salt determination consists of taking a sample of the soil at the proper depth, mixing it with a known quantity of water, packing it in a cell with parallel metal electrodes separated by insulating walls of hard rubber, sending an alternating electric current through the soil and measuring its resistance, at the same time observing the temperature. An equal quantity of the soil is then mixed with a similar volume of liquid containing a known quantity of pure salt. The effect of the salt added will be to lower the resistance. From the quantity of salt added and the effect it has in lowering the resistance the amount of salt originally present in the soil can be estimated in terms of the kind of salt thus used. This determination can be very easily and quickly made.

The method is exceedingly sensitive, and where salts of the same kind are present it is exceedingly accurate. Where mixtures of salts occur, it is not so accurate, and especially where the salts have not the same value, weight for weight. Where, however, the salts are reasonably constant, or where the mixture does not change in its relative composition, the method can be used to great advantage in making rapid salt determinations. Several plats have been made of fields showing the amount of salt at different places and at different depths under the surface, and it will be quite feasible to make underground surveys of the soil of any locality showing the relative amount and distribution of the salt at different levels below the surface. This is a matter of very great importance where the alkali problem is present, for it is especially valuable to know the relative quantity of salt at different depths, whether it be before or after damage has been done by its appearance at the surface.

RELATION OF SOIL CONDITIONS TO THE DEVELOPMENT OF PLANTS.

It will be well to refer briefly to a line of work which is being developed to round out the series of soil investigations. It is a well-known fact, upon which these investigations are based, that differences in soils and soil conditions affect the physiology of plants, so that different types and grades of the same variety may be maintained on adjacent soils. The investigation of the soil conditions is merely a study of the causes which produce these differences in the development of plants. The actual growth and character of the plant itself, however, is the measure of the practical value of the soil conditions, and soil investigations are incomplete without using this as a measure to interpret the results of the investigations.

A tobacco plant grown upon a certain soil will produce a cigar-wrapper leaf. If grown upon another soil, perhaps adjacent to it, a different type of tobacco is produced, suitable only for some of the foreign markets. If grown upon a third soil, the tobacco may be unfit for any use, or of such a common type that it is not worth the cost of production. We may investigate and explain the conditions in the soils which determine the character of the crop, but if it is desired to change the conditions in any of these soils, in order to improve the quality of the tobacco, it is necessary to understand the influence of slight changes in the soil conditions upon the character of the leaf.

What is the character of a tobacco leaf which adapts it for use as a cigar wrapper? What is the difference between such a leaf and one adapted only to pipe smoking or for the export market? Dealers recognize these differences readily by handling the leaf, but the physiological differences have never been worked out. It is necessary in the first place to understand the physiological characters which determine the commercial value of the leaf. If these standards are established as a basis for the comparison of the crop grown on any particular soil and the influence of changing soil conditions on the physiology of the plant is worked out, more intelligent methods of improving the character of the crop can be reached than can possibly be used at the present time. Therefore, soil investigations should always be interpreted by the physiological condition of the plant grown upon the land, and the value of any change in the soil conditions by methods of cultivation, fertilization, or irrigation should be measured by the effect upon the quality and other commercial properties of the class of crops adapted to that kind of soil. It is difficult work, and it is essentially a new line of work; for while the influence of environment on plants has been studied in a general way, very little attention has been given in the case of commercial crops to the physiological characters which determine their market value.

OFFICE OF EXPERIMENT STATIONS.

By A. C. True, *Director*.

INTRODUCTION.

The Office of Experiment Stations represents the Secretary of Agriculture in his relations with the agricultural colleges and experiment stations. How this came about is thus explained: Thirty-five years ago Congress granted large tracts of public lands to the States to enable them to establish colleges for the especial benefit of people engaged in the industrial arts. Agriculture, along with many other subjects, was to be taught in these land-grant colleges. The organization of these institutions, already begun before the passage of the act of Congress, proceeded rapidly in the years immediately thereafter. Now many of the colleges are strong institutions with large faculties and hundreds of students.

About fifteen years later agricultural experiment stations began to be established under State authority and were so successful that in 1887 Congress passed what is commonly called the Hatch act, giving $15,000 a year to each State and Territory for the maintenance of experiment stations, which must, as a rule, be departments of the land-grant colleges.

In 1890 Congress provided for the further endowment of the land-grant colleges by the passage of the Morrill act, which granted $15,000 a year to each State and Territory for the benefit of these colleges. This regular stipend was to be increased by $1,000 each year until it reached $25,000. The law requires that the land-grant colleges shall annually report to the Secretary of Agriculture and to the Secretary of the Interior their receipts and expenditures on account of the Morrill fund. Moreover, "an annual report by the president of each of said colleges shall be made to the Secretary of Agriculture, as well as to the Secretary of the Interior, regarding the condition and progress of each college, including statistical information in relation to its receipts and expenditures, its library, the number of its students and professors, and also as to any improvements and experiments made under the direction of any experiment stations attached to said colleges, with their costs and results, and such other industrial and economical statistics as may be regarded as useful."

While the experiment stations established under the Hatch act are managed by the local authorities, the law provides for their being united to form a national system of agricultural research by making it the duty of the Secretary of Agriculture "to furnish such advice and assistance as will best promote the purpose of this act," "in order to secure, as far as practicable, uniformity of methods and results" in their work. Some years afterward Congress further made it the duty of the Secretary of Agriculture to prescribe schedules for the financial reports of the stations, and to ascertain whether their expenditures of the Hatch fund are in accordance with the law.

To enable the Secretary of Agriculture to discharge his duties relative to the experiment stations, the Office of Experiment Stations was established as a branch of the Department of Agriculture in 1888. And after the passage of the Morrill act this office was made the representative of the Secretary in his relations with the land-grant colleges.

LAND-GRANT COLLEGES AND EXPERIMENT STATIONS.

A better understanding of the nature and scope of the work of this office may perhaps be quickly reached if a few statistics regarding the land-grant colleges and agricultural experiment stations are next considered. In 1897 there were 64 colleges receiving the benefits of the Morrill act. These institutions had permanent funds, lands, farms and grounds, buildings, apparatus, machinery, libraries, and other equipment valued at $51,274,546, and their total revenues for the year amounted to $5,178,580, of which $1,619,090 was derived from the United States through the land-grant and Morrill acts. Their faculties contained 2,290 professors and other teachers, and the students in attendance numbered 28,260, of whom 3,928 were in the agricultural courses. Connected with these colleges, or in a few cases maintained separately under State authority, were 54 agricultural experiment stations, having a total income of $1,129,833, of which $720,000 was received from the United States under the Hatch act. These stations employed 628 persons in the work of administration and research and issued 378 bulletins and reports, which were distributed to more than half a million addresses. Their operations covered investigations in the sciences of chemistry, physics, meteorology, geology, botany, biology, zoology, and entomology, as related to agriculture, besides numerous inquiries involving both scientific and practical work in such subjects as soils, fertilizers, field crops, horticulture, breeding and feeding of animals, dairying, diseases of plants and animals, drainage and irrigation, seed testing, and bee keeping.

WORK OF THE OFFICE.

The business of the Office of Experiment Stations may be classified in a general way as follows: (1) Examination of the work and expenditures of the agricultural experiment stations, and the preparation of a report thereon for transmission to Congress; (2) the preparation of technical and popular bulletins based upon the published reports of the agricultural experiment stations and kindred institutions throughout the world; (3) examination of the expenditures and work of institutions having courses in agriculture as the basis for reports regarding the progress of agricultural education; (4) miscellaneous duties, such as giving advice to the experiment stations regarding their expenditures or lines of work, arranging for cooperative experiments between this Department and the stations, answering inquiries regarding the work of the colleges and stations. The office may also, by direction of the Secretary, undertake the supervision of special investigations ordered by Congress. As a basis for all its work, the office carefully collects, catalogues, and indexes the published reports of the agricultural colleges and experiment stations in the United States and other countries.

In its examination of the work and expenditures of the agricultural experiment stations established under the Hatch act, the office first considers the published reports and bulletins of the stations. The financial reports received from the stations on the schedules prescribed by the Secretary of Agriculture are examined with reference to their recommendation for approval by the Secretary. The director or other representative of the office personally visits each station at intervals of about a year to inspect the accounts, examine the work in progress, and confer with the station officers. At least one representative of the office annually attends the convention of the Association of American Agricultural Colleges and Experiment Stations, which includes delegates from the agricultural colleges and experiment stations throughout the country. This affords an excellent opportunity for conference with station officers and the gathering of much useful information regarding their work. From the information gathered from the publications and financial reports of the stations and the official visits a summary report on the work and expenditures of each station, together with a general résumé of their operations, revenues, and expenditures, is made to the Secretary for transmission to Congress. Inasmuch as the management of the stations is vested in the local authorities and not in the Department of Agriculture, it is necessary that much pains should be taken to secure such relations with the managers and workers of the stations as will best promote that reasonable degree of uniformity in general principles and policy which should govern the work of the stations as contemplated by the Hatch act.

In the countries of Europe and in many other parts of the world numerous institutions for agricultural education and research have been established, and it has been made the duty of the Office of Experiment Stations to collect their published reports and other information regarding their work and prepare such summaries of this material as will be of advantage to our investigators, students, and farmers.

PUBLICATIONS OF THE OFFICE.

The publications of the office are divided into six classes: (1) Official reports; (2) Experiment Station Record; (3) Card Index of Experiment Station Publications; (4) technical bulletins; (5) popular bulletins and articles; (6) circulars. During the past year the office issued 39 different documents, aggregating 2,600 pages. From this it is obvious that a very large part of the routine business of the office consists in the preparation of publications.

THE OFFICIAL REPORTS.

The official reports of the office include the annual report of the operations of the office, made to the Secretary of Agriculture, and an annual report on the work and expenditures of the agricultural experiment stations, made to the Secretary of Agriculture for transmission to Congress.

THE EXPERIMENT STATION RECORD.

The Experiment Station Record is a periodical publication containing concise summaries of accounts of agricultural investigations made by the Department, the experiment stations, and kindred institutions throughout the world. It is prepared under the editorship of the director of the office by a corps of several specialists, among whom are divided the various subjects with which agricultural science deals. In the work on the Record the office also has the cooperation of the scientific divisions of the Department and the abstract committee of the Association of Official Agricultural Chemists. Besides the abstracts of reports of agricultural investigations, the Record contains leading articles by eminent foreign and American experts in agricultural science and editorials on topics of special interest to agricultural investigators. These articles and editorials often contain suggestions of lines of work which may be carried on by our experiment stations. As our stations have developed and work of a similar character in other countries has increased, the task of preparing anything like a complete summary of agricultural investigations has become a very large one, as will be indicated by the following brief statement regarding the contents of Vol. VIII of the Experiment Station Record:

The eighth volume of the Experiment Station Record comprises 1,210 pages, and contains abstracts of 340 bulletins and 62 annual reports of 53 experiment stations in the United States, 92 publications of the Department of Agriculture, and 702 reports of foreign investigations. The total number of pages in these publications is 38,552. The total number of articles abstracted is 1,565, classified as follows: Chemistry, 157; botany, 69; fermentation and bacteriology, 5; zoology, 10; meteorology, 54; air, water, and soils, 55; fertilizers, 103; field crops, 228; horticulture, 154; forestry, 11; seeds and weeds, 29; diseases of plants, 79; entomology, 126; foods and animal production, 177; veterinary science, 51; dairying, 139; technology, 4; agricultural engineering, 22; statistics, 92. Classified lists of articles, in some cases with brief abstracts, are also given in each number. The aggregate number of titles thus reported is 2,200. An author index and a detailed subject index is published with each volume of the Record. It is believed that the Record now covers the field of agricultural science quite fully, and that with its aid our investigators can readily acquaint themselves with whatever is done in agricultural research throughout the world. As the Record is intended primarily for investigators, its style is made severely technical, and its gratuitous distribution is strictly limited to officers of agricultural colleges and experiment stations and the libraries of scientific institutions. It may, however, be purchased from the Superintendent of Documents, like other similar publications of the Government.

THE CARD INDEX.

The Card Index of Experiment Station Publications is intended to supply a means of ready reference to the publications of the stations, and gives a brief account of the contents of each publication. It is based on a topical synopsis of the subjects included in agricultural science and practice, which has been more carefully and extensively elaborated than any previous scheme for indexing agricultural literature. Each card bears the title of an article, the name of the author, references to the station publication in which the article appeared and to the Experiment Station Record, and a concise summary of the contents of the article. The index is furnished gratuitously to the libraries of the agricultural colleges and experiment stations and is sold to a limited number of subscribers. The preparation, printing, sorting, and distributing of these cards involves a large amount of work. The number of printed cards has now reached 15,000.

THE TECHNICAL BULLETINS.

The technical bulletins of the office include digests of agricultural investigations and publications relating to the organization and work of the experiment stations. After investigations on a given subject have proceeded for a considerable period, a large amount of data accumulates which in many cases is distributed among many different reports and journals. It then becomes difficult for the investigator or student to obtain a clear notion of what has been done in this line, unless the scattered literature is brought together and a concise statement of the methods and results of the work is prepared. This task this office has undertaken as far as its other duties have permitted. Examples of its work in this direction are a compilation of analyses of American feeding stuffs and a bulletin on the history, botany, chemistry, culture, enemies, and uses of the cotton plant. A condensed digest of the reports of all the experiment stations has also been made in the Handbook of Experiment Station Work. Each year the office issues a bulletin containing lists of the officers of the agricultural colleges and experiment stations, a catalogue of the station publications received during the year, the federal legislation relating to the colleges and stations, and the rulings of the Federal Departments on this legislation. The proceedings of the annual conventions of the Association of American Agricultural Colleges and Experiment Stations are edited by the director of the office and the chairman of the executive committee of the association and published by the Department.

THE POPULAR BULLETINS.

The popular bulletins of the office are issued as a part of the general series of Farmers' Bulletins of the Department. The first two Farmers' Bulletins were issued as publications of this office, after which this designation was adopted by the Department for its general series of popular bulletins intended for wide distribution. Popular articles are also prepared in this office for the Yearbook of the Department. Lately the office has begun the preparation of a series of popular résumés of experiment station investigations for the purpose of acquainting the farmers throughout the country with the results obtained at the stations in the several States and in general with the progress of agricultural research on its practical side. These résumés will be published as Farmers' Bulletins, but will be designated by the general title of "Experiment station work."

THE CIRCULARS.

The circulars of the office include miscellaneous brief papers containing information on some subject of experiment station work, addresses delivered at conventions, committee reports, statistics of colleges and stations, etc.

RELATIONS OF THE OFFICE WITH THE AGRICULTURAL COLLEGES.

In connection with its work regarding the experiment stations, the office is brought into close relations with the agricultural colleges. Since the stations are, as a rule, located on the same grounds with these colleges, representatives of the office have numerous opportunities for examining the educational work of the colleges and conferring with the college managers and faculties. As stated above, the reports of the colleges are deposited in this office. In recent years the office has paid considerable attention to studying systems of agricultural education in foreign countries as well as in the United States. The statistics of our agricultural colleges have been collated in the office, and articles and reports on agricultural education have been issued. Naturally the Secretary of Agriculture is often called upon to give advice regarding agricultural education and to promote the perfection of plans for its extension in this country. In a general way the office is endeavoring to obtain such information as will enable the Department to perform its legitimate functions in this important matter.

MISCELLANEOUS DUTIES OF THE OFFICE.

Under the head of miscellaneous duties, this office is often called upon to advise the stations regarding their expenditures and work, to aid them in arranging cooperative experiments with the Department, or to facilitate their business with different branches of the Government or with foreign institutions for agricultural research. Inasmuch as the office is regularly traversing the literature of agricultural science, it is in a position to give more or less definite replies to inquiries addressed to the Department on a wide range of subjects and to furnish memoranda on many topics which are useful in the general business of the Department.

SPECIAL INVESTIGATIONS.

The special investigations at present in charge of this office are: (1) Investigations on the nutrition of man, and (2) investigations regarding the agricultural possibilities of Alaska and the desirability and feasibility of establishing experiment stations in that Territory.

NUTRITION INVESTIGATIONS.

Three years ago Congress for the first time made an appropriation for investigations regarding the food habits of the people with a view to aiding them in improving their diet. In a word, this was to be an attempt to study the nutrition of man in much the same way as the feeding of domestic animals has been studied by the experiment stations. If it is a good thing to find out what are the best rations for these animals when used for different purposes, surely it must be a better thing, though obviously a much more difficult undertaking, to ascertain the principles which should govern the selection and use of food by men and women when engaged in various occupations. Considerable work in this line had been done in Europe, where, for example, the great German armies are fed in accordance with scientific advice, and some similar investigations had been made in this country. The law provided that this investigation should be carried on by the Department in cooperation with the experiment stations. The general supervision of this work was, therefore, intrusted by the Secretary to this office. Special expert agents have been employed and investigations have been undertaken in different parts of the country. The first work was to collate and publish the methods and results of previous investigations. This was done in both popular and technical bulletins. Then investigations in various lines were begun. The food habits of people of various occupations have been closely observed and recorded, questions relating to the relative expensiveness of different foods and dietaries have been considered, experiments have been made to determine the digestibility of different articles and combinations of food, and investigations have been conducted to discover the effects of cooking on the composition, digestibility, and nutritive value of foods. At the same time efforts have been made to improve the methods and apparatus for investigation. About 20 bulletins and articles have been published. Necessarily most of the work has thus far been in making experiments and recording the results. So little accurate scientific work has been done in this line that on many points it is impracticable to give useful advice until many investigations have been completed. However, a considerable amount of popular information on subjects relating to the food and nutrition of man has been given out in different forms. A special effort has been made to come into close relations with teachers and physicians. The charts and popular bulletins of the Department on these subjects have already been used in hundreds of schools and colleges throughout the country, and have largely supplemented the very meager information on these subjects furnished by the text-books on physiology and hygiene.

THE AGRICULTURAL POSSIBILITIES OF ALASKA.

On the recommendation of the Secretary of Agriculture indorsing a suggestion made by the director of this office, Congress provided in the appropriation bill for this Department for the current fiscal year for an investigation into the agricultural possibilities of Alaska, with special reference to the desirability and feasibility of establishing agricultural experiment stations in that Territory. The general supervision of this investigation was intrusted to this office, and commissioners were appointed to visit the Coast and Yukon River regions for this purpose. A brief account of the results of this work is given elsewhere in this volume by one of the officers engaged in this investigation, and a more complete report will be made to Congress.

DIVISION OF FORESTRY.

By B. E. FERNOW, *Chief.*

INTRODUCTION.

Forestry is the art of managing forests or wood crops, using the same rationally, and reproducing them so as to secure continuous supplies. As long as there are extensive virgin forests from which to draw for our enormous requirements of wood material, it appears to many people unnecessary to bestow any care upon the methods of using them. They are cut wastefully, and their reproduction is left to chance and nature's beneficent but slow processes, nature having endless time and infinite space at her disposal and no economic objects to subserve. So it is that, with virgin supplies nearing exhaustion and the forest area becoming more and more limited by the extension of the agricultural area, it becomes apparent that wood crops are not only as necessary as food crops, but that, like food crops, they require some knowledge and care to produce the best results from limited areas, and the need of forestry appears.

Another aspect also becomes apparent with the reckless denudation of mountains and hillsides, namely, the influence of the forest cover upon the soil and water conditions of the agricultural lands below. A new interest in forest conditions arises, and again the need of forestry appears.

RELATION OF FORESTRY TO ALL CLASSES OF FARMERS.

Forestry was not practiced in this country when the first attempt was made to have it represented in the Department; the Division of Forestry was created in advance of a well-developed interest, and even now the work of the division is still more or less of a missionary character, trying to bring about a reform in our method, or rather in our absence of method, in the use of forest resources. When the work of the division was begun, only tree planting in the Western prairies and plains, as a means of ameliorating the climate, for shade, wind-breaking effects, and for ornament, was practiced; but forestry as applied to existing forests was practically unknown. Here and there a farmer may have cut his wood lot with more or less care, but the majority did not know that their wood lot was capable of being reproduced in superior quality merely by an intelligent use of the ax.

To be sure, the larger portion of our forest resources is not in the hands of the farmers, and hence the larger direct interest in the subject of forestry lies with another class of men, namely, those who control our forest area and the production of our lumber and wood manufactures—industries which rely upon forest growth to the extent of a round half billion dollars for raw material—who employ readily a million workers and produce material worth nearly two billion dollars annually.

This tremendous business of harvesting and transforming our virgin forest crop far outranks all other industries in employment of capital and labor and in value of products except agriculture itself.

While the business of harvesting and using the forest crop in which these industries are engaged is, to be sure, only a part of forestry, yet, it is the most important part, for, as stated above, the difference between crude forest exploitation and rational forestry lies in the manner in which the harvesting is performed. Forestry teaches how to cut and utilize the forest crop so as to secure the largest money returns and yet maintain natural reproduction.

It may be argued that the farming community of the plains and prairies, which produces the bulk of our agricultural produce, has comparatively little concern in the question except so far as shelter-belt planting may be considered a branch of forestry. Yet, even if there existed no direct relation of farming to forestry, such as will presently be shown to exist, the indirect relation must not be underestimated. In these times of close interrelation between all portions of our country and between all pursuits and industries, it would be difficult to find any pursuit or industry or development or condition that does not have a more or less direct bearing upon the farming industry, and hence such a large and far-reaching industry as that which is concerned with the exploitation of our forest resources must have a potent interest for the farmer.

Paradoxical as it may appear, for instance, the farmer in the forestless region is in one direction more concerned in the fate of our forests than his brethren in the forested States. For these have stone, iron, and coal ready at hand as substitutes for the wood material, while the development of the plains and prairies has been possible only by means of cheap and easily transported building material. When prices for wood material rise, owing to the rapid decimation of our virgin supplies, which is now appreciable, the first one to feel the difference will be the farmer on the prairie.

FORESTRY KNOWLEDGE NECESSARY FOR THE FARMER.

But the forestry business has a much more direct and intimate relation to the farming industry in the forested than in the forestless regions. Having to deal with crops of the soil, the farmer in these regions must divide the soil with the forester. If he be the owner of land not all fit for the plow he must know what portions to leave to wood crops and which to devote to farm crops. He must then learn to manage his wood crop as well as his food crops, and thus a direct need for forestry knowledge by the farmer arises.

In deciding upon the allotment of lands for forest and farm purposes the fact that wood may be grown successfully in soils and situations which are not adapted for farming forms the primary basis; yet, other considerations must also enter into this determination. The farmer not only manages the soil, but he must also manage the water resources and climatic conditions so far as he is able, although he has hitherto but imperfectly realized the possibility, importance, and methods of such management.

FOREST INFLUENCES.

There is a well-substantiated belief that a forest cover exercises certain influences not only upon the soil on which it stands and on the waterflow and climatic conditions within its own boundaries, but beyond these; hence the existence or absence of a forest cover, its presence in situations where a beneficial influence upon surrounding conditions may be exercised, its treatment so as most effectually to secure its protective influences—all these considerations are of direct concern to successful farming.

This question of forest influences has been again and again discussed in annual reports, but most exhaustively in Bulletin No. 7 of the division, "Forest influences," published in 1893. This publication enables the farmer to form his own opinion as to the character and degree of influence which a forest cover exercises upon the wastage of his water resources, upon the erosion and silting of his fields, and upon the loss in his crops from winds and other causes which may be affected by the forest cover; and thus he may be enabled to decide judiciously as to what portion of the farm to leave in woodland.

WATER MANAGEMENT.

To bring the application of this knowledge more fully to the farmer's conception, the loss which our farming lands suffer annually by erosion, amounting to millions of dollars of soil capital, is graphically depicted in a colored chart, designed to be exhibited as an object lesson in schools, post-offices, and other public places. It shows how the denuding of the hilltops and the compacting of the soil by the rains and by the trampling of cattle induce rapid surface drainage. The compacted soil is gullied and washed away, the valley fields silted, and the farm is lost. The chart also shows how by keeping hilltops and steep slopes under forest, by filling gullies with brush and stonework, and providing for underground drainage, etc., the farm is regained, and how by judicious distribution and management of forest cover and proper assignment of soil to various purposes the farm is retained in best producing capacity. This relation of forest to farms has also been discussed and illustrated in Farmers' Bulletin No. 20, "Washed soils: How to prevent and reclaim them," and in the Yearbook for 1895. Water management (meaning thereby not only the use of water for irrigation in the arid and subarid regions, but the rational distribution and use in the humid regions of available water supplies) is the great problem of the future, upon the solution of which more productive agriculture depends; and with the solution of this problem the forestry problem is most intimately connected, for without forest management no rational water management is possible.

RELATION OF FORESTS TO SURROUNDING CONDITIONS.

As this is perhaps the most important direct relation of the farmer to forestry and there are still erroneous notions as to the philosophy, character, and degree of this relation abroad, we may be allowed to briefly state what our present knowledge regarding it seems to be, referring the reader for a fuller discussion to the publications cited above.

There are two questions involved, namely, the effect of a forest cover on the conditions within its own boundaries and on the conditions of adjoining territory. That the degree of influence depends largely on the kind and condition of the forest growth itself must be self-evident; it must differ according to the composition (hardwoods or conifers), the density (open or close stand), the height or age of the trees, and many other conditions.

The influence upon the conditions under its own cover are mainly due to the mechanical barrier which the canopy of foliage interposes between the sun, the rain, the winds, and the air of the interior and the soil. The exclusion of sun and wind reduces the evaporation, and hence both the air and soil under the shade of a forest cover should, as a rule, be not only cooler, but moister than in an open or barren field. Trees, to be sure, require water for their growth, but it seems that they require less than a growing field or grass crop or weeds, and, since they bring up the water from greater depths and transpire the greater part into the air, they increase the humidity of the air in their neighborhood.

Yet, it is still an open question whether forests contribute to an increased rainfall in their neighborhood. Other conditions producing rainfall are so much more powerful that it is doubtful whether this forest effect, if it exists, would be appreciable even within a restricted area. On the other hand, it is well known that a timber belt or even a few rows of trees in a wind-break or shelter belt have not only a beneficial effect on orchards and cattle, especially in the open prairies and plains, but also on crops in adjoining fields; because, by breaking the force and velocity of droughty winds, the evaporation is reduced, and hence more moisture remains for the use of the crop.

The most patent and most potent effect of forest cover upon water and soil conditions is to be found in a hilly or mountainous country. Again, this effect is a mechanical one. Crops depend less on rainfall than on water supplied to their roots, however obtained, whether it be furnished by rain directly, by artificial surface irrigation, or by natural underground irrigation. Rain is not the most desirable form in which our water supply comes to us, as the districts relying on irrigation testify. The ideal form of supply is by natural underground drainage.

Now this is precisely what a forest cover, on the higher levels as well as in the valleys, aids in securing, namely, the changing of surface drainage into subdrainage and the conservation of moisture against dissipation by the evaporative influence of sun and wind. A forest growth keeps the soil porous, and with its deep-reaching root systems assists the percolation of the falling waters or melting snows, and permits subdrainage of these waters, which prevents their wastage by surface evaporation; while on a bared slope and even in a cultivated field the pattering raindrops compact the soil, thus finally by their own action impeding percolation. As a consequence, less water penetrates and more is finally evaporated by capillary action, and hence less remains available for the crops at lower levels. The waters falling on a well-forested slope find the lower levels underground and furnish the desirable constant supplies to the lowland fields. This explains the constancy and even flow of springs and brooks in a well-wooded country, where uneven flow, floods, and droughts become frequent after denudation.

Between the extreme conditions of an absolutely bare slope and a well-wooded one there may be many gradations, and the condition of the forest cover will necessarily determine the amount of influence it exerts. Besides, geologic formation and topographic contour must be considered. There may be loose rocks and gravels which, without a protecting forest cover, remain readily permeable, and again there may be such precipitous slopes that even a forest cover can not much impede the surface drainage.

In addition, the rapid surface drainage on a thinly forested or bare slope induces the gullying and eroding process, and the destruction and wastage of the fertile soils at lower levels is the consequence. The character and degree of this erosion, to be sure, varies according to the character of the soil and the slope. There may be conditions where no dangers need be feared from this source, but over large areas in our country there are just such conditions as in France, where whole communities have been impoverished and large areas depopulated by erosions and floods, induced by forest devastation on the slopes. In such localities, at least, it is essential that the farmer exercise judgment in the location of his fields as well as in the management of his woodlands.

The loss of soil capital in the United States, due to this cause, has been roughly estimated at 200 square miles of soil per annum. The great floods of the Mississippi and the hardships to agriculture resulting therefrom are intimately bound up with the condition at the head waters of streams and along stream banks, and may, in time, be avoided or at least reduced in frequency and danger by a judicious management of the drainage conditions which furnish the flood waters. Forestry, as Captain Eads himself foresaw, will have to come to the aid of the engineer.

From these statements it will appear that not merely as a citizen interested in the general welfare of the country is the farmer under obligation to take interest in the subject of forestry—if not in its technical aspects, then at least in its importance with reference to other economic conditions—but as one whose own industry and capital are directly influenced by forest conditions.

SYLVICULTURE.

For those who desire to get a general conception of the objects as well as the methods of forestry as practiced abroad, there is, besides the annual reports which discuss various phases of the subject, a brief yet comprehensive discussion to be found in Bulletin No. 5, entitled "What is forestry," of which a large edition has been published and distributed.

For those who desire more technical information and wish to apply some of the forestry principles to the treatment of their wood lot, the Yearbook for 1894 in the paper "Forestry for farmers" gives concise instructions, elucidating first the manner in which trees and forests develop and then giving hints as to how the wood lot should be cut systematically to secure a young growth of desirable species.

Under the caption of "Tree planting in waste places on the farm," the Yearbook of 1896 gives, at least, valuable hints as to how the untillable ground, the rocky and unsightly spots of a farm, may be made useful by devoting them to tree growth.

It is only possible in such brief papers to give general principles, since the flora, the climate, and other conditions vary to such an extent over our large country that specific rules could be formulated only for a definite locality. When it comes to the practice, the farmer will have to study his own conditions and apply the principles according to his own judgment and experience, just as in other agricultural problems. Furthermore, much of the specific knowledge which would entitle us to give authoritative advice is still lacking.

FOREST BIOLOGY.

In order to manage a forest growth intelligently we must know first of all the biology, or life history, of all the kinds of trees which compose it, what conditions they require for their best development, how their growth progresses from the seed to maturity, especially their relative height growth and their light requirement or shade endurance, for this knowledge alone will enable us to judge whether and how we can maintain the desired composition and secure its best development and reproduction.

The European forester needs this knowledge only for six or eight species, while the American forester in almost any part of the country must be familiar with the requirements of at least a dozen or two; and he who would want to give specific advice for all parts of our country must know the life history of at least 100 tree species out of the 450 which are found native in the United States. He must, in the first place, know to which of the host of tree forms to direct his attention; he must determine which are to be considered economically valuable species, which have only subordinate sylvicultural value, and which must be considered simply as weeds (for there are weeds among trees as well as among other plants). But weeds, we must not forget, are only plants, the use of which is not yet known. He must, therefore, classify the trees as to their relative value, and for such classification he must have sylvicultural, biological, and technological knowledge of them.

NOMENCLATURE.

It may be well to remind the reader that in the development of any science or art there is much work necessary to be done that has apparently no direct practical value. Yet, to insure the satisfactory progress of such development it has to be done, and sometimes the practical value will show when least expected. Of such a class of work is the revision of the nomenclature of the arborescent flora, which was published in Bulletin No. 14—an attempt to bring about uniformity in the use of the botanical as well as of the vernacular names. It was a very practical question which suggested the urgent need of this work, namely, the loss of money by a firm of nurserymen, who, in ignorance of the different use of names by the customer, supplied the wrong plants. Again and again has the confusion of names led to similar troubles.

BIOLOGICAL WORK OF THE DIVISION.

The work of the Division of Forestry in a biological direction has been progressing very slowly, partly because of a lack of men fitted to pursue this particular line of work, which requires a certain amount of forestry education and close observation in the field, and partly because of scant appropriations.

A first attempt at a tentative classification of our forest flora was made in the annual report for 1886, in which a list of 97 species then conceived as of economic importance was given, classified according to their relative value, with notes regarding their sylvicultural requirements. A revised list of this kind will be found in the Appendix to this volume.

More comprehensive studies were made regarding the most important timbers of the Eastern United States, the conifers (spruces, pines, hemlock, cedars, cypress), which, although perhaps of less direct interest to the farmer than the broad-leafed trees that usually compose his wood lot, at least in the Northeastern section of the country, furnish from two-thirds to three-fourths of our enormous lumber consumption, and their reproduction is, therefore, of the greatest interest to the people at large and to the forester of the future.

So far, the division has been able to make a thorough study of five species only with sufficient completeness to warrant the publication of results, namely, the white pine, the monograph on which is to be published shortly, and the four Southern lumber pines, which were discussed in Bulletin No. 13, "The timber pines of the Southern United States," published in 1896.

Although these studies are designed more particularly to meet the needs of that class of men who control the pine forests, and to assist them in a better management of the same, every farmer who wishes to widen his conception of the drift and importance of the subject should read this Bulletin No. 13. It is the first attempt in the United States of a comprehensive statement, from a forestry point of view, of the economic, technical, and sylvicultural conditions and requirements of four species of forest trees.

A knowledge of the life history of the species composing the forest and of their sylvicultural requirements is all that is necessary to manage the crop for best development and reproduction. This part of forestry—the growing of the crop—is designated as sylviculture. But the forester whose business it is not only to grow the crop, but to market it and produce a money result, must have knowledge in three other directions, namely, he must know how fast his crop develops, he must know for what purpose the different parts of his crop can be most profitably employed, and lastly he must have some knowledge of market conditions and market requirements.

FOREST MEASUREMENT AND FINANCE.

The forest crop differs from all other crops and forestry differs from all other industries of production in two ways. There is no definite period when the crop can be said to be mature, as in the case of agricultural products; it consists, first, of annual accumulations which are allowed to continue until the individual trees attain either a useful or a profitable size, and, secondly, to attain such size a long time, and, with different species and conditions, a variable time, is needed; thus, for firewood production a growth of fifteen to twenty-five years might suffice, while for good lumber production not less than seventy-five to one hundred years and more are needed. This indefiniteness of the time of maturity and the unusually long period of production during which the crop has to grow predicate peculiar business arrangements, entirely different from those prevailing in other industries, if forest growing is to be carried on as a financial business, and so necessitate to a greater extent than with any other a full knowledge of the forest industry.

Tree measurements, especially measurements of the rate of growth of single trees and of whole stands of trees, furnish the basis for determining the first question, namely, when under given conditions the useful or the profitable sizes may be expected to be attained.

The division has, therefore, for some time, as opportunity has been afforded, carried on measurements of the rate of growth of certain species, especially of the important conifers. It is now in position to make a comprehensive statement of the growth of white pine, having analyzed nearly 700 trees from many localities, the results of which will permit an estimate of the possible yields that can be expected from this species at different periods of its life. This is a much more complicated matter than most people would suspect, especially since our measurements can only be made on trees and stands of trees which have grown in nature's unattended forests, while with the application of knowledge and skill in the management of the crop quite different results may be secured. Bulletins of this division will shortly be published on the measurement of standing trees and forests and on the measurement of the rate of growth of trees and forests.

There have been many misconceptions abroad as to the rapidity of tree growth and the amounts that may be harvested from an acre in a given time. If wood alone were to be produced, the matter would be much more simple. We could, from the experience which has been gathered in other countries and in our own, soon arrive at a statement as to the amount of wood which an acre of a full grown dense forest crop could produce, just as we know the productive capacity of an acre of wheat or barley.

In an average of a hundred years the yearly growth, according to species, soil, and climatic conditions, would vary between 30 and 180 cubic feet of wood per acre each year. But, unless firewood is the object of forest cropping, it is not quantity of wood merely, but wood of given size and of given quality, wood fit for the arts, that is to be grown. Such wood alone it will pay to raise. Hence, it is necessary not only to know what sizes can be grown in given periods of the life of the crop and what sizes can be profitably handled at the mill or in the market, but also what qualities are desired and under what conditions they can be produced. Trees develop very differently at different periods of their life. Thus, while a white-pine tree may in the first fifty years have grown on an average one-third of a cubic foot of wood per year, if we had waited till the hundredth year the average rate per year would appear as more than 1 cubic foot, and the total volume four to five times what it was at fifty years, although the diameter has only about doubled. Again, while at fifty years hardly more than 15 per cent of the total wood volume would have furnished saw timber, perhaps making 50 feet B. M., at one hundred years the proportion of the more valuable milling material would have risen to 40 per cent and more of the whole tree, and the output of timber has reached 500 feet B. M. On the other hand, an acre of pine fully stocked which at one hundred years may have produced at the rate of 140 cubic feet per year could under the same conditions have produced for the first fifty years at the rate of 180 cubic feet per year, or nearly one-third more. Yet, the value of the wood on that same acre at one hundred years is very considerably more than the fifty-year old wood, on account of the increased proportion of highly useful material that can be got from it. Similarly, we find that not more than 1 to 2 per cent of the wood produced in the coppice woods of twenty to twenty-five years' growth, in which New England abounds, is serviceable in the arts, while 50 to 75 per cent and more may be thus profitably utilized from the same acre if allowed to grow one hundred years.

It will be readily seen from these few glimpses into the subject that this knowledge of the rate of development and yield of our timber trees is indispensable for the discussion of the profits of forest cropping, and also furnishes hints for rational methods of sylviculture. This same white-pine tree, for instance, could have made much more wood if it had been allowed to grow without interfering neighbors, but it would not only have assumed less useful, conical shape, but would have put much of its energy into branches, which not only do not furnish serviceable wood, but produce knotty lumber, an inferior or unsalable article. Moreover, the wood of most or many of our trees changes in quality with age, so that with size, form, and freedom from knots, not only the technical value, but the money value also, grows disproportionately.

CONSUMPTION AND WASTE OF WOOD.

Regarding the technical value of our woods the ignorance of our people, even of those whose business it is to use wood in structures and otherwise, is so great that an enormous waste of good material is the result. Our nation has used and is now using more wood materials than any nation ever did, our wood consumption per capita outside of firewood being eight to ten times that of Germany and eighteen to twenty times that of Great Britain. Not only do we rely more on wooden structures, but we are more wasteful in their construction. This waste is induced by two causes—ignorance regarding our supplies, which we seem to believe inexhaustible, and ignorance regarding the properties of our timber and of wood in general, which results in wasteful lavishness.

In the opinion of the writer, change in our methods of using wood has become an absolute necessity, for if we persist in the wasteful squandering of our virgin supplies of timber we must inevitably exhaust them before a new crop is ready to supply even our more limited necessities. The farmer should be as much interested in this question as any other class of citizens, and perhaps more, for he relies upon wood more than any other class, not only in his buildings but in his implements.

STATISTICS.

The division has never been placed in position to ascertain with any degree of accuracy the question of supplies, but has gathered at least such information as was accessible from other sources, and has endeavored to present them in such a manner as to attract attention to the gravity of the situation.

In Circular No. 11, "Facts and figures regarding our forest resources briefly stated," it was estimated that at the very best there were to meet our annual consumption of a round 40 billion feet B. M., in bolt and log size, not more than 2,300 billion feet of timber standing, or less than sixty years' supply. This is probably a very sanguine position, and does not take into account that much of this timber is certain to be cut into firewood or burned in our annual conflagrations.

The situation is still less assuring when we confine the inquiry to the coniferous growth, which, as we have stated, furnishes at present nearly three-quarters of our lumber consumption. This was discussed in a report in answer to a resolution of the United States Senate of April 14, 1897 (Senate Doc. No. 40, Fifty-fifth Congress, first session). In this report it was shown that there was probably not sixteen years' supply standing in the Eastern States if we continue to cut and waste it as hitherto, and that the supply of the Pacific Coast would not suffice to lengthen this period of plenty beyond thirty years, even if this supply were not largely destroyed by fire.

The lesson to be learned from these statistical inquiries is that the time when supply is in excess of demand has passed, considering that to grow a really serviceable mill log of pine requires not less than one hundred years—the trees that have hitherto been considered serviceable for such purposes being much older. Farmers who own really good saw timber will do well not to fritter it away, but carefully cut it, when salable at good price, in such a manner as to reproduce the crop.

FOREST TECHNOLOGY AND TIMBER PHYSICS.

The other element of ignorance which leads to waste, namely, the properties of wood in general and of our timbers in particular, acts detrimentally in two ways: First, by not knowing or appreciating the value of many of our woods, we fail to use them, and waste the supply in logging operations; and, second, by not knowing more exactly the properties of those we use, we apply them in wrong places and wastefully. Everybody knows how the black walnut has been squandered in fence rails and been burned without the knowledge that it could have been kept for a century (in logs, if not standing), with increase in value and without danger of decay. Who does not remember how millions of feet of hemlock, from which the bark was taken, were lying rotting in the woods, because the value of the wood was unappreciated! And even to-day millions of feet of most valuable chestnut and oak are left in the woods unused after the bark has been taken by the tanner. While this may be in part due to economic conditions, the transport of the wood being too difficult and too expensive, there is no such reason for leaving the excellent hemlock of the Pacific Coast uncut in the woods.

In some portions of Washington and Oregon about one-half the forest growth consists of hemlock trees 300 feet and more in height and 3 to 4 feet in diameter, furnishing a magnificent material for many purposes. Yet, such is the ignorance regarding its value that it can not be marketed, and it is left standing. This would at first sight appear an advantage for the future; but it is not, for the trees, suddenly placed in different conditions, even if the fires that follow the logger should spare them, die as the consequence of the exposure by removal of their neighbors, and thus one-half the value of the forest growth is lost. Examples of this kind could be multiplied from all sections of the country. The other kind of ignorance, namely, regarding the properties of the woods which we do use, exhibits itself in their wrong and wasteful application.

There has been so little systematic and reliable investigation on our timbers that until a short while ago the sizes which architects, builders, and engineers prescribed for use in structures were formulated upon the data furnished by European investigators on European timbers, which are by no means of the same quality as ours. The use of unsuitable woods in places where liable to decay, and the absence of proper handling of woods used for such purposes, occasion a large wastage, due to the necessity of replacing them; and many a disaster, from the break of a wagon pole to the collapse of a building in which large amounts of property and even life are destroyed, may be traced to ignorance in the use of woods.

The first statement as to the wasteful use of our timbers we can substantiate by the investigations of the division, which have shown that the strength of our longleaf pine is from 20 to 25 per cent greater than had hitherto been supposed; by this knowledge an annual saving of at least $6,000,000 worth of this material alone could be effected. The demonstration by the division that the bleeding of this same species for turpentine does not deteriorate the timber value of the trees has added at least $2,000,000 annually to the product of the pineries of the South.

A few years ago the division inaugurated a most comprehensive investigation, such as had never been attempted elsewhere, in order to remove, once for all, ignorance so fatal to a conservative use of our forest resources. The plan elicited the commendation of both European and American engineers and wood consumers in general, who realized most readily how little we know of wood and how important such knowledge is, and how dangerous in its consequences is the absence of reliable information. The results, being capable of immediate application in practice, promised more immediate effects in the direction of more conservative use of our forest resources than any other line of work. Yet, through lack of appreciation of its direct influence upon the forestry problems of the country and deficient appropriations, the plan was curtailed in its scope, and has finally been abandoned.

This work and the publications that have resulted therefrom so far may not be of direct and special interest to the farmer, as they are necessarily in the first place designed for use of architects, engineers, and others using wood on a large scale. Yet, even though the farmer's interest in the subject is seemingly limited, it may be well worth his while to become familiar with two of the publications emanating from these investigations, namely, Bulletin No. 10, "An elementary discussion of the characteristics and properties of wood," which attempts to give in concise form what general knowledge we have regarding wood, with such examples of our own timbers as were available, and the paper in the Yearbook for 1896 on "The use of wood," in which the principles are discussed which should guide in the choice of our woods for various purposes. From the final results of these investigations, if they should be continued, the farmer would indirectly benefit as much as every other citizen who builds a house or uses a spade.

Those engaged in growing wood for profit will recall what has been said regarding the profitableness of forest culture as depending on our knowledge of the qualities of our product and its serviceableness for different purposes, and will readily form an opinion as to the paramount need of these investigations, which can in a comparatively short time be brought to conclusion.

We repeat, that as far as the enormous business of harvesting and marketing forest products and of wood manufactures is concerned, the forestry interests lie in the hands of other men than the farmers, who own only a limited portion of the great forest areas.

TREE PLANTING IN FORESTLESS REGIONS.

Forests grow in humid regions; and as forestry has to do with forests rather than trees merely, as the etymology of the word indicates, the work of the division has had most concern with the interests of these regions instead of making the tree planting in the Western

States its most prominent concern. Nevertheless, the beneficial influence which tree growth may exercise on surroundings being first realized when the absence of it suggested it to the settler on the open prairies and plains, tree planting became early a practice among the settlers in those regions.

This tree planting had in view protection from cold and hot winds, shade, and shelter rather than wood supplies, and we may as well recognize at once the fact that while undoubtedly this beneficial influence of timber belts may be secured in most parts of the arid and subarid belts, and incidentally the supplying of firewood and other timber of small dimensions for domestic use, it is entirely out of the question to expect that these plantings will ever furnish supplies for our great lumber market. These supplies will always, the writer believes, be grown in the regions in which forests now grow and which are by nature best adapted to wood crops. Nevertheless, the division has given attention to the needs of the tree planter in the prairies and plains, who is concerned in the artificial creation of forest growth to ameliorate his climatic conditions.

In these arid and subarid regions, where nature has denied tree growth, the climatic conditions are so different from those of the humid parts that not only different methods of cultivation are necessary, but the plant material must be imported and selected with a view to a rigorous climate, characterized by extreme ranges of temperature. A range of 40° below zero to 120° F. above must be endured by the trees, their moisture requirements must be of the smallest, and they must be capable of responding to the enormous demands of evaporation. At first, whatever trees will grow successfully from the start under such untoward conditions would have to be chosen, no matter what their usefulness otherwise might be.

The first settlers have ascertained by trials some of the species that will succeed under such conditions, but unfortunately most of these are of but small economic value and some of them are only short lived under the conditions in which they have to grow. The methods of planting were naturally suggested by the experience of orchardists and nurserymen, since forest planting had never been practiced in this country, but unquestionably many failures can be avoided by application of forestry principles in these plantings. Whether more useful kinds can be found that may be grown to advantage, and whether methods of planting can be devised by which a greater efficiency of the plantation may be gained, are problems which the division has taken up within the last few years. Such problems can, of course, only be solved by actual fieldwork, experiment, or trial, and hence the cooperation of the State agricultural experiment stations has been secured to carry on such experiments. The station authorities have placed some land at the disposal of the Department, and the professor of horticulture or some other officer of the station superintends, free of charge, the labor of planting, cultivating, etc., while the Division of Forestry furnishes the plans, plant material, and all expenses.

So far, the stations of Montana, Utah, Colorado, Texas, Oklahoma, Kansas, Nebraska, South Dakota, and Minnesota are engaged in this cooperative work. In addition, there are two planting stations located in the forested regions, namely, one in Minnesota and one in Pennsylvania, to experiment on practical methods of reforesting cut-over waste brush lands.

Some few years ago the writer came to the conclusion that the conifers, especially the pines, would furnish more useful and otherwise serviceable plant material for the arid regions. Not only are they of greater economic value than most of the diciduous trees that have been planted, but, requiring less moisture for their existence, they would, if once established, persist more readily through droughty seasons and be longer lived; besides, their persistent foliage would give more shelter all the year round.

A small trial plantation on the sandhills of Nebraska, described in the annual reports of the division for 1890 and 1891, lent countenance to this theory. To be sure, the difficulty of establishing the young plants in the first place is infinitely greater than would be experienced with most deciduous trees. A large amount of attention was, therefore, devoted to finding practicable methods of growing the seedlings cheaply for extensive use and of protecting them for the first years in the plantations, for the transplanting of conifers is attended with considerable difficulties, especially in a dry climate, and they require in the first years protection from the sun and winds. They must, therefore, be planted in mixture with "nurse" trees which furnish not too much and yet enough shade. It can not be said that the success in using these species has so far been very encouraging; nevertheless, the failures may be charged rather to our lack of knowledge and to causes which can be overcome than to any inherent incapacity of the species. The experimentations should, therefore, be persistently continued.

Mixed planting and close planting are undoubtedly the proper methods of establishing quickly forest conditions, when without further attention the plantation will take care of itself. But it is essential to know what species should be planted together and how close in order to secure the best results, and this knowledge can only come from experience and actual trial, since the behavior of trees in regions in which they are not indigenous can not be predicted by anyone.

SEED EXCHANGE.

There is one other cause of failure which has rarely been suspected, and which it is most difficult with the present practices of nurserymen and seed dealers to overcome.

It has generally been known that the hardiness of a plant, its capacity for withstanding cold and drought, is dependent on what it has been accustomed to endure in its native habitat. The seed and the plant originating from that seed possess no more hardiness than the parent plant. It is, therefore, essential, when attempting to introduce plants into climates in which they are not indigenous, to secure them from climates as nearly as possible like the one into which they are to be introduced. With annuals, this is perhaps less essential than with trees which are expected to persist all the year for many years. Yet, no care has been taken in this respect. We transplant acorns, or oak seedlings, from the warm, moist climate of Pennsylvania into the dry, cold climate of the Dakotas, or we use the seed of the Douglas Spruce from the moist, even-tempered Pacific Coast instead of from the dry, rigorous climate of Colorado, and no wonder the planting is a failure.

To demonstrate that this is so, and at the same time to ascertain how far this adaptation to climatic conditions extends, a seed-exchange experiment has been instituted, in which a large number of the agricultural experiment stations have kindly consented to participate. Seeds of the same species are collected at the various stations and are exchanged between the stations, so that at each station the same species from all localities is grown simultaneously. No more striking illustration could be had of the truth of the law as stated than the rows of box elder and ash at the station at Grand Rapids, Minn.; those from seed gathered in Ontario, fully germinated, 30 inches high the first year, vigorous and entirely unaffected by the first September frost; by their side are the rows grown from seed gathered in Oklahoma, a thin stand, half the height of their neighbors, poorly developed, and the foliage completely collapsed by the slight fall frost.

The conclusion is, that unless we control the collection of the seed from most northern and driest points, where the species grows, we have neglected a most essential element of success in the effort of acclimatization.

PLANT INTRODUCTION.

This work of introducing and bringing to trial new and untried species has been lately extended to exotic species in addition to our native ones. It is proposed to systematically collect all the trees and shrubs which exist in the arid and subarid regions of the world into arboreta, or trial grounds, located in different parts of our own arid belts, where they can be studied and observed, and where finally those can be selected which promise the best results for planting under those untoward conditions. Such systematic effort, carried on with persistency and circumspection, must, it would seem, lead to the discovery of new and valuable additions to our economic flora.

It stands to reason, that if this is desirable for the regions which are poorly endowed with native forms, it is not less desirable for more favored localities, and if the systematic procedure is preferable to the haphazard sporadic attempts, with regard to the introduction of tree growth, it is equally preferable in the introduction of other economic plants. It is, therefore, to be hoped that this work of plant acclimatization will be extended to all kinds of plants with liberal appropriations from Congress, when the Division of Forestry will have the satisfaction of having assisted the farmer by having taken the lead in this work, though in a direction not exclusively its own.

PROPAGANDA.

Besides attention to technical work, a large amount of time and effort has been spent by the members of the division in and out of office hours in forwarding the movement for a more rational treatment of our forest areas. Many lectures before farmers' institutes and elsewhere, articles in newspapers and technical journals, and official circulars of information have been the result.

Thus, in Circular No. 1, addressed to teachers in public schools, it was tried to enlist them in the movement. Circular No. 10 gives suggestions to lumbermen how to secure their property against fire; Circular No. 11 attempts by a succinct statement of facts and figures regarding our forest resource and wood consumption to arouse interest in the subject; Circular No. 13 gives a synopsis of the more recent laws against forest fires, most of which were, in part at least, formulated in the division, and Circular No. 17 gives a synopsis of other legislation on behalf of forestry in the States, also largely formulated in consultation with the division.

FOREST RESERVATIONS.

The condition of the public timber lands naturally occupied the attention of the division from an early time. A full report on the condition of the forests in the Rocky Mountain States was presented in Bulletin No. 2, published in 1887, and in the same year the writer formulated a comprehensive bill, with report, providing for a rational and profitable administration of the same. This bill, introduced in Congress, afterward known as the Paddock bill, did not become a law, but its educational effect and its frequent discussion before the Committees on Public Lands, led finally to the passage of a law empowering the President to set aside forest reservations from the public domain. After some 18,000,000 acres had under this law been so reserved, the necessity for their protection and administration was persistently urged, and finally this year, besides an increase in reservations, legislation attempting to provide for such administration has been secured.

The reservations being located in the mountain districts of the Western States, where farming is largely dependent upon irrigation by means of the waters collected in the mountains, there is naturally a very close though indirect relation of the farming interests to the condition of these forest areas.

The destruction by fire, ax, and indiscriminate pasturing of these mountain forests without reproduction or reforesting must ultimately lead to even worse damage to agricultural interests than has been experienced in France from similar maltreatment of the mountain forests. Where the farmer relies upon irrigation he will suffer from uneven distribution, excess, and deficiency of water supplies, and, with the mountain slopes bared, floods and droughts will be aggravated and the fertile lands below gullied, washed, and silted.

While at present these public reservations are under the Department of the Interior, in the General Land Office, such close and important relation between agricultural interests and forest conditions suggests as a logical proposition the ultimate transfer of these reservations and their administration to the Department of Agriculture, which is charged with the cultural interests of the country, and to which the technical problems involved in such administration have already been referred by the creation of the Division of Forestry. When such transfer is effected, not only will the Department of Agriculture, and with it the farming community, gain in prestige, but the farming and forestry interests by being under the same administrative head will find increased relation to each other.

DIVISION OF AGROSTOLOGY.

By F. Lamson-Scribner, *Agrostologist.*

INTRODUCTION.

There is no line of work more intimately connected with the agricultural interests of the country than that pertaining to investigations of grasses and forage plants.

Let us consider for a moment the actual cash value of grasses. Grasses are so common, growing everywhere in meadows and waste places, upon hillsides and plains, covering the bare places of the earth with their myriad hosts of individual plants, that we are apt to forget their vast significance in the economy of nature, and that they constitute the greatest of our agricultural resources and form the very foundation upon which rests all our agricultural wealth and prosperity. According to estimates of the Division of Statistics the hay crop of 1896 alone amounted to 60,000,000 tons, valued at nearly $400,000,000, exceeding by a third the total value of the wheat crop. In addition to this vast quantity of hay, which would barely suffice to carry through the year the 16,000,000 milch cows owned in the United States, enough pasturage, fodder, and green forage were supplied to feed 37,000,000 sheep, 30,000,000 cattle, 14,000,000 horses, and 2,000,000 mules. A conservative estimate places the total annual value of the grass and forage crops of this country at more than $1,000,000,000.

Among the great nations of the world, ours has been the first to give official recognition to the importance of these crops by establishing in the Department of Agriculture a Division of Agrostology, especially devoted to working out grass problems. The law establishing this division authorizes investigations in the natural history, geographical distribution, and uses of the various grasses and forage plants, their adaptability to special soils and climate, and the preparation of bulletins and monographs upon this group of plants. The work has been laid out on broad lines, embracing the practical and scientific sides, making the work of interest both to the farmer and the botanist. It thus becomes the duty of this division to afford the people information as to the habits and uses of all these plants and to introduce into cultivation, through carefully conducted experiments, promising native and foreign kinds. During the past year 6,000 trial packages of seeds from collections made by the division have been distributed, more than 3,000 grasses have been identified for correspondents, and replies to more than 600 inquirers, relative to the methods of cultivation, uses, and feeding value of grasses, have been prepared.

ABUNDANCE OF NATIVE GRASSES.

No other country has so large a number of useful grasses and forage plants as our own. We have 60 native species of clover, 70 blue grasses, 25 gramas and curly mesquite grasses, which have produced more beef and mutton than all the cultivated hay grasses put together, 90 lupines, 20 wild beans, 40 vetches and an equal number of beggar weeds, 20 kinds of wild rye, 30 kinds of brome grasses, one nearly identical with that recently imported from Russia, and meadow, pasture, woodland, and swamp grasses without number, each kind adapted to a particular soil or climate and to some special use. There is a wild millet on the South Atlantic Coast which grows from 6 to 10 feet high. There are wild perennial beans in the Southwestern mountains growing luxuriantly with only 20 inches annual rainfall, and many of them far surpass in productiveness and value for forage those which have come to us from foreign lands through importation by seedsmen. There are free-seeding wheat grasses in the Northwest, in many species, which equal the best of our hay grasses, and in the mountain parks we find green turf which rivals in fineness and beauty the best artificial lawns. In all this wealth of varieties, unequaled in any foreign land, there is abundant opportunity for selection of good kinds adapted to every soil and climate or purpose. These grasses and forage plants are here already, and here because the soil and climatic conditions favor their growth; our work chiefly lies in determining which are the best kinds, and to which condition or purpose the several kinds are best adapted. We ought to foster and extend the propagation of these native sources of wealth—these forage plants which, because of their abundance, landowners have been thoughtlessly destroying for the past hundred years or more.

There are other lines in which the grasses are of commercial importance. They are used as fiber in the manufacture of binding twine or paper; they are used in making hats and many other articles of woven work. They are planted to subdue or bind the drifting sands of the seashore, to hold the soil of railway embankments, to prevent the washing out of dikes and levees, and to aid in reclaiming fields denuded of their soil by torrential rain. Through the agency of their growth and decay the fertile prairie loams have been formed; they are the forerunners which nature sends to cover the bare surfaces and to lessen the sterilizing effect of heat and drought. Not all grasses have value as forage, but we can not doubt that all serve some humble purpose in the economy of nature.

The work of this division is, then, of direct value to every farmer who is interested in the production of better forage and more of it. If forage crops can be discovered which by their superior feeding value or productiveness will lessen the cost of growing meats and animal products, by ever so little, the aggregate gain to the agricultural wealth of the nation would many times repay the sum now appropriated to carry on this work in the national Department of Agriculture.

DEPARTMENTAL TESTS FOR VARIETIES.

Tests of forage plants can best be carried on by the Department of Agriculture. It can better afford to make the initial distribution of seeds and continue doing so until the particular grass or forage plant is sufficiently well known to be supplied by private growers. The buffalo grass, or curly mesquite, is a grass that deserves more attention than it has received. Its habit of growth is similar to Bermuda, but it is suited to cultivation on a greater range of soils from the Gulf to the Canadian border. There is no turf-forming pasture grass that excels it in palatability and digestibility.

The seeds of native grasses and forage plants collected during the season of 1896 included some 135 different kinds, which were distributed to agricultural experiment stations, chiefly those west of the Mississippi, to correspondents of the division interested in the work, and to numerous botanical gardens in this and foreign countries. The distribution to foreign countries has resulted in bringing into the hands of the division a number of interesting forage plants which have been experimentally cultivated here, and this number will be largely increased in the course of time.

GRASS GARDENS.

In addition to the distribution of seeds for trial at various points in this and other countries, the division has undertaken the cultivation of these plants in grass gardens under its own management. One of these gardens is located upon grounds of the Department (see frontispiece), and, although covering a very limited area, has afforded during the season an object lesson in grass culture of unusual interest. More than 500 varieties of grasses and forage plants from all parts of the world have been grown here, the varieties included representing not only those which may be purchased from seedsmen, but also those which have been gathered by the field agents of the division, and many that have come from Europe, from northern Africa, from Asia, and from Australia. Those from Australia are of special interest, as, for the most part, they represent forage plants from warm, arid regions where conditions prevail like those in our Southwestern Territories. A large assortment of leguminous plants, including clovers, vetches, cowpeas, soy beans, and alfalfa, have been cultivated with success in this garden, also numerous varieties of sorghum, Kafir corn, that wonderfully productive plant teosinte from Chiapas, Mexico, which is a peculiarly valuable plant for the Southern States, and curly mesquite and the buffalo grasses, unrivaled pasture grasses of the great cattle ranges of the West and Southwest. In addition to this, a number of grasses have been grown with a view of exhibiting their qualifications as lawn grasses, and some of these have been marked subjects of interest. Anyone who has seen these plats will not hesitate to assert that most satisfactory lawns are to be obtained by pure cultures of single varieties of grass. The most pleasing, and apparently the best suited for lawn making, are Kentucky blue grass, the fine-leafed forms of creeping bent, Rhode Island bent, and some of the fine-leafed fescues.

A walk through the garden at Washington, D. C., will prove instructive. Here is a little square of saltbush from the Queensland Downs; beside it a pure culture of an alpine fescue from Switzerland; there some curly mesquite grass from Texas; a bit of lawn grass from Korea; "ankee" grass from southern California, roasted seeds of which are used as food by the Indians; marram, or beach grass, from Cape Cod, where many acres of this grass have been successfully planted to prevent the drifting of the sands; giant-seeded cuzco corn from Peru; a 10-foot-high millet from the islands at the mouth of Chesapeake Bay; broom from Scotland; millets from India; soy-beans from Japan; a dozen little plats of turf that represent as many lawn grasses, each showing what it can do when grown by itself, and over two hundred grasses from the Western plains and prairies. This collection of forage plants and grasses presents an object lesson of peculiar interest and value. Here is a living collection of the important forage plants of all countries; their individual characters and habits can be studied better than in the finest illustrated or best written books, and here also may be noted their adaptability to local conditions. In this garden, small as it is, are combined the elements of a turf garden, a hay garden, a clover garden, and, to a certain extent, a botanical garden of grasses, for it contains many species of only botanical interest, each forming, as it were, an interesting chapter in a book thus made complete.

Another grass garden under the supervision of the division is located at Knoxville, Tenn. This garden covers an area of several acres, and experiments are there conducted upon a larger and more practical scale than can be carried on within the small area allotted to this work upon the Department grounds.

VALUABLE RESULTS OF EXPERIMENTS.

It has already been settled by experiments carried on by the division that a number of species which many have asserted would not submit to cultivation may be easily propagated under the same conditions which favor the growth of tame varieties. This is markedly true of such grasses as the curly mesquite, and true buffalo grass, and the grama grass of the Southwestern plains, grasses especially adapted to the semiarid regions of the West, which in former times afforded nutritious grazing to vast herds of cattle, and which still in some sections afford the chief and most nutritious forage of the now somewhat limited ranges.

PUBLICATIONS AND CORRESPONDENCE.

Information has been disseminated by correspondence in answer to letters of inquiry requesting information upon a great variety of topics relative to grasses and grass culture. The naming of specimens sent in for identification forms no inconsiderable feature in the work of the division, requiring the use of a herbarium which contains 30,000 specimens. The publication of bulletins upon the subjects under investigation serves to disseminate and popularize a knowledge of the grasses and forage plants of our country. A number of technical bulletins have been published, and among those of a practical nature may be mentioned Bulletins Nos. 2 and 3 of the division, describing nearly all known economic species of grasses and forage plants; Farmers' Bulletins on alfalfa, on sorghum as a forage plant, on soy bean, on the formation of meadows and pastures in the middle Eastern States; and numerous papers published in the Yearbooks of the Department, among which may be mentioned "Grasses as sand and soil binders," "Cowpea," "Grass gardens," and "The cultivation of timothy in the prairie regions." One of the bulletins which has been in greatest demand is "American grasses," containing illustrations of 302 different kinds of grasses. Engravings for illustrating 300 additional species have been prepared and will soon be published.

FIELDWORK.

In order to supply correct information as to the best forage crops for meeting the needs of the various sections and climatic divisions of the United States, the soils, temperature, and rainfall must be studied, and the character, habits, and probable value of the grasses and forage plants native to the several regions must be investigated by direct observation. With the view of meeting these requirements the Secretary of Agriculture has undertaken the thorough field investigation of the grasses and forage plants of several grand divisions of our territory, where stock raising is of primary importance, through details from the division force or by the employment of local or special agents. All field observers have been instructed to collect not only illustrative specimens of the grasses and forage plants coming under their observation for preservation and future study, but also to gather liberal supplies of seeds of the more promising kinds for further propagation or experimental cultivation. A large collection of seeds of some of the native forage plants of New Mexico and Wyoming have been acquired during the season of 1897 and are being prepared for distribution. It is hoped by this means to find some kinds which can be used to advantage in the arid districts to reclaim the worn-out ranges and to grow as crops to be used when the pasturage is short.

The demand for new and improved forage plants which will grow and thrive on Western farms and ranches is constantly increasing, and it is of the first importance that the valuable grasses that are disappearing from the prairies and cattle ranches as a result of overstocking should be preserved and the possibilities of their cultivation and restoration determined.

The field agents in the West have been directed to secure all possible information in regard to the cattle and sheep ranges, both by direct observation and by consultation with prominent stock owners; to study the effects of drought and overstocking and the methods to be employed in restoring the ranges to their former or normal condition, and to note, so far as circumstances permitted, the nature and habits of those grasses and forage plants best suited for hay or pasturage.

FORAGE PLANT INVESTIGATIONS IN THE NORTHWEST.

For the past three years the division has been engaged in a systematic study of the various forage problems of the eastern Rocky Mountain region, including more especially the States of Colorado, Wyoming, and Montana. During the summer of 1895 two field agents made a preliminary survey of the region, visiting various points in Colorado, Wyoming, Utah, Idaho, and Montana, making collections of seeds and herbarium specimens of grasses and forage plants and gathering information regarding the forage conditions and needs of the different parts of the region.

Acting upon the information thus gained, more detailed investigations were planned for the season of 1896. One agent was sent to central Montana for making a careful study of the conditions prevailing in that district, two were sent to central and southern Colorado for a similar purpose, and a member of the division force was sent out on a tour of inspection, to advise with the field agents, and to obtain a personal knowledge of the region, in order to be able to carry on the investigations in the most intelligent and practical manner possible.

During the summer of 1897 three field agents have been employed, working chiefly in western South Dakota, Wyoming, and southwestern Colorado, and one member of the division force spent nearly three months in the field, principally in Wyoming, southeastern Idaho, and northeastern Utah. In addition to visiting localities easily accessible from the railroad, our field agents and assistants have made extensive wagon trips into newly-settled and little-known localities, covering several thousand miles of territory and obtaining much valuable information regarding the conditions, needs, and future possibilities of the places visited. This information consists of data concerning soil and climatic conditions as related to forage problems, present condition of the ranges and means of improving them, best methods of growing grasses and forage crops both native and introduced, distribution and value of native grasses and forage plants, and other questions pertaining to forage production.

In these investigations every effort is being made to get into the closest possible touch with the farmers, stock raisers, and dairymen, and, through correspondence and personal conference, to secure their cooperation in the work. The results thus far have been gratifying.

One of the first things made apparent in the course of the work was the fact that under the conditions prevailing at present over a large part of the Northwest as much good can be done by preserving and improving many of the native grasses and forage plants as by the introduction of foreign sorts. The results already obtained certainly favor increased efforts in this direction.

NATIVE GRASSES FOR ARID LANDS.

Among the most promising native grasses for the Northwest are several kinds of wheat grasses, three of which are worthy of extended trial, namely, Western wheat grass (*Agropyron spicatum*), Western quack grass (*Agropyron pseudorepens*), and slender wheat grass (*Agropyron tenerum*). In a number of instances these have been used to reclaim worn-out native pastures with good results, and all seem to improve rapidly under cultivation. Throughout a large portion of this region these grasses form a good meadow sod in a very short time after the unbroken land has been brought under irrigation. Wheat grass, or "blue-stem" hay, is the most highly valued of all the native sorts. Many farmers break up the sod and let the grass come back again, claiming that they get a cleaner, more even, and more permanent sod, well worth the extra labor given to it. Among other grasses that may be mentioned as deserving extended trial on the range are bunch grass (*Poa buckleyana*), prairie June grass (*Koeleria cristata*), upland blue grass (*Poa arida*), grama (*Bouteloua oligostachya*), and sheep fescue (*Festuca ovina*). Prairie June grass and upland blue grass are both valuable for early pasturage, which is greatly needed over a large part of this region. The prairie June grass is short lived, but it thrives on a great variety of soils, starts well from the seed, fruits abundantly, and the seed is easily saved. It can often be used to advantage on native pastures for early grazing, allowing the later, more slowly developing, but more permanent grasses to get started before being eaten down by the stock. There are also a number of native grasses that could undoubtedly be successfully cultivated in meadows and pastures at comparatively high altitudes. Some of the most promising of these are mountain foxtail (*Alopecurus occidentalis*), mountain timothy (*Phleum alpinum*), Western brome grass (*Bromus pumpellianus*), short-awned brome grass (*Bromus breviaristatus*), and several kinds of mountain blue grass (*Poa* spp.), buffalo bunch grass (*Festuca scabrella*), and rough-leafed bent grass (*Agrostis asperifolia*).

VALUE AS FORAGE OF SO-CALLED WEEDS.

In certain parts of the eastern Rocky Mountain region there are many plants usually classed as weeds, but which are really of great value for forage. These plants are sufficiently hardy to endure the extremes of drought that prevent the development of the valuable grasses, and many of them thrive on soil so strongly impregnated with alkali as to entirely preclude the growth of the latter. As a consequence, there are thousands of acres of range on which the forage is composed very largely, often nearly exclusively, of white sage (*Artemisia* spp.), green sage (*Bigelovia* spp.), sweet sage, or winter fat (*Eurotia lanata*), salt sage (*Atriplex* spp.), and grease wood (*Sarcobatus vermiculatus*). Several of these, particularly sweet sage and three of the salt sages (*Atriplex canescens*, *A. confertifolia*, and *A. argentea*), could without doubt be profitably grown under cultivation and with a little care be made to produce a much larger amount of forage than is now obtained. There are several of the leguminous forage plants native to this region that deserve the attention of the agriculturist, notably the Montana bush pea (*Thermopsis montana*), the wild vetches (*Lathyrus* spp., *Lotus americana*, and *Vicia* spp.), and several wild clovers (*Trifolium beckwithii*, *T. megacephalum*, and *T. longipes*).

Of the introduced grasses, smooth, or Hungarian, brome grass is giving the best results on the dry prairies of the Northwest, and the seed of this grass has been sent out to a large number of farmers and stockmen in this region for trial. Reports from those who have experimented with it are quite encouraging. It is hoped that it will prove valuable to use in connection with the native grasses in reclaiming worn-out pastures and ranges.

CHANGING CONDITIONS IN GRAZING LANDS.

With but few exceptions, the ranges of the Northwest have been overstocked, and this, together with drought and other unfavorable conditions that have generally prevailed during recent years, has resulted in a great decrease in their stock-carrying capacity. At the present time the ranges are improving considerably through a more abundant supply of moisture and the limited supply of cattle; but this improvement will only be temporary unless some system of control is adopted for the grazing lands which will insure a more rational treatment at the hands of the ranchers and stockmen. Another point of vital importance on the ranges is the water supply for the stock. In many instances ranges well supplied with forage have been ruined through the grasses being destroyed by the trampling of the stock going back and forth in search of water. In some localities, at least, this trouble could undoubtedly be largely overcome by the construction of reservoirs for holding the water from melting snows and spring rains that under present conditions mostly runs off and is lost.

Over a large portion of this region the conditions of stock raising have changed very materially during the last five years. The number of large ranchers controlling immense numbers of cattle is rapidly decreasing and the land along the streams and water courses is being taken up by settlers and turned into farms and small stock ranges. A considerable portion of the land is at once put under irrigation and its forage-producing capacity increased many fold. Thus, in many places in the Big Horn Basin in Wyoming, as along No Wood Creek and Grey Bull River, land that five years ago produced little else than sagebrush, now, under irrigation, gives excellent yields of oats, wheat, rye, timothy, red top, alfalfa, and clover, and the ranchers have no difficulty in raising plenty of winter forage for their stock. However, in these same localities there are thousands of acres that will probably never be used for anything but grazing, and here some rational system of control of such lands seems imperative. Under the present system each rancher tries to get all the grazing he can from the public lands; continual overstocking is the result, and the ranges are given no opportunity to recuperate, whereas with a little care their stock-carrying capacity could be materially increased instead of being continually diminished.

THE RED DESERT REGION OF WYOMING.

There are certain regions which, because of their peculiar geological origin and the prevailing meteorological conditions, at the present time seem destined to be of little value to man except as a pasture for stock during a portion of the year. For this purpose, however, some of these regions are of considerable importance, and in such instances are worthy of investigation as to their present resources and future possibilities. Such a region is the "Red Desert of Wyoming," covering an area much larger than that of the State of Massachusetts, in which salt sages predominate, and which, on account of the absence of potable water, can only be used for winter range. It is, topographically, a high, undulating plain, having an average elevation of 7,000 feet. The soil is poor in humus, and everywhere more or less impregnated with various salts. The water of the region is charged with minerals, sulphur, iron, and the alkalis predominating. The rainfall is scanty and irregular.

In spite of these disadvantages and the almost desert-like character of the country, the Red Desert region is distinctively a stock region, and supports through the winter and early spring months many thousands of head of stock. The total number of sheep in the desert during five months of the winter is estimated at from 300,000 to 500,000. Native plants support these herds, and it is interesting to know what they are. They must, upon the whole, be plants suited to arid regions and strongly alkaline or sandy soils.

In view of the peculiar soil and climatic conditions of the region and its stock-supporting capacity, an agent was commissioned by the Secretary of Agriculture to investigate its forage supplies. His collections of plants and seeds are of much value, and doubtless his report will contain much interesting information relative to forage plants, which may be utilized in similar arid and desert-like regions. It is reported that the ranges are improving by use, which may result in some degree from enrichment of the soil by the accumulation of manure, but is more probably due to the fact that the plants chiefly depended upon for forage are small shrubs of many kinds, which, being grazed from winter to winter close to the ground, annually produce an increasing number of tender shoots. This result is dependent upon the fact that the region is used for winter pasture only, giving time for growth and recovery each summer. Something can doubtless be done in the way of improving these ranges by seeding with salt sages or other alkali-enduring vegetation, and several of the native grasses are worthy of trial. Wonderful results are reported from seeding the ground to some of these grasses, especially to wheat grasses (*Agropyron*), and this, too, where the water was far from the best and the soil strong with alkali.

INVESTIGATIONS IN THE SOUTHWEST.

While the investigations above referred to are being carried on in the Northwest similar investigations are in progress in the Southwest. Under date of April 10, 1897, the Secretary of Agriculture directed the division to "begin an investigation of the forage problems and conditions that exist throughout the grazing regions of the Southwest, including the States and Territories of Kansas, Arkansas, Arizona, New Mexico, and Texas, giving particular attention to the native grasses and forage plants, their abundance and value, their preservation, and the possible methods to be employed in restoring those ranges which have become nearly valueless through overstocking or other causes." As a preliminary step in the prosecution of this work, it seemed desirable to get into communication with and secure the cooperation of those interested in improving the forage conditions of the region under consideration, and with this end in view 2,000 circulars asking for information along certain lines were sent to ranch owners, cattlemen, and stock breeders in the States and Territories above named. The principal subjects of inquiry were: (1) What is the chief forage problem in your section, that is, at what time is the forage supply shortest? Is there greater need for more and better hay grasses, or for pasture grasses, or can the supply of green feed be advantageously increased at certain periods, as during annual recurrent summer droughts, in early spring before the range grasses commence to grow, or to lengthen out the supply of green forage in autumn? (2) Are the ranges in better or worse condition than they were twenty or thirty years ago? Are the good grasses and forage plants becoming more abundant, or has the stock-carrying capacity diminished because of the decrease in the number of good grasses and the increase of those weedy ones not relished by sheep and cattle? (3) In such cases, where the range grasses are poorer and less abundant and the stock-carrying capacity of the ranges has materially diminished, what method of treatment is to be used to bring back former prosperous conditions, renewing the grasses and restoring the fertility of the land? Is it possible, in other words, to improve the natural range, whether woodland or prairie, without too great cost in time, money, and labor?

The replies to these circulars, of which more than 1,000 have been received, are very gratifying, and the fund of information thus acquired from practical stock raisers and breeders will be not only of extreme importance to those engaged in the ranching business throughout the region under consideration, but will be of great assistance to the Department in carrying on experiments to improve the quality and increase the number of forage plants grown in that section.

INVESTIGATIONS IN TEXAS.

Actual field investigations in the region of the Southwest was begun early in May by detailing the assistant chief of the division to conduct the work. He was instructed to secure the fullest possible information regarding the existing forage conditions of the cattle ranges by direct observation and by consultations with the leading stock raisers throughout the section, as well as to prosecute lines common to the duties of our field agents. Most of the time while in the field was spent in visiting various points in Texas where the cattle interests are of first importance, and it is pleasant to note here that the agent from the division everywhere met with a cordial reception, and was aided to the fullest extent possible by the citizens of the State in gaining the desired information.

A comprehensive report on "The grasses and forage plants and the range conditions of central Texas" has been prepared under special authorization by Mr. H. L. Bentley, of Abilene, Tex. This report discusses a great variety of topics connected with the cattle ranges and their improvement, and will be of interest not only to the cattlemen of central Texas, but to all stock raisers throughout the Southwest.

EXCELLENCE OF SOUTHWESTERN GRASSES.

The excellence of the Southwestern ranges as breeding grounds and the superior quality of "feeders" produced there is undoubtedly due in large measure to the great variety and high nutritive value of the wild grasses. There are over 350 kinds of grasses recorded from the State of Texas alone, a third of the entire number found in the United States. Among these the two kinds of turf-forming "curly mesquites" and a dozen or more "gramas," which are not surpassed by the turf-forming grasses of any other country for summer pasturage or in their quality of curing into excellent hay on the ground, thus furnishing the best of autumn and winter feed. These are preeminently the pasture grasses of the semiarid regions of the Southwest. Experiments have been made with one of the two "curly mesquite" grasses on a limited scale at Washington, D. C., and a small amount of seed of the other was collected in Texas and New Mexico this summer. Trials of other promising kinds will be made as soon as enough seed can be secured. Besides the grasses, there are in Texas over 150 distinct kinds of sedges and 20 of rushes, plants so much like the true grasses in appearance that they are generally classed with them by untrained observers. These sedges and rushes mostly inhabit low and marshy lands, the borders of ponds and streams, and in such places supply a much larger portion of the grazing than do the true grasses. Many of them approach the clovers in the amount of muscle-making protein contents, as shown by chemical analysis, although they do not equal in feeding value the gramas and mesquite grasses of the higher and drier lands. They lack strength, and, as stockmen say, are "washy" foods, yet are of a certain value on wet soils, where they naturally grow. Then there are a great many representatives of the bean and clover tribe in Texas. A quantity of seed has been collected of a wild vetch (Stolley's vetch, *Vicia leavenworthii*) that grows among the granite hills of Burnet County, Tex., where it is reported to be a magnificent winter and early spring forage plant; so good, in fact, that cattle and sheep have almost exterminated it in their eager search for it on the ranges. It commences to grow in autumn, and by early spring covers the ground with a mat of green. It has been tried on a limited scale in cultivation, and enough seed ought to be collected so that it may be widely disseminated and preserved.

FORAGE PLANTS NEEDED.

Forage plants that will supply pasturage in the late winter and early spring months are greatly needed. Ordinarily range feed is scarce at this time. The vetches, wild beans, and clovers come just at the right season to supply this want, and there is need of some experimentation with them. "Tallow weed," familiar to every sheep raiser in all the stock counties of Texas, and so named because of its remarkable fattening qualities, is especially valuable for this purpose, but stockmen say that even this formerly abundant plant is disappearing. Enough seed ought to be collected to try it on a large scale.

There are other forage plants native to the Southwest which are exceedingly valuable but whose individual characteristics and merits are practically unknown. Among the little known sorts are Texas pea, buffalo clover (*Lupinus*), 5 wild true clovers, 9 true kidney beans, 6 beggar weeds, 6 milk peas, 4 vetches other than Stolley's, ground nuts, wild bladder pods of great variety, and last, but not least, the mesquite bean with its one to three crops of nutritious pods every year. The saying in regard to the latter is that "the drier the year the more beans." Then there are 52 sorts of mallows in Texas, most of which are of some forage value especially to sheep and goats. There are 18 true wild sages, 70 kinds of so-called saltbushes of the same class as the Australian saltbush. These all enter into the diet of the Southwestern steer and wether, and the excellence of these latter is undoubtedly in great measure due to the immense variety of foods thus produced by nature. It is a part of the work of this division to attempt the cultivation and preservation of the most valuable of the forage plants and grasses that grow naturally upon the Southwestern plains and prairies.

INVESTIGATIONS IN THE SOUTH.

The grazing and forage problems in the South are hardly less important than in the West. Keen competition is compelling the adoption of a more diversified system of agriculture than has existed in the past. Fine cattle and good milk and butter are more profitable than cotton, and there is an increasing demand for good hay and pasture grasses and other forage crops. The climate is excellent for the growth of many kinds of grasses, and the soil is for the most part good or readily susceptible to care and cultivation. One observer alone has found more than 160 species of grasses in the State of Louisiana, while 255 are known to occur in Alabama. In the National Herbarium there are more than 350 species from the five Gulf States east of Texas, and doubtless there are many not represented in the collection. A large proportion of these grasses are unknown in the Northern and Western States, being peculiar to the Gulf Coast region. There is besides, in the South as in the West, an abundant variety of native forage plants which do not belong to the grass family.

The value and adaptability of these many kinds, and foreign sorts as well, to special purposes or local conditions ought to be systematically investigated. The work of determining the most practical methods of introducing and cultivating those grasses and forage plants which are most likely to succeed, and which will at the same time be best suited to meet the needs of the stock raisers and dairymen, has been inaugurated by the present Secretary of Agriculture, who has instructed "this division to begin an investigation of the grasses and forage plants and forage problems of the Gulf States, including Georgia, Florida, Alabama, Mississippi, and Louisiana. Particular attention will be given to noting the abundance and value of the native forage plants and the possible methods to be employed in maintaining or improving the existing conditions of pasturage and forage supplies." A circular letter, requesting information relative to the points involved in the investigation, was sent to many parties thought to be most interested in the work proposed, and replies containing much interesting and valuable information bearing on the subject were received from a large number who expressed great interest in the work.

In furtherance of this investigation, Prof. S. M. Tracy, formerly of the agricultural college of Mississippi, has been authorized to prepare a report on "The forage plants and forage resources of the Gulf States east of Texas." During the past season Professor Tracy has, under the direction of the Agrostologist, traveled over much of the territory to be covered by the report.

SAND-BINDING GRASSES.

The Agrostologist has received many inquiries as to the best grasses for binding drifting sands or holding soils subject to wash, and in the Yearbook for 1894 he presented an article on "Grasses as sand and soil binders," in which marram, or beach grass, was described and reference made to its use at Provincetown, Mass., for holding the drifting sands on the cape and to its similar use near San Francisco, Cal. Beach grass is a native grass ranging along the coast from Maine southward to Virginia, in some places, as along the sandy beaches of Massachusetts and New Jersey, covering areas many hundreds of acres in extent. Nowhere is it more abundant nor its growth finer than on the great sand dunes of Cape Cod. Here many years ago the United States Government attempted to propagate the grass or transplant it to points requiring its protective influences. The work appears not to have been performed with any system and little or no evidence remains of what was then done or attempted.

BEACH GRASS IN MASSACHUSETTS.

In the spring of 1895 the State of Massachusetts began the planting of beach grass on the Province Lands near Provincetown. The work was undertaken systematically in accordance with well-matured plans, by Mr. James A. Small, superintendent of Province Lands, and has been continued under Mr. Small's direction up to the present time. The writer has inspected the work being done at Provincetown each season since its commencement, and can testify to the complete success of the operations for accomplishing the ends in view.

About 70 acres have now been set out to this grass. The transplanting is done either in the spring or fall, the latter season being preferred owing to the better condition of the roots at that season. The distance apart to which the plants are set varies with the slope. If near the base of the sand dune where it is nearly level, 24 to 30 inches apart may be allowed, but if near the top where the surface is quite steep, 15 to 18 inches apart is required. The amount of exposure to winds is also considered in determining the space between the plants. The cost per acre in planting beach grass will vary, of course, with the price of labor and the distance the plants have to be transported. At Provincetown, where the plants are transported one-half mile to 1 mile, and labor costs $2 per day, the cost per acre the past season has been about $43.22.

The plantations of beach grass at Provincetown are made entirely by transplanting from points where the grass has made a natural growth to places requiring protection. Seeding has not been resorted to in any case, but the abundant natural seeding of the grass was especially noted during the past season, and it was evident that the germination and subsequent growth of the seed was favored by the placing of brush and sticks on the naked areas in the vicinity of seeding plants. Beach grass spreads naturally by seed and by extensively creeping rootstocks. The course of the latter may be traced from the parent plant by a succession of young plants which spring up at intervals, those farthest from the parent stock (often many feet distant) being smallest. The leaves of beach grass will resist the wind and sand storms to which it is subjected, and the habit of growth of the plant enables it to rise above and hold about its base the sands drifting upon it.

After the establishment of plantations of beach grass, tree seeds of suitable varieties may be successfully planted, as demonstrated by Mr. Small on the plantations at Provincetown. Here were seen in September, 1897, thousands of young pines with well-formed roots and stems grown from seeds planted in the spaces between the bunches of beach grass the year previous. This growth of beach grass and young pines is upon huge sand dunes—hills of drifting sands containing no evidence of soil.

GRASS FOR TIDE LANDS.

In conclusion, it may be said that beach grass is only suitable for holding shifting sands; it will not resist the action of tides and waves. Under the action of the latter it is soon destroyed. There is a grass native to both the Atlantic and Pacific coasts which may be used in reclaiming lands subject to the action of tidal waters. This grass is referred to on page 436 of the Yearbook for 1894 under *Spartina glabra*. On the Atlantic coast it is generally known as "thatch." This grass is an excellent colonizer and land former, and is of great service in fixing and solidifying the sand flats that accumulate about the mouths of rivers and low coasts.

On the north shore of the Bay of San Pablo, California, is the town of Reclamation, so named from the valuable effect of the growth of this grass. In several places it has modified the coast line and increased the acreage of farms around the bay (San Francisco).

OFFICE OF ROAD INQUIRY.

By Roy Stone, *Director*.

INTRODUCTION.

In the convention of the National League for Good Roads at Washington, D. C., which led to the establishment of the Office of Road Inquiry in the Department of Agriculture, Secretary Rusk asked, "What shall the farmer do with his surplus product, and why raise this surplus if its way to the outside world is barred by impassable highways?"

The various divisions of the Department teach the farmer how to increase his product and how to care for it to the best advantage, but the question which finally interests him most is how to dispose of this product. It is useless for him to raise anything beyond supplying the mere necessities of his family unless he can be sure of finding a market and of reaching it at the proper time. Taking the country at large, the Chamber of Commerce of the State of New York declares this country is handicapped in all the markets of the world by an enormous waste of labor in the primary transportation of our products, and the National Board of Trade says that the country is "poverty stricken in the midst of its riches by reason of the badness of its roads."

MAIN LINES OF INVESTIGATION.

The investigations of the Office of Road Inquiry are mainly directed:

(1) To ascertaining, as nearly as practicable, the actual cost of bad roads and the benefit of good roads.

(2) To demonstrating the interest of cities and towns, and the owners of property of all kinds wherever situated, in the improvement of country roads.

(3) To developing the methods by which all of these interests may cooperate with the farmers in the work of road improvement.

(4) To discovering what actual and systematic road improvement is being carried on in any part of the United States, and how the same or modified methods may be applied to other sections.

(5) To discovering road materials in the various sections of the country.

(6) To discussing new plans for road construction and encouraging experiment in this direction.

(7) To actually constructing sample roads at some of the agricultural colleges and experiment stations.

Incidentally, the office devotes much attention to the subject of wide tires; to the use of convict labor in road construction; the organization of State and local road associations, and the assistance of road conventions. It has also made important experiments to test the power required in hauling over various kinds of roads.

The publications of the office number 20 bulletins and 17 circulars of information.

LOSSES BY REASON OF BAD ROADS.

As to losses by bad roads, the office has learned, by consultation with many thousands of the most intelligent farmers of the country, that the expense of moving farm products and supplies averages, on all our country roads, 25 cents per ton per mile; whereas in the good-road districts of this and other countries the cost is only about one-third of this amount. This extra expense amounts in the aggregate to more than the entire expenditures of the National Government, and taking into account all of the hauling done on the public roads the loss is equal to one-fourth of the home value of all the farm products of the United States. The increase in cost of hauling actually done is by no means the only loss resulting from bad roads. The loss of perishable products for want of access to market, the failure to reach market when prices are good, and the failure to cultivate products which would be marketable if markets were always accessible, add many millions to the actual tax of bad roads. Moreover the enforced idleness of millions of men and draft animals during large portions of the year is an item not always taken into account in estimating the cost of work actually done. The tax of bad roads will become constantly harder to bear as the people of the United States are brought into keener competition with the cheap productions of other agricultural countries. The continuous improvement in transportation facilities, both by rail and water, is steadily opening our markets to countries where labor is cheaper and in many cases where roads are better, and the agriculture of this country will not long stand a needless tax equal to one-fourth the value of its products.

THE INTEREST OF TOWNS AND CITIES IN GOOD ROADS.

The interest of towns and cities in good roads is easily demonstrated, and in many cases is already well understood by these communities. The whole people have equal rights on the country roads, and those living in cities and towns have often greater need of them than the farmer, who at a pinch could live upon what he raises, while the cities raise nothing and could not live a day without the country roads.

The farms of the United States comprise less than one-fourth of the total property of the country, yet that small fraction pays the whole cost of building roads. The injustice of this system, which we have inherited from the old countries, but which was abolished there many generations ago, is not yet fully appreciated by the farmers of this country, and the greatest difficulty now experienced in road improvement is in getting the farmers' consent to have this injustice wiped out, and in inducing them to accept the aid which the cities and towns are willing and anxious to give to the general improvement of the highways.

PROGRESS IN COOPERATIVE ROAD CONSTRUCTION.

The cooperation of cities and towns with the farmers in good-road building has been in some cases freely volunteered, but it is much more effective when regulated by State law. The Yearbook for 1895 discusses, under the head of "Cooperative road construction," the various methods of contributive action. Since the date of that writing the progress of New Jersey, Massachusetts, California, Connecticut, and Rhode Island in this direction has been constant and satisfactory, and the same general principle of State aid given to localities which volunteer to contribute on their own part is being strongly advocated in many other States. It is probably the only method in which the aid of cities and towns can be generally and practically applied. The effort of the Office of Road Inquiry has, therefore, been constantly directed to this end, and in most of the States which are generally aroused to the need of road improvement, legislation for State aid is very actively urged. Several States are proposing amendments to their constitutions in order that this legislation may be accomplished.

ROAD IMPROVEMENTS ACTUALLY MADE.

Actual road improvement is being carried on in so many parts of the United States, and so little publicity is generally given to the work, that great care and effort are necessary to discover the location and learn the details of these improvements. The farmers at Canandaigua, N. Y., for instance, have been actively building stone roads for several years, and have now nearly all of the principal roads of the township improved in a most substantial manner, and with great satisfaction to themselves; but there was no public knowledge of this fact until this office discovered and spread it broadcast. Since that time it has had a great influence in promoting road improvement elsewhere. The Canandaigua methods of road building and of paying the cost are equally simple. The roads are made entirely from the field stone of the farms alongside, and are paid for by direct taxation. The village of Canandaigua has joined willingly in voting for the increased tax, and the farmers have carefully expended the money, so that these roads have cost less than $1,000 per mile. Many other instances could be given showing that the people in many localities of the United States, widely separated and variously conditioned, are actually solving the road question to their own satisfaction.

CHEAP TRANSPORTATION FOR ROAD MATERIALS.

Road materials are found to be more abundant and better distributed than has generally been supposed. The office has communicated with all of the railroad companies in the country, and through their engineering departments has received a mass of information on this subject, showing that either quarry rock, surface stones, or gravel are accessible in nearly all districts of the country.

The office has also sounded the disposition of the railroad companies as to the cheap transportation of road materials, and finds a very general willingness to carry such materials at an extremely low price whenever the States take up the subject of road improvement in good earnest.

NEW PLANS FOR GOOD ROADS.

New plans for road construction are being developed, especially in localities where good road stone is not immediately available. Circular No. 25 of the Office of Road Inquiry details various plans for building good roads of vitrified brick, some of which have reached the stage of actual experiment, and others are only proposed for consideration. Numerous plans for steel trackways have been offered, and a careful investigation has been made in this direction, both as to actual experiments and plans yet untried. The prospect in this regard is extremely encouraging, and it is almost certain that a very thorough trial of steel road will be made next season at Scranton, Pa. A turnpike company at that place has a large traffic, but no material available that will stand the wear of heavy vehicles. It desires, therefore, to lay its road with steel tracks to diminish the cost of repairs as well as to increase its traffic. If this venture is successful great numbers of turnpike companies may find that their charters, which are now almost worthless, will become valuable, and if this is the case, new charters will be sought for in many localities. The Office of Road Inquiry has arranged with one of the leading steel mills in the country to roll special shapes of rail as soon as definite orders amounting to 1 mile of road are received.

Construction of sample roads is fully treated in another paper elsewhere in this volume.

THE PROBLEM OF WIDE TIRES FOR FARM WAGONS.

The subject of wide tires is one of great interest and importance, and it is being thoroughly discussed by this office in connection with various road associations and others interested. Important investigations of the University of Missouri will soon be given to the public, and will show very clearly the advantages of wide tires on the farm as well as on the road. The Office of Road Inquiry, being asked to recommend legislation upon the subject, has proposed that the width of tire be based upon the size of the axle rather than upon the estimated weight to be carried; for instance, making the width of the tire equal to the square of the diameter of the iron or steel axle at the shoulder and exactly the same width for the wooden axle of the same strength. As one method of enforcing the change, it is suggested that after a certain date all sales of new wagons whose tires fall below the standard established shall be taxed, and that a rebate of taxation be allowed for old wagons altered to this standard. This would bring no additional tax upon the farmers, but would place the burden upon the wagon builders. Under this plan, they would promptly build up to the standard, and their agents would become advocates of wide tires. There is already very general progress throughout the country in this direction.

CONVICT LABOR IN ROAD BUILDING.

The proper use of convict labor is a matter of the utmost importance from many points of view, and one upon which there is much difference of opinion. Bulletin No. 16 of the office gives the information obtainable regarding the use of convict labor upon roads up to its date (January, 1898), together with the conclusion of the Director of the Office of Road Inquiry as to the best of the various methods of convict employment in connection with roads. Further experience has confirmed the view then expressed that long-term convicts should not be placed upon the public roads, but should be employed in quarries, where they may be guarded and secluded as readily as in the prisons, and where their physical and moral condition will be greatly improved. This plan of disposing of such convicts meets every objection which is made to their migratory use for this purpose, and has many advantages. It does not compete with free labor, but by furnishing cheap materials stimulates the employment of free labor in the actual construction of roads. The use of short-time prisoners on the roads, as practiced in North Carolina, according to Bulletin No. 16 of the office, has been thoroughly successful and is being gradually extended, especially in the Southern States, and the provision of such employment for vagrants and tramps also meets with much approval.

EXPERIMENTAL GARDENS AND GROUNDS.

By William Saunders, *Superintendent.*

INTRODUCTION.

In order to comply with the direction of the Secretary and to give a comprehensive view of the relations of the Experimental Gardens and Grounds to the farmer, it has seemed best to furnish in this paper a retrospect of the work from the time the writer entered office. This may be best accomplished by first reprinting a paper prepared for Commissioner Newton and published under date of October 15, 1862. The suggestions then made have formed the basis of work, and efforts have been directed mainly to their development.

OBJECTS AND AIMS OF THE EXPERIMENTAL GARDENS AND GROUNDS.

(*1*) *To procure and encourage the transmission of seeds, cuttings, bulbs, and plants from all sources, both foreign and domestic, for the purpose of testing their merits and adaptation in general, or for particular localities of this country.*

The collecting of seeds and plants is one of the most important matters. No doubt there are in various countries numerous useful vegetable productions not yet introduced that are capable of reaching their highest state of development in some one or other of the various climates of this country. It is worthy of consideration whether future efforts would not be rendered more directly useful by issuing letters of instruction to foreign representatives and correspondents, enumerating such seeds and plants in their respective localities as may, in the opinion of the Department, be most worthy of experiment. With such advice it is reasonable to hope that much of the disappointment consequent upon indiscriminate collection may be avoided, and only such products introduced as present at least plausible expectations of utility.

The efforts of the Department would be greatly strengthened in this respect and its area of usefulness vastly extended if all who were possessed of new or rare seeds and plants would cooperate by transmitting samples for investigation. Many persons throughout the country occasionally receive plants and seeds from distant correspondents, and not having facilities for their proper cultivation they are consequently lost. It would be highly advantageous for the Department to encourage the reception of such favors, have them carefully noted, their merits properly investigated by competent cultivators, the result made known to the donors, and such disposition made of them as would be considered most advantageous.

(2) *To procure, by hybridizing and special culture, products of a superior character to any now existing.*

The improvement of vegetable races by hybridizing and crossbreeding is at once the most direct and important means which we possess in modifying and adapting them to special purposes. The field of experiment here is boundless, and some sections of it have, so far, scarcely been trod upon. The improvement of various fruits, and their better adaptation to domestic purposes, present enticing inducements to the experimentalist. It may safely be assumed that none of our most valuable and oldest varieties of fruits have attained that degree of excellence to which they may be brought; neither do they afford the variety nor continue their season of productiveness to the extent which is evidently possible. We have fruits that individually possess desirable qualities, but associated with qualities that equally tend to depreciate their merits; and, from the experience derived from former efforts, there is abundant evidence for encouragement in our efforts to produce a variety invested with a combination of excellencies not individually attained. Let us take, for example, that universally admired fruit, the strawberry, and originate a kind combining the wonderfully hardy and productive powers of the "Albany," the stately growth of the "Fillmore," and the exquisite delicacy of flavor found in the "Vicomptesse Hericourt de Thury," and we might gratify ourselves with the possession of a plant approaching closely to perfection in this fruit. The grape, of all other fruits, offers great promise to the hybridizer. A good wine grape is yet a desideratum, and every attention should be directed to the production of a grape that will possess the necessary peculiar characteristics for this purpose.

There is scarcely a limit to the objects presented to the hybridizer for experiment. To increase the size and color of flowers; to improve the flavor of fruits by changing austerity and acidity into sugary matter; to increase the hardiness of tender plants and make barren races productive; to extend the season of productiveness by hastening the maturity of some and retarding that of others, are only a few of the many improvements awaiting the systematic efforts of the hybridizer.

It is true that in many cases the operation is somewhat difficult to perform, and in all a delicacy of manipulation is required, which tends to prevent experiment of the kind from being general; but carefully conducted operations will certainly be followed by valuable results.

(3) *To ascertain, by experiment, the influences of varied culture on products, and the modifications effected by the operations of pruning and other manipulation on trees and fruits.*

To establish definite systems of culture; to ascertain how far certain desirable results can be influenced by pruning, how and when it is beneficial and when injurious; to institute carefully concerted experiments with a view of discovering to what extent the mere physical or mechanical condition of a soil affects its capacity of production, and how much is dependent upon its chemical constitution for the highest development of the cereals and fruits, opens up a line of inquiry by which valuable truths may be reached. The exact specific relation that exists between the soil and its vegetable productions, and the special appliances to render plant food soluble and in a condition available to the purposes of vegetation, are subjects upon which many opposite and seemingly conflicting opinions exist.

In this connection also the application of manures, the kinds to be employed, and the time and manner of their use, whether as surface dressings or by an intimate mixture with the soil, present a series of questions well known to be of vital importance, and of which much yet remains in obscurity.

(4) To investigate more thoroughly the various maladies and diseases of plants and the insects that destroy them.

The diseases of plants are now attracting much attention. It is notorious that much of the difficulty now experienced in the production of fruits is, in a great degree, due to the prevalence of various maladies in trees. Thus, we have to contend with the yellows of the peach and nectarine, as well as the so-called blister of their leaves in spring; the cracking and spotting of the fruit of the pear and apple, and the blighting of their branches, and the mildew and rot of grape and gooseberry. How far these affections may be induced by deficiencies or repletions in the soil, or how much of their virulence is due to local position in connection with atmospheric currents, has yet in the majority of cases to be determined.

Insects also beset the cultivator on every side. These are insidious and powerful opponents, requiring close study, minute and patient observation, in order to learn their habits and adopt effectual means for their extermination. Experiments tending to elucidation of these subjects are now in progress and their further investigation will receive attention as soon as means will allow.

(5) To provide ample means for thoroughly testing samples of all seeds and other contributions that may be received.

The necessity for testing seeds and plants is one of the most obviously useful, as it has been one of the most assiduously and successfully conducted operations of the garden. Increased facilities for extending these tests have become necessary, especially with reference to agricultural seeds, roots, and tubers. Comparative results can only become definite and reliable when attained under similar circumstances. To ascertain whether one variety of plant is earlier, hardier, or more productive than another, it is necessary that they should be cultivated under the same conditions of climate and soil. When it is impracticable to procure other than small packages of new and choice articles, the purposes of distribution will be greatly enhanced by their previous increase. By this means a knowledge would be gained of their value, which might prove of much moment. The necessary requirements for testing the products of hybridization further point to the paramount necessity of the Department having at its disposal greater facilities than the present garden affords, and where the more extended and economical operations of field culture may be introduced.

(6) To cultivate specimens of various hedge plants and exhibit their availability for that purpose.

The subject of live fences is one of vast import alike to the agriculturist, horticulturist, and pomologist. The heavy investments annually incurred in the erection and repairs of fencing has long been a matter of serious consideration, and the introduction and culture of hedges has in some quarters occupied much attention and been extensively adopted. Orchardists and gardeners are gradually awakening to the conviction that shelter is one of the most necessary appliances conducive to the health and earliness of their crops. The dry, frosty breezes of early spring are especially pernicious, and their effects lay the foundation for many plant diseases. On the Western prairies, particularly, it may be questioned whether successful fruit culture will be realized in the absence of shelter from exhausting winds.

Then, again, for the purpose of forming neat boundary and dividing lines in pleasure grounds and gardens no fence is so beautiful, and when proper plants are selected for it no barrier so effective and permanent. As examples of what may be done and how best to do it, specimen hedges should be established, showing the relative merits of various plants for the purpose, both deciduous and evergreen. This would afford demonstrative evidence far more satisfactory and conclusive than can be conveyed by any amount of mere descriptive advice.

(7) *To cultivate a collection of the best fruit trees and plants, such as grapes, apples, pears, peaches, strawberries, raspberries, currants, etc., so as to compare their respective merits.*

It is known that our lists of fruit trees have reached an extent that renders it a matter of much perplexity to select those best suited for particular purposes. Tastes vary widely in this respect, and, happily, nature has provided so ample a variety that all may be gratified. With a view to assist in the selection of sorts, specimen orchards should be established, consisting of a discriminate collection of the acknowledged best fruits, as far as they are known, in each class. In order to make this result more immediately effective, advantage should be taken of the valuable labors of the American Pomological Society in making a selection of sorts.

There is every reason to believe that plantations of this description will be of great service to all who contemplate planting fruit trees. The relative merits of sorts, both as regards the intrinsic qualities of the fruit and the productiveness of the plant, as well as the general appearance and habit of growth, hardihood, and freedom from disease, would here be exhibited. The modifying influences of culture, in training and pruning, already alluded to, should here receive prominent attention. From such a source facts of the highest value would be demonstrated.

(8) *To plant a collection of choice shrubs adapted for decorating gardens and landscape scenery.*

Everyone will admit that the embellishment of dwellings and their surroundings has an ameliorating effect upon the habits of the occupants. It is also well known that many persons are deterred from undertaking this kind of improvement owing to their inability to decide upon the kind of plants and shrubs that would prove most satisfactory. A choice collection of hardy shrubs should therefore be cultivated, and if arranged so as to produce landscape effect, those who contemplated landscape improvements, and, indeed, all who felt desirous of studying the various forms and peculiarities of this family of plants, with a view of becoming familiar with their adaptabilities, either as isolated plants for particular positions or the general effect produced by combined masses, would here find instructive examples.

(9) *To erect glass structures for the twofold purpose of affording the necessary facilities for cultivating exotic fruits and plants and to furnish examples of the best and most economical modes of constructing, heating, and managing such buildings.*

The opinion is by far too prevalent that glasshouses for the accommodation of plants or the culture of fruits are expensive luxuries within the reach of a comparative few. Nothing can be further from the truth; the pleasures as well as the profits to be derived from an exotic grapery are so great, the expense of erection so moderate, and, withal, the general management so simple and so easily acquired that it should form an adjunct to every country residence. Even in the limited area usually allotted to city dwellings a small grapery can be established where little else can be cultivated. It would be a duty worthy the attention of the Department to show how to build such structures cheaply, and systematize and popularize a mode of management within the capacity of all to understand.

The trouble connected with raising hardy fruits, such as the plum, apricot, and nectarine, in some districts has led to the culture of these fruits under the protection of glasshouses, where a family supply is as certain as a crop of corn. The amount of fruit thus grown in a limited space is truly surprising. Successful examples of this and other projects can not fail in conveying instruction and effecting an economy of time, labor, and money.

There is much yet to be demonstrated in the form, materials employed, ventilating, heating, and general arrangement of glass structures.

A brief review of the operations and results suggested in the foregoing paper will best illustrate what has been attained, and how far the suggestions have been useful to the fruit-growing and farming communities.

PEAR TREES.

In the fall of 1862 a collection of pear trees numbering 120 plants were set out. These were in 60 varieties, one of each variety on quince roots, and one of each on pear roots; the purpose being mainly to ascertain what merit, so far as relates to early fruiting, the dwarf tree had as compared with the standard. After the lapse of a number of years it was found that some varieties proved to bear as early on pear roots as their respective duplicates on the quince. Of these, the most precocious on the pear were the Howell, Buffum, Beurre Giffard, Bartlett, Beurre Clairgeau, Belle Lucrative, and Dearborn's Seedling. The trees were all of the same age when planted, soil and locality alike, and all made a healthy and even luxuriant growth.

In 1870 a collection of pears, all on pear stock, were set out in order to illustrate results of nonpruning. These when planted were pruned close, so that they appeared like walking canes; no further pruning was permitted. In after years some limbs were entirely removed where branches became too thick and crowded. But no "shortening in," as it is termed, was performed on the points of branches; even when the yearly leading growths acquired a length of 3 feet or more they were not disturbed, and in the course of two years these shoots were covered with fruiting spurs, and ultimately with fruit from bottom to top. On the contrary, the cutting back, or shortening in, of these young growths simply induces a thicket of young shoots instead of forming fruiting spurs; in fact such treatment destroys the buds from which the fruit-bearing short-branch processes are formed.

These trees were productive of fine fruits. In the fall of 1871 a collection from the dwarf trees was exhibited at the meeting of the Pomological Society. Placed alongside a collection of similar varieties from California, they were pronounced to be equal in size and superior in flavor to the California fruit.

Those on pear stock, and unpruned, also produced fine fruits, which received commendations from fruit growers, and which had the effect, in some known instances, of changing former methods of pruning.

TREATMENT OF PEAR DISEASES.

With regard to the blight on the leaves and branches of the pear and the occasional cracking of the fruits, experiments continued for many years proved that the blight was reduced to a minimum when the main and secondary and minor branches were annually treated to a covering of lime wash in which a portion of sulphur was incorporated, and no blight has been perceived on any part of a tree that has been protected by a coating of this mixture.

The sulphur ingredient is of much importance. This is well known as an effectual remedy for the destruction of fungi and bacteria, and when this mixture is applied as indicated, and acted upon by sun heat, sulphurous gases are evolved so that the sulphury smell is perceptible to those who walk through an orchard on a sunny day where the application has been made.

The fruit of the pear is often greatly injured by splitting or cracking when about half grown, and several of the best varieties are so subject to this disease that their extension and planting are greatly restricted on that account. The cause and prevention of this injury are therefore matters that induced a study of conditions. The conclusions reached indicate that the cause is climatic, and is not affected in any perceptible degree by the nature of the soil, or by any system of culture, or any special application to the soil. The cracking is the consequence of the fungous growth upon the skin of the fruit, which apparently destroys its vitality, as it becomes hard and unyielding, and as the fruit expands, the injured skin, being too hard for expansion, cracks open. It was pointed out that the only known remedy is shelter and protection, and this was proved by many examples, which were considered as ample proof of this conclusion.

GRAPES.

A complete collection of native grapes was obtained and planted during the spring of 1863. This collection was increased from time to time as new varieties were introduced. As they fruited their merits or otherwise were noted and published in reports. Much attention was given to the cause and effect of mildew and other fungoid diseases. From information thus gained, it was shown how to choose the best localities for grape culture, where diseases would be measurably avoided. It was shown also that by covering the grape trellis with a comparatively narrow wooden coping the vines were completely exempted from leaf mildew and largely protected from rot of the fruit. To prove that these diseases were of atmospheric origin, a rude glass structure was erected by placing a few glazed sashes against a common board fence. A collection of native grapes were planted in a line 4 feet from and parallel with this inclosure. In due time two leading stems were secured from each plant, one of which was trained under the glass roof, and the other to the outside trellis where the plants were set. This arrangement was continued for six years, with the same result each year, a fine crop of finely ripened fruit under the glass, and the usual failures from leaf mildew and rot on the outside branches. The fruit of the Iona under the roof was pronounced superior to some of the foreign kinds under glass, while the other half of the plant never ripened a bunch, and finally its badly ripened wood was completely destroyed.

LISTS OF NATIVE GRAPES.

The study of this extensive collection of native grapes enabled the superintendent to furnish a contribution toward the preparation of a classified list, showing the relation of each variety to the particular native species from which it had been produced, also those which had originated from hybridization with the foreign species. This was published in the annual report for 1869, and was accompanied by a description of the relative values of varieties for wine or for table use, or for both; also the districts and climatic conditions most suitable for their successful cultivation. Previous to the publication of this list no particular attention had been given to the subject by grape growers. It was, however, recognized as being valuable and attracted attention to important facts connected with the culture of the grape.

This classification was recognized by some of our best grape growers, and in the commercial lists of nurserymen it afterward became usual to indicate their origin, whether from *Vitis labrusca*, *Vitis æstivalis*, or other native species, whether hybrids with foreign species, or crosses of native kinds.

In the spring of 1870 a collection numbering over 90 varieties of the foreign species (*Vitis vinifera*) were planted in a glass structure specially erected for them. The object of this collection was mainly for purposes of propagation. From time to time the less valuable have been removed and new varieties introduced. Plants from these vines have been distributed on the Pacific Coast, also in western Texas, and more recently somewhat numerously in parts of Florida.

REMEDY FOR GRAPE THRIPS.

For several years, beginning in 1876, the vines of this grapery were severely injured by the insect known as the grape thrips; applications of tobacco water, quassia water, etc., on the foliage, as also fumigations of tobacco stems, had the effect of keeping these insects in check, but having to be abandoned when the fruit was ripening, as it would thus be rendered unfit for use, the insects would then increase rapidly and destroy the foliage; so the utter destruction of the plants seemed inevitable, unless some more effectual means could be adopted to annihilate the insects. This means was adopted. It consisted simply in covering the floor of the house with tobacco stems, the refuse of cigar manufactories; this was repeated for three seasons, when it was discontinued, no thrips having been seen since.

Many articles have been prepared by the Horticulturist, which have been published from time to time in the reports of the Department, on the propagation, cultivation, and treatment of grapes. Among these appeared a lengthy article in the report of 1866 on the pruning and training of the grape vine, with quotations and illustrations from various authors.

JAPAN PERSIMMONS.

Persons familiar with the cultivated fruits of Japan unanimously agree in the praise of the persimmon of that country. In order to introduce them here an order for seeds was placed in the office of the United States legation in Japan. Consequently, early in the summer of 1863 a package of these seeds was received and planted at once. This was the first effort, so far as known, to introduce this fruit into the United States for the purpose of testing its adaptability for general or special culture and use.

Several importations of seeds were made from time to time, from which plants were raised and distributed in different States. The report from these, as well as tests made here, indicated the climatic conditions necessary for their successful culture. About ten years after the receipt of the first seeds it was ascertained that a nursery had been established at Tokio, Japan, and that special attention was directed to grafting the best varieties of persimmons by name. Yearly importations of these were made, and the plants distributed in selected localities. In 1878 a large consignment was widely distributed in California by agents of the Department in that State. They are now growing largely in several of the Southern States. The Japan persimmon may be said to be about as hardy as the *Magnolia grandiflora*. Some varieties are hardier than others, but all are perfectly safe where the thermometer does not fall below 12° F. above zero. The demand for plants is now well supplied by nurserymen, especially those in the South, so that their distribution by the Department has greatly fallen off. The names of imported varieties have given much confusion, as the same name would be found on different kinds, but this is gradually being corrected by those who grow the fruit and by nurserymen who propagate the plants.

This is in accordance with a rule followed by the Department in all its introductions, viz, that when any of these become sufficiently popular to attract the attention of nurserymen to its propagation and dissemination, the Department ceases its propagation and distribution.

ORANGES, LEMONS, AND OTHER CITRUS FRUITS.

In 1863 a collection of named oranges was begun by the purchase of three varieties—a Maltese oval, a St. Michael, and a Mandarin. Previous to that an importation of plants from Japan included plants of the Kum-quat, both of the oval-fruited and the round-fruited varieties. This is the *Citrus japonica* of botanists. Its fruits are about the size of a large gooseberry, and are held in high esteem for preserving in sugar.

In 1871 an extensive collection of the citrus family was received from Europe. These were collected specially for the Department by agents employed for the purpose, and was pronounced to be as good a collection as had ever been gotten together. Especially was this said in regard to the selection of commercial citrons, as the agents received special instructions in regard to these fruits, as they were intended to establish the manufacture of commercial citron in this country. These citrons were propagated from and the plants distributed in the citrus regions, but they seemed to be neglected at that time, as attention was given more to planting oranges twenty-five years ago than to any other kind of citrus fruits. More lately, however, requests are frequent for citrons, and some interest is now apparent in preserving this fruit for market.

REMEDY FOR SCALE INSECTS ON CITRUS FRUITS.

This European collection was found to be badly infested with a scale insect, which had to be destroyed before the plants could be used for propagation. After many fruitless attempts with various washes, coal oil was tried, and after many trials it was found that 1 gill of oil thrown into 5 gallons of water, agitated with a syringe, and sprayed over the trees, destroyed the insects without injury to the plants. The method of making an oil emulsion before mixing with water is a great improvement upon the primitive system described above, although that probably was the first successful attempt to use coal oil for killing scale insects.

ORIGIN OF NAVEL ORANGES.

During 1868 it was learned, through a correspondent then in Bahia, that the oranges there were of a superior character to any seen in the United States. An order was sent for a small shipment of plants, which, after considerable delay and minute advice as to budding, packing, and shipping, were received here in fairly good condition. In due time buds from these were inserted in orange stocks, and the young plants so produced were distributed in Florida and California. They were sent out under the name Bahia, which name, without action by the Department, has been changed, first, to Riverside Navel and subsequently to Washington Navel. As is well known, this orange is conceded to be the best flavored and otherwise the best table fruit of its kind. It is brisk flavored, solid, seedless, and of large size.

A drawback to its general culture in some parts, especially in Florida, is its lack of fruit. The trees may flower abundantly and no fruit follow. As the flowers of this variety are nearly always destitute of pollen, the writer has hitherto attributed its unfruitfulness to this cause, but he now feels convinced that the absence of pollen is its normal condition. This might have been surmised from the absence of seeds in the fruits, and when an occasional seed is found in them, it is evidently the result of transported pollen. Physiologists state that the genus *Citrus* is very subject to a monstrous separation of the carpels, producing what are called horned oranges, or to a multiplication of the normal number of carpels, in which case orange is formed within orange, such fruits being called navel oranges.

The Washington Navel orange is highly esteemed in California, where it is being largely cultivated, and proves a remunerative crop. It is stated that from 800 to 1,000 car loads of this orange are sent to market yearly.

Early in 1878 a glass structure, 100 feet by 26 feet, was erected for the special purpose of growing orange trees; this was constructed with a movable roof, which is taken off about the end of May and replaced about the end of September. The culture has been successful. Since its erection all new additions are planted in a prepared border and allowed to fruit, so that their merits may be known and their value determined before being propagated for distribution.

APPLES.

In the year 1871 the Department received from Russia a collection of apple trees. The efforts to secure these trees were undertaken several years previous, but some time elapsed before they could be secured from any source which seemed reliable. Something over 200 varieties were ultimately secured through Dr. Regel, of the Imperial Botanic Garden, St. Petersburg; they were mostly in duplicate, and were planted on the grounds of the Department. When the first year's growth was completed, all the young wood was cut off and the scions distributed to nurserymen and others who could utilize them.

The principal object of this importation was the hope that a greater variety of hardy apples might be secured for the rigorous regions in the Northern States, and especially with a view of extending the season of late varieties. The few hardy Russian apples which were then in cultivation in this country were early ripening kinds.

For ten years following their introduction the crop of scions was distributed, and as the trees increased in size the distribution became heavy. The greatest number sent out in one year was 95,000 eight-inch lengths.

The trees were than removed. It was considered that the purpose of their introduction had been accomplished so far as the Department could be of any service, and the space they occupied was needed for other uses.

From this importation a few desirable apples have been added to the list of those worthy of cultivation; but it has possibly been of greater value in directing attention to northern Europe as a region where hardy fruits of various kinds may be found, and which may prove to be the means of introducing fruit culture in the more rigorous sections of this country, where fruit culture is but little known.

APPLES IN SOUTHERN STATES.

Thirty years ago the opinion was prevalent that the climates south of Maryland were not suited to the apple; at all events, it was stated that winter, or long-keeping, apples could not be produced in the Southern States.

This statement was true as far as it referred to the winter apples of the Northern States, such as the Baldwin, Rhode Island Greening, etc. These varieties when planted in Southern States ripened during the fall and could not be kept as winter fruits.

Some of the most prominent nurserymen and fruit growers in Virginia, North Carolina, Georgia, and other States had long been aware of the futility of planting Northern winter-keeping apples in their sections, and had been for some time industriously engaged in collecting winter varieties from among the many seedlings picked up in old fields and fence rows in these States, many of them having great local reputation for their excellence and good keeping qualities.

For the purpose of greater acquaintance with the apples of North Carolina (a State where this fruit attains its greatest perfection), a visit was made in the fall of 1869, which enabled us to collect samples of many varieties of repute in that and adjoining States.

An article descriptive of this collection, with sectional drawings and woodcuts from photographs, appeared in the report of the Department for 1869. About 40 varieties were described, 30 of which proved to be of Southern origin, most of them unknown to Northern orchardists, and to that time never noticed in pomological works.

The publication of this list not only effected its main object, which was to draw the attention of Southern planters to the fruits of their regions, but it had the effect of attracting the attention of some Northern nurserymen, who procured collections from the South, which, after testing, added several excellent fruits to those cultivated in the North.

FIGS.

The introduction of varieties of figs and their propagation and distribution was a matter of early as it has been one of constant consideration. Ever since the establishment of the Department it has been importuned to procure the true Smyrna fig, and although collections have been procured from various European sources, embracing all the popular figs of commerce, only in one importation were found plants named White Smyrna, and these on fruiting proved to be the same as the White Marseilles. Smyrna figs are probably of *multiple* variety, as are Malaga grapes, and derive their names from places of export. It is well known that numerous varieties of figs are dried and enter into commerce under the name of Smyrna figs.

The fig can be grown over a large part of the United States, and will withstand a temperature of 20° F. below the freezing point when the young growths are thoroughly matured; this, however, seldom occurs north of Georgia, unless in some favored spots. Even in Georgia early winter frosts will kill the unripened wood.

In more northern localities the plants can be protected during the winter by bending the branches close to the ground and covering them with a foot of soil.

If the young shoots have ripened properly, this covering will protect them safely during the winter; if the wood is immature, covering will be of little avail.

The ripening of the wood can be assisted by planting in a gravelly or sandy soil; if the soil is rich, growths will be made at the expense of the fruit.

During the past twenty-five years many importations of figs have been made, and numerous varieties have thus been introduced. These have all been fruited, and the best of them selected for extensive propagation. In the aggregate not less than 100,000 fig plants have been distributed by the Departmemt during the period mentioned above.

EUCALYPTUS.

In the year 1865 there appeared a notice of some experiments conducted in German hospitals wherein it was made apparent that the Blue-gum tree of Australia (*Eucalyptus globulus*) possessed antiperiodic properties. Acting upon this information, a package of seeds of this tree was procured through an Australian correspondent, which were sown during the spring of 1866. After three years, at which time the plants had reached a height of 20 to 25 feet, a number of them were cut down and submitted to chemical tests for alkaloids similar to the cinchona, but they failed to reveal any indications of alkaloids of this character, and subsequent experiments afforded additional proof that no part of the plant contained them. Nevertheless the febrifugal nature of the leaves appears to be well established, and preparations from them constitute a popular remedy in Australia and in other countries against fevers, and several preparations from various parts of the plant have the reputation of being successfully used in intermittent fevers. The leaves by distillation yield an essential oil which has been found to possess the properties of cajuput oil; it is known in commerce as Eucalyptus oil; other species of Eucalyptus furnish oils which are sold under this name.

The Blue-gum tree yields an astringent substance which is applicable, like catechu and kino, in medicine. The leaves have a strong camphorated scent, and have been used in the cure of gunshot and other wounds. Their balsamic nature not only cures, but after a few hours' application all unpleasant odor is entirely removed.

But the great popularity for a time of the *Eucalyptus globulus* was owing to its reputed properties for preventing malarial fevers. Unhealthy districts in Spain, Italy, and in some parts of France were planted with the Blue-gum, now called the antifever tree. Its antimalaria reputation soon reached the United States, and the demand for young trees became so great that the Department procured supplies of seed and propagated and distributed many thousands of the plants during several years from 1870. Their hardiness had been well tested here; it was found that they were destroyed when the temperature fell to 24° F. As reports came in its climatic range could be more accurately located, which proved to be more limited than was hoped for at the start. It was destroyed by cold at Galveston, Tex., and in Florida as far as latitude 29°. In California it is successfully grown, and is largely planted in certain parts of the State.

With regard to the sanitary value of the tree, it has been strongly stated that its value was owing to its rapid growth and the great absorbent power of its roots in drying up wet and marsh lands, but it is no longer doubted that *Eucalyptus globulus*, along with other species of Eucalyptus, evaporate with water a volatile oil and a volatile acid, which permeate the atmosphere and contribute to its invigorating and healthy nature and character.

The distribution of Eucalyptus plants has not been confined to this species. More than 40 species have been propagated and sent out, but no special merit, either in hardiness or in utilizable economic products, has been noted from any of the species, so that their further propagation was abandoned several years ago.

PINEAPPLES.

The climate in the United States suited to the pineapple is limited to southern Florida, and perhaps some parts in southern California. It can not be considered as a perfectly safe crop in Florida north of the twenty-eighth degree of latitude, although with protection it is profitably grown north of this limit. The climate of southeastern Florida seems favorable, and there the industry is rapidly becoming important. With a view of introducing good varieties the Department during 1882 erected a glass structure for this purpose, and imported a number of the best varieties attainable, which were planted for propagation. Under a limited glass surface their increase proceeds slowly. Among other choice kinds the smooth-leafed Cayenne has been introduced and is in much demand.

CINCHONAS.

The cinchonas, which furnish quinine, have been raised and distributed to some extent for many years. The value and demand for this drug were strong incentives to efforts looking toward its home production. Seeds of several species were received in 1864, and from these several hundred plants were obtained, and were distributed mainly in California and Florida. Since the first distribution many others have been made, but the reports that have been received do not indicate success at any point where they have been tried.

Cinchona bark is so largely furnished by plantations in the East Indies, and so cheaply, that West India growers have abandoned the culture of the trees.

OLIVES.

The introduction of the olive tree into this country dates back one hundred and fifty years; first, it is stated, in California by the Jesuits, and shortly afterwards in Florida, brought by a colony of Greeks and Minorcans. Since then up to the present time various attempts have been made to revive and extend its culture in the Southern States, which have in turn been abandoned. On the Pacific Coast the revival of olive culture, instituted some years ago, seems to be now on a paying basis and is yearly extending.

The Department during the past twenty-five years or more has, at intervals, imported olive trees of noted varieties, from which large numbers of plants have been propagated and distributed, mainly in the States south of the District of Columbia. It is not a tender plant; it will usually withstand 20° F. of frost, and even more in favorable localities.

Olive seeds are frequently called for, but this is an injudicious mode of propagation so far as securing plants of valuable commercial qualities.

In selecting varieties the Department has, during the past few years, paid more attention to those famed for the pickling qualities of the fruits than to those more specially used for oil, as it is surmised that the prepared fruits will be in greater demand, owing to the oil from olives being largely supplemented by oils from other sources.

ORCHARD HOUSE.

During the fall of 1863 a small orchard house was planted with peach, nectarine, and other kinds of fruit trees for the purpose of showing the arrangement and management of trees under glass protection. A bed of soil 9 inches in depth was laid over a drainage foundation of broken brickbats and oyster shells, and trees planted about 5 feet apart. Ample means for ventilation were provided, and the purpose was not to force the trees by heat for early fruit, but to illustrate the effects of a shallow bed of soil in preventing luxuriant growths and hastening and advancing precocity in bearing. Considering the size of the trees and small space they occupied, the crops were excellent and of the finest quality. When the fruits attained the size of marbles, a weekly drenching of guano water was applied to the soil. This enabled the trees to mature a large crop of fine fruit.

To show further the controlling influence of restricting root growth in the production of fruit, and for other purposes, several wooden troughs were constructed, in which peach trees were planted and set in the open air. These were made of boards 10 inches wide for sides and bottom, filled with soil, and the trees set about 3 feet apart in the troughs. The produce on these trees proved to be very satisfactory. A trough 7 feet in length contained three trees, and the whole could easily be carried by two men. The suggestion was made that in northern latitudes where peaches and nectarines do not thrive in ordinary orchard culture, or in city yards, where space is limited, an arrangement of this kind would afford an agreeable recreation and some fruit to the owner. In severe climates the whole could be kept in a cellar or a protected shed during winter.

Forty years ago orchard houses were very much in vogue and many of these structures were erected, and when properly managed were quite satisfactory. But interest in them was not permanent, mainly, it was surmised, on account of defective management; for, although it seemed a simple matter, it required more skill and judgment to make them successful than was required in the management of any other culture under glass. These houses were first used by Mr. Rivers, an English nurseryman, who published a small work on the subject. An edition of this work was published in New York, edited by the writer, with suggestions and illustrations adapting it to American climates.

The peach and nectarine are specially fitted for this system of culture, and are not liable to any of the maladies and diseases which are apt to follow outdoor cultivation. The young yearly growths always ripen thoroughly, so that the yellows, which occasionally follows the freezing of the immature shoots in early winter, is not known, and the protection from severe and sudden changes of temperature in early summer, or when the leaves are young and tender, is a sure guaranty against the curl leaf or blister, which at times severely injures the trees in most of our peach-growing localities.

CHINESE TEA PLANT.

The tea plant of China was first introduced in large quantities in 1858 by the Commissioner of Patents, who made distributions of them in the Southern States. But little attention was given to their culture at that time, except as a merely domestic product; the cost of labor and manipulations of manufacture precluded the idea of competition with low-priced Asiatic labor.

The successful progress of tea culture in India, where labor-saving machinery was employed in its manufacture, suggested the probability that it might be made profitable in some parts of this country, where labor-saving appliances are usually forthcoming as soon as their necessity is made known.

Following this idea, tea seeds were imported from Japan. Plants were in due time raised in quantities to warrant liberal distributions; and when, about 1867, it was found that an abundance of tea seed could be procured in some of the Southern States from plants that had been distributed from the importations of 1858, it materially increased the facilities for distributing tea plants in any desirable quantity.

The supply of tea plants has been constantly kept up, at first with faint but increasing hopes that the production of tea would become a profitable industry, mainly through the introduction of machinery for the drying, roasting, twisting, and other manipulations supposed to be necessary, but always with a view of introducing a domestic commodity of which anyone could avail himself in climates where the plant could live in the open air without protection.

TEMPERATURE AND MOISTURE FOR TEA.

As our knowledge of the tea industry widened it became evident that even more than the cost of the labor the controlling factor of profitable production was rainfall. In British India tea plantations are not considered profitable where the rainfall is less than 80 inches yearly. In some parts 120 inches yearly rainfall is recorded, and the production there is at its maximum. In gathering, the young points of the growing shoots (having three or four small tender leaves) are pinched off between the thumb and finger. This checks the growth of the plant for a longer or shorter period, depending upon climate. If the weather is warm and dry, it will be some time before a second crop of shoots is produced; if warm and moist, only a few weeks will intervene between the pickings. With abundance of moisture the plants furnish from twelve to eighteen crops during the season. Thus pickings are continuous, and the manufacturing machinery is constantly employed. In dry climates only a very few pickings could be secured during the season. For long periods the machinery of manufacture would be idle, while the product would be inferior; the leaves would be hard and woody, as compared with the thin juicy leaves produced in warm climates saturated with moisture. Irrigation would be indispensable in any attempt to grow the article anywhere in the United States to commercial advantage, independent of considering the cost of manual labor here as compared with that of Asiatic countries.

For these reasons no effort is made to encourage investments in the culture of tea, but from 5,000 to 10,000 plants were distributed annually in districts where a zero cold rarely, if ever, exists, and where the article can be prepared for domestic use by simple methods of drying and roasting the leaves.

EXPERIMENT AT SUMMERVILLE, S. C.

During the past three or four years a well-considered effort at tea production has been inaugurated by Dr. Charles U. Shepard on his Pinehurst estate, near Summerville, S. C., where the success so far is quite remarkable and encouraging, and where it is recognized that the only method of making a profitable crop is to put on the market a tea superior to any now found in the trade, and this he claims to be doing at present, even while the whole business is but in its infancy.

When Dr. Shepard resolved to experiment in the culture and manufacture of tea he was quite familiar with the tea plant in South Carolina, where it had been growing for nearly a century. He was also conversant with all previous efforts in trying to grow tea with profit and their results; but he felt assured that these results were not by any means conclusive, as they were based upon practices prevalent in countries where climatic conditions and other important factors to success were greatly different from those existing here. He recognized that the problem of adaptation required the prosecution of a series of studies which, so far as known, had never been taken up.

Among the problems to be solved was that of growing tea in a district which had a yearly rainfall of 56 inches, while Asiatic authorities claim that for tea-growing it should not be less than 80 to 100 inches per annum, and the more of this that falls during the early part of the year the better. Some of the best tea districts have 120 inches of yearly rainfall. Again, it is found that authorities agree in the opinion that the temperature should never be lower than 40° F., for although it is well known that the tea plant will exist in climates where the thermometer may reach zero, yet the best production is obtained from plants where frosts do not prevail. At Summerville 15° F. may be expected during winter.

In everything connected with this industry Dr. Shepard has had to be guided almost solely by his own experiences and observations. Literature relating to the subject is plentiful, but all of it relates to countries where the climatic and other conditions leading to success are so different from those in South Carolina that it proves to be of but little general value, and of no specific value whatever.

During the past thirty years the Department has propagated and distributed all of 150,000 tea plants, but has now practically abandoned their further propagation.

COFFEE.

Many thousands of coffee plants have been raised from seed and distributed in Florida and California and in some parts of Texas, but its growth, as furnishing a product to enter into commerce, is rather problematical. In southern Florida, below 27½° north latitude, coffee plants withstand the climate in ordinary seasons and occasionally produce ripe berries. Several years ago a quantity of ripe seed was received from Manatee, the produce of plants growing at that place. These seeds vegetated freely and produced good plants. Since then we have learned that the original plants had been frozen to the ground, but had sprouted up again as vigorous as ever. Authorities on coffee culture very generally coincide in the opinion that it can not be grown profitably in any climate where the temperature falls as low as 50° F. at any time of the year. This refers to the production of the fruit. Many plants will grow in climates too cold for perfecting their fruit with any degree of regularity, if at all, and this is the case with the coffee plant. A lowering of temperature occurs before the fruit is ripe, and its progress toward maturity is retarded, if not completely checked, and these climatic conditions may occur in any part of Florida.

Thus, it happens that when the fruit ripens it is in reality the crop of the preceding year. The plant flowers, forms seed in the fall, but not early enough to ripen before winter; then, if the winters are not too severe, the fruits will remain and ripen up the following spring, thus requiring the best part of two seasons to make one crop.

About twenty-five years ago a new species of coffee was introduced from Liberia. The plant was described as being of more robust growth, with larger berries than the Arabian. Hoping that it might also prove to be more hardy, after several failures to procure fresh seed from Liberia (coffee seeds of all kinds soon lose their vitality) a few were ultimately secured, from which plants were raised, but it was soon made evident that the Liberian species was more tender than the Arabian.

THE CAMPHOR TREE.

The camphor tree has been distributed more or less since the establishment of the Department, and many of the earlier distributions have now produced trees of considerable size and beauty, for it grows into a symmetrical evergreen tree which always attracts attention. It is a hardier tree than the orange, and was distributed in earlier days as a shade tree, and as a shelter tree for the orange family. It will stand the coast climate as far north as Charleston, in South Carolina. Of late years it has been thought possible that a profitable industry might be inaugurated by extracting camphor for commercial purposes, and many thousands of plants have been propagated in the greenhouses and distributed in districts where the climate is suited to its growth. An average of 6,000 plants has been the yearly output for five or six years, with the hope that some of the recipients would test the question of profit.

But the best mode of procuring the gum has yet to be decided—whether from the leaves, twigs, wood, or roots. The best season of the year for operating, the best methods of distillation, and other matters which enter into the economies of the industry are also points to be determined.

GRASSES.

In the spring of 1867 upward of 50 species of grasses and forage plants were sown. A plot of ground 10 feet square was alloted to each. About once in ten days measurements were taken of their growth and other characteristics. Much information was gained from these tests as to the rapidity of growth, resistance to droughts, and endurance during summer. The rapidity of growth of the Italian rye grass (*Lolium italicum*) was especially noted, and led to the suggestion that it might prove valuable in the South when sown in the fall, say in September, and as it grows in a low temperature, a crop fit for cutting for hay would be produced in the following April, when the sod could be turned under in time for a spring crop. To test this matter of winter growth, sowings of Italian rye grass were made about the middle of October, 1869. The weather proving dry for some time afterwards, the young grass made slow progress, so that in December it was not more than 1 inch in average height. The winter was about the average in severity as experienced in the District of Columbia. No covering or protection of any kind was afforded, and on the 28th of the following April it showed an average height of 18 inches. Common perennial rye grass sown at the same time averaged 10 inches in height on the above date. This was about the beginning of experiments with grass gardens in the Department.

HEDGES.

In the spring of 1864 specimen hedges were established, with a view to showing the relative merits of various plants for this purpose, either as fences for farm or garden protection, or for forming neat boundary and dividing lines in pleasure grounds and lawns, or for shelter from cold and biting breezes. These specimens afforded much interest to those seeking information in that line. An inspection of them afforded more information than could be conveyed by the most labored description. The following plants were used: Osage orange (*Maclura aurantica*), honey locust (*Gleditschia tricanthos*), buckthorn (*Rhamnus catharticus*), berberry (*Berberis vulgaris*), Japan quince (*Cydonia japonica*), beech (*Fagus sylvatica*), European hornbeam (*Carpinus betulus*), European field maple (*Acer campestre*), Japan privet (*Ligustrum japonicum*), hemlock spruce (*Abies canadensis*), Norway spruce (*Abies excelsa*), Chinese arbor-vitæ (*Biota orientalis*), American arbor-vitæ (*Thuja occidentalis*), evergreen euonymus (*Euonymus japonicus*), silver thorn (*Eleagnus parvifolius*), jujube (*Zizyphus vulgaris*), and later the *Citrus trifoliata* was added to the list, and as a formidable hedge plant is superior to any of those mentioned.

These hedges were maintained in good condition for six years, when the ground they occupied was used for other purposes, but they were good examples of hedge culture, and as such attracted a good deal of attention by those interested in live fences.

MISCELLANEOUS PLANTS PROPAGATED AND DISTRIBUTED.

Much has been done also with plants of which an extended notice can not be given. Some of the more important are given here.

FOREIGN PLANTS OF IMPORTANCE IN THIS COUNTRY.

RAMIE, OR CHINA GRASS (*Boehmeria nivea*).—Seeds of this fiber plant were procured early in the year 1865 and sown in a glazed frame. This precaution was taken because the seeds are very minute and have to be sown on the surface of the soil and pressed in without covering. Thousands of plants were produced and distributed throughout the country the following year. The distribution of the plant was abandoned when it became apparent that machinery was wanting to prepare the fiber for market, and that consequently there was no demand for it. The plant is easily cultivated, and could be produced in quantities should a demand arise. It is quite hardy south of the District of Columbia.

NEW ZEALAND FLAX (*Phormium tenax*).—The fiber in the leaves of this plant is reputed for its strength. On the supposition that it might be utilized, seeds were procured from its native country, from which several thousands of plants were produced and distributed. The fiber is difficult of extraction and has been the subject of much experiment by chemists and others. The latest results prove that the fiber is held together by various kinds of gum, and when these are removed the fibers are quite short and have no felting properties.

SISAL HEMP (*Agave sisalana*).—This plant was introduced into Florida fifty years ago, but its culture was abandoned during the Indian war in that State. Some years ago a consignment of young plants of this, or an equally utilizable species, was received from San Domingo, and they were distributed.

CABUYA FIBER (*Fourcroya cubense*).—The leaves of this plant yield a useful fiber, somewhat similar to the above mentioned. Neither of the plants is yet cultivated to any extent in the United States. Plants of this fiber were received at the same time as the sisal hemp and sent to the same localities.

GUMARABIC (*Acacia arabica*).—This gum is also found in other species of Acacia. Plants of these have been raised from time to time and sent out to Southern climates. Quite a number of plants of *A. arabica* have lately been distributed.

COCOANUT PALM (*Cocoa nucifera*).—About twenty years ago a consignment of cocoanuts was received from Central America, and some years later a small quantity was procured from the West Indies. These were distributed in localities where it was supposed the plants would flourish. At that time but little was thought about the profitable culture of the plant, and it is presumed that no attention was given to the few sent out by the Department. Of late years, however, more attention has been given to this fruit in southern Florida.

THE COCA PLANT (*Erythroxylon coca*).—This plant has been under propagation for many years, but, like the cinchona, it has not found a suitable climate, so far, in this country. During the past few years considerable interest has been attached to the plant, and it has been in much request. Plants have been furnished to all applicants, and many of them have been sent to the Southern States and to California, but so far no one has reported success in its growth.

THE MANGO (*Mangifera indica*).—The mango, in some of its many varieties, is esteemed as one of the most delicious of tropical fruits. It is largely cultivated in the East Indies, where much attention is given to the propagation of the best selected kinds. Seeds of mangoes have been procured at times during many years past, both from the East Indies and the West Indies, said to have been selected from the finest varieties, but no guaranty can be given as to the value of the fruit which they may produce. About ten years ago a case of grafted plants of esteemed varieties was procured from a botanic garden in Jamaica, West Indies, but owing to great delay in transportation few of the plants were found to be alive.

DATE PALM (*Phœnix dactylifera*).—Like the mango, there are many varieties of this species, some of them quite superior in the quality of their fruits. Unlike most palms, the date palm throws out suckers from its main stem, near the roots, so that it can be increased or propagated in that manner, which is often done with choice varieties. For many years the Department has distributed quantities of this palm which have been raised from imported seeds. Some of these importations consisted of seeds collected in southern Europe, where the hardiest varieties are cultivated. In raising the date palm from seed there is the same uncertainty about the value of the plants as there is in the raising of seedling oranges or seedling peaches. Efforts have been made to secure offsets or suckers from kinds of reputed merit, and several importations have been received, but reports as to their value have proved to be unsatisfactory.

GINGER (*Zingiber officinale*).—Rhizomes of this plant have been distributed for a long time, but no reports of success have been received. Although a tropical plant, its annual growth is completed in a few months, like cotton, and it is probable that it could be grown wherever cotton will mature. The roots being lifted and kept warm and dry during winter will be in condition to plant the following spring. The conserve known as "preserved ginger" is an article of considerable commerce. It is prepared from immature roots, so that they are soft and succulent and can readily absorb the sirup in which they are preserved.

FOREIGN PLANTS OF LESS IMPORTANCE IN THIS COUNTRY.

The following plants have been propagated and sent out, most of them in quantities not exceeding a few hundred each:

Tamarind tree (*Tamarindus indica*), vanilla (*Vanilla planifolia*), cork oak (*Quercus suber*), black pepper (*Piper nigrum*), licorice (*Glycyrrhiza glabra*), basket willow (*Salix viminalis*), Japan varnish tree (*Rhus vernicifera*), pistacio nut tree (*Pistacia vera*), allspice (*Eugenia pimento*), the Lee-chee (*Nephelium litchi*), gum arabic plant (*Acacia arabica*), the Carob tree (*Ceratonia siliqua*), cinnamon (*Cinnamomum zeylanicum*), mammea apple (*Mammea americana*), dwarf banana (*Musa cavendishii*), Avocado pear (*Persea gratissima*), Japan medlar, or Chinese Lo-quat (*Photinia japonica*), pomegranate (*Punica granatum*), Mexican pepper tree (*Schinus molle*), and Cattleya guava (*Pisidum cattleyanum*).

TESTING THE MERITS OF SPECIES AND VARIETIES OF PLANTS.

The above subject was one of early consideration in the operations of the Department. The writer, in his report to the Commissioner of Agriculture for 1863, alluded to the necessity for a series of experiments to test the comparative merits of cereals, vegetables, and fruits, most of which had run into a vast number of varieties, many of them being comparatively worthless. From the report of 1863 the following extract is taken:

CHOICE OF VARIETIES FOR CULTIVATION.

In a sale catalogue of agricultural and garden seeds now before me, there are enumerated 52 varieties of peas, 32 varieties of beans, 34 varieties of lettuce, 18 varieties of onions, 48 varieties of turnips, 42 varieties of cabbages, and 10 varieties of celery. No one desires, neither is it necessary, to cultivate all of these; it is therefore of much importance to know which are best and most suitable for the purpose required, whether early or late, large or small; whether productive, of good keeping qualities, or otherwise. Possessed of such information the buyer could make his purchases understandingly and the seller would speedily drop unsalable sorts from his list and both would be gainers. As a commencement toward carrying out the above suggestions 40 varieties of potatoes were procured, also many varieties of peas, turnips, and other plants, but owing to the limited space only a small quantity of each could be planted, not a sufficient basis upon which to found an opinion.

In 1864 Government Reservation No. 2, now the grounds of the Department, was placed under the control of the Commissioner of

Agriculture for the purpose of an experimental farm. For some years test experiments were attempted with cereals, forage plants, and garden fruits and vegetables. In 1865 there were produced on the reservation 120 varieties of wheat, 16 varieties of rye, 17 varieties of oats, 70 varieties of peas, 30 varieties of beans, 18 varieties of cabbage, 14 varieties of lettuce, 13 varieties of onions, 43 varieties of potatoes, and 30 kinds of melons, and, in addition, many forage plants, such as clovers and grasses, among them the crimson clover, now becoming popular.

In 1866, 32 kinds of sorghum were cultivated, and many kinds of turnips, beets, etc. It soon became evident that as a farm the area was altogether too limited for the requirements of satisfactory results in this line, and, in 1867, the Department building having been located upon the grounds, it became necessary to lay them out in a manner more in keeping with surrounding improvements.

IMPROVING THE DEPARTMENT GROUNDS.

During the fall of 1867 ground was broken for the erection of the Department building, which was completed and ready for occupancy the following year.

The soil of the reservation was underlaid with a subsoil of tenacious clay, which rendered it necessary to drain the whole area. This was thoroughly accomplished by tiling, the tiles being laid 30 inches below the surface. Afterward it was deeply and carefully plowed and subsoiled, then leveled, and most of it sown with grass seed in the fall of 1868. Before the final plowing, the ground was heavily coated with manure, using upward of 300 cords of rotted stable manure, which was furnished by the War Department from corrals in various parts of the District of Columbia. The preparation of the ground was so thorough that the greater portion of the park has not received any manurial application since.

Having prepared plans for laying out the grounds, the work of planting was commenced in the fall of 1869 and virtually finished in 1871.

As an experiment in road making, about 1,000 yards of concrete was laid on the carriage road in front of the Department building, the first that was laid in the city.

Immediately in front of the building a geometrical flower garden was introduced, finished, and supported by a stone terrace wall, surmounted with an ornamental iron balustrade, in order to produce an effective example of this style of improvement as a fitting accompaniment to such a structure, the only connection in which architectural terraces and similar features are admissible.

The most distinctive feature of the plan for planting the ground was the arboretum, in which would be represented, so far as space would admit, a specimen of every tree and shrub capable of existing in the climate, to be planted in strict accordance with a botanical system, and at the same time secure some degree of effective landscape gardening and pleasure ground scenery, a combination not hitherto attempted on a similarly extended scale.

THE CONSERVATORY.

In 1868 the writer submitted designs for a conservatory 320 feet in length and of an average width of 28 feet. The structure was completed and occupied in 1871.

The conservatory was erected for the purpose of maintaining a collection of economic plants. No plants were to be admitted because of the beauty of their foliage, or the beauty of their flowers, or for their historic interest; but only those which yielded, or furnished in some measure, commodities of commercial importance of more or less value; also with a view to the propagation and distribution of such as might be deemed worthy of trial in suitable climates in this country.

This collection was so far advanced in 1872 that during the latter part of the year the writer prepared a descriptive catalogue of these exotic plants, in which about 500 species were briefly noted and their uses explained.

This structure is heated by hot water circulating in iron pipes. In arranging the pipes a notable exception was made to the methods usually employed. The prevailing method was to incline the pipes for some distance from the boiler or water heater. In other words, the flow pipes were laid on an ascending grade and the return pipes on a descending grade. No uniformity existed as to either the height or distance of the ascending pipes. These conditions were regulated by the length of the building; if 200 feet in length, the ascent would be to that extent; if 20 feet in length, so would be the length of the ascending pipes. From these distances the water is conducted in a descending grade to the boiler. Observations having proved that the ascending pipe retarded the circulation of water, and that, other things being equal, the most rapid circulation is secured when the top of the boiler is the highest point in the whole arrangement, and all the pipes descending from that point until they reach the bottom of the boiler, the piping was laid so as to secure as much as possible of a descending grade. For instance, in a length of 160 feet from the boiler to the end of the house, an upright pipe 3 feet in length is attached to the boiler, from which the pipe descends the whole length and returns back on a similar grade, making a uniform descent through 320 feet of pipe.

If the water absorbed and transmitted heat by conduction only, then the position of the pipes would be of but little importance; but as it is by convection or actual movement of the water, then gravitation and diminished friction are notably influential in the efficient working of the apparatus.

BUILDING GLASSHOUSES.

All the glasshouses are constructed upon the fixed-roof plan, consisting of skeleton framework supporting a series of light sash bars for holding glass. This method is not only cheaper than the plan of heavy rafters supporting framed sashes, but by using less woodwork there is less shade and more light to the plants. Since the introduction of this method of building by the writer in 1850, together with the mode of glazing adopted, no other kind of roofing is used. The ordinary way of glazing window sashes is to set in the glass, fasten it with triangular bits of tin, then fill the outer surface of the sash bar with putty.

When this method is applied to greenhouse roofs it is almost impossible to prevent leakage. The frosts of winter and the hot suns of summer cause the putty to crack and fall apart, requiring continual repairs in the effort to maintain a water-tight roof, and which are only partially successful at best.

To make a permanently tight roof, the glass should be bedded in well-worked, rather soft putty. A layer of this having been uniformly spread on the sash bar, the pane of glass is gently pressed on it until it reaches an equal bearing, and so working up a portion of the putty that it will fill all spaces between the edge of the glass and the woodwork. After the surplus putty is neatly trimmed off, both inside and out, it is allowed to dry and shrink; then a coat of paint is applied which will fill up all crevices, and make a perfectly water-tight finish. If any slight leak should appear, a coat of paint will stop it.

After testing glasses of different sizes, panes 10 inches by 12 inches are preferred. For this size glass the sash bars are placed 12½ inches apart, measuring from their centers, allowing one-fourth inch rebate on each side for the glass to rest upon. The pane is secured by brad nails three-fourths of an inch in length, four to each pane, inserted at the corners. The two upper nails form a support to the next pane above, and their position determines the amount of lap, which should not be more than one-sixteenth of an inch. Wide laps hold dust, which in turn holds water, which may freeze in frosty weather and split the glass. Ventilation is provided for by hinged or by small sashes on the roof, which can be fixed so as to prevent leakage.

DIVISION OF PUBLICATIONS.

By GEO. WM. HILL, *Department Editor.*

INTRODUCTION.

That the work of publication is an essential part of the work of the Department of Agriculture calls for no argument. It goes without saying that the acquisition of information of value to the people demands its publication, and so we find that in the act creating a Department of Agriculture its chief duties are thus defined: "* * * to acquire and diffuse among the people of the United States useful information on subjects connected with agriculture in the most general and comprehensive sense of that word." * * *

KINDS OF PUBLICATIONS NOW ISSUED.

In carrying out the provision above cited the Department issues several distinct classes of publications. It prepares a Yearbook—a book of nearly 700 pages and containing many illustrations. This Yearbook (published annually as the name implies) consists of the Annual Report of the Secretary, and of numerous—from twenty-five to thirty—papers on agricultural topics prepared mainly by scientific workers in the Department, but including occasionally papers prepared by specialists not in the service of the Department. It includes also, in the form of an appendix, statistics and other useful information. This book is printed under an act of Congress, and from funds specially provided, in an edition of 500,000 copies, of which, however, only 30,000 are given to the Department for distribution, the remainder, 470,000 copies, being reserved for distribution by Senators, Representatives, and Delegates in Congress. The Department, however, frequently prints in the form of "separates," as they are called, articles from the Yearbook to satisfy special urgent demand for information on certain subjects covered by them.

The Department also issues large numbers of popular publications, known as Farmers' Bulletins, on all sorts of agricultural topics and adapted to the various sections of the country. These are paid for from a special appropriation, which, however, forms a part of the general appropriation for Department expenditures. By law, at least two-thirds of the whole number printed are subject to the orders of Senators, Representatives, and Delegates. As a matter of fact, this proportion has generally been exceeded. Of this series also, some are prepared by persons outside the Department service, specially engaged for the purpose, but by far the greater number are written by persons regularly employed in the Department. A list of these bulletins now available (December 31, 1897) is to be found in the Appendix to this volume. Last year 2,387,000 copies of these bulletins were printed and distributed.

Special reports and bulletins, scientific or technical in character, are prepared in the several bureaus, divisions, and offices of the Department, generally covering some special investigations and reporting the results. These are usually printed in editions of 2,000 to 4,000 copies, though it is sometimes found necessary to issue 10,000 or even 15,000 copies. In a few cases the cost of these is defrayed from special appropriations made for the bureaus or divisions that issue them, but the expense of the greater number of them is paid from a printing fund appropriated to the Public Printer, but subject to the order of the Secretary of Agriculture. This fund amounts for the current year to $85,000.

The Bureau of Animal Industry and the Weather Bureau each prepares an annual report, which is printed by Congress—that of the Bureau of Animal Industry in an edition of 30,000 copies, of which the Department receives 9,000, while of the report of the chief of the Weather Bureau 4,000 copies are printed, of which 1,000 only are reserved for the bureau.

Other publications of the Department consist of periodicals, being compilations of matters relating to agriculture and of the work done at the various agricultural experiment stations throughout the United States and at analogous institutions abroad. Thus, the Division of Statistics issues a monthly report on the conditions of the crops and including other statistical matter; the Weather Bureau, in addition to its series of weather maps and climate and crop reports, issues a Monthly Weather Review, and the Office of Experiment Stations issues monthly a record of work done at the experiment stations, appropriately named Experiment Station Record.

Finally, the Department publishes numerous "Circulars of information" prepared in the several bureaus and divisions. Sometimes these are mere leaflets, containing two to four pages; sometimes they extend to twelve or sixteen pages. They are specially designed to furnish information on subjects concerning which special inquiries have frequently been made, and are primarily designed to save correspondence.

METHODS OF DISTRIBUTING PUBLICATIONS.

The above are the principal classes into which publications of the Department are divided, and the following are the methods adopted for their distribution:

Certain institutions receive all of the Department publications; such are (1) a limited number of libraries, either free to the public or connected with prominent educational institutions, but which are not included among the public depositories supplied by the Public Printer;[1] (2) libraries of all State agricultural colleges, beneficiaries under the Morrill acts of 1862 and 1890, and of the agricultural experiment stations established under the Hatch act of 1887. Very nearly all the publications, that is, all except those whose editions are limited by law, as will be explained hereafter, are also sent to the

[1] Under the law regulating the public printing and binding, approved January 12, 1895, certain libraries, nearly 500 in all, are designated as public depositories and receive all the Government publications through the Public Printer, an extra number being printed by that official for the purpose. Through the courtesy of the Superintendent of Documents this list is accessible to the Librarian of the Department, by whom other libraries are supplied, so that duplication is effectually avoided.

agricultural papers and others, such as daily papers issuing a regular weekly agricultural edition, and to foreign institutions of learning, scientific societies, and agricultural experiment station workers specially interested. Furthermore, each bureau, division, or office maintains a "divisional" list, consisting of persons engaged in kindred lines of work and cooperating as correspondents or otherwise with the bureau or division in question. To this list are mailed all the publications of the particular division or divisions with which they cooperate. They are also sent to journals devoted to the same lines of work. As far as the supply will permit, coworkers in any line of the Department work and correspondents rendering any special service to any bureau or division are favored with the Yearbook, while promiscuous applicants are referred to their Senator or Representative, the Department's limited quota not permitting any general distribution. The technical and scientific publications are not sent free to all applicants, but a certain number of each is turned over to the Superintendent of Documents, an officer created under the law of January 12, 1895, by whom they are sold at a low price, covering the cost of printing from the plates with 10 per cent added, thus practically supplying applicants with these reports at the bare cost of paper, presswork, binding, and handling. As the Superintendent has the franking privilege, no charge is made for postage. Farmers' Bulletins and circulars are mailed free to every applicant while the supply lasts, and as the plates are always preserved for a considerable time, reprints of those for which a demand continues are frequent, being only limited by the funds available for the purpose.

ANNOUNCEMENTS OF NEW PUBLICATIONS.

To enable persons interested, outside of the special classes above mentioned, to procure such publications as they may desire to obtain, two methods are adopted to publish as widely and as promptly as possible information as to what publications have been issued and are available. In the first place, slightly in advance of the appearance of every bulletin, except such as are not for general distribution, a press notice is prepared presenting some details as to the character and contents of the forthcoming publication. This is sent to all papers on the general list, and, of course, how widely the information is distributed depends entirely upon the extent to which these papers use the notices so supplied. Secondly, a list is prepared and issued on the first day of each month, containing all publications issued by the Department during the previous month. This list, in addition to title and number, gives in a very few words a résumé of the contents of each. It is mailed regularly to everyone applying for it, and the edition of this circular now exceeds 20,000 copies.

Although it has been found necessary in recent years to restrict the free distribution of Department publications in many ways, and notwithstanding means have been adopted to prevent duplication and waste, the demand has so increased in all directions that the number of copies of all publications has multiplied since 1894 more than two and a half times. The total number of copies of all publications issued during the past fiscal year, exclusive of the Yearbook, which was not ready for delivery before June 30, was 6,541,210, and for the first half of the current fiscal year 3,290,225.

REVIEWING AND EDITING MANUSCRIPTS.

While the various branches of the Department conduct their several investigations within certain limits independently, all of them submit the results, when the information acquired is ready for publication, to the Secretary for review. This review takes place in the Division of Publications, which was primarily created for this purpose and no other. Incidentally the work of editing and preparing manuscripts for the printer, of supervising illustrations, etc., has been added to the duties of the chief. Thus, before any of the work of the Department or any of the several divisions reaches the public it is submitted to the Secretary through the Division of Publications, by which all matters which seem to call for the Secretary's consideration are referred to him, and only after this process does any of the information acquired in the Department reach the public.

By his letter of transmittal, which accompanies every paper, the chief of the division of its origin assumes responsibility for all the statements it contains, and by authorizing the chief of the Division of Publications to affix the seal of the Department, the Secretary expresses his approval of them. It thus follows that in the fullest sense no division can be said to publish. Only the Department publishes, and this division supplies the machinery by which this publishing is done, thus serving, as it were, as the mouthpiece of the Department.

DEVELOPMENT OF PUBLICATION WORK.

It will not be uninteresting to trace the gradual development of the present methods regulating the publication work of the Department. The publication of agricultural matter for free distribution long antedated the creation of a Department of Agriculture. References to agricultural matters in public documents were, no doubt, frequent from the organization of the Government, but the first reference bearing directly upon work done for agriculture under Government auspices seems to be that occurring in the annual report of Mr. Henry L. Ellsworth, then Commissioner of Patents, for 1837. In this report Mr. Ellsworth devoted something less than two pages to the distribution and improvement of seeds of corn and wheat.

Again, on January 22, 1839, Mr. Ellsworth, replying to an inquiry of Mr. Isaac Fletcher, chairman of the Committee on Agriculture of the House of Representatives, for information as to the collection and distribution of seeds and plants and as to the collection of agricultural statistics, devoted to the subject a couple of pages immediately following his report. In this communication, as also in his report of January 1, 1839, Mr. Ellsworth dwells upon the need of means to distribute the material on hand.

EARLY OFFICIAL AGRICULTURAL PUBLICATIONS.

In the report of the same officer for 1841 we have what may be regarded as the first official publication of agricultural matter. This report discusses new processes for making illuminating oil from corn and of producing sugar from cornstalks. The statement is made that three times as much sugar can be had from cornstalks as from beets, and the proposal of a company to furnish corn oil for light-houses on the lakes is noted. The report also devotes 4 pages to agricultural statistics, followed by 15 pages of comments, and is the first publication separate from the Commissioner's signed statement. In the Patent Office Report for 1842, out of 111 pages, 105 are devoted to agricultural matters. The edition of the complete report for 1843, embracing the list of patents and agricultural matter as usual, was only 3,000 copies, but the agricultural portion, consisting of 232 pages, was also printed separately in an edition of 15,000.

In the report for 1845 (1,184 pages) the agricultural portion consisted of 1,082 pages, and, although the number of copies printed is not given, Commissioner Burke reports that of the $3,000 appropriated for agricultural matters a great part was devoted to the "mere copying of the report."

The agricultural portion of the Patent Office Report for 1846 was omitted, because no appropriation was made for printing it. In 1847, 577 out of 661 pages were given up to agricultural matters, and in 1848, 725 out of 816 pages related to agriculture. Of this report, 5,000 copies were printed entire and 40,000 without the list of patents. In 1849 the Patent Office Report appeared in two parts, Part II being devoted entirely to agriculture and containing 574 pages and 7 plates. Henceforth the agricultural portion was thus printed.

The main divisions of the contents of this report were as follows: Agricultural statistics; general view of American agriculture; agricultural meteorology; report of Prof. Lewis Beck on breadstuffs of the United States; reports and letters relating to crops, etc.; miscellaneous communications; analytical tables; statistical tables.

Dr. Daniel Lee was employed to prepare the report, but nothing was paid for investigation or collection of facts with the exception of statistics. Dr. Lee was obliged to condense and rewrite much that was voluntarily furnished him, not because the matter or form was unsatisfactory, but for lack of space. In the report appear the names of 105 contributors whose contributions were deferred for subsequent use.

Of the reports for 1851 (676 pages), 1852 (448 pages), and 1853 (448 pages), the number of copies printed was, respectively, 110,000, 110,000, and 100,000. Of the report for 1854, however, only 55,000 copies were printed, but this number was increased the following year to 200,000, and remained several years at that figure, except that of the report for 1858, 210,000 copies, and of the report for 1859, 300,000 copies, were printed.

COST OF EARLY AGRICULTURAL PUBLICATIONS.

During these years the cost of the Annual Report on Agriculture largely exceeded the total expenditures of the Division of Agriculture in the Patent Office. In 1856, when the number of copies printed was 200,000 and could not have cost less than $80,000, Commissioner Mason reports that the expense of distribution was $17,487, while the total disbursement of the section was $37,442. In 1862 the Department of Agriculture was established, and the report for that year contained 632 pages. The edition was 120,000 copies, costing at least $50,000, and probably nearer $60,000, to produce, to say nothing of the cost of distribution. The Commissioner, Mr. Newton, gives the total expenses of the Department for this year, exclusive of the report, as $34,342.

It will be seen, therefore, that in the early days the great bulk of expenditures for agriculture was devoted to the second item in the legally defined duties of the Department, that is, the diffusion of information concerning agriculture. This condition prevailed for several years after the establishment of the Department. Gradually, as means of acquiring information were enlarged and the investigations undertaken became more extensive and more scientific, the cost of acquiring exceeded that of diffusing the information acquired, until in 1870, for the first time, the total cost of the printing and distribution of the Department publications appears to have been slightly less than half of the total expense. With the exception of such publications as may be occasionally reprinted by special resolution of Congress, the present cost of the publication work, aggregating in round numbers $545,000, amounts to less than one-fourth of the total expenditures for the Department, exclusive of experiment stations. And yet the number of persons demanding information has increased far more rapidly than the number of subjects calling for investigation.

CHARACTER OF THE EARLY DEPARTMENT PUBLICATIONS.

Up to the time when the Department of Agriculture was called into being, the whole of the publication work of the Government on behalf of agriculture seems to have consisted practically of the one yearly report. This book, beginning especially with the appearance of the agricultural matter in a separate volume, more nearly resembled the present Yearbook than the annual reports of a few years ago, in so far at least as it seems to have been made up largely of independent contributions on agriculture and kindred topics, of certain agricultural statistics, including climate and crop, while one of the features of interest was the large number of pages devoted in these early reports to citations from newspapers, both agricultural and other, in various parts of the country. These extracts consisted mostly of views as to the year's harvest, but contained also expressions of opinion on various matters connected with agriculture.

After the organization of the Department was thoroughly effected the important work of editing the reports was assigned to the Division of Statistics, and in 1863 a system of monthly reports was undertaken under the auspices of that division. What number of copies of these reports was published and what was the cost of them has not been ascertained. These reports were continued until 1876. In 1877 a new series was undertaken, prepared like the previous one by the Statistician.

The first series was in the nature of a monthly or bimonthly record of agricultural matters, chiefly domestic, of course, but still giving considerable attention to such matters abroad. The only regular features of the publication consisted of reports of the principal crops, extracts from correspondence, reports on experiments in growing Department seeds, and, for some years, the meteorological reports of the Smithsonian Institution. Most numbers contain many excerpts from contemporary journals and a variety of short notes and comments upon all sorts of agricultural topics, forming a very readable assortment of matter of general interest to all persons interested in agricultural affairs.

With the new service, beginning in 1877, the contents, while retaining the monthly crop reports as one of the principal features (the meteorological reports had been already abandoned), consisted of a number of independent articles, most of them signed, although many of them, doubtless contributed by the Statistician, Mr. J. R. Dodge, were still unsigned. These independent articles were sometimes contributions from other divisions, and some of them, contributed by persons outside the Department, treated of subjects pertaining to the work of the various divisions. Many of these were of considerable length, and there was a noticeable absence of the special character of the former series, which made it a sort of newsy record of current agricultural matters and events.

CHARACTER OF MONTHLY REPORT.

The first indication of the changes thus inaugurated is found in Mr. Swank's interesting history of the Department of Agriculture, issued in 1872. On page 40, referring to the Monthly Report as then issued, he says: "It may be remarked, however, that the present Commissioner [Hon. Frederick Watts] favors the policy of increasing the value and extending the influence of the Monthly Report. He has already ordered that the several heads of divisions in the Department shall regularly contribute to its pages, and he believes that its contents should be yet more varied and comprehensive than they have been. He believes, also, that it would be wise to publish the report at least once in every month in the year, instead of only eight times yearly, as is now the practice."

The monthly reports were still edited, as were the annual reports, by the Statistician; and, in spite of the varied topics discussed and their relation to the work of other divisions, they were numbered in regular series. But for the regular appearance, as a principal feature of the series, of the crop reports and other statistical matter, it would perhaps have been more appropriately issued as a Departmental than a divisional series.

The following list of subjects in the bound volume containing the first fifteen numbers will serve to show the general character of these publications: The cane-sugar industry; condition of crops, wheat supply, etc.; Thea viridis (Chinese tea plant); cultivation of the fig; condition of crops June, 1878; condition of crops July, 1878; condition of crops August, 1878; condition of crops September, 1878; condition of crops December, 1878; condition of crops January, 1879; silkworm: how to produce silk; diseases of swine, etc.; condition of crops, April, 1879; condition of crops June, 1879; condition of crops July, 1879.

Until 1883 these monthly reports, with the annual report, constituted almost all the publication work of the Department. From time to time, usually at very long intervals, there were issued some independent miscellaneous publications, bulletins, or reports. Two of these miscellaneous publications appeared in 1862. Both of them appear to have been issued in October of that year, although one of them was simply dated 1862. This one is entitled a "Circular from the Commissioner of Agriculture of the United States on the present agricultural, mineral, and manufacturing condition and resources of the United States." It appears to have been addressed to a selected list of names, and its purpose to have been to invite attention to the new Department, and to solicit cooperation in its work from persons interested in agriculture. The other, which may be regarded as the first divisional, if not the first Departmental, publication, was entitled "Catalogue of the plants, bulbs, tubers, etc., for distribution from the United States Propagating Garden, with a report on the objects and aims of the garden," by William Saunders, superintendent.

Until 1867 no other publication appeared save the Annual and Monthly Reports. These miscellaneous publications constitute no regular series, and were unnumbered. They have continued to appear occasionally, even up to very recent times.

FIRST DIVISIONAL PUBLICATIONS.

The regular issue of divisional publications, each division adopting a numbered series of its own, may be said to have begun in 1883, although in 1882 the third report of the United States Entomological Commission, of which the then Entomologist, Dr. C. V. Riley, was chairman, was issued from the Division of Entomology. The first and second reports had previously appeared as publications of the Department of the Interior, the Commission as originally constituted being required to report to the Secretary of the Interior; but later, under an enactment of March 3, 1881, it was directed to report to the Commissioner of Agriculture.

In 1883 bulletins were issued by the Divisions of Entomology, Chemistry, and Statistics. The monthly series, edited by the Statistician, was discontinued to give place once more to a new series, devoted exclusively, in this instance, to statistical matters, and becoming strictly, in matter as well as in form and sequence, a divisional publication. This series was also the first of the divisional periodical publications, though several of these followed in due course of time.

Bulletin No. 1 of the Division of Entomology, submitted January 14, 1883, contained 62 pages, and was a report of "Experiments, chiefly with kerosene, upon the insects injuriously affecting the orange tree and cotton plant."

Bulletin No. 1 of the Division of Chemistry, issued the same year, contained 69 pages, and was a report by C. Richardson on an "Investigation of the composition of American wheat and corn."

The first bureau report, issued as an independent volume, was the Report of the Bureau of Animal Industry, then recently established. This was in 1884, and the report was issued as a Congressional report, and paid for from a special appropriation. This report has been so issued regularly, usually biennially. Beginning with 1883, publications have been issued from the several divisions and the Bureau of Animal Industry with more or less frequency and a regrettable lack of uniformity. The term "bulletin" has been the one most frequently used in the nomenclature of these publications; others were called reports, special reports, circulars, etc.

PERIODICAL PUBLICATIONS.

In 1889 the periodical form hitherto in use only by the Division of Statistics was adopted by the Division of Entomology, a periodical monthly journal being established in that division under the title Insect Life. Seven volumes of this periodical were issued, and, as an evidence of the popularity it enjoyed among entomologists and of the ability with which it was edited, it may be stated that the complete set now commands a price of $5 a volume. It was discontinued in 1893 for reasons which seemed sufficient to condemn the system of periodical publications for Departmental literature save under very exceptional conditions. Of such exceptional conditions, the monthly Statistical Report and the Experiment Station Record furnish examples. The latter was established in the same year as Insect Life (1889), being, as the name implies, a record of the work done at the agricultural experiment stations. While originally endeavoring to satisfy the popular demand for information on this subject, it has been found expedient, and, indeed, almost unavoidable, to devote it more and more to the use of professors and students of agricultural science and others engaged in technical and scientific work. The index to the yearly volume of the Record, which is issued as No. 12 of each volume, serves as a comprehensive guide to the work of experiment stations throughout this country and abroad, the work of foreign stations of late years being reviewed as extensively as that of our own.

Other periodicals were established, if the term "periodical" can be applied where periodicity was irregular, as per the following statement, giving the name of the division, the name of the publication, and the date of first issue:

By the Division of Vegetable Physiology and Pathology (then a section of the Division of Botany), the Journal of Mycology, 1889.[1]

By the Division of Ornithology and Mammalogy (now the Biological Survey), North American Fauna, October 25, 1889.

By the Division of Botany, Contributions to the National Herbarium, in 1890.

The Weather Bureau having been in 1891 transferred from the War Department to the control of the Department of Agriculture, the Monthly Weather Review was that year established in that bureau.

FARMERS' BULLETINS.

The first Farmers' Bulletin was issued from the Office of Experiment Stations in 1889 under the title of "The what and why of experiment stations." It was designed for widespread distribution and the edition printed was 100,000 copies. No. 2 of this series was issued from the same office in 1890 under the title of "The work of the agricultural experiment stations." It was the design of the then director of the office, Dr. W. O. Atwater, that these Farmers' Bulletins should be issued regularly from the Office of Experiment Stations, to be devoted especially to popularizing the work of the stations among the farmers. The publication notice attached to Farmers' Bulletin No. 2 states, after referring to the publications then issued by the stations, that "the work of the stations is also summarized in publications of this office," and adds: "The Office of Experiment Stations issues two

[1] The Journal of Mycology was adopted rather than established by the then Section of Vegetable Pathology, it having been originally started in Kansas in 1885 by Mr. W. A. Kellerman, professor of botany in the Kansas Agricultural College. This gentleman issued volumes 1, 2, 3, and 4, and with volume 5 the Journal was transferred to the Section of Vegetable Pathology.

classes of publications for general distribution: (1) Farmers' Bulletins, which are brief and popular in character and are sent on application." * * *

The name "Farmers' Bulletin" was, however, so general in its character as to meet with the special approval of the then Secretary of Agriculture, Hon. J. M. Rusk, for application to a series of brief, clear, practical bulletins to be contributed by all the bureaus and divisions and to constitute a Departmental series. The name was, therefore, adopted for a Departmental series, with No. 3, a bulletin by the Chemist of the Department, Dr. H. W. Wiley, on the "Cultivation of the sugar beet," which was issued in March, 1891.

No 4, also issued in 1891, was by Prof. B. T. Galloway, chief of the Division of Vegetable Pathology, and was entitled "Fungous diseases of the grape and their treatment." No. 5, on the "Treatment of smuts of oats and wheat," was contributed by the same division, and No. 6, on "Tobacco," was prepared by Mr. John M. Estes, a special agent of the Department in connection with the Department exhibit at the Columbian Exposition. Up to the close of 1893, 15 of these bulletins had been issued, and the series had proved so popular and the demand so extensive as to threaten serious inroads on the printing fund of the Department.

APPROPRIATIONS FOR FARMERS' BULLETINS.

One of the first acts, therefore, of the new Secretary, Hon. J. Sterling Morton, was to recommend to Congress a special appropriation "for the preparation, printing, and publishing of Farmers' Bulletins, which shall be adapted to the interests of the people of different sections of the country, an equal proportion of two-thirds of which shall be supplied to Senators, Representatives, and Delegates in Congress for distribution among their constituents as seeds are distributed." For the fiscal year 1895, $30,000 was appropriated for this purpose. This amount was increased the following year to $50,000, including the cost of distribution. For the current year the appropriation for the preparation and printing of Farmers' Bulletins, the distribution being elsewhere provided for, is $35,000. The following table gives the total number of Farmers' Bulletins printed from Nos. 1 to 57, and covering the period from 1889 to 1897 (fiscal years), inclusive·

Number of Farmers' Bulletins, Nos. 1 to 57, printed.

Date.	Total number issued.	Distributed to Congressmen.
Prior to 1894	540,000	
In 1894	278,500	
In 1895	1,567,000	885,770
In 1896	1,891,000	1,316,695
In 1897	2,387,000	1,967,237
Total	6,663,500	4,169,702

The total number of Farmers' Bulletins printed up to December 31, 1897, was 65, while three more numbers, to appear as Nos. 66, 67, and 68, were still in the hands of the Public Printer at that date. It is customary to reprint these bulletins from time to time as the demand continues, provided the subject-matter is still timely. The usual editions are from 30,000 to 50,000 copies, in a few cases reaching as high as 100,000; but in many cases reprints have been required, so that of the more popular of these bulletins as many as 200,000, 250,000, or even, in one case, 300,000 copies have been published.

ESTABLISHMENT OF THE EDITORIAL DIVISION.

Up to 1889 great confusion existed in the publication work of the Department. As already remarked, there was a lack of uniformity in form and sequence even in the publications of the same division. No adequate index of the publications had been undertaken, and no one person was responsible for the proper administration of the printing fund of the Department. The result was that this fund was invariably exhausted before the end of the year, and frequently a deficiency appropriation had to be obtained from Congress, pending which useful publications were delayed for want of funds. The need of an editor had been for some time apparent, and after the abandonment of editorial supervision by the Statistician over the publications of other divisions than his own, the imposition of such work upon some one else became almost a necessity, which had been growing more urgent with the increase in the number and variety of publications. Early in his administration, Secretary Rusk decided, after consultation with the Assistant Secretary, Hon. Edwin Willits, and others, that the publication work must be systematized and a regular editor employed, who should be responsible to the Secretary for all matter in the publications which was not strictly technical, in the same manner that each chief makes himself responsible—by his recommendation in his letter of transmittal—for the technical matter in every publication issued from his bureau or division. There being no special appropriation for such an officer, the Division of Statistics, originally charged with the editorial work of the Department, was drawn upon to supplement the deficiency. The writer was appointed by Secretary Rusk as assistant to the Statistician, in charge of editorial work, being, however, with the concurrence of the Statistician, ordered to report directly to the Secretary, and being also charged with the administration of the printing fund. At the same time a special appropriation was asked from Congress for the establishment of a division to be known as the Division of Records and Editing. This appropriation was duly made, and July 1, 1890, the editorial division was regularly organized. At the same time a considerable increase was obtained in the printing fund, which amounted for the fiscal year ending June 30, 1891, to $47,000. This sum was found to be still inadequate, in view of the increase in the number of divisions and the rapid growth of the demand for publications. It was consequently still further increased the following year to $75,000, which, however, included a special provision of $10,000 for the printing of the Weather Bureau, recently transferred to the Department of Agriculture. Since that time—that is, the fiscal year ending June 30, 1892—the printing fund has been increased by only $10,000, except for the special appropriation, available for the first time June 30, 1895, for Farmers' Bulletins.

CHANGES IN THE ANNUAL REPORT—THE YEARBOOK.

One of the first duties of the writer after his appointment was the preparation of the forthcoming annual report, and some discussion of the subject with the several chiefs revealed the fact that were each chief given the number of pages he considered necessary to cover the work of his division in that publication, it would result in a bulky volume of over 1,400 pages, even though all outside contributions should be excluded. It was quickly decided that this latter feature, which had been growing gradually less with each succeeding annual report for many years, should in the report for 1889 be entirely abandoned, and in order to keep the volume within reasonable limits as to size, somewhat arbitrary limitations had to be put upon the reports of the several divisions. By this means it was restricted to 560 pages.

With the growth of the Department during the next few years the annual report grew in 1892 to 656 pages, and in 1893 the form and character of the publication were again the subjects of considerable discussion and review. It was generally conceded that in the form in which for many years it had appeared, it failed signally to fill the requirements of a book published in an edition of 500,000 copies for popular distribution, and costing, including the expense of handling and distributing, not less than $400,000. The reports of the several bureaus and divisions covered, in most cases, many details of scientific work interesting only to scientific men, and at the same time included necessarily a large amount of administrative detail, of interest only to the official force and to the members of the Committees on Agriculture of the Senate and House. As a natural and inevitable consequence, it followed that the greater part of this large and costly volume was made up of matter appealing to a comparatively limited circle of readers. The size of the edition was justly regarded as an indication that Congress designed this annual report to be a popular publication specially adapted to interest and benefit the practical farmers of the country. As the result of the discussion and of the conclusions ably presented by Assistant Secretary Charles W. Dabney, jr., to the committees of both Houses of Congress charged with representing the Department in their respective bodies, a clause providing for the future publication of the annual report of the Department was inserted in the printing bill then pending, and which subsequently (January 12, 1895) became a law under the title "An act providing for the public printing and binding and the distribution of public documents."

ADOPTION OF NEW FORM FOR ANNUAL REPORT.

Section 73, paragraph 2, of the act in question prescribes what the annual report shall consist of in the future, and the report for 1894 was prepared and published in accordance therewith. This paragraph reads as follows:

The Annual Report of the Secretary of Agriculture shall hereafter be submitted and printed in two parts, as follows: Part one, which shall contain purely business and executive matter which it is necessary for the Secretary to submit to the President and Congress; part two, which shall contain such reports from the different bureaus and divisions, and such papers prepared by their special agents, accompanied by suitable illustrations as shall, in the opinion of the Secretary, be specially suited to interest and instruct the farmers of the country, and to include a general report of the operations of the Department for their information. There shall be printed of part one, one thousand copies for the Senate, two thousand copies for the House, and three thousand copies for the Department of Agriculture; and of part two, one hundred and ten thousand copies for the use of the Senate, three hundred and sixty thousand copies for the use of the House of Representatives, and thirty thousand copies for the use of the Department of Agriculture, the illustrations for the same to be executed under the supervision of the Public Printer, in accordance with directions of the Joint Committee on Printing, said illustrations to be subject to the approval of the Secretary of Agriculture; and the title of each of the said parts shall be such as to show that such part is complete in itself.

To Part II of the report, the name of Yearbook of the Department of Agriculture was given in conformity with the provision that "the title of each of the said parts shall be such as to show that such part is complete in itself;" and the following from the preface to the first Yearbook (1894) by Dr. Charles W. Dabney, jr., Assistant Secretary of Agriculture, indicates the lines upon which this book was prepared—lines practically followed with each succeeding book:

This volume is divided into three sections:

First. The Report of the Secretary of Agriculture for 1894, giving a general account of the operations of the Department during the year.

Second. A series of papers, prepared for the most part by the chiefs of bureaus and divisions and their assistants, discussing either the general work of their bureaus or divisions or particular lines of work with special reference to interesting and instructing the farmer.

Third. An Appendix made up of statistical tables and information useful for reference, compiled in the various bureaus and divisions.

CHARACTER OF THE TWO PARTS OF THE ANNUAL REPORT.

Thus, as we trace back the evolution which has brought the publication work of the Department to its present development, we find that the Yearbook of to-day more closely resembles the reports of the early sixties and even that portion of the Annual Report of the Commissioner of Patents devoted to agriculture as in the fifties than it does the annual reports of the eighties and early nineties.

The executive reports of the Department (Part I) are published separately under the title of Message and Documents, these reports forming a part of the documents accompanying the President's message. It is, however, proposed to change that title, beginning with 1897, to a form more intelligible to the average reader, and to entitle Part I Reports of the Department of Agriculture, comprising (1) report of the Secretary and (2) miscellaneous reports.

The report of the Secretary appears in its entirety in both Part I and Part II. Its appearance in the Yearbook fulfills the requirement that Part II shall "include a general report of the operations of the Department." * * *

PRESENT COST OF PUBLICATION WORK.

An estimate of the cost of the publication work of the Department is essential to a proper appreciation of its usefulness and magnitude, and must of course be an important factor in considering how best to solve the problem of efficiently and promptly and fairly diffusing the information acquired by the Department, so as to impart it on equal terms to all American citizens who are interested in it.

The cost of the Yearbook and other annual reports—that is, Part I of the Annual Report of the Secretary of Agriculture, the Report of the Chief of the Weather Bureau, and the Report of the Bureau of Animal Industry—may be fairly estimated at $350,000, and it is a rare year that the publication of special reports and reprints of other bulletins of the Department by Congressional resolution will not involve an additional cost of about $50,000. It is quite safe to say that, altogether, the cost of what may be called the Congressional publications of the Department during the past five or six years have exceeded on an average $400,000 a year. During the same time the regular printing appropriations of the Department have amounted to $85,000 annually, and the printing defrayed from bureau and divisional funds to $6,800. The total appropriations may therefore be summed up as follows:

Division of Publications	$20,260
Preparation and printing Farmers' Bulletins	35,000
Illustrations and labor and material in distribution	30,000
Weather Bureau (estimated)	25,000
Congressional publications	400,000
Regular printing fund	85,000
Total	595,260

This sum, it may be further remarked, is, under the present system, totally inadequate, the estimates for the ensuing year being—

For regular printing fund	$100,000
Printing and preparation of Farmers' Bulletins	40,000
Illustrations and labor and material in distribution	60,000

These additions would bring up the expense to $645,260. This estimate takes no account of the cost of handling and transporting from 6,000,000 to 7,000,000 publications through the mail, though it has been estimated by the post-office authorities that this cost amounts for the Yearbook to about 20 cents a volume, or $100,000 a year, and the remaining publications, aggregating about 6,500,000 copies, will certainly involve no less expense; so that it may be conservatively stated that the cost to the Government of distributing to the people the information acquired for the benefit of agriculture by the Department can not be less than $840,000, and this with the exercise of all care possible to prevent duplication or the printing of unnecessarily large editions.

GROWING DEMAND FOR PUBLICATIONS.

The demand for publications of the Department continues to increase steadily and rapidly, far more rapidly than the growth of the population, and in spite of the fact that during the past ten years the increase in the rural population has been far less than the average increase for the whole country. This increase seems likely to continue until every one of the 5,500,000 farms of the United States is provided with all of such publications of this Department as may be adapted to the needs of its owners. This fact at least can not be gainsaid, that in the five years, from 1893 to 1897, inclusive, the increase in the total numbers of all publications of the Department has been, in round numbers, from 2,500,000 to 6,500,000, or 160 per cent., a rate of increase which would give us for 1901 a total of 16,000,000 copies, costing for printing and distribution considerably over $2,000,000.

In the face of such figures it may be safely concluded that the problem of an efficient and equitable distribution of the information acquired by the Department has not yet been solved, and that its earnest consideration is worthy of the best thought of the Secretary and of our national legislators.

THE LIBRARY.

By W. P. CUTTER, *Librarian.*

INTRODUCTION.

In 1868, the building for the then recently created Department of Agriculture having been completed, the books on agricultural subjects which had been collected by the Division of Agriculture when part of the Patent Office were transferred to rooms set apart for them in the new Department building. Since that time varying amounts have been appropriated for the purchase of books and periodicals and for the employment of a librarian and assistants. The Library has grown from the collection of less than 1,000 volumes when transferred to one of nearly 59,000 volumes, and from the few bookcases in the office of the first Commissioner of Agriculture, has spread out to such an extent as to require the largest room in the Department building and a considerable amount of shelf room in every division of the Department. There are books in nearly every modern language, and publications are received from every civilized nation.

AMERICAN AND FOREIGN AGRICULTURAL PUBLICATIONS.

Of American agricultural publications, the Library has complete sets of those issued by State boards of agriculture and agricultural societies and of the bulletins and reports of the agricultural experiment stations. There are sets of many of the American agricultural journals, and the current issues are preserved and bound for future use. There are many volumes of the publications of local agricultural societies and organizations of similar character. Of separate books on agriculture, the Library has as complete a collection as may be found anywhere. Especial care has been taken to add to this collection at every opportunity, but it is seldom that an American book on agriculture is offered for sale that is not already on the shelves of the Library.

An attempt has been made to obtain the chief publications of foreign countries on agricultural subjects. The official publications of these countries are regularly received and preserved, and numerous agricultural papers and journals from all over the world are on file. The total number of volumes on purely agricultural subjects in the Library is about 12,500.

IMPORTANT COLLECTIONS ON AGRICULTURE.

Some special features of the agricultural section are of interest. The Library has a very complete set of the registers (herd books) of blooded stock published by the various live-stock societies in the United States and foreign countries. An especial effort has been made to obtain a complete collection of publications relating to poultry. There are more than 100 separate volumes treating of the history, culture, and commerce of tobacco, and special treatises on uncommon agricultural crops are numerous. In every special branch of agriculture an endeavor is made to add every work of importance and to keep serial publications complete and up to date.

The collection of books on horticulture, forestry, and landscape gardening comprises about 8,000 volumes, and is as varied and complete in its composition as the agricultural section. Of especial interest is the Von Baur library of forestry recently purchased. This is a collection of about 1,700 volumes in the German language, comprising complete sets of the various forestry periodicals and copies of every important German work on forestry.

The Library has a notable collection of works on agricultural and general statistics, including the official statistical reports of all the prominent European countries, and a number of yearbooks, periodicals, and separate works. These are supplemented by the official publications of the various States of the Union, dealing with such subjects as population, economic resources, health, labor, and charities, and by an important collection of the laws of the various States as included in their compiled statutes and the subsequent session laws. This portion of the Library numbers about 10,000 volumes.

BOOKS OF GENERAL REFERENCE AND NATURAL SCIENCE.

The Library contains a large number of works of general reference, such as encyclopedias, directories, dictionaries of the various languages, atlases, gazetteers, and dictionaries of biography and history. There are also a number of volumes of travel, especially those including scientific or economical descriptions of the countries visited. A few standard historical works and about 250 volumes of general literature make up the total of 2,500 volumes in this section.

The remainder of the Library, some 20,000 volumes, may be classified as natural science, and includes working reference libraries in chemistry, physics, zoology, and botany, with the works in general science, including periodical publications. The science section is especially noteworthy for its completeness in the line of periodical literature. There are sets of all the important journals used for reference by scientific workers, and the Library subscribes to more than 300 periodicals for their use.

There is in the Library a fairly complete set of the publications of the United States Government, especial prominence being given to such as contain matter of agricultural, statistical, or scientific interest.

USEFULNESS OF THE LIBRARY.

The influence of the Library of the Department on the general welfare of the farming community may at first glance seem very slight, yet, on more careful investigation it will become evident that this influence, although indirect, is greater than might be supposed. The Library, being as it is in the foremost rank of the agricultural libraries of the world, is a storehouse for printed knowledge on agricultural subjects, and as such serves to preserve for the workers of the future the literature of the present and the past. The value of books to the farmer is becoming more and more evident. Of course, it is impossible for many of the farmers of the country to come to Washington to consult the Library, but it is possible for the information stored in the Library to reach the farmer in an indirect manner. In the preparation of the publications of the Department, especially those of direct interest to the farming community, the collection in the Library assists by giving the printed opinions and the results of the experience of past investigators all over the world, and thus serves as a guide to the compiler of such publications. Through its relations with the agricultural experiment stations and colleges, the Library is attempting to be of assistance to those workers in agricultural science who are located nearer the farmer and are thus familiar with his interests.

But the Library is especially useful indirectly to the agricultural community through the assistance rendered to the scientific workers in the Department in connection with their researches. Little work can be accomplished in scientific investigation without access to the literature of the subject investigated and a careful search after the truth as discovered by previous investigators. On the organization of a new line of research in the Department, the first demand is almost invariably for books and periodical literature. The preparation of statistical bulletins, especially those which relate to the crops and markets of other countries, would be almost impossible without access to the literature relating to these countries. The identification of useful plants, of weeds and noxious insects, of plant and animal diseases, depends largely on the examination and study of the printed observations of other workers. The work of the Department in the publication of the Experiment Station Record deals almost entirely with the literature of agriculture and the allied sciences. Indeed, a careful examination of the work of any of the scientific and technical work of the Department will reveal the large dependence on the collections of the Library in the daily work.

DISTRIBUTION OF PUBLICATIONS TO LIBRARIES.

The Librarian has charge of the distribution of the publications of the Department to the college and public libraries of the United States, and particular care has been taken to have a complete set of these publications available for reference in the libraries of the country, so that students of agriculture, wherever located, may be able to consult them within a short distance of their homes. Arrangements are also made to place the publications in numerous libraries throughout the civilized world, in order that the inhabitants of foreign countries may be able to follow the operations of the Department, and thus keep in touch with the agricultural methods in vogue in this country.

CONTRIBUTIONS TO AGRICULTURAL LITERATURE.

As a contribution to the knowledge of the literature of agriculture, accurate lists of the various sources of information on specific agricultural subjects have been published, and others are in course of preparation. These lists are finding ready acceptance among workers in agricultural investigation, and have called forth much favorable comment. There is now in course of preparation a list of the best publications covering the whole field of agriculture, and it is the intention in the near future to prepare suitable printed indexes to the main authorities on agricultural subjects, to serve as a partial guide to students and teachers of agriculture. Questions as to the best books on certain branches of farm or garden practice are often sent to the Library, and such information is always cheerfully furnished.

The general catalogue of the Library will be completed in the card form in the course of the next few years, and will doubtless be printed; it will be the most complete catalogue of agricultural literature ever issued, and will be of great value to workers in agricultural investigation.

OFFICE OF FIBER INVESTIGATIONS.

By CHAS. RICHARDS DODGE, *Special Agent.*

INTRODUCTION.

The present imports into the United States of raw fibers amount to a total value of over $19,000,000. But this vast sum must not be taken as representing the total money value of fiber industries in this country, as probably three or four times the amount above stated annually goes out of the country for fibers imported in the form of manufactures.

In very general terms the work of the Office of Fiber Investigations is to ascertain how new fiber industries may be introduced into this country, and the best means by which those industries that are already a part of our national economy may be extended, in order to save to the country many of the millions of dollars now paid for imported fibers or their manufactures.

Our raw and dressed flax imports amount to perhaps $1,750,000, while the imports of flax manufactures have reached $12,000,000. Even Mexican manufactures from sisal grass, such as hammocks, etc., are sold in the United States, and the imports of cordage and yarns from various fibers is considerable. Where $20,000,000 worth of fibers are now manufactured in this country it might be possible to manufacture $40,000,000 worth, and thus double the home fiber industries, and it might easily be possible to produce home-grown fibers to the extent of half of the supply needed in the manufactures that these industries represent. Considering the proposition as stated, it would seem, at first glance, that the work of the office was mainly in the line of inquiry and the dissemination of the information thus secured. This would argue that the conditions of fiber culture are similar the world over, while the fact remains that the conditions between this and other countries are so greatly differentiated that at the very outset of the necessary experimental work, with almost any cultivated fiber, the new industry will be found beset with obstacles and discouragements that can only be overcome by patient study and the most careful and scientific investigative effort. And the end is not attained when the fact has been demonstrated that the fiber is susceptible of cultivation, for the economical harvesting of the crop and the preparing of the raw product for market are even more important questions. And when all these obstacles are overcome, there yet remains the introduction of the fiber commercially, for a manufacturer has no money to waste on philanthropy, and he must know beyond question that the native fiber will answer his purposes equally with the foreign.

This suggests a point which should be fully understood, the difficulty of introducing cultivation. The farmers know nothing concerning the market for the new crop, and can not afford to run any risks, while the manufacturers, as a rule, neither know nor care if the farmers will be able to produce the kind of fiber they desire to purchase, and they continue to buy abroad with the result that a perfectly practicable cultural industry is not developed. A part of the effort of this office has been directed toward bringing the farmer and the manufacturer together, so that the Government fiber work covers a wide range of investigation, beginning with a study of the agricultural conditions of an industry, both abroad and at home, and ending with its exploitation as a national resource.

BEGINNING OF THE WORK.

The initial work of fiber investigation was begun in Europe in 1889. At that time the special agent in charge of what is now the Office of Fiber Investigations was in Paris, where he was occupied as a technical expert of the American Commission to the Paris Exposition. Being in Europe, he was authorized by the Department of Agriculture, before returning to the United States, to study the flax and hemp industries of France, Belgium, and Great Britain, and to prepare a report for publication by the Department.

There was beginning to be considerable inquiry in the United States regarding the flax, hemp, and ramie industries, and it was considered of the greatest importance that the Department should, at the outset, be placed in possession of the latest and most reliable European information, not only regarding culture, but in relation to new processes for the preparation of these fibers for market, which involved the study of all the new machinery that had been brought to public notice. The flax interest was therefore studied in northern France, Belgium, and Ireland, while some time was spent in the Breton hemp region of France, resulting in the securing of much valuable information relative to the best practices of European culture in these specialties. At the same time the Exposition itself furnished abundant material for study, particularly in regard to ramie decorticating machinery and the manufacture of the fiber.

ESTABLISHMENT OF THE OFFICE OF FIBER INVESTIGATIONS.

Returning to this country, the writer submitted his reports, but before they were sent to the printer it was deemed advisable to supplement them with statements showing the status of prominent fiber industries in the United States; also a statement relating particularly to the efforts for the reestablishment of flax culture. A section of fiber investigations was therefore created in the Division of Statistics and the work placed in the hands of the present special agent. The investigations were continued through 1890 under the Division of Statistics, but on January 1, 1891, the section was given an independent existence under the title of Office of Fiber Investigations, where the work has been continued to the present time.

EARLY FIBER EXPERIMENTS UNDER GOVERNMENTAL DIRECTION.

Experiments for the development or extension of vegetable fiber industries under governmental auspices or direction have been instituted at different times in many countries, and such experiments date back nearly one hundred years. In some instances these experiments have been confined to testing the strengths of native fibrous substances for comparison with similar tests of commercial fibers, as the almost exhaustive experiments of Roxburgh in India early in the present century. Another direction for Government experimentation has been the testing of machines to supersede costly hand labor in the preparation of the raw material for market, or in the development of chemical processes for the further preparation of the fibers for manufacture, or in microscopic and chemical investigation. The broadest field of experiment, however, has been the cultivation of the plants, either to introduce new industries as sources of national wealth or to economically develop those which require to be fostered. The introduction of ramie culture is an example of the first instance; the fostering of the almost extinct flax industry of our grandfathers' days is an illustration of the second.

INVESTIGATIVE WORK OF THE OFFICE OF FIBER INVESTIGATIONS.

The investigative work of the Office of Fiber Investigations is prosecuted in three ways: (1) By circulars and correspondence; (2) by personal inquiry and observation, either on the part of the special agent or by a representative of the office specially commissioned; or, (3) by actual experiments running over a few months or a season in charge of a field special agent, or the officer of an experiment station, or an intelligent agriculturist, who is directed from the office in the city of Washington when the special agent in charge of the office work is not personally in the field. Another source of information is the published matter known to be reliable and authoritative which appears in American or foreign official reports, the publications of scientific or technical experts, and any periodical literature known to have been prepared by a competent authority. This latter class of information, however, is, as a rule, substantiated by correspondence before use is made of it.

The early fiber investigations referred particularly to flax, hemp, and ramie, though the study of other fibers became a necessity in order to meet a demand for general information on fiber subjects. The first circulars of inquiry were widely distributed, and created much interest in the subject, which interest was further augmented by the publication during the year 1890 of the first special and annual reports, and the answering of letters for information formed no small part of the correspondence of the office.

EQUIPMENT FOR PRACTICAL WORK.

While not over forty fibers are comprised in the list of the world's commercial species, over a thousand different fiber plants have been recorded, many of which could be employed as substitutes for the commercial species. The fiber correspondent who desires particular information may have slight knowledge of the comparative value of the commercial and the mere "native" forms, and does not distinguish between them. To meet the demand for information made by all classes of inquirers necessitates a general knowledge of the fiber species of the world without regard to their utility, a familiarity with the world's commercial species and with their uses, and, lastly, a practical knowledge, based on experience, of those species which are or may become sources of wealth in our country.

This is the broadest scope of usefulness of the office, though the possession of such knowledge is, after all, only an equipment for intelligent investigative effort, upon which the practical value of the office depends. As previously stated, a knowledge of the conditions surrounding an industry in one country is no criterion by which to judge the conditions in another country, though such knowledge may afford a basis upon which to make beginnings. The real work of the office, therefore, is to accumulate useful facts in the fiber interest relating to our own country, either by experiment or through the records of personal experience of others, which will enable those who have no means to properly investigate the possibilities of a new industry to take up the enterprise intelligently and with some assurance of making it successful.

THE SCOPE OF THE WORK.

Among the lines of investigation which comprise, in part, the work of the office, may be mentioned a study of the botanical considerations of the species under investigation; the proper soils and climatic conditions; the utility of the fiber and its value in comparison with other commercial species; the cost of production, which is affected by various elements that must be carefully studied; the yield of the species under the new conditions surrounding its growth, and the quality of the fiber; the means of extracting the fiber in order to give the crop a money value or, in other words, to market it when produced, and lastly a careful study of all the economic conditions which help or hinder the launching of the enterprise as a commercial venture. Years of time might be given to the investigation of a single species, the successful cultivation of which would mean the saving of millions of dollars to the country annually; but the work of the office is not confined to the investigation of a single species, but to the entire range of fiber-plant growth and the economic utility of the varied forms.

FIBERS THAT MIGHT BE PRODUCED.

Among the possible industries that have been the subject of experiment and investigation by this office—though in some instances the effort has gone no farther than mere inquiry—or that should be fully investigated, the following may be mentioned:

The cultivation of flax for home manufacture and export; the extension of hemp culture and the production of grades of fiber that will compete with the best imported; the production of certain varieties of cotton now imported; the production of ramie fiber, which depends largely upon the availability of an economically successful machine; the cultivation of jute in the South, which doubtless also depends upon proper machinery for the extraction of the fiber; the cultivation of sisal hemp; the growth of bowstring hemp, which is a valuable new fiber of easy growth in the State of Florida; the utilization of pineapple leaves, after the fruit harvest, pineapple fiber being a superior textile, susceptible of manufacture into the most delicate fabrics; the utilization of the palmettos, to compete with imported crin vegetal, and other products; the growth of the vegetable sponge now so largely imported from Japan; the utilization of the flax straw produced on a million acres of flax grown for seed alone; a study of new substances suitable for paper manufacture, for the time is surely coming when new sources of supply of paper-pulp material must be discovered. Besides these, there are scores of native fiber plants which, while they may not be able to compete with the commercial species, might find employment in some useful manufactures, and thus form small local industries.

The office has already carried on series of experiments with several of these native substitutes and demonstrated their exact position in the fiber economy. Even when it is discovered by experiment that the cultivation of one of these plants is impracticable, the knowledge is of value to the public, because many of these fiber plants have been repeatedly "discovered" in the past by people knowing nothing about them, and money wasted on futile efforts at utilization.

FLAX INVESTIGATIONS.

In the first two years of the work of the office an extended series of flax experiments was conducted with three varieties of imported seed in fifty localities of the United States, both by experiment stations, working under the direction of the Department, and by experienced flax growers who were asked to cooperate. The results of the two years' work were most satisfactory, demonstrating the falsity of the prevailing popular opinion that flax fiber and seed could not be produced in the same plant, and the matter began to be viewed in a new light.

Thus, the first work of the new office in relation to flax culture was in the nature of a "tearing down" process, and a clearing away of wrong ideas founded on prejudice on the one hand and on the opposition of the importers and representatives of the foreign industries on the other. At this time the Department was able only to demonstrate that flax could be grown for both seed and fiber, without being able to show how the culture could be taken up by a considerable number of people so as to produce a new industry, or to state definitely the best sections of the country for its growth. The practical work of encouraging and promoting the reestablishment of the industry was just begun.

At a later stage of the flax investigations it was shown that a practice distinctively American was essential to success. Such a practice was fully outlined, the importance of a cooperative system, with divisions of labor, being demonstrated. It was also found to be the most practicable, as it would relieve the farmer from any responsibility beyond the cultivation and harvesting of the crop of straw. During the past two or three years the flax investigations have been more localized, being confined to special experiments in particular localities. The investigation conducted two years ago in the Puget Sound region of the State of Washington demonstrated that there is in that State a flax region equaling the most famed in Europe. Straw from this experiment, sent to Ireland to be treated by the skilled labor of that country, produced scutched flax valued at $350 per ton, and hackled flax worth $500 per ton, even with the use of only 1½ bushels of seed to the acre.

A present important and practical line of effort in the flax-fiber investigations is the encouragement of culture on a commercial basis. Something more than distributing the exhaustive literature of the subject issued by the Department is essential at this point of the work, for, as has been shown, nothing can be done without cooperation, and the farmers, who will directly reap the benefits from the culture, do not know how to set about making a beginning. With all its connections, the office in Washington, D. C., is essentially a central bureau of information, and is thereby enabled to give direction to any new movement in any particular section, to advise regarding the proper methods of procedure in establishing the enterprise, and to give intelligent instruction that will guaranty the organization of the cooperative industry on practical lines. And the fact that the advice of the Department is sought from all sections of the country is proof that its work is appreciated, and that it is practical.

SISAL HEMP INVESTIGATIONS.

This statement of what has been accomplished in flax culture will serve to illustrate how similar investigative work has been pursued with common hemp and other fibers. At the outset little was known regarding the growth of sisal hemp in Florida, though the high prices of the Yucatan cordage hemp had called attention to the possibility of establishing the industry in southern Florida, where the descendants of some of the plants set out in the Perrine experiments, during the thirties, had multiplied and covered small areas on several of the Keys. Many inquiries were received by the Department regarding value, yield, cost of production, etc., of the fiber in Florida. In 1892, the Office of Fiber Investigations established an experimental factory on Biscayne Bay, sending down machinery to extract and clean the fiber. A fast sailing vessel was chartered for exploration and for the rapid transporting of the raw material from the place of growth to the factory. During the two or three months that the factory was in operation the fiber resources of southern Florida were fully investigated, and the results were subsequently given to the public in two special reports. In addition to the production of sisal hemp, the possibility of successfully exploiting bowstring hemp and pineapple fiber was studied in an exhaustive manner, and a valuable series of specimens and considerable quantities of the fibers were brought back. These important experiments were made at a total cost not exceeding $1,000, and were widely noticed in this and foreign countries.

RAMIE INVESTIGATIONS.

The work of the office in aid of the ramie industry has been in two directions:

(1) By the collection of material giving the results of past and present experiments with this wonderful fiber throughout the globe, in which the Department has had the assistance and cooperation of the experts of many countries, the final results of the investigation of this material when brought together forming the basis of report No. 7, "The cultivation of ramie in the United States," etc., which gives practically all necessary information regarding the present status of the ramie industry.

(2) By the aiding of invention through the study of decorticating machinery, and by testing officially, in the field, ramie machines of

American and foreign invention claiming to have solved the question of the economic and practical extraction of the fiber from the stalks.

Records of private trials of American machines and of foreign machines brought to this country have been forwarded to the Office of Fiber Investigations of the Department from time to time, but the results in a majority of cases have not given the information desired by the Department as to the capacity of the machines or their utility in continuous operation. A point which can not be overlooked is that the records of private trials published by interested parties are liable to be regarded as advertisements, while the records of an official trial are at once accepted as authoritative, the trial being made under specific rules and by a board of wholly disinterested persons. The advantage of Government trials in Europe and elsewhere has been recognized by all whom they interest, and it is only through these trials, as new machines are developed, that it has been possible to note the progress in the construction of decorticating devices. In our own country these trials have been productive of great good, first, by demonstrating the impracticability of particular principles of construction on the one hand, and, second, by forming bases of comparison on the other, thus stimulating invention in new directions, to the end of developing the perfect machine.

But there is another way in which the Department aids the inventor. It is no uncommon thing for inventors to go over their plans with the special agent in charge of the office when ready to begin building their machines, the matter of course being considered strictly confidential. In some instances the inventor has been shown so clearly the weak points or impracticability of his proposed construction that the machine has been abandoned, and a money loss avoided. This office tests machines that are offered to the public in order to officially demonstrate what the machine is able to accomplish; and companies have put forth claims for machines that an official trial has shown could not be substantiated, resulting in the abandonment of manufacture. One of these machines, which was offered to farmers as a practical device, was never taken away from the testing ground after trial, the company going out of existence immediately after the test.

Valuable aid has been rendered to farmers of the country especially by acquainting them with the obstacles which have prevented success in the ramie industry, thereby saving them loss of time and money through undertaking culture while yet there are no machines with which to utilize the crop when grown or to make the fiber a marketable commodity.

In passing, attention should be called to one of the evils which attend the establishment of all new fiber industries and which has added largely to the correspondence of the office. Reference is made to the promotion schemes pushed upon the public by those having no interest in the welfare of the new industries that they pretend to foster, but who are solely actuated by motives of personal gain. Sometimes the promoters are ignorant of the real obstacles to be overcome in establishing the industry, but in some cases the scheme is pushed with evident intention to misrepresent or conceal the truth in order to make money out of that portion of the public which is ever willing to take large risks in "promising" speculative schemes. Such schemes were more common eight years ago than now, for the publications of the Office of Fiber Investigations have been so widely distributed that no one need be in the dark as to the practicability or honesty of any scheme or enterprise that may be seeking capital, or the cooperation of the farmer. And the Office of Fiber Investigations, through its connections in many parts of the world, is able to keep abreast of the times regarding every phase of progress in the legitimate industry, and to give reliable and up-to-date information to all inquiring correspondents.

SOURCES OF FOREIGN INFORMATION RECEIVED BY THE OFFICE.

In the matter of securing information regarding foreign fiber industries, the progress of invention, or improved practice, the Office of Fiber Investigations is well equipped, for, at the present time, it has correspondents in the principal countries of Central America, South America, Europe, Asia, Africa, and in the islands of the Pacific. These correspondents are largely scientific men, government officials, and economic experts, while some are high authorities in everything relating to the fiber interest. The office is able, therefore, to keep in touch with the work of foreign countries, and to speak authoritatively regarding the latest phases of progress in fiber technology in countries other than our own.

CLASSES OF INFORMATION GIVEN TO THE PUBLIC BY THE OFFICE.

In replying to the large number of letters of inquiry received by the office, two classes of information are to be considered. The first may be termed positive information, or that relating to the best practices involved in cultivating such forms of fiber plants as may be produced with profit, or which are possible agricultural resources. That of the second class may be termed negative information, and is afforded to a large body of correspondents of the office, chiefly farmers, in relation to the value of certain plants yielding fiber found growing wild in all sections of the country, and which have been the subject of investigation. Letters with samples of such fibers are being continually received; and while it has been known for years that some of the plants are capable of producing a good quality of fiber, yet for many reasons they can not be utilized. Still they are interesting. The masses of their filaments, disintegrated and semibleached on the parent stalk by the winter storms, attract attention, and often the observer, regarding his discovery as new, and seeing in it a valuable, undeveloped industry, writes to learn the name and history of the species, how far the plant is susceptible of cultivation, and what price the fiber will bring in the market. In considering such plants the first question is not merely can we grow the species, but what will be its uses in manufacture; or, in other words, What commercial fiber will it supplant or become a substitute for? In most instances the inquiry need not be carried further than a mere examination, for the present commercial fibers represent in a sense those that have stood the test of experience, and until these are crowded out by new conditions, or through what might be termed evolution in the economic arts, the new fibers will have no chance. The only opportunity that may be afforded these secondary forms is in the creation of special uses to which they may be peculiarly adapted, for which the standard forms are not so well fitted. As a rule, then, such fibers are of no commercial value, but until the statement of the facts concerning them has been received by the correspondent he is apt to regard his discovery as of value, and frequently a source of future wealth. The replies of the office to such inquiries are of practical benefit by preventing loss of time and money through fruitless experiment. A great deal of such negative information has been given to farmers anxious to rush into ramie culture, who had been misled by unreliable accounts of possible profits, and who were not aware that the question of the economical stripping of the fiber from the stalks by machinery had not been settled.

TECHNOLOGICAL WORK.

It has not been practicable for the office to pursue technological investigations, nor, indeed, are they essential in the line of work which has been followed in past years. It is a legitimate field of effort, but for the present the office can only give assistance to technological students by furnishing them samples of identified fibers for examination. The office also aids colleges and schools by sending out classroom specimens when they can be spared from the duplicate series of fibers preserved by the Department.

VALUABLE FIBER COLLECTIONS SECURED BY THE OFFICE.

The Office of Fiber Investigations has accumulated the nucleus of a national collection of raw materials, and already possesses a good working collection in spite of the fact that a large part of the valuable series of world's fibers collected by the writer at Philadelphia in 1876, and which formed a part of the old Agricultural Museum, has disappeared. Since 1892, however, the office has brought together three valuable collections of commercial and native fibers, the first being the present Museum collection of the Department of Agriculture, the second the superb collection exhibited in Chicago, and which was given to the Field Columbian Museum, and the third a collection of several hundred specimens, exhibited at the Atlanta Exposition, and at its close permanently placed in the United States National Museum.

THE PUBLICATIONS OF THE OFFICE.

In this connection, it may be stated that the foreign distribution of the recently published "Descriptive catalogue of useful fiber plants of the world" promises to be productive of incalculable good to the Department in the line of its fiber work, through the new material, both information and specimens, that its publication is bringing together from many parts of the world. As both the common and botanical names of fiber plants are employed in this descriptive catalogue, its use as a check list will enable comparison, country with country, and supply material for working out the geographical distribution of the world's species. The differentiation of the commercial from the purely "native" forms can then be readily accomplished, and the countries traced where these are found.

While this is the most comprehensive work which the office has prepared, the eight previous reports are still in large demand, though complete series can no longer be supplied. The special reports issued by the Office of Fiber Investigations to date are: (1) A Report on Flax, Hemp, Ramie, and Jute, figs. 7, pp. 104, 1890; (2) Recent Facts Regarding the Ramie Industry in America, fig. 1, pp. 16, 1891; (3) A Report on Sisal Hemp Culture in the United States, plates 8, figs. 21, pp. 59, 1891; (4) A Report on Flax Culture for Fiber in the United States (and Europe), plates 2, figs. 12, pp. 93, 1892; (5) A Report on the Leaf Fibres of the United States, plates 10, figs. 12, pp. 73, 1893; (6) A Report on the Uncultivated Bast Fibers of the United States, plates 5, pp. 54, 1894; (7) A Report on the Cultivation of Ramie in the United States, plates 5, figs. 7, pp. 63, 1895; (8) A Report on the Culture of Hemp and Jute in the United States, plates 3, figs. 4, pp. 43, 1896; (9) A Descriptive Catalogue of Useful Fiber Plants of the World, plates 13, figs. 103, pp. 361, 1897. Five annual reports have been issued, which will be found in the "Annual Reports of the Secretary of Agriculture, 1890 to 1895;" also Farmers' Bulletin No. 27, "Flax for seed and fiber in the United States," pp. 16, 1895.

DECLINE OF THE FOREIGN FIBER INDUSTRY.

The necessity of fostering fiber industries by official experiment and direction is beginning to be appreciated in foreign fiber-growing countries where, generally, the flax industry is steadily declining, and the hemp culture both in France and Italy shows not only decline but deterioration of quality. Already experimental stations have been established in some sections to improve the methods of culture in vogue by peasant farmers in order to revive interest in the culture and restore lost ground.

THE UNITED STATES AS A FIBER-PRODUCING COUNTRY.

It is significant that representatives of Irish spinning mills have visited the Pacific Coast since the remarkable showing made by the flax experiments of the office in the Puget Sound region of Washington, and that they speak in the most encouraging terms of the fitness of this region for the growth of fine flax. In view of the steady decline in foreign production, causing foreign buyers to investigate new sources of supply, and with the fact fully demonstrated that flax of the best quality can be grown in the United States, the work of the Office of Fiber Investigations is at this time of great value to the people through the information it gives in reply to inquiring farmers and industrialists, and in its direction of new enterprises on lines of practice that are essential to success.

Within two years California has come to the front as a hemp-producing State, the product being of superior quality, and in other States experiments in water retting have been begun. The time is propitious to extend the hemp industry, for the falling off of Italian hemp production should stimulate this country to a better practice in the curing and preparation of American hemp, and in the use of labor-saving machinery in place of the hand brakes of a hundred years ago. This most important question has been taken up by the Office, and it is hoped by another year to bring together for the first time the promising hemp-cleaning devices that have been brought to public notice, for an official trial, to show on the one hand their practicability and on the other any wrong principles of construction. There are several such inventions, of which nothing is known beyond the claims of their manufacturers, and an investigation into their merits can but give valuable results.

CONCLUSION.

In conclusion, it will be seen that the efforts of the Office of Fiber Investigations have largely been expended in pioneer work, looking toward the establishment, in this country, of fiber interests that now take out of the country $20,000,000 annually, representing the raw materials imported for American manufacture; and when the value of fiber in the form of foreign manufacture imported into this country is taken into consideration the amount lost to the country will approach $75,000,000 annually, which will give some idea of the importance of the subject.

With the experience and added knowledge that has been gained during the years of pioneer work, the office is now equipped to render most efficient service in furthering the establishment on American soil of these important fiber industries, which mean so much to our material resources. It is an interesting fact that the money expended for these investigations does not in any year amount to 1 per cent of the value of the sisal hemp alone annually imported into this country from Mexico.

BUREAU OF ANIMAL INDUSTRY.

By D. E. Salmon, *Chief.*

INTRODUCTION.

The Department of Agriculture was impressed early in its history with many and difficult problems connected with the animal industry of the country that needed solution, but in regard to which the most enlightened agriculturists and the most expert scientific men were profoundly ignorant. Most important among these problems were the diseases which often caused disastrous losses. The second Commissioner of Agriculture had occasion to call attention, in his second and third annual reports, to "the prevalence of fatal maladies among all varieties of farm animals, resulting in the annual loss of not less than fifty million dollars," and recommended the establishment in the Department of a division of veterinary surgery. The next year, 1870, Commissioner Capron renewed the subject, referring particularly to a forthcoming report upon pleuro-pneumonia and Texas fever, diseases then prevalent and recently investigated under the supervision of the Department. He says in the annual report:

> The value of stock lost annually from disease is enormous, and threatens not only to decimate our animals, but to expose the human family to disease from the consumption of unwholesome meats. Neglect of animals and their overcrowding in transportation are prolific sources of disease, and its spread is permitted by the ignorance of a majority of the present class of veterinarians. Another class of disease arises from causes obscurely known, if known at all, and these fatal maladies are as yet without any indicated effort of cure, rendering necessary the barbarous plan of stamping out * * * as the only means of saving the agriculturist or stock raiser from total ruin.

While recognizing the danger and losses from animal diseases, these observations emphasize the prevailing ignorance of the times. Veterinarians at that period were few and widely scattered, and how could they be expected to guard against the spread of contagion when they were seldom consulted, and under any circumstances were without authority to prevent the driving, the transportation, or the sale of affected animals, and the consequent unlimited exposure of other animals to the cause of these diseases!

The method of eradicating disease by the slaughter of affected and exposed animals, rather contemptously referred to as "the barbarous plan of stamping out," must in many cases remain for all time the proper course of procedure. It is sentiment and not science that raises objections to it, in those special cases where its application is clearly indicated. With pleuro-pneumonia, for instance, it is absurd to allow animals affected with this important plague to remain alive as breeding places of the contagion a single hour after they can be properly killed. Until we can perform miracles and cure an animal in an instant, freeing it by the same instantaneous process of the power to transmit the contagion with which it is saturated, it will be folly to preserve and treat animals affected with plagues that are not already generaily disseminated. The failure to recognize this axiomatic principle delayed for a long time the beginning of the work for stamping out pleuro-pneumonia, and threatened at times to arrest it before a fair trial of this method had been made.

Notwithstanding the attention given annually in the reports of the Department to special manifestations of animal disease, no specific appropriation of money was made for investigation until 1877, when Congress granted $10,000 for such purpose, impelled by the prevalence of diseases among swine and cattle. Whatever the results achieved through the subsequent reports, published by the Department in 1878, in the way of educating stock raisers to avoid such diseases, the writer will only mention his own effort at that time to lay down some general principles for the investigation and successful management of contagious animal diseases in general. This method was developed more fully in the annual report for 1881–82, of which Commissioner Le Duc stated introductorily:

> The ultimate objects of Dr. Salmon's investigations have been, first, to discover the exact form and nature of the germ causing the diseases under consideration; second, to learn how it is distributed, and how this distribution can be prevented; third, the best methods of destroying the virus within as well as outside of the animal body; fourth, methods of rendering animals insusceptible to the effects of these germs; and, fifth, if it be possible, to establish breeds of animals that are insusceptible to such diseases.

To properly apply these principles, based upon the recent bacteriological discoveries, in order that the work might be of permanent value, a veterinary division was established in the Department in 1883, which was replaced by the Bureau of Animal Industry, the organization of which was directed by Congress in 1884. The effect of the labors carried on under the direction of this bureau upon the health and value of farm animals and their products is a matter of world-wide knowledge; and it is at least possible now to modify the official statement made by the head of the Department in 1868, that our domestic animals "have all suffered from the local prevalence of malignant forms of disease, against which little veterinary skill is opposed, and little more than empiricism and superstitious folly is practiced."

NUMBER AND VALUE OF FARM ANIMALS IN 1884.

It is of interest, in connection with the above, to know both the number and value of the principal classes of our domesticated animals at the time this large but sensitive source of wealth and convenience became officially represented in the Department of Agriculture. The following table, showing the number and value of these animals on

January 1, 1884, is, therefore, prepared from Miscellaneous Bulletin No. 11 of the Division of Statistics:

Number and value of principal farm animals on January 1, 1884.

Animals.	Numbers.	Total.	Values.	Total values.
Horses	11,169,683	13,083,809	$833,734,400	$994,949,376
Mules	1,914,126		161,214,976	
Milch cows	13,501,206	42,547,307	423,486,649	1,016,715,703
Other cattle	29,046,101		683,229,054	
Sheep		50,626,626		119,902,706
Swine		44,200,893		216,301,139
Grand total		150,458,635		2,467,868,924

Five years later there were, according to the Eleventh Census, a little over 49,000 asses and 285,609,440 domestic fowls, and there were also 500,000 goats, all of undetermined value. The number of these were not much less in 1884, and at a low valuation they were jointly worth $57,000,000, making the aggregate value of our domestic animals at that time not less than $2,525,500,000. A striking fact is that should this bureau be able to save to the owners of live stock by the information which it distributes and by its executive work but 1 per cent per annum of that value, this saving would amount to $25,255,000 of their capital, at the comparatively insignificant cost of the annual appropriations which sustain the bureau, whatever their amount may be. The real losses upon hogs, cattle, and sheep not killed by dogs, which died during the last census year, reckoned at $10, $15, and $2 per head, respectively, was $133,601,743, and over $98,000,000 of this was in hogs. In addition to the possible and probable saving of 1 per cent per annum in live stock alone, there should not be forgotten the benefits to human health and the maintenance and increase of commerce in animals and their products, at home and abroad, through inspection, certification, and diminished insurance.

THE REASONS FOR THE ESTABLISHMENT OF THE BUREAU.

The immediate cause of the establishment of the Bureau of Animal Industry was the urgent need by the Federal Government of official information concerning the nature and prevalence of animal diseases and of the means required to control and eradicate them, and also the necessity of having an executive agency to put into effect the measures necessary to stop the spread of disease and to prevent the importation of contagion into the country, as well as to conduct the original investigations through which further knowledge might be obtained. Our exported cattle and sheep had recently been refused admission into Great Britain and condemned to slaughter upon the docks where landed because of alleged contagious diseases in this country dangerous to foreign live stock. Our pork had been prohibited entrance into most of the countries of continental Europe because it was alleged to be infested with trichinæ, and therefore dangerous to the health and lives of the consumers. Twenty-five to thirty million dollars' worth of hogs were dying each year from contagious disease. Cattle raisers were in a condition bordering upon a panic from fear of Texas fever and contagious pleuro-pneumonia, and State restrictions were seriously interfering with interstate traffic in bovine animals. Sheep raising had become precarious in many sections because of scab and other parasitic diseases. The repeated demands and agitation for governmental assistance culminated in 1884 in the enactment of the organic act of this bureau.

THE PLEURO-PNEUMONIA PROBLEM.

The most pressing duty devolving upon the new bureau was to arrest the extension of pleuro-pneumonia and, if possible, eradicate that disease from the country. In attempting to perform this duty, it developed that notwithstanding the investigations and reports of scientific men, the Commissioner of Agriculture, under whom that work was to be entered upon, doubted the existence of the disease in the United States. The prevalence of some peculiar disease of cattle in certain portions of the country was evident, and elaborate experiments were made to demonstrate whether or not it was of a contagious nature. After this demonstration had been made it was necessary to secure further authority from Congress before effective work could be undertaken. By the original legislation, only diseased animals could be purchased for slaughter; but the contagion could not be eradicated or appreciably diminished while exposed animals were left in the stables to develop the disease and infect other animals. It was not until 1887 that authority to use the appropriation for the purchase and slaughter of exposed animals was received. From that time forward there were no extensions of the disease into fresh territory, and the infected districts were rapidly freed from it. The work was at first concentrated upon Illinois, Kentucky, and Maryland, and the contagion eradicated from the two first and controlled in the last. Then the remainder of the infected district, which was included in the States of Pennsylvania, New Jersey, and New York, was embraced in the field of operations. In five years from the time the work of eradication by slaughter of both diseased and exposed animals was commenced the disease was officially declared to be eradicated. Since early in 1892 no case of contagious pleuro-pneumonia of cattle has been discovered in the United States, and events have consequently confirmed the thoroughness and reliability of the work.

It is almost impossible at this time to give an idea of the danger with which the cattle industry was menaced by the spread of that fatal and treacherous disease to a point so far in the interior as Chicago, or of the difficulties under our form of government of promptly and effectually meeting the emergency. Fortunately, although the cattle owners in the infected districts were not friendly, the State authorities cooperated in every case and supplied the power which was lacking in federal legislation. And although there were many who questioned the existence of the European lung plague in this country, who did not believe in the success of the measures that were adopted, who were positive that the disease could not be eradicated, or who were certain that untold millions of money would be squandered before the end was reached, the result was accomplished with an expenditure of less than five years of time and of $1,500,000—a sum which is less than 5 per cent of the value of the beef exported in 1892.

When we consider that the Governments of Great Britain, France, and Germany all undertook the work of eradicating pleuro-pneumonia long before the establishment of our Bureau of Animal Industry, and that none of them have yet succeeded in freeing their territory from the plague, we can appreciate the fact that the completion of our task in a comparatively short time was a notable achievement.

TEXAS FEVER.

A disease which was causing much heavier direct losses than pleuro-pneumonia, and which was almost equally feared by cattle owners, was known by the local name of Texas, or Spanish, fever. This disease, which has numerous popular and local names, has more recently been called by different writers splenetic fever, Southern fever, and tick fever.

When investigations of this disease were first entered upon by the Department of Agriculture, there were the most profound ignorance and skepticism in regard to its nature and even its existence. Cattle owners in the Southwest and Middlewest asserted that the herds from the Gulf coast of Texas carried with them a poison that destroyed nearly all the cattle with which they came in contact. So virulent was this poison declared to be that cattle which were simply driven across the trail of the Gulf Coast herds, thirty, sixty, or even ninety days after they had passed, would still contract the disease in the same proportion and in as fatal a form as if they mingled directly with the Southern animals. To these assertions were added others to the effect that the Gulf Coast cattle were healthy, and that the susceptible cattle to which they conveyed a disease which they themselves did not have were, even when fatally affected, unable to transmit the malady or disseminate the virus to any other cattle.

A few observations of a similar nature had been made in the Eastern States. Cattle from North Carolina and South Carolina, though apparently in good health, had caused outbreaks of disease among the cattle of Virginia, Maryland, and Pennsylvania, which had mingled with them or grazed along the roads over which the Carolina animals had been driven.

The general features of this disease, as described by the various observers, were so unusual, so entirely different from what was seen in any other known communicable malady, that the correctness of the observations was not generally accepted by scientific men, and perhaps the majority of stockmen were of the opinion that the malady was the result of some local conditions, and was incorrectly attributed to poison disseminated by the Southern cattle. The cattle raisers of Texas were indignant at the charge brought against their herds, which they asserted were as healthy as any in the world, and not having a disease could not convey one.

The allegations and discussions in regard to this mysterious disease were almost forgotten when, in 1867 and 1868, the herds of the Gulf Coast had recovered from the destructive effects of the war and appeared upon the markets and feeding grounds of the Northern States in great numbers. With the warm weather of summer there appeared a remarkably acute and fatal disease among the native cattle in the sections where the Southern animals had been grazed and marketed, which threatened the utter destruction of the native herds, and even of the milch cows kept in the vicinity of the stock yards of the principal market cities.

These serious and widespread losses demonstrated conclusively the reality of the disease, while careful observations and elaborate reports made by Professor Gamgee for the Department of Agriculture, and by the boards of health of New York and Illinois, served to collate and record all that was then known of the symptoms, mode of transmission, the general characteristics, and the changes found in the several organs upon post-mortem examination.

The problem presented to the country was a most important one. There were millions of cattle in Texas, Louisiana, and Mississippi seeking a market, and other millions of cattle in the more northern States liable to destruction by this fatal infection which they carried. The ranges of the West and Northwest needed these Southern animals to consume their grass, and vast herds were driven through Kansas and Colorado, Nebraska and Wyoming, to the most northern limits of our territory. The owners of cattle along these trails were heavy losers from disease, and hence there was an effort to confine these infectious herds to narrow trails, or even to close the trails entirely. This action was resented by the Southern men, who still were not convinced that their cattle caused disease, and who looked upon these restrictions as efforts to avoid competition and prevent the marketing of the herds from the prolific ranges of the South. The time had come when it was necessary for the Federal Government to assist both parties. It was essential to protect the Northern herds from destruction and scarcely less important to provide for the marketing of the Southern cattle.

Another danger threatened the cattle industry in connection with this disease. Our export trade in live cattle, which was giving an important outlet for our surplus stock, was looked upon by foreign Governments with suspicion. It was feared that Texas fever might be introduced among the cattle of Europe and added to the numerous plagues that they had struggled with from time immemorial. The limitation to the spread of the disease, due to the failure of the sick animals to transmit the infection, and the eradication of the disease in newly infected districts by the frosts of winter, were characteristics so unusual that they were not accepted as correct. As a great cattle-producing nation, we could not afford to allow the foreign markets to be closed against us. The Texas-fever question was, consequently, one of the most momentous ones which confronted the bureau at the time of its organization.

The first step toward the control of this disease was evidently to ascertain the exact extent of the district from which cattle carried infection. To determine this, three classes of facts were available: First, the history of the cattle which had caused outbreaks of disease could be traced, and it could be learned where they originated; second, by diligent inquiry many sections could be discovered where cattle taken from the North were affected with the disease called "acclimation fever," a disease which we had found was identical with Texas fever; and, third, it could be determined by observation and experiment whether the cattle of any particular section were susceptible to the disease, and if they contracted Texas fever upon exposure to cattle from the known infected district, that fact was evidence that the district in which they were raised was not infected. By a diligent collation and study of such facts the border line of the infected district was traced from the Atlantic coast in Virginia to the Pacific coast in the vicinity of San Francisco, a distance, allowing for the departures from a direct course, of about 4,000 miles.

The scientific study of the disease had not been neglected, and it was found that the infectious cattle could be shipped to market without endangering other animals, provided separate pens were set apart for them at the stock yards where they were unloaded, and provided the cars in which they were shipped were properly cleaned and disinfected. The settling of the Western States and the construction of railroads led to the marketing of cattle from the infected district without much driving, and the trail was gradually abandoned except during the winter months.

The regulations of the bureau hastened this solution of the difficulty. The border line of the infected district was made a quarantine line. No cattle were permitted to cross this line between February 15 and November 15, except for immediate slaughter. The cars carrying such cattle and the waybills accompanying them were marked to show the origin of the stock, and when the destination was reached the animals were unloaded into quarantine pens and the cars were disinfected under the supervision of an inspector. From November 15 to February 15 (changed to January 15 for 1898) cattle were allowed to be shipped or driven without restriction. By these comparatively simple measures the dissemination of the disease was almost entirely prevented, and the cars and stock yards used for Northern and export cattle were kept free from the contagion.

In this manner the most urgent problems in connection with the disease were solved, but others still remained of great economic importance. Buyers took advantage of the fact that the Southern cattle must be sold for immediate slaughter, and would not pay as much for cattle in the quarantine pens as they would for the same class of stock in the free pens. Hence, the regulations were more or less of a hardship to those who produced cattle within the infected district. Again, cattle taken from the Northern States to the infected district for breeding purposes and to improve the native stock were subject to the disease, and from 75 to 100 per cent would die the first year. This was very discouraging to the breeders of that section, who desired to produce the most improved varieties of cattle, but who were prevented from doing so by the presence of this infection.

The peculiarities of Texas fever made it a most difficult disease to investigate, and it seemed at times as though its mysteries could never be fathomed. By diligent and persevering observations the pathological division discovered in the blood of diseased animals a microscopic animal parasite, which lives within and destroys the red blood corpuscles, and is evidently responsible for the causation of the malady.

It was also discovered that the Southern cattle tick (*Boophilus bovis*) carried this microorganism from the infectious cattle of the South to the Northern susceptible animals, and that when free from the tick the Southern cattle were harmless.

It is impossible in this paper to enter into all of the interesting details, but it may be said, without attempting any demonstration of the statements, that these discoveries made it possible to mark out the lines of investigation by which alone any further progress could be made. Investigators were put to work to discover a mixture in which Southern cattle might be dipped to free them from the tick; also to work out a method of inoculation or vaccination by which Northern stock might be made immune to the disease before they were shipped South for breeding or other purposes; and, finally, to ascertain whether it was possible to eradicate the tick in the infected district, and by what means.

These great questions have been patiently studied, and it is now possible to state that these studies appear to be reaching a successful conclusion. A cheap and comparatively efficient dip has been made by floating paraffin oil upon the surface of water. This has some disadvantages, but these apparently are not serious, and improvements will undoubtedly be made after the system of dipping is put into practical operation. Again, it has been proved that if young Northern cattle are inoculated by injecting under the skin late in the fall or in the winter from 5 to 10 cubic centimeters of blood from an infectious Southern bovine animal they contract a mild form of Texas fever and recover. Afterwards they may be taken to the infected district without much danger from subsequent attacks. The eradication of the tick, although a serious problem, is not so hopeless as a first impression might lead one to suppose. Some farms have been freed from this insect by picking all of the ticks off the cattle and allowing none to mature. In a year or two they disappear entirely. A number of counties in Virginia, which prohibit cattle from running at large, have apparently been freed from ticks by that measure. It would appear that this tick can only mature and reproduce its kind by passing a portion of its existence upon bovine animals, and that the whole species will die out within a year or two if they can not reach such animals. If this supposition is correct, then it is only necessary to fence up a piece of ground so that no cattle can get upon it for the period of time mentioned, in order to rid it from infection.

From this brief statement of the case it is plain that cattle raisers may congratulate themselves that the most difficult problems connected with this disease are solved, and that it is only a matter of detail to put into effect measures which will obviate the hardships and losses that in the past have been so burdensome.

INSPECTION, TAGGING, AND CERTIFICATION OF EXPORT CATTLE.

The fear expressed by foreign governments of the introduction of pleuro-pneumonia and Texas fever with cattle from the United States made it necessary to adopt some method by which the history of the animals exported could be ascertained and the animals inspected, numbered, and recorded, so that a certificate could be issued showing freedom from contagion. Occasionally it was alleged by the English inspectors that some of our cattle were suffering from pleuro-pneumonia when landed at the British ports. In two cases German inspectors reported our cattle affected with Texas fever when they reached Hamburg. The German reports plainly show that the two lots of cattle were not affected with the same disease, and that the diagnosis in one case at least must have been incorrect. Such occurrences, however, emphasize the importance of supervising the trade, as our live cattle and fresh beef have been entirely excluded from Germany since this alleged discovery of disease.

It was found to be by no means a simple matter, at first, to obtain the history of the cattle purchased for export and to mark them for identification with a numbered tag. Such tags had been put in the ears of cows in the pleuro-pneumonia inspection without any serious trouble, but it was quite another kind of work to go into the stock yards and put tags in the ears of the powerful and bellicose steers, many of which had never recognized the sovereignty of man. By perseverance, however, the details of a practical system were worked out. Tagging chutes were constructed, through which the cattle passed in single file and where the tag could be easily attached to the ear with an ordinary hog ringer. The cattle were tagged at the first stock yards to which they were shipped, their feeding places were ascertained, a note was made of the cars in which they were forwarded, and the bureau inspectors at the next unloading point, and also at the port from which they were to be exported, were notified. With this system in operation the inspector at the port could conscientiously give a certificate of freedom from contagious disease after the animals had passed his inspection.

The number of inspected and tagged cattle which were exported during the year ending June 30, 1897, was 390,554. Sheep are also inspected before exportation, but are not tagged; and of these animals 184,596 were inspected. To properly examine and supervise the loading of so many animals, to tag the cattle and see that they are shipped from the interior to the seaboard without exposure to contagion either in cars or pens, and to obtain and record the history of the cattle is alone a very extensive work and one which requires constant vigilance and attention. In every case where disease has been reported from England we have been able to retrace the path of the animal to the farm where it was raised; and in none of the alleged cases of pleuro-pneumonia reported since March, 1892, could any trace of that disease be found either at such farms or anywhere in the vicinity—evidence which demonstrates that, whatever the disease may have been, it was not contagious pleuro-pneumonia.

By such measures the British contention has been proved erroneous, and, although the regulation requiring the slaughter of our animals at the foreign-animals wharves has not been removed, further limitations have been prevented, and we have held the trade for nearly 400,000 cattle and 200,000 sheep.

REGULATION OF SHIPS THAT CARRY EXPORT CATTLE.

Another danger that menaced our export cattle trade had its origin in the improperly fitted ships and in the alleged cruel treatment of the animals on shipboard. In the early years of the transatlantic traffic, before the commodious cattle boats of the present day were constructed, these animals were largely carried on "tramp" ships, with temporary fittings and without facilities for supplying the proper quantities of feed and water. The attendants were often inexperienced and worthless. The space was overcrowded. The ventilation was insufficient. The boats were occasionally unseaworthy.

As a result of these conditions, there were frequently reports of ships arriving in the British ports, after an unusually long voyage, with the feed and water exhausted and the animals suffering from hunger and thirst. Sometimes during storms it was necessary to batten down the hatches, and then on account of deficient ventilation large numbers of animals would die asphyxiated. Again, it occasionally happened that in heavy seas the weight of the cattle would be thrown upon the halters with such force that the fastenings would give way and the animals be mixed and jammed together in the greatest confusion. If the attendants were inexperienced and unequal to the occasion some of the animals would be crushed and trampled to death, others would be bruised and maimed, and the general appearance of those landed would make a most unfavorable impression. In still other cases, a great wave would sweep the decks, tearing the temporary fittings from their supports and carrying both fittings and cattle together into the sea.

Such occurrences could not fail to attract the attention of humane people abroad, particularly when the sentiment of humanity was intensified by the desire to limit American competition. The barbarities of the transatlantic cattle traffic were depicted by the pen of romance, the cruelties were exaggerated and magnified, atrocities were described that never were committed, and illustrated pamphlets were prepared and circulated in order that the full power of sensationalism might be invoked. As a result of this agitation, a bill was presented in the British Parliament to prohibit the importation of live cattle from beyond the seas, and the Queen was strongly urged, in the name of humanity, to use her influence to secure its passage.

This emergency was met by Congress through the passage of the act of March 3, 1891, authorizing the Secretary of Agriculture to enforce necessary regulations to secure the safe carriage and humane treatment of cattle exported from the United States. Careful investigations were at once made by the bureau and regulations formulated which were acceptable to the British Government. The rigid enforcement of such regulations drove the poorer class of ships out of the trade. Magnificent iron ships were constructed for the cattle traffic, with every convenience, with permanent fittings built into the vessels, and having all the comforts and safety for which human ingenuity could provide. The losses were soon reduced to the minimum of about one-third of 1 per cent. The cattle were unloaded in as good condition, as vigorous and active, as they were when they went on board. As a result of the improved conditions and the greatly diminished losses, insurance rates were reduced from $8 and upward per head of exported cattle to less than $1 per head. This saving in insurance alone, with an average exportation of 325,000 head, amounts to $2,275,000 per year, nearly three times the entire cost of maintaining the bureau.

In this elaborate system for determining the healthfulness of its exported animals and for guarding them from infection, injury, and cruel treatment the United States stands alone among the nations of the world, and its certificates should have great weight in any country that is fairly disposed toward our products.

MICROSCOPIC INSPECTION OF PORK FOR EXPORT.

In 1881 our pork was prohibited entrance into Germany, France, and the principal countries of the continent of Europe, on the ground that it was infested by trichinæ and was injurious to human health.

Notwithstanding the fact that it could not be shown that our pork had caused disease, and that it was manifestly more wholesome than the European pork, and notwithstanding the most vigorous protests were made by the American Government, the trade was crushed and destroyed. The year before the prohibition went into effect we sold to France 70,000,000 pounds and to Germany 43,000,000 pounds.

For ten years our pork was shut out of nearly every market of continental Europe, when in 1891 the bureau began the microscopic inspection and certification of pork destined to the markets of the prohibiting countries. This action led to the removal of the prohibitions, but the restoration of the trade was a slow and difficult process. Our brands of meat were no longer familiar to the people of those countries, commercial connections had been severed, and requirements as to cuts and cures had materially changed. It was like introducing an article into a country for the first time. Moreover, the prohibition had engendered suspicion as to the wholesomeness of our product, while the agitation had established prejudice and antipathy. There were vexatious and burdensome restrictions by both the general and municipal governments.

Notwithstanding such adverse conditions, the trade with these countries has continued to grow until now it requires more meat than the bureau is able to inspect with the available appropriation. The following table shows the pork which has been microscopically inspected and the quantity which has been sold in the prohibiting countries since this inspection was inaugurated:

Shipments of pork microscopically inspected, fiscal years 1892–1897.

Year.	To countries requiring inspection.	To countries not requiring inspection.	Total.
	Pounds.	*Pounds.*	*Pounds.*
1892	22,025,698	16,127,176	38,152,874
1893	8,059,758	12,617,652	20,677,410
1894	18,845,119	16,592,818	35,437,937
1895	39,355,230	5,739,368	45,094,598
1896	21,497,321	1,403,559	22,900,880
1897	42,570,572	1,001,783	43,572,355

The difficulties met with in the inauguration of this system of inspection were very serious. There had been no microscopic inspection on a large scale in America, and we had neither the appliances nor trained inspectors. The glass compressors for preparing the specimens of meat and the microscopes used in the German inspection were considered too clumsy and not adapted to accurate or rapid work. An American type of microscope was, therefore, selected, the stage was grooved so that an examination of every part of the specimen was insured, and a special form of compressor was adopted which greatly facilitated the work.

The cost of microscopic inspection was estimated before the work was begun all the way from 15 to 50 cents per carcass. The actual cost has been reduced to less than 6 cents per carcass. The packers asserted that it would be impossible to microscopically examine any considerable quantity of pork without delaying their business and damaging the meat. These fears proved to be groundless. The work of the abattoirs has neither been obstructed nor the meat injured. On the contrary, there are now from all points the most urgent appeals for more microscopic inspection.

THE GENERAL MEAT INSPECTION.

By the act of March 3, 1891, Congress directed the Secretary of Agriculture to inspect previous to their slaughter all cattle, sheep, and swine, the carcasses of which were to be disposed of through the interstate or foreign trade, and authorized him in his discretion to make a post-mortem inspection. This enormous undertaking was added to the many other duties of the bureau.

The general meat inspection was designed to protect our domestic consumers from the meat of diseased animals and at the same time to enable the Government to certify to the wholesomeness of exported meats. It was specially provided that no beef should be allowed to go abroad unless it had been inspected and was certified as free from disease.

The magnitude of this work was probably not appreciated by Congress at the time the legislation was enacted, although the desirability of such an inspection is incontestable. Owing to the great extent of our territory and the enormous number of animals slaughtered, it was impossible to at once cover the whole country. It was necessary to instruct inspectors and to devise a system of administration with proper safeguards. Beginning at a comparatively few abattoirs, the service has been gradually extended until it is now established in 33 cities and covers the product of 128 abattoirs.

The animals are first examined while in the stock yards, either at the time they are unloaded from the cars or when they are driven upon the scales to be weighed. Another examination is made of the carcasses immediately after slaughter and when the viscera are being removed. Carcasses are condemned if found affected with any serious disease, or if the animals are emaciated, too far advanced in pregnancy, or have recently given birth to young. They are also condemned when too young to produce wholesome meat.

The condemned meat is put into the tanks with the offal, cooked with steam, and made into fertilizer. The sound meat goes forward with a meat-inspection stamp upon cases and boxes, and with a tag or brand upon carcasses and pieces. It has been a very troublesome matter to obtain a satisfactory method of marking inspected meat for identification that would not be at the same time too expensive. A tag attached with a wire and lead car seal has been generally used upon carcasses, but is quite expensive, costing from $1.40 to $2.25 per thousand, according to the kind, and the cheaper forms are liable to be tampered with. Such a seal, to be satisfactory, should be so constructed that it can not be removed from one piece of meat and attached to another without plainly showing that it has not been properly applied.

The expense of seals, and the difficulty of securing those that could be depended upon, early led to experiments in branding. A hot iron was discarded for this purpose because of inconvenience and danger of fire. Branding ink has been used in some European countries, but samples imported gave marks which were too easily blurred and removed by friction or moisture to be of any use under the conditions which obtain in this country. The biochemic division has, however, after much experimenting, produced an ink which is a great improvement on any we have found elsewhere, and which promises to largely supplant the more expensive and laborious methods of marking that have been heretofore in use. Many gallons of this ink have been satisfactorily used in the work of the bureau during the past two years.

It is impossible in this brief account of the work of the bureau to give more than the merest outline of the meat-inspection service. It was intended by Congress that all meat shipped from one State to another should be previously inspected, but the appropriation up to the present has not been sufficient for this purpose. The inspection force, however, is being enlarged as rapidly as the appropriation will permit. The inspection is, therefore, having a healthy growth, which, if it is continued for a few years longer, will cover all of the meat prepared for the interstate trade, and then it can no longer be said, as it has been said occasionally in the past, that we are more particular in protecting the people of Europe from unwholesome meat than our own citizens.

The following table shows the number of animals inspected before slaughter from 1891 to 1897, thus giving an intelligent idea of the growth of the inspection service and the enormous number of animals that are annually slaughtered in the United States for the preparation of food products:

Animals inspected for abattoirs having inspection, fiscal years 1891-1897.

Year.	Cattle.	Calves.	Sheep.	Hogs.	Total.
1891	83,891	----------	----------	----------	83,891
1892	3,167,009	59,089	583,361	----------	3,809,459
1893	3,922,174	92,947	870,512	----------	4,885,633
1894	3,862,111	96,331	1,020,764	7,964,850	12,944,056
1895	3,752,111	109,941	1,344,031	13,576,917	18,783,000
1896	4,050,011	213,575	4,710,190	14,301,963	23,275,739
1897	4,289,058	259,930	5,179,643	16,813,181	26,541,812

THE INSPECTION AND QUARANTINE OF IMPORTED ANIMALS.

One of the first steps taken for the control of contagious diseases among animals was the establishment of quarantine stations at the principal Atlantic ports, where imported animals might be detained until there was no longer any danger of the development of disease from exposure to contagion in other countries. These stations were at first under the direction of the Treasury Department, but soon after the organization of the Bureau of Animal Industry they were transferred to its control.

There are a number of destructive diseases in other parts of the world which it was necessary to guard against. Pleuro-pneumonia had already been imported and had caused us an endless amount of anxiety, trouble, and expense. Foot-and-mouth disease had several times reached our shores, and it was rather by good luck than good management that we had escaped a visitation reaching to every State of the Union and to every part of the American Continent. Rinderpest existed in European and Asiatic countries, and there was always danger of its importation to America.

We had taken the risk of these plagues for years without giving them much thought. Our people, always buoyant and optimistic, and never willing to seriously consider danger or admit the possibility of trouble until it is upon them, could never be brought to realize the danger to which they were exposed until restrictions upon our export trade convinced them that something should be done at once. The establishment of quarantine stations furnished the necessary means to exclude further importations of contagion, and permitted us to undertake the eradication of pleuro-pneumonia with confidence that when the existing centers of the disease had been discovered and stamped out we should not be troubled by new outbreaks caused by imported cattle.

The wisdom of maintaining the quarantine of animals from countries in which contagious diseases exist is shown by the terrible epizootic of rinderpest which for two years has been spreading over South Africa, almost annihilating the stock of bovine animals. The contagion was doubtless introduced from Asia, and neither its existence nor the perils from it were sufficient to arouse the people to that prompt and vigorous action by which alone it could have been arrested. And now we see it sweeping across the country like a wall of fire, irresistible, seizing upon every herd, and claiming from 90 to 100 per cent of the animals as victims.

Science has at last been able to do something to mitigate these losses. A method of vaccination has been adopted which will possibly save 60 per cent of the animals to which it is applied, but even with this in operation, the disease is a great calamity. Such a visitation of disease in the United States would cost us hundreds of millions of dollars directly, and many years of labor to recover from it.

Three stations are maintained on the Atlantic Coast, one at the port of Boston, one at New York, and one at Baltimore. In the early years of these stations, several importations of animals affected with foot-and-mouth disease were detected, and one importation of pleuro-pneumonia was discovered in the Canadian quarantine. During recent years certificates of healthfulness and freedom from exposure have been required to accompany imported animals, and permits for importation are refused for animals from countries in which dangerous contagious diseases are prevalent.

The inspection system has been extended so as to include the frontiers bordering upon both Canada and Mexico. For a number of years all cattle from the United States were quarantined three months by Canada, and all cattle from Canada were quarantined three months by the United States. By mutual arrangement these quarantines have been removed, and at present animals accompanied by proper certificates of health are permitted to cross the frontier in either direction without detention. Cattle from Canada for breeding or dairy purposes must have been tested with tuberculin and found free from tuberculosis, otherwise they are quarantined one week and tested by the inspectors. This regulation is required for protection against tuberculosis, and is of special importance to those States which are trying to control the disease.

Along the Mexican frontier the principal problems are to prevent the importation of animals carrying the contagion of Texas fever and sheep scab. Mexico has her Texas-fever districts as well as the United States, and sheep scab there is a most common and virulent disease. It was necessary, therefore, to carefully inspect all of the nearly 300,000 head of cattle and of the 43,000 sheep imported last year from that country. If cattle from the tick districts of Mexico are allowed entrance into the noninfected region of the United States, they cause heavy mortality among our native stock; and if cattle from the elevated section of Mexico, free from infection, are forced to cross the boundary where they will enter our Texas-fever district, then the imported cattle contract the disease and die in large numbers. Hence, the necessity of expert inspection and great care in carrying out the regulations.

Notwithstanding the numerous sources of disease in other countries from which the animals must be imported and the vast numbers of animals which are annually brought to our country from abroad, the bureau has successfully protected our animal industry from exotic contagion. The quarantine stations and the inspection of imported animals have therefore fulfilled their purpose.

THE HOG-CHOLERA QUESTION.

The great losses from the contagious diseases of swine early attracted the attention of the Department and of Congress, and an appropriation for the purposes of investigation was made in 1878, with annual provisions for continuing this investigation until the present time. Two diseases, closely resembling each other, yet caused by distinct germs, and frequently both affecting an animal at the same time, have been recognized. The question of formulating practical measures for controlling these diseases has been as difficult as it is important. While most prevalent in the great corn-producing States, the diseases have been carried to all parts of the country, and, therefore, any regulations to be effective must be enforced over a wide extent of territory, and would be correspondingly expensive. The losses have, however, been tremendous, being placed by some as high as $100,000,000 a year, an estimate which does not appear exaggerated in the light of the careful inquiries in the State of Iowa, from which it was concluded that this one State lost from $12,000,000 to $15,000,000 worth of swine in a single year.

The scientific investigations relating to this subject have been persistent, careful, and comprehensive, and the problems that are to be met have been very clearly defined. Passing over the details of these investigations for the sake of brevity, the efforts now being made will alone be discussed. There are but two methods of control which, from our present knowledge of the contagious diseases of swine, appear to promise adequate results. One is the old stamping-out method, the slaughter of diseased and exposed animals, the quarantine of infected farms, the regulation of transportation, and the disinfection of stock cars, stock pens, infected farms, and all other places harboring the contagion. The other is the treatment of diseased and exposed animals with antitoxic serum. Both of these methods have been tried to a limited extent during the past year.

The stamping-out method is attended by many difficulties and limitations. Farmers often object to the slaughter of exposed animals which are still healthy, unless paid more than the animals are worth, and they are unwilling to have their breeding stock killed as long as there is a chance of saving a part of it. On the other hand, it is embarrassing, if not impossible, for Government officials to utilize in any way the carcasses of exposed animals which have not yet developed symptoms of disease, and to destroy these adds largely to the expense. Again, it is next to impossible to control transportation and the disinfection of cars so as to prevent constant reinfection. The disinfection of farms is also a troublesome matter, as the germ of hog cholera has great vitality and is able to maintain its existence and virulence in the soil, in moist organic matter, and even in water, for several months. Finally, the wide distribution of the disease, the ease with which the contagion is carried, the numerous agencies which contribute to its spread, are all elements which increase the gravity of the problem and militate against the success of the stamping-out method.

The use of antitoxic serum appears at present to be a much more promising method of diminishing the losses, and it is possible that it may be combined with sanitary regulations, such as quarantine of infected herds, disinfection of premises, and supervision of transportation, so as to give the advantages of the stamping-out method while avoiding many of its embarrassments. The serum is prepared by inoculating horses or cattle with cultures of the disease germs and repeating these inoculations with gradually increasing doses until the animals have attained a high degree of immunity. The blood of such animals injected under the skin possesses the power of curing sick hogs and of preventing well ones from becoming infected. Unless the blood is to be used immediately after it is drawn, which is not often the case, it is allowed to coagulate or clot, and the liquid portion or serum is separated and preserved for future use.

The bureau has been diligently working for several years to bring the serum treatment of hog cholera to the highest degree of efficiency. The most important point is, of course, to secure a serum with a high protective and curative power. This is by no means an easy task. The products of the hog-cholera germ are very irritating, and when injected into the tissues their tendency is to cause paralysis and death of the part with the formation of large abscesses. The intense local action hinders the absorption of the cultures into the general circulation and prevents the animal from acquiring immunity. It is doubtless for this reason that the inoculation of swine has generally failed to give the necessary degree of protection, and that inoculated swine are found to contract cholera when they are afterwards exposed.

The serum produced in 1897, when used in affected herds, saved over 80 per cent of the animals. During the past few months the methods have been considerably improved, and it appears probable that a serum of higher efficiency will be the result. There is no danger connected with the use of this serum, as it is absolutely free from the germs of the disease. It is easily applied, and the good effects in sick hogs are seen almost immediately. There is every reason to believe, therefore, that we have in this serum a practicable method of preventing the greater part of the losses from hog cholera, but it must be tested upon a larger scale before absolute assurance can be given. It is hoped that all doubts may be cleared up by the experiments planned for 1898.

TUBERCULOSIS.

Although the bureau has not attempted to enforce regulations for eradicating tuberculosis in any section of the country, it has, in many cases, cooperated with State and municipal authorities which were working with this object. The biochemic division manufactures tuberculin, which is furnished to local authorities for official use. During the past year sufficient tuberculin to test 50,000 cattle was thus distributed.

Cattle for breeding and dairy purposes which are imported from Canada are required to be accompanied by a certificate that they have been tested for tuberculosis, and lacking this they are held in quarantine and tested by the inspectors of the bureau. A number of States also have regulations requiring similar tests for these classes of cattle, and the bureau inspectors at the various stock yards cooperate with the State authorities by inspecting the animals and giving notices of shipment.

BLACKLEG.

The disease known as blackleg, quarter evil, or symptomatic anthrax, is one which has long been dreaded by the producers of beef cattle, because it appears suddenly among the young stock, affects the best and most promising animals, and is almost invariably fatal. It has a great tendency to discourage stockmen in their efforts to improve their cattle, because the best bred animals are the ones most certainly affected. Many plans of prevention have been adopted, such as bleeding, setoning, feeding upon diuretics and alteratives, all with the object of keeping down the condition, and thus making the animals less susceptible.

Such methods of prevention, while only partially successful, are opposed to the principles of successful husbandry. The stock raiser should have the best breeds for his purpose, and he should keep them thriving and growing rapidly, without check or hindrance. Methods of preventing disease which tend to arrest the development of his young stock are distasteful to him, and more or less unprofitable.

Vaccination was proposed as a preventive fifteen years ago, and has been adopted to some extent, but was never very popular on account of two vaccines being used with an interval of ten days or two weeks. The efficiency of these vaccines has also been questioned. Experiments made by the pathological division have demonstrated that cattle may be vaccinated with much less trouble and expense and with greater efficiency by the use of a single properly prepared vaccine.

A few months ago a circular letter was distributed, offering to supply vaccine prepared in the bureau for experimental purposes upon application by the owners of cattle, providing a report were made as to the losses from this disease and the effects of the vaccination. The information thus received has been very surprising. It appears that blackleg causes greater losses in some of the Southern and Western States than all other diseases combined. These losses are placed at from 10 to 20 per cent of the young stock.

About 100,000 doses of the vaccine have been distributed, and reports show that it can be safely used by the owners of cattle and that the deaths from blackleg soon stop after the herd has been vaccinated.

SHEEP SCAB.

Scabies of sheep should not be allowed to exist in any sheep-raising country. It is caused by a parasite which is easily killed and eradicated, and if this parasite is exterminated the disease will no longer develop. The continued existence of such a disease is a reflection upon the intelligence and humanity of a people.

Notwithstanding these facts, sheep scab has for many years been one of our most common, widespread, and destructive diseases. The time has come when the disease should be controlled and eradicated. In order to assist in this, the zoological laboratory of the bureau has been making experiments with various remedies in order to determine which are most effective in curing the disease, and which cause the least damage to the wool and to the general condition of the animals.

The information obtained in this manner will soon be collated and published, in order that sheep growers may avail themselves of it before sending their animals to market. The shipper of diseased sheep must always expect to lose money upon them. They may be quarantined, they may be condemned as unfit for the production of human food, they may be subjected to charges for dipping before being forwarded from one State to another, and under any circumstances the purchaser is unwilling to allow the full price of healthy animals. It is, therefore, greatly to the advantage of the sheep raiser to eradicate the disease from his flock before any are marketed. This the bureau proposes to assist him in doing by furnishing information as to how to make and apply the best remedies.

ANIMAL PARASITES AND PARASITIC DISEASES.

The study of animal parasites and the diseases which they cause has until recently been greatly neglected in this country, and yet the subject is a most important one. A brief mention has just been made of scabies in sheep, but this species of animal is subject to many other serious parasitic diseases. There are lung worms, stomach worms, and intestinal worms of various species, each variety of which may cause outbreaks of diseases debilitating and stopping the growth of the animals and causing the death of many of them.

Other species of our domesticated animals are often seriously affected by animal parasites, and many mysterious cases of disease are due to their effects. Some of these parasites are even dangerous to the health and lives of the people who consume the meat of affected animals. Everyone has heard of the trichina which is so common in the flesh of hogs and which has brought so many restrictions upon our foreign trade in pork products. It goes without saying that parasites which not only menace the health and lives of our domesticated animals, which threaten the health of the consumer of meats, and which endanger the commercial relations of great nations are worthy of careful and thorough study. Such a study is being made in the zoological laboratory of this bureau, where there is now the best collection of such parasites that is to be found in the world.

Investigations are being made to learn the exact nature of each parasite, how animals become infected, how and where the parasites multiply, and how they are to be treated.

THE DAIRY WORK.

The importance of the dairy industry has long deserved the recognition of the Department, but it is only recently that a dairy division has been organized in this bureau. Its efforts have been largely confined to the collection of information, the publication and distribution of bulletins upon dairy topics, and the encouragement of dairy organizations by attending their meetings and giving legitimate assistance. The milk supply and service of large cities has been made a special subject of investigation, with the object of assisting in the improvement of the quality of the milk and its condition upon delivery to the consumers.

The depressed condition of the exports of dairy products for a number of years emphasizes the desirability of active measures to assist and encourage this branch of the foreign trade. With a view to this, a number of experimental shipments of carefully selected butter from creameries in the great butter-producing sections of the country were made during the last year. These have furnished much information concerning the difficulties that are encountered by the trade and as to the requirements of foreign markets. They have also convinced English merchants of reputation and influence of the high quality of butter obtainable in this country, and of the practicability of placing it in British markets without appreciable deterioration. It is proposed during 1898 to repeat these trial shipments and to extend them to a wider field.

PRESENT ORGANIZATION OF THE BUREAU.

In 1891 it was found that the growth and extension of the work of the bureau made it desirable that it should be reorganized into a number of distinct divisions, in order that it might be better systematized and directed. There have been formed up to the present time the following divisions:

(1) The inspection division, to which is assigned work of an executive nature, including the eradication of contagious diseases, the inspection of export and import animals, meat inspection, vessel inspection, and the regulation of the movement of Southern cattle (to prevent the spread of Texas fever).

(2) The pathological division, which is principally engaged in investigating the diseases among domesticated animals to determine their nature, cause, and treatment, together with the most practical method of prevention.

(3) The biochemic division, to which is assigned the chemical problems arising during the investigation of disease and the preparation of tuberculin, mallein, and the various serums for the prevention and cure of disease.

(4) The zoological laboratory, to which is assigned the study of the parasites affecting our domesticated animals and the diseases which they induce.

(5) The dairy division, which collects and disseminates information relating to the dairy industry in the United States.

(6) The miscellaneous division, which has supervision over the accounts and expenditures, conducts the general correspondence in regard to diseases and the animal industry of the country, and directs the field investigations.

(7) The experimental station, where the animals used in the experiments are kept, where small animals for these purposes are bred, and where antitoxic serums for animal diseases are prepared.

All of this machinery of the bureau is working in one way or another to stop the losses and to increase the receipts of the stock raisers of the United States. To understand the different lines of this work, the objects in view, and what is being accomplished, it is desirable to take up one problem at a time.

THE BENEFITS DERIVED FROM THE BUREAU WORK.

In what has preceded an effort has been made to give a general idea of the work of the Bureau of Animal Industry, the objects in view, and some of the more important results. Many minor points have been omitted, and much valuable service that is being rendered has not been mentioned. It may be stated in a general way that the policy of the bureau has always been to render direct returns to the country of a value greater than the appropriations which it consumes. It has never been willing to spend money without being able to show commensurate results.

The eradication of pleuro-pneumonia stopped the ravages of that disease and saved just that much to the cattle industry. The regulation of vessels reduced the losses at sea and saves from $2,000,000 to $3,000,000 annually in insurance of export cattle. The Texas-fever regulations yearly prevent at least $500,000 in losses from that disease. The manufacture of tuberculin saves State authorities not less than $15,000 a year and gives them a more reliable article than they formerly obtained by importation from abroad. The distribution of blackleg vaccine is already saving $100,000 worth of cattle a year, according to the reports of the owners.

In other words, the executive work for the eradication and control of diseases and the supervision of export animals has yielded, and will continue to yield, direct results that save our farmers many times the cost of the bureau work. The scientific laboratory and experiment station are furnishing tuberculin, mallein, blackleg vaccine, and hog-cholera serum worth much more than the cost of the scientific work. And, finally, the dairy division, by extending the markets for American butter, will bring returns that will fully justify its existence and the expenditures which it is making.

Although these few lines of work have yielded such satisfactory returns, the benefit of the meat inspection and that of the inspection of export and import cattle has been even greater in maintaining our export trade and establishing the reputation of our meats. The money value of this work is incalculable, as is that of the scientific investigation of diseases. The serum treatment for hog cholera, for example, will make it possible to save many millions of dollars annually. The object at present is to show, however, that the bureau is yielding direct and definite returns far beyond its cost.

These statements are made because the appropriations to the bureau have been comparatively large and there has not always been a clear understanding of the nature and results of its work. It is incontestable that this is one bureau of the Government which has yielded to the country a constant profit and which still has opportunities before it that warrant a further extension of its field of work.

DIVISION OF STATISTICS.

By JOHN HYDE, *Statistician.*

INTRODUCTION.

By the employment of the statistical method in the aggregation of individual facts, conditions are determined and the operations of various natural laws are defined. The aggregations performed by this method are usually too large to be perceptible to the senses.

Men know by sight a bushel of wheat or potatoes, but practically they can know millions of bushels only by representative figures.

It would, therefore, appear that statistics are as necessary to our larger comprehension as are vision, touch, and other senses to our so-called personal knowledge of things. Their uses are various, but always of an importance corresponding to the necessities of our larger comprehension of the affairs to which they apply, and, as this comprehension is of the first importance in the conduct of all business that must concern itself with questions of demand and supply, so statistics are of first importance as the best means to the attainment of this complete knowledge of conditions.

Such being the character and importance of statistics in general, their particular relation to agriculture, the greatest and most widely distributed business of the world, employing the greatest capital and the largest amount of labor, is worthy of more than ordinary attention; and the more so because a business so vast, of such wide geographic distribution and so varied a character, can not be known in the extent and value of even its more important particulars or in their material effects on human relations except through the one means of the statistical method.

NECESSITY OF STATISTICS TO AGRICULTURE.

While the necessity of statistics to agriculture is unquestionable, there are far greater difficulties encountered in this application of them than in any other great department of the world's business. These difficulties spring in part from the character of the business itself, and in part from its minute subdivision of operations and its wide distribution. That it is far easier to ascertain the output of a group of mines or mills than of a group of farms representing the same value of investment or of product, is obvious.

These difficulties are such as can not be overcome by individual effort. It is not easy—it is rarely even practicable—for private initiative to conduct a statistical inquiry in a field so extensive as the United States. The volume of our agriculture, as well as its distribution, is so vast that the most interested private parties can never wholly measure it statistically.

It was perhaps the greater facility with which a complete and fairly accurate knowledge of the operations of large branches of business other than agriculture is obtained that gained for them their far earlier and more adequate recognition in legislation, the collection of agricultural statistics being for many years the work of an obscure section of one branch of a bureau in the Department of the Interior.

NEED OF A STATISTICAL OFFICE.

It will readily be inferred from the nature and distribution of the matters necessary to be ascertained in relation to agriculture as well as from the impossibility of obtaining definite knowledge of them, either as to their extent or value, by any means not of continuous operation and of public direction, that a statistical bureau early became a necessity to that large portion of the industrial community represented by the Department of Agriculture. Such a branch of the Department has therefore been in continuous operation since 1863, and it is no disparagement to any other branch of the Department's operations to assert that some of the most general, the most diversified, and in the aggregate the greatest benefits which have accrued to the industries combined under the name of agriculture, through its representative department, have been the result of the knowledge obtained and disseminated through this statistical office.

If these benefits are not so direct and apparent as those derived from the investigations of the scientific men who tell the farmer how to suppress the insect enemies that infest his fields and orchards, how to eradicate the various diseases that affect his crops, what are the conditions under which the growth of particular products is most successfully promoted, what fertilizers to use and how to apply them, how the quality of his butter and cheese may be improved, and many other things of high practical value, still they are no less vital and far-reaching, and inevitably tend to increase the rewards of industry by the augmentation of production through the analysis of comparative results, by the maintenance of a reasonable equilibrium between supply and demand, and by contributing to stability of value through the reduction to a minimum of the risks involved in trading.

KNOWLEDGE OF MARKET CONDITIONS REQUIRED.

The American farmer is one of some five million persons who are cultivating our soil, in areas of from 3 acres to well up in the tens of thousands, for subsistence and other profit. Some products he consumes quite largely at home, in the maintenance of his family and hired help, and the keeping and fattening of farm animals. One or more products, however, he annually raises to sell. In some States cotton is the principal or the only money crop, in others wheat, while in not a few extensive regions of the country a wisely diversified system of farming yields varying quantities of many important products for which a market is available. But all that is raised in one place, whether for farm consumption or for local or distant market, has some relation to all that is raised elsewhere, and it is finally the amount of the supply relative to the extent of the demand which wholly or partially fixes the price and determines the profit or loss.

The all-important matter is how to secure a market, for, in spite of the suppression of pests, of the eradication of the diseases of plants, of a knowledge of the most favorable conditions of culture, of the most suitable and wisely applied fertilizers, and of a high standard of excellence in the product, without a market surplus production above farm consumption is not simply valueless, but positive loss, to the extent of its cost in the use of land, implements, stock, fertilizers, seed, labor, and other expenses.

SERVICE OF DIVISION OF STATISTICS.

Without being specific as to details in a matter where details are inevitably to a large extent elusive, it is certain that statistical information widely and carefully gathered and properly presented and disseminated, relative to the condition and prospects and in due time to the actual measure of the principal products of agriculture, has the strongest influence in maintaining a reasonable equilibrium between production and demand, and the consequent assurance of profit to the producer.

In so far as statistics give timely information to producers of specific conditions affecting the marketing of products, such statistics do all that can be done, and what can not be done in any other way, to secure to agriculture a profit on its productions. It is too much to expect that this result will ever be attained with such sufficiency as to leave absolutely nothing to be desired; but so far as it is complete, the benefit secured is due to the statistical method, and will always require its service. What honest producers and interested consumers desire is relations which shall be of mutual benefit, and in the promotion of these relations the Division of Statistics of the Department of Agriculture has not only directly benefited agriculture to an incalculable extent, but, in doing this, has incidentally benefited all legitimate occupations and all consumers.

MAGNITUDE OF AGRICULTURAL INTERESTS.

It may be useful to examine into the extent and value of the interests to which agricultural statistics particularly relate, as further showing their utility, and to consider the numerical and business importance of our agricultural population, whose most vital interests are frequently affected by matters that can be definitely known only through statistics. The following table from the census of 1890 shows the number and classification of the agricultural population ten years of age and over:

Number and classification of the agricultural population ten years of age and over.

Occupation.	Male.	Female.	Total.
Farmers and planters	5,055,130	226,427	5,281,557
Agricultural laborers	2,556,957	447,104	3,004,061
Gardeners, florists, nurserymen, etc	70,186	2,415	72,601
Dairymen and dairywomen	16,161	1,734	17,895
Other agricultural pursuits	19,058	462	19,520
Total	7,717,492	678,142	[1]8,395,634

[1]This is 36.9 per cent of all persons having gainful occupations.

This population, comprising only actual workers, constitutes almost 13½ per cent of the entire population of the United States at the last census, and represents in families probably more than a third of the total number of inhabitants. Numerically, at least, its needs in the prosecution and protection of its endeavors are especially worthy of attention. Its investments in land, implements, and live stock are enormous, the value of farm lands, fences, and buildings being $13,279,252,649; that of implements and machines, $494,247,467, and that of live stock (on farms only) $2,208,767,573, a total of $15,982,267,689, or nearly 25 per cent of the total estimated wealth of the country. Thus, interests represented in a third of our population and a fourth of our national wealth are the direct interests of agriculture.

The value of the products of agriculture in 1889 is stated in the census of 1890 to be $2,460,107,454, and the estimate is acknowledged to be considerably below the actual facts. Of many elements of these enormous values, the agricultural statistics of the Department of Agriculture take annual, monthly, or other account, as required by the frequent changes in their status. Many matters of information that are of vital interest to agriculture, which the census gives once in ten years, as an indication of our progress as a nation, together with much that the census necessarily omits, are given to the public monthly, or as occasion requires, through this division, as freshly collected news of current importance, and thus the national record of progress as regards the business that is in greater or less degree the foundation of all other human industry becomes an annual one.

The first statistics of agriculture published by this Department were those of a census taken three years before, and under a date that was itself a year old. At that time there was no agency for the annual gathering of farm statistics and no organization for the publication of facts relative to agricultural production or distribution, while those facts were alive with meaning and influence. Now, periodic conditions of growth and quality, and finally the amount of production, are recorded by the farmers themselves in all parts of the Union, and are tabulated and published from their returns by this division. The advantage to the farmer is just as certain as it is incalculable, and it is sure to increase with the perfection of the statistical methods employed.

ILLUSTRATION OF THE VALUE OF STATISTICS.

The fluctuation in the values of live stock, as well as of other farm property, during the last five years strikingly demonstrates the utility of reliable periodic statistics.

For many years this division has annually published, as of the first of January, a carefully prepared statement of the number and value of the principal farm animals, as horses, mules, cattle, sheep, and swine.

It is well known that the year 1893 witnessed the beginning of a period of almost unexampled depression throughout the United States in all branches of business, and that recovery from it did not begin to appear until 1897. While statistics covering the full extent and results of this depression are, in the nature of the case, unobtainable, statistics gathered periodically for other purposes, but yet furnishing a measure of the value-destroying influence of such depression in definite instances and to a definite extent, must be of value.

Thus, a comparison of the numbers and values of farm animals, as contained in the published statistics of this division for 1893, 1896, and 1897, the years in which the depression began, culminated, and seemingly began to disappear, will show the estimated losses of value (out of all proportion, in most cases, to the actual numerical decrease) indicated by the scores of thousands of reports received by the Department in January of each year from its State, county, and township correspondents in all parts of the country.

Unless there were a statistical organization to collect and publish these facts annually nothing definite could be known of the extent or progress of this great interest, except to speculators interested in it in a large way, nothing of its relative value as property, nothing of the effects upon it of economic changes, and consequently no clear deductions could be drawn as to the influences of public policy on private business. The following table shows the number and value of farm animals in the United States, with particular reference to fluctuations in value and numbers:

Number and value of farm animals in the United States, 1893 to 1898, showing particularly fluctuations in value and numbers.

January 1—	Total value of live stock.	Horses.		Mules.		Sheep.	
		Number.	Value.	Number.	Value.	Number.	Value.
1893	$2,483,506,681	16,206,802	$992,225,185	2,331,128	$164,763,751	47,273,553	$125,909,264
1894	2,170,816,754	16,081,139	769,224,799	2,352,231	146,232,811	45,048,017	89,186,110
1895	1,819,446,306	15,893,318	576,730,580	2,333,108	110,927,834	42,294,064	66,685,767
1896	1,727,926,084	15,124,057	500,140,186	2,278,946	103,204,457	38,298,783	65,167,735
1897	1,655,414,612	14,364,667	452,649,396	2,215,654	92,302,090	36,818,643	67,020,942
Decrease, 1893 to 1897[1]	828,092,069	1,842,135	539,575,789	115,474	72,461,661	10,454,910	58,888,322
Per cent of increase or decrease, 1893 to 1897	—33.3	—11.4	—54.4	—5.0	—44.0	—22.1	—46.8
1898	1,891,577,471	13,960,911	478,362,407	2,257,665	99,032,062	37,656,960	92,721,133
Per cent of increase or decrease, 1897 to 1898	+14.3	—2.8	+5.7	+1.9	+7.3	+2.3	+38.3

[1] Intervening years show gradation of change.

Number and value of farm animals in the United States, 1893 to 1898, showing particularly fluctuations in value and numbers—Continued.

January 1—	Cattle.				Swine.	
	Milch cows.		Other cattle.			
	Number.	Value.	Number.	Value.	Number.	Value.
1893	16,424,087	$357,299,785	35,954,196	$547,882,204	46,094,807	$295,426,492
1894	16,487,400	358,998,661	36,608,168	536,789,747	45,206,498	270,384,626
1895	16,504,629	362,601,729	34,364,216	482,999,129	44,165,716	219,501,267
1896	16,137,586	363,955,545	32,085,409	508,928,416	42,842,759	186,529,745
1897	15,941,727	369,239,993	30,508,408	507,929,421	40,600,276	166,272,770
Decrease, 1893 to 1897 [1]	482,360	[2] 11,940,208	5,445,788	39,952,783	5,494,531	129,153,722
Per cent of increase or decrease, 1893 to 1897	—2.9	[2] +3.2	—15.1	—7.3	—11.9	—43.7
1898	15,840,886	434,813,826	29,264,197	612,296,634	39,759,993	174,351,409
Per cent of increase or decrease, 1897 to 1898	—0.6	+17.8	—4.1	+20.5	—2.1	+4.9

[1] Intervening years show gradation of change. [2] The only increase.

It should be stated that the decrease in the value of horses (the greatest shown in the above table), in so far at least as it exceeds the average decrease of all, may be attributed to the rapid extension of the use of electricity on street-car lines and otherwise during the period considered. The cause or causes of the decline in the number and value of farm stock in general must be sought elsewhere as affecting the status of all classes of property.

But the present purpose is to illustrate the value of statistics to agriculture in presenting facts of the most far-reaching consequence through the only possible method. If the assertion were ventured without proof that our farm stock of all kinds had decreased in number nearly 14 per cent (23,835,198) and in value 33.3 per cent ($828,092,069), or over four-fifths of a billion dollars, during five years normally free from epizootics, years of profound peace and of natural growth of population and demand, the statement would gain little credence and exert no influence. Proved, it can scarcely fail to excite the most widespread interest and give occasion for the most serious reflection.

Among other services rendered by statistics to agriculture may be mentioned the statistical demonstration and measurement of the advantage accruing from the use of machinery as compared with human labor, and also the definite ascertainment of the extent to which production is increased by the use of fertilizers.

There is, however, a service still more important. The more closely the production of any given crop is ascertained—in other words, the less the uncertainty existing as to the amount available for consumption and export—the smaller will be the risk attending the operations of the merchant and trader, the less will be the inducement to speculation, and the more stable will be the value of the commodity. In every sphere of human thought uncertainty is the mother of speculation; in every field of human activity great risks call for large profits.

Herein lies the current value of agricultural statistics—that they reveal true conditions in ascertained measure and furnish in large matters the only basis for comparisons. From such conditions and comparisons logical deductions can be made for individual guidance. It is in this view that these and related statistics are continually being gathered, arranged, and published by this division, and the information thus regularly made public is in constant demand.

UTILITY OF FOREIGN STATISTICS.

What has so far been stated has particular reference to domestic statistics, furnished through this division. To much of it, however, may be given a wider application. Our insufficient production of certain agricultural commodities and our surplus production of certain others have a relation to foreign markets, if these commodities are imported or exported, and the collection and study of facts relating to production, consumption, and market prices in other countries becomes an important part of our duty toward our own agriculture.

This consideration of foreign production and consumption enables us to determine with reasonable accuracy the demand that will be made upon our surplus, if any, in the current or ensuing year, or the supply that can be furnished us to meet our own requirements. This kind of information relates principally, of course, to agricultural commodities subject to competition, and which are the products of our own and other countries in constantly varying amounts and proportions; and as demand and supply regulate prices, such information is of manifest importance both to producers and consumers. These supplemental statistics of foreign production, correlated with our own, often foretell approximately the measure of our own profit or loss.

An illustration of the benefit to our agriculturists which may be derived from foreign statistics is furnished by certain ascertained facts relative to the production of wheat in Argentina. The statistics of wheat production in that country for a series of years are as follows:

Statistics of wheat production in Argentina from 1890 to 1896.

Year.	Production.	Exports.	Consumption.
	Bushels.	*Bushels.*	*Bushels.*
1890–1891	32,000,000	14,400,000	17,600,000
1891–1892	34,000,000	16,800,000	17,200,000
1892–1893	58,000,000	33,600,000	24,400,000
1893–1894	84,000,000	56,000,000	28,000,000
1894–1895	60,000,000	35,600,000	24,400,000
1895–1896	44,000,000	18,000,000	26,000,000
1896–1897	28,000,000	4,000,000	24,000,000
Average	48,600,000	25,500,000	23,100,000

These figures show a range of production in seven years from 28,000,000 bushels in 1896–97 from an estimated area of 5,200,000 acres to 84,000,000 bushels in 1893–94 from about 4,600,000 acres, and an annual yield per acre ranging from about 5.4 bushels to apparently 18.2 bushels.[1] The area in wheat in 1884–85 was 1,000,000 acres; in 1890–91, 3,100,000 acres, and in 1896–97, 5,200,000 acres, according to the report of an expert correspondent of the Northwestern Miller. The acreage and yield in 1888–89, according to Argentine official statistics, were, respectively, 2,036,254 acres and 19,690,575 bushels, 91 per cent being in four provinces. The yield that year averaged not quite 9.7 bushels per acre.

In 1888 Pennsylvania, upon 31.6 per cent less land than this, raised only 4.5 per cent less wheat, at an average rate of 13½ bushels per acre; one of our own States, in which wheat is not the principal farm product, thus producing nearly as much as the whole of Argentina in a year in which its own production fell below the average.

Last year (1897) the wheat production of the single State of Kansas was almost equal to the average Argentine crop of the last seven years, while that of Minnesota exceeded it by 23 per cent.

These are some of the principal statistical data relative to wheat production in Argentina, with a few facts concerning one or two of our own States by way of comparison. Such statistics would be of no particular importance but for the widespread fear of Argentine wheat as a competitor of our own product in the markets of the world, destined, we have been assured, to finally drive it from the field. Such a threat, handled by skillful speculators, and combined with similar terrors as to Russian surplusage, has not been without influence on our markets, and the statistics of Argentine production are therefore especially worthy of consideration.

QUALIFYING FACTS REGARDING FOREIGN STATISTICS.

It is just here that an element not necessarily statistical must enter into the consideration of foreign statistics of competitive products, such as the leading cereals, if we would arrive at correct conclusions—an element which generally enters easily and naturally into the consideration of domestic statistics. This is an element of qualifying conditions, sometimes capable of statistical proof, as in the case of climate, but not infrequently insusceptible of statistical expression. We know in a broad sense, at least, and of personal or hand to hand knowledge, the conditions of wheat culture at home, and we can judge of statistics of its production, consumption, surplus, price, etc., without, perhaps, deliberately referring to such knowledge in arriving at our conclusions. It will not, however, do to omit this in consider-

[1] Crop statistics for Argentina can scarcely be regarded as furnishing conclusive evidence that so high an average yield as 18.2 bushels of wheat per acre was ever actually attained in that country. All the probabilities are against it.

ing corresponding foreign statistics, but the value of statistical facts, at least their value in relation to similar domestic facts, must be carefully weighed by taking into account all important related facts and circumstances. It will be seen, if this be true, and admitting the importance to us of foreign agricultural statistics, how necessary it often becomes that qualifying facts be carefully and intelligently weighed by the statistician. The performance of this duty to our own people can not be delegated to ignorance and inexperience, or to those pecuniarily interested.

Briefly, then, the statistical showing relative to Argentine wheat is qualified as to the future by the following facts, not statistical, but of official authority and from Argentine sources:

(1) Wheat raising was unknown as a regular branch of farming until the introduction of subsidized immigration in 1882, and production has greatly decreased with the emigration of foreigners since 1893, the business being principally one of their institution.

(2) It is mostly confined to four provinces—Santa Fe, Buenos Ayres, Entre Rios, and Cordoba—which, with over three-fourths of the cultivated land in the country, produce over 90 per cent of the wheat, and which alone among the provinces are suited to its extended cultivation.

(3) Santa Fe and Entre Rios are inland and alluvial, possessing the best conditions of location and soil in the country for continuous successful culture. Buenos Ayres is littoral and subject to destructive pamperos, equivalent to northeast storms in the United States. Both this province and Cordoba have a poor, thin soil, the fertility of which rapidly diminishes under grain-cropping, in the absence of artificial fertilization.

(4) One year out of three (or even two out of five) is practically a year of failure in cereal production here or there in the provinces, as a result of pamperos, droughts, or locusts.

(5) The United States has more than once increased its wheat acreage in two years by an area greater than the largest total area ever devoted to that crop in Argentina.

The statistics alone in this case show the yield of the Argentine wheat fields year by year for a series of seven years, and the amounts annually consumed and exported; also the averages of these for the entire period. Incidentally they show an extreme variation in yield of 56,000,000 bushels, or 7,400,000 bushels more than the average yield; also that the average annual production is about 2,400,000 bushels more than double the home consumption, and about 2,400,000 bushels less than double the average amount of the exports. Further, they show a steady decrease in production from 1893–94 to 1896–97, culminating in a decrease of 56,000,000 bushels, and an export of only 4,000,000 against an export of 56,000,000 bushels three years before, and an annual average for the preceding six years of

29,066,666 bushels. These statistics, taken in conjunction with those of acreage, show that the decrease in production has accompanied an increase in acreage, and that the lowest aggregate production has been from the largest acreage.

PROOF OF THE VALUE OF STATISTICS.

Of the nonstatistical facts in the preceding paragraphs 1, 2, 3, and 4, each throws its particular light upon the Argentine wheat question, as set forth statistically in the table, and helps to determine its importance as regards competition in the markets of the world. The conclusions to be drawn from the total sum of statistical and nonstatistical facts need not be dwelt upon further than to state that, in view of the sudden rise of a considerable wheat industry in a comparatively new and very extensive country and of the claims and expectations based thereon, it is of particular interest to the farmers of the United States to ascertain the exact status of that industry, and, as far as may be, the limits of its possible extension; that such knowledge must at least have a statistical basis; and that to be entirely assuring, this statistical basis should be accompanied by certain nonstatistical information not within the general knowledge.

If the apparent result of this primarily statistical statement is an assurance that Argentine wheat can never become a really serious competitor of our own, that product is effectually eliminated from future consideration as a serious disturber of prices, and the knowledge of this fact is only of less value to our wheat raisers than is the fact that speculators are thus deprived of one of the greatest advantages they have enjoyed in their manipulations of the markets.

This illustration of the use and value of foreign statistics goes necessarily into some detail, and is somewhat out of proportion to the article of which it forms a part. It is given for the purpose of showing, first, the advantage accruing to our farmers from a clear understanding as to competitive, or possibly competitive, foreign production; and second, that they may see that the task is not an entirely simple one which devolves upon the statistician who honestly and vigilantly seeks to protect their interests.

That the making of estimates and the free discussion of anything in the way of a numerical statement are very dear to the heart of the American people, we have innumerable evidences entirely outside of the domain of agriculture. Almost anyone, however, can make some sort of an estimate and obtain the true arithmetical aggregates of tabulations. But, while in the working out of statistical results everything in the nature of necromancy or even of mystery should be carefully avoided, a broader knowledge of the matters to which statistical data relate than comes of their mere handling is not infrequently of vital importance.

The benefits conferred upon agriculture by statistics, great as they are, have no more attained their full limits than has agriculture attained its full development. In any consideration of the subject, therefore, this important fact must be taken into account. In addition to the enormous advantages already accruing, it is not too much to expect that through the gradual utilization of whatever knowledge of physical conditions and of human needs, susceptible of numerical expression, may be available, and the careful setting forth of its precise relation to the great business of agriculture, the statistician of the future will be able to promote the agricultural interests of the country in directions that as yet are hardly dreamed of.

Even if we consider, however, only the present scope and importance of statistical investigation as applied to the vast, the highly diversified, and the ever-changing agricultural conditions of a country like the United States, and keep in mind the fact that the experience of the present and the past will enormously influence the judgments and labors of the future, it will surely be evident to every thinking man that there is no true economy in the curtailment of this work by depriving it of the means by which alone it can accomplish its important purpose.

PROMPT AND WIDE DISTRIBUTION OF STATISTICS THE AIM OF THE DIVISION.

If agricultural statistics are of any value in themselves, their timely availability for the use of those to whom they are of particular interest becomes a matter of importance. They would be of no value to farmers, but might even be positively detrimental to their interests, if possessed by only a few persons or restricted to commercial circles. It is, therefore, the aim of the Division of Statistics in the Department of Agriculture to make the widest possible distribution of the information received through its various agencies, and to make such distribution as prompt and speedy as the necessity of securing reasonable accuracy will admit of. The monthly crop reports of this division are therefore mailed with as little delay as possible to the Department's State statistical agents and the 7,500 persons who report to them, to the 2,400 county correspondents and the 6,800 persons who report to them, to the 40,000 township or district correspondents, to 12,500 cotton planters, to 1,200 newspapers, mostly rural, and to 120,000 other persons, the individual recipients, both correspondents and noncorrespondents, being mainly farmers. These reports relate, according to the season of the year, to the conditions of soil, weather, planting, growth, harvesting, yield, quality, transportation, markets, and prices. They are sent regularly and gratuitously to all persons who have taken the trouble to ask for them, and however susceptible of improvement they may be in any particular respect, the great demand for them leaves little doubt that considerable value is set upon them. When the statistical information received by the Department is made still more promptly available for the use of farmers by being bulletined in rural post-offices, and the information itself is made still more reliable by the institution of certain changes in the crop-reporting system, there will surely be no single division of any Government department, and certainly no independent organization, that will be promoting so greatly and so generally the agricultural interests of the country.

SECTION OF FOREIGN MARKETS.

By Frank H. Hitchcock, *Chief.*

INTRODUCTION.

Agricultural productiveness in the United States far exceeds the consuming capacity of our population. After domestic requirements have been amply supplied there remains each year a vast surplus of farm produce that must either be disposed of abroad or become a burden upon the home market. The slightest excess of supply over demand leads to a depression of prices, and when the excess is large, as frequently happens in this country, there is always danger of a serious decline in values and consequent loss to the producer. In order to prevent the glutting of our own market and its attendant evils, the surplus production of American agriculture must be shipped to other countries. The extension of our export trade in agricultural commodities is therefore a matter of the highest moment to the farming community. For the purpose of aiding in this important object the Department of Agriculture has established the Section of Foreign Markets.

OUR DEPENDENCE UPON FOREIGN MARKETS.

The extent to which we have become dependent upon foreign markets for the disposal of our surplus products of the farm is shown by the fact that during the past fiscal year (1897) our agricultural exports amounted in value to $689,755,193. This enormous sum, comprising fully two-thirds of the total value of all exports, represents a branch of our foreign trade that is well worth fostering.

INCREASING COMPETITION.

In the earlier stages of our agricultural development we found it comparatively easy to market our farm products abroad. The wonderful agricultural resources of the country, far surpassing those of the older European nations, gave us a ready mastery of the situation.

There were no competitors formidable enough to endanger our control of the trade. But the situation to-day is changed. Powerful rivals now confront us in our contest for the world's markets. The fertile grain fields of Russia and of Argentina offer their abundant product to the importing nations of Europe at prices we find it difficult to meet. The marvelous agricultural possibilities of Australasia are becoming more fully recognized as with each succeeding year still larger quantities of produce from that distant country are placed upon the European market. Our neighbor Canada has also made astonishing progress in some directions, and is now one of our most successful competitors in supplying meats and dairy products to the British people. Even the older countries of Europe show in some instances a surprising development in certain lines of agricultural production, as, for instance, the rapidly increasing output of butter in Denmark. From such changes as these a much fiercer struggle among the competing countries has resulted, and if in the face of this stronger competition we are to maintain our supremacy in the world's markets, it will require on the part of our exporters a more determined and persistent effort than has hitherto been necessary.

AGRARIAN OPPOSITION TO OUR FARM PRODUCTS.

In addition to the growing competition we are compelled to meet because of recent agricultural development in other parts of the world, we now find a serious obstacle confronting us in the active hostility that is being exhibited toward our agricultural products by the agrarian population of certain European countries where we formerly possessed a profitable market. Yielding to the pressure brought to bear by the agrarian classes, who see in the successful competition of American products a dangerous menace to their own interests, the governments of these countries have in several instances sought to limit importation from the United States by the imposition of unwarranted restrictions. These unfair acts of discrimination, together with certain criticisms of our products that appear also to have emanated from the agrarians, have had a tendency in some countries to create an unfounded prejudice against the character of American goods in general, and this prejudice it has been very difficult to overcome.

FAILURE OF OUR PRODUCERS TO STUDY FOREIGN WANTS.

Another impediment to the extension of our export trade is the failure on the part of our producers to give sufficient attention to the peculiarities of taste that often prevail in the foreign markets they are attempting to supply. A notable example of this is found in the character of the bacon we send to the United Kingdom.

THE BRITISH BACON MARKET.

To supply the present demand of the British market requires the importation of more than 500,000,000 pounds of bacon a year. This bacon is procured almost entirely from three countries, the United States, Denmark, and Canada. Although the United States is still the chief source of supply, the quantity purchased from this country is decidedly smaller than it was five or six years ago. On the other hand, the British have greatly increased their importations of Danish and Canadian bacon. An inquiry into the reason for this change in the course of trade discloses the fact that our bacon is not so well adapted to the requirements of the British market as is that imported from Denmark and Canada. The article produced in the United States is chiefly corn-fed bacon, and although regarded with high favor in our own markets, it carries altogether too much fat to suit the taste of the English consumer. Denmark and Canada furnish a much leaner grade of bacon. Their producers have studied the peculiar wants of the British market, and with such success that they are already making important inroads upon our trade. The Danish and Canadian brands of bacon are regarded in Great Britain as being so far superior to ours that the price paid for them is several cents a pound higher. As we send annually to the British market more than 300,000,000 pounds of this product, the loss of only a few cents in the price per pound makes an enormous difference in the profits of the trade. It will therefore be to the interest of our producers, in providing bacon for the British trade, to give more attention to the peculiar wants of the people to be supplied, for in this way only can a profitable development of our export business be accomplished.

IMPORTANCE OF STUDYING FOREIGN REQUIREMENTS.

These facts relative to our export trade in bacon show how important it is for our exporters to familiarize themselves with the exact requirements of the markets sought. In the face of the keener competition that is now being waged by the great producing countries, this policy becomes all the more essential. Not only must the goods offered be of the highest grade and quality, but they must also be adapted in every particular of style and flavor to the peculiar taste or fancy of the desired purchaser. Even the nature of the receptacle or covering in which the goods are sold, the size and shape of the package, must be regarded. These minor requirements of the trade differ materially in different countries. The style of package that is popular in one quarter may prove to be a decided disadvantage in another. Only recently our exporters discovered that one of the reasons why American butter did not find a readier sale in England was because it has been the practice to ship it in round tubs, such as are commonly used for packing the article in the United States, whereas the customs of the British market make a square package more desirable. In order to compete successfully in the butter markets of the United Kingdom, therefore, American exporters find it almost as essential to regard this preference for a square package as it is to satisfy the British taste in respect to the color and flavor of the article itself.

Upon the careful observance of such matters of taste and custom as are illustrated by these references to our foreign trade in bacon and butter depends very largely our future success in competing with other nations for the world's markets. In this contest for trade the first requisite is a thorough knowledge of the conditions to be met. To assist in supplying such a knowledge is the object of the Section of Foreign Markets.

SUBJECTS INVESTIGATED.

With this end in view the agricultural resources of foreign countries are carefully investigated. It is important, first of all, to learn what these countries produce from their own soil and how far their products meet the requirements of their population, the purpose being to determine the extent to which they are likely to become dependent upon outside sources for their supply. Special attention is given to the character of each country's import trade. The nature, extent, and source of the imported commodities are examined, to ascertain what possibility there is for successful competition on the part of our own producers. At the same time the export trade of the United States is closely watched. Every significant change in the quantity of a product marketed abroad is noted. In cases of declining trade the cause is inquired into and a remedy sought, while evidences of growth in any direction are studied with the hope of promoting still further expansion.

INFORMATION DISSEMINATED.

The results of these investigations, supplemented by practical information regarding transportation facilities, customs duties and regulations, equivalents of foreign money, weights and measures, rates of exchange, etc., are given to the public in the form of bulletins and circulars. Much information is also disseminated in response to inquiries that come through the mails. The large number of such inquiries received and the numerous requests that are made for the publications of the section show that our farmers are beginning to recognize more fully the importance of a foreign market.

SOURCES OF INFORMATION.

In the work of gathering facts regarding commercial opportunities abroad much valuable information is derived from the official returns of international trade published by the several countries, and also from the reports issued by foreign agricultural bureaus. In addition to these important official documents, various unofficial publications, such as the reports of boards of trade, chambers of commerce, agricultural societies, and similar organizations, as well as all other available sources of published information, are utilized.

CONSULAR REPORTS.

Through the courtesy of the State Department the Section of Foreign Markets has also been enabled to avail itself to some extent of the services of the United States consular officers stationed abroad. The promotion of our commercial interests is the most important duty of these officials, and they possess exceptional opportunities for this work. Residence at the place of investigation naturally brings them into close touch with the trade situation and gives them every facility for ascertaining the possibilities of the market. With the intimate knowledge of local conditions thus acquired, they are able to render great assistance to our exporters. The reports they have furnished the section, in response to circular letters of inquiry regarding opportunities for the disposal of American products in their respective districts, have contained much timely information. This information has been published in the bulletins of the section and has added much to their practical value.

NEED OF SPECIAL AGENTS ABROAD.

While the Section of Foreign Markets has received much valuable assistance through the cooperation of United States consuls, these officials have important duties in other directions, and the extent to which they can be called upon to furnish information for the use of the Department of Agriculture is necessarily limited. The work would be greatly facilitated, therefore, by the employment of special agents to carry on certain lines of investigation abroad. For the purposes desired, special agents of the Department would have a great advantage over our consular officials in being able to devote their attention exclusively to this branch of inquiry, and also in the important fact that they could travel from place to place, whereas our consuls must necessarily confine their investigations very largely to the district in which they are stationed. The work of special agents abroad, if properly directed, could undoubtedly be made to yield results of great value.

AGRICULTURAL ATTACHÉS.

The recommendations elsewhere made by the Secretary of Agriculture in regard to the appointment in certain countries of agricultural experts as attachés to our embassies and legations justify the consideration here of the various ways in which such representatives could further the work of this section. Under such an appointment, the representative charged with the sole duty of looking after the interests of American agriculture in the country to which he is accredited would be capable of rendering important services to our agriculturists. Residing at the seat of government, he would have an excellent opportunity to watch the course of legislation there and to keep our Government informed regarding all measures likely to affect the agricultural interests of the United States, as, for instance, changes in tariff rates or restrictions of any kind placed on the importation of American goods. He would also be in a favorable position to investigate certain complaints against our products and to determine whether or not they are well founded, a service that is sorely needed in some lines of trade. In this and various other ways he could be of great service to the American producer.

FOREIGN CROP REPORTS.

One of the important duties that could be required of an agricultural attaché would be to keep our farmers regularly informed as to crop and market conditions abroad. Modern transportation facilities have so closely united all countries that the prices of the leading products of agriculture are practically uniform throughout the world. It is the relation of the world's supply to the world's demand that determines the value. The price of wheat established at Liverpool on the basis of the world's production and requirements fixes the price of that grain in the markets of the United States and other countries. It is therefore a matter of no little importance to our farmers, for guidance in the sale of their own products, to have prompt and reliable information as to the crops of other nations. Information on this subject can be obtained most readily at the capitals of the several countries, for it is there that the national crop reporting service is almost invariably centered. Our embassies and legations have from time to time reported in reference to crop prospects abroad, but not with sufficient regularity or promptness to make the information particularly useful. If each embassy or legation had a special attaché whose exclusive duty it should be to furnish our Government with all available information regarding the agricultural situation in that country, it would doubtless lead to a much more efficient service in this important matter.

With the additional information that could be furnished along these lines by agricultural attachés stationed at foreign capitals, and by an intelligent corps of special agents carrying on investigations abroad, it is believed that the work of extending our agricultural export trade, in which the Section of Foreign Markets is so actively interested, could be rendered far more effectual.

PRACTICAL RESULTS OF THE WORK.

To illustrate the value of the information that is being collected regarding opportunities for the extension of our export trade in farm products, and the practical work that is being accomplished as a result of such investigations, a brief review of what the Department of Agriculture is doing to increase our exports of butter may be of interest.

OUR EXPORTS OF BUTTER.

The United Kingdom is the principal butter market of the world. During the calendar year 1897, according to the British trade statistics, the total importations reached the enormous aggregate of 360,393,712 pounds, valued at $77,459,647. Of this amount, less than 5 per cent came from the United States. The chief source of the British supply has been Denmark. Of the butter imported during 1897, fully 40 per cent was of Danish origin. About 14 per cent was furnished by France, 9 per cent by Sweden, and 8 per cent by the Netherlands. While it is true that these European countries are all more conveniently situated as regards proximity to the British market than is the United States, the modern system of transporting butter under refrigeration renders this an advantage of little importance, and it should be easily offset by the superiority of our agricultural resources. The failure of the United States to compete more successfully in the British butter trade can no longer be attributed to remoteness from the market. Even far away Victoria, four weeks distant by steamer from Liverpool, sends more butter to the United Kingdom than we do. The British import trade in Australian butter has sprung up almost entirely within the past decade, and now each succeeding year sees its further development. Similarly, there has been a rapid increase during the last few years in the importations into the United Kingdom of Canadian butter.

In view of the important gains that were thus being made by our competitors in the British market, coupled with the fact that a surplus production of butter in the United States threatened to overstock our own markets and depress prices, the Department decided to take active measures for the extension of our export trade. The chief obstacle to be overcome in the accomplishment of this purpose was the impression prevalent among foreign buyers that United States butter is as a rule inferior to that furnished by other countries. This impression had resulted from the fact that in past years it was a common practice to send abroad only our lower grades, whereas the British consumer generally requires the very best obtainable. In order to refute this unfavorable opinion of our butter and convince the foreign purchaser of its superior quality, the plan of making experimental shipments of our best grades to the British market has been put into operation. These shipments, made under the direction of the dairy division, consist of selected lots of the finest American creamery butters, prepared with special reference to the requirements of the foreign consumer. Thus far they have been consigned to the London market, where they are disposed of under the supervision of a representative of the Department, who sees that each package is plainly labeled and advertised in order to show its United States origin. In this way it is hoped to remove the prejudices that have existed abroad in regard to our butter and to prove to the satisfaction of the British importer that the best grades produced in the United States compare favorably with the finest received from other countries. When this reputation for our butter is once fairly established in England the disposal of our surplus product in the British market will be a matter of little difficulty.

AMERICAN HORSES ABROAD.

Another product of American agriculture for which the Department is striving to create a wider foreign market is the horse. Germany, the United Kingdom, France, and Belgium are the leading importers of this animal. The number imported by these four countries during the calendar year 1896 amounted to 210,323, valued at $33,119,125. Of this number, only 24,813, valued at $3,717,748, were purchased from the United States. In other words, our farms and ranches, although surpassing those of any other nation in their advantages for the raising of horses, supply the principal markets of Europe with barely more than one-tenth of their requirements. The opportunity for increasing our exportation of horses is a most promising one, and as our own horse market is frequently in a sadly overstocked condition, every effort should be made to take advantage of the opportunity. With this purpose in view, the Department has instituted an investigation regarding the exact requirements of the principal European horse markets. Every effort is being made to gather accurate information as to the styles in draft and road horses preferred at each market, and also as to the kind of horses required by the several European governments for army purposes. With information of this nature at our command the exportation of horses from the United States can be more intelligently and more successfully conducted.

A FOREIGN MARKET FOR AMERICAN CORN.

The movement that has recently been set on foot by American producers to extend the use of our Indian corn, or maize, in foreign countries is also receiving the active cooperation of the Department of Agriculture. This leading cereal crop of the United States is produced so abundantly by our farmers that its disposal at a profitable price in seasons of plentiful harvest is extremely difficult. As a result of our surplus production, corn has at times been used quite extensively for fuel in some portions of the West. To relieve the overstocked condition of our own markets it is necessary to send more corn abroad. Less than 10 per cent of our total product is at present marketed in foreign countries, and as we produce on the average about four-fifths of the world's crop, the field for the development of our export trade is almost unlimited. If a sufficient foreign demand can be created to dispose of our surplus product the value of this important cereal will be materially enhanced. As our average crop amounts to about 2,000,000,000 bushels, every cent that can be added to the price of corn by creating a larger demand abroad will mean an increased profit to the American farmer of $20,000,000. The only feasible plan to bring about a larger demand for American corn in foreign countries seems to be a more general introduction of this grain as an article of human food. The Department has accordingly inaugurated a special inquiry to ascertain what are the possibilities in this direction. The results of this investigation will be published in the near future, and it is believed that the information thus disseminated will be of material assistance in this important undertaking.

CONCLUSION.

These brief references to the efforts that are being made by the Department of Agriculture to increase the exportation of American butter, American horses, and American corn will suffice to indicate the great possibilities of the line of work in which the Section of Foreign Markets is engaged and its practical utility to the farmer.

MISCELLANEOUS PAPERS.

POPULAR EDUCATION FOR THE FARMER IN THE UNITED STATES.

By A. C. True, Ph. D.,
Director of the Office of Experiment Stations.

INTRODUCTION.

If a farmer's boy has obtained a good common-school education and can command the means to spend four years at school away from home, he can have a thorough course in agricultural science and practice free of charge for tuition and at comparatively small expense for living, for agricultural colleges are now in operation in every State and Territory. A considerable number of students are now pursuing such courses, and undoubtedly many more might profitably undertake them. The importance of thorough technical training in the industrial arts is increasingly recognized. Agriculture is no exception to the rule, and we may expect to see our agricultural colleges growing stronger in resources and students year by year. But it is also much clearer now than when these colleges were established that their chief functions must necessarily be to train the leaders in agricultural progress, and that they are and will be unable to meet the needs of the masses of farmers' children. From the colleges are to come the investigators, teachers, journalists, and managers of agricultural enterprises and industries requiring a relatively high degree of scientific knowledge and expert training for their successful operation.

The length and expense of a four-years' college course will remain indefinitely as a barrier over which the average farmer's son can not climb. The recognition of this fundamental fact, and the rapidly increasing evidence that the farmer, as well as the business man and artisan, needs special training for his occupation, have combined to create a strong demand for other agencies besides the colleges for the farmer's education. The first responses to this demand have been attempts to meet the educational needs of adult farmers. These attempts have been largely made in connection with the agricultural colleges.

EDUCATION THROUGH THE PUBLICATIONS OF THE DEPARTMENT AND THE EXPERIMENT STATIONS.

The most important and wide-reaching effort for the popular education of the masses of our farmers thus far made has been through the agricultural experiment stations and the Department of Agriculture. In one sense these stations are the crowning feature of our agricultural colleges. They are departments of original research, whose primary object is to search for new truth in order that the boundaries of human knowledge regarding agricultural science and practice may be enlarged. But under the law the stations have been compelled to issue frequent bulletins for distribution among the farmers, and it was soon discovered that the only way by which the stations could clearly set forth the results of their original investigations so that the masses of the farmers might understand and utilize them was to furnish a large amount of preliminary information explaining the progress made in various lines of agricultural theory and practice prior to the establishment of our stations. Hence, a great deal of the time and energy of our station workers has thus far been spent in educating the farmers through bulletins of information. Indeed, so popular has this kind of publications proved that the pressure upon station officers to prepare them has often compelled them to defer other important work, and this task is still a serious hindrance to the progress of our stations along the lines of research for which they were established. Some idea of the extent of this work may be obtained from the fact that during the past year the stations issued 407 bulletins, which were mailed to 506,100 addresses. The total number of pages in these publications was 15,785. The United States Department of Agriculture has aided in this movement through numerous publications, especially the Farmers' Bulletins, of which over 2,000,000 copies were distributed last year, and the Yearbook, of which 500,000 copies are annually printed.

THE FARMERS' INSTITUTE—THE ADULT FARMERS' SCHOOL.

Meantime the farmers' institutes have been extending their work. These have been an outgrowth or extension of the "open" or "public" meetings held by State or local agricultural societies. While they have not displaced such meetings, they now exceed them in number and popularity, and have become important agents in the education of the farmer in a number of States.

The institute is the adult farmers' school. Here they may learn from scientists and investigators the principles which underlie the art of agriculture, and from successful farmers the best methods of applying those principles. The scientist at the same time learns the needs of the farmer and finds out from the results of actual practice the truth or falsity of theories and deductions made from experiments on a limited scale. The views of both farmer and experimenter are broadened, and sympathetic relations are established by the close social contact which marks the institute in its most perfect form.

The institutes are carried on under various auspices and are supported in very different ways in different sections, but the character of the meetings themselves is everywhere essentially the same. They may last for but half a day, as in Louisiana, where the farmers assemble once a month at the experiment station, or may continue three or four days. The tendency, however, seems to be toward shortening the duration and increasing the number of the meetings, thus distributing them among a greater number of localities. They are usually held during the winter, when the stress of the farm work is somewhat lessened, but in some States very valuable meetings have been held at other seasons of the year, the character of the work being adapted to some need specially felt at the time.

The programmes are planned to promote the interchange of ideas, a full and free discussion being sought upon topics introduced in an address or paper by some specialist. Speakers upon scientific subjects and successful farmers who have attained more than local reputations are usually selected as institute workers by those who have charge of the system of institutes for the State, or they may be chosen by the local authorities from lists of such workers prepared by the central bureau. The local committee invites successful farmers of the neighboring districts to explain their methods and provides music and literary or other general exercises. All persons in attendance, the humblest as well as the most prominent, are urged to ask questions upon points suggested in the addresses and to present related facts gained from personal experience. A "question box" is frequently made use of, answers being given by the conductor of the institute or by some one specially fitted to supply the information asked.

For the evening sessions the usual plan is to have a popular lecture upon some subject of general agricultural interest. This address is made somewhat more elaborate and complete than those of the day sessions, and less opportunity is given for discussion.

The institutes have been so successful and so popular in States where they are carefully and systematically conducted that there is a growing demand for increase in their number and frequency in these States and for the extension of similar systems to States which now hold institutes at irregular and infrequent intervals.

In nearly all the States and Territories institutes or meetings of similar character are now held with more or less frequency and regularity.

SHORT AND SPECIAL COURSES IN AGRICULTURE.

The agricultural colleges have further sought to meet the demand for more elementary and practical education in agriculture by establishing short courses. These may either cover agriculture in general or be confined to some special line, as dairying. The courses offered by the University of Wisconsin may serve to illustrate this feature of the American system for agricultural education. "The short course in agriculture," it is stated, "is designed to meet the wants of young farmers who desire practical, helpful instruction in agriculture before taking up their chosen vocation. This course covers two terms of twelve weeks each, beginning the first of January each year." It includes lectures on feeds and feeding, breeds of live stock, agricultural chemistry, agricultural physics and meteorology, plant life, veterinary science, dairying, farm bookkeeping, horticulture, agricultural economics, and bacteriology. Laboratory practice is given in dairying, physics, plant life, stock judging, and horticulture, and practical work in carpentry and blacksmithing. The dairy course occupies one term and includes theoretical and practical instruction in the science and practice of dairying and dairy farming. It is definitely planned to meet the needs of persons intending "to operate creameries and cheese factories," and has been very successful in training men competent for work of this kind. The students engage in milk testing, operate separators and butter extractors, and attend to the ripening of the cream, churning and packing butter, and all the operations of a creamery and cheese factory.

HOME READING IN AGRICULTURE.

Various plans for extending the influence of the agricultural colleges among the farmers by what is known as university extension work have been tried during the past five or six years. One of the most interesting of these movements was inaugurated by the State College of Pennsylvania. In 1892 this college offered a course designated as "Home reading in agriculture," the main features of which were as follows:

(1) A carefully prepared course of reading designed to cover the most important branches of agricultural science and practice.

(2) A reduction of price upon the books needed, all of which were standard works.

(3) Personal advice and assistance through correspondence.

(4) Examinations upon subjects read, with certificates and diplomas for those attaining certain grades of excellence.

This course attracted considerable attention at home and abroad and received numerous applications for admission from students, a number of whom did excellent work, completed their prescribed course, and received diplomas.

During the following years the number of students was largely increased, and a demand was made by them for more extended work and more individual aid from the college. To meet this demand the list of books has been largely increased, now constituting five divisions of five books each upon the subjects of crop production, animal production, horticulture, dairying, and domestic economy. In addition to these twenty-five books, a supplementary list of fifteen books is added, from which students may select books to form additional courses if they desire.

The course consists of thorough study of ten books and a satisfactory examination upon the same.

To meet the demand made by the students for greater aid from the college, lessons have been provided on various books in the course. These are sent to students free of cost. These lessons aim to give new matter, or, in other words, to bring the book up to date, to make suggestions for study, observation, and experiment, and to give page references to the book. Each lesson is accompanied by an examination paper covering the subject of the lesson. Students are required to satisfactorily answer these examination questions or discuss the topics there mentioned before they can receive a second lesson.

THE NEW YORK PLAN FOR UNIVERSITY EXTENSION IN AGRICULTURE.

In 1894 the legislature of New York passed a bill out of which has grown a movement in behalf of agricultural education, which bids fair to make a deep and lasting impression, especially upon the common schools. The Nixon bill, as it is popularly called, grew out of a desire on the part of certain persons in Chautauqua County, N. Y., to have the experiment station connected with the College of Agriculture of Cornell University undertake some cooperative experiments in their vineyards. As finally passed, the act gave $8,000 to the station "for the purpose of horticultural experiments, investigations, instruction, and information in western New York." The work was organized under Prof. L. H. Bailey, and consisted of investigations in horticulture, plant diseases, and entomology; teaching by means of itinerant schools and lectures, and the publication of bulletins of information. So successful was the first year's operations that the appropriation was increased to $16,000 for the next two years. The educational features of the enterprise were extended, with the effect that the legislature of 1897 made an appropriation of $25,000 for "the promotion of agricultural knowledge in the State," and put this in charge of the College of Agriculture instead of the experiment station. The work now in progress is much wider in scope and more thoroughly organized than that hitherto attempted. It retains, however, the main features of the previous enterprise. These are—

(1) The itinerant or local experiment as a means of teaching.
(2) The readable expository bulletin.
(3) The itinerant school.
(4) Elementary nature teaching in the rural school.
(5) Instruction by means of correspondence and reading courses.

Several hundred simple field experiments with fertilizers, potatoes, and sugar beets have been conducted the past season in different parts of the State. Several bulletins, with numerous illustrations, have been widely circulated. Numerous itinerant schools have been held. "These are meetings which last two or more days, at which time certain instructors take up definite lines of instruction, giving by far the greater part of their attention to underlying principles and not to mere facts or methods." The attempt to introduce nature teaching into the rural schools has aroused much popular interest. The purpose and method of this work have been fully set forth in a recent bulletin and are here summarized. It was conceived that the fundamental difficulty with our agricultural condition was that there was no attempt to instruct the children in matters which will awaken an interest in country life, and therefore that the place in which to begin to correct the agricultural status was with the children and the rural schools. For the purpose of determining what should be done many rural and village schools were visited during the past year and simple lessons were given on natural objects. The result was that all the instructors were impressed with the readiness with which the children imbibed the information, their keen desire for it and appreciation of it, and the almost universal interest which teachers took in this kind of work. It was clear that the greatest good which could be rendered to the agricultural communities was to awaken an interest in nature study on the part of teachers and children. In order to facilitate teaching in this direction, leaflets were issued to show teachers how nature study may be presented to the pupils, and these have been received with the greatest enthusiasm by educators and many others who have examined them.

The outgrowth of this work with the schools is that it seems certain that the best way in which to reach the pupils and the teachers is by short and sharp observations upon plants, insects, and other natural objects, and not by means of definite lectures of stated lengths. This work has already been presented to the teachers at some of their institutes, where it has also met with favor, and it has received the commendation of the superintendent of public instruction and other persons in authority. So far as the present outlook is concerned, it is, perhaps, not too much to say that many believe that this movement, directed toward the young people of the rural communities, is the most important one which has developed in agriculture since the consummation of the experiment-station idea.

Instruction by means of correspondence has been an outgrowth of the last year. There were about 1,600 readers upon the lists at the close of the first three months. It is the plan in this reading course to set the farmers to reading upon certain definite subjects, and then to make them think upon those subjects by periodical questioning.

Some months ago the College of Agriculture had enrolled under the head of "University extension work" 15,000 pupils and 10,000 teachers of the public schools and 1,600 young farmers. The pupils and farmers receive guidance by means of printed circulars, and the farmers report progress and difficulties upon special blanks, which are furnished. Six instructors are employed throughout the State in conducting university extension work, and special teachers are employed from time to time as occasion requires. These instructors meet the teachers of the public schools in the presence of their pupils and at teachers' associations and institutes for the purpose of illustrating methods for teaching nature studies directly or indirectly related to agriculture. The leaflets furnished serve as texts for the subjects taught.

The result of pushing this educational motive into the rural communities has been a most decided waking up of those communities, which, even if the work were to stop at the present time, will continue to exert an influence for a generation and more.

All this work has been experimental—an attempt to discover the best method of teaching the people in agriculture. The promoters of this movement believe that the most efficient means of elevating the ideals and practice of the rural communities are as follows, in approximately the order of fundamental importance: (1) The establishment of nature study or object-lesson study, combined with field walks and incidental instruction in the principles of farm practice, in the rural schools; (2) the establishment of correspondence instruction in connection with reading courses, binding together the university, the rural schools, and all rural literary or social societies; (3) itinerant or local experiment and investigation, made chiefly as object lessons to farmers, and not for the purpose, primarily, of discovering scientific facts; (4) the publication of reading bulletins which shall inspire a quickened appreciation of rural life, and which may be used as texts in rural societies and in the reading courses, and which shall prepare the way for the reading of the more extended literature in books; (5) the sending out of special agents as lecturers or teachers or as investigators of special local difficulties or as itinerant instructors in the normal schools and before the training classes of the teachers' institutes; (6) the itinerant agricultural school, which shall be equipped with the very best teachers, and which shall be given as rewards to the most intelligent and energetic communities.

NATURE TEACHING IN THE RURAL SCHOOLS.

There are many interesting points in the scheme of university extension work for agriculture thus outlined, but particular attention should be given to that part of it which relates to the introduction of nature teaching in the common schools. For more than a hundred years schemes for the teaching of agriculture in the common schools have from time to time been put forward and have attracted more or less public notice. None of them, however, has been found practicable. This is largely because they have ignored the conditions existing in our common schools, as well as the nature of the subjects with which the theory and practice of agriculture deal. The great object of teaching agriculture in school courses must ever be to acquaint students with the principles on which sound practice should be based and show the direction in which agricultural progress is going. The art of agriculture is best learned on the farm. That is the place where the boy learns how to plow, plant, and reap, and how to feed and care for stock. It is true that at an agricultural college or other school where the farmer's boy may reside for a considerable period he may learn new and better ways of doing these things than on his father's farm, but what chance is there that he can ever learn such things as a child in a common rural school where most of his time must necessarily be given to acquiring the rudiments of a general education? If he is to be taught agriculture at all in the common school, the course must consist very largely of the principles underlying agricultural practice, that is, he must be taught why he plants and plows and reaps in one way rather than another and what laws of nature he violates in the bad management of his crops, stock, or dairy, and the penalties which will surely result. But agricultural principles are complex affairs, having their foundation in several sciences and only imperfectly understood even by the most advanced investigators. They are matters which the mature mind may profitably consider, but which are out of place in elementary schools. For this reason most of the experiments in teaching agriculture in the lower schools have proved failures. It is true that something has been done in Europe, but it is only here and there where unusually gifted teachers have been found that even a measure of success has been attained. In our rural elementary schools there is much less prospect that any useful work of this kind can be done.

NATURE TEACHING SHOULD BE INTRODUCED IN COMMON SCHOOLS.

There is every reason to believe that the plan of "nature teaching," as proposed by Cornell University, may prove a grand success and be of very great benefit to farmers' children. The element of education which is at present most lacking in our common schools is the training of the powers of observation. The children need above all things else to be taught to observe carefully and correctly and to state their observations in clear and terse language. The ordinary child, whether on the farm or in the town, actually sees comparatively little in the world about him. The wonders of the trees and plants in park or meadow, of birds and insects flying about the house, float like shadowy visions before his eyes. "Seeing, he sees not." He needs a teacher who can open his eyes and fix his mind on the realities among which his daily life is passed. This accurate observation of natural objects and facts is the only foundation on which scientific attainments can rest. The scientist is chiefly a man who sees better than his fellow men. But it is also a great help in practical life. Many farmers acquire much of this power by their own unaided efforts. And these are the very men who most regret that they did not have in early life the help of a trained teacher. The farmer's child lives where he has the best opportunity for such training. It would benefit him in the practice of his art, and it would add an interest to his life which would do much to wean him from a desire to leave the farm for the turmoil and uncertain struggles of the town. With proper provision for the training of teachers in normal and other schools, it would be entirely feasible to have this nature teaching in all our common schools within a few years. It is such teaching that the child mind craves. With it the school becomes a delightful place and the teacher an angel of light. The leaflets which the College of Agriculture of Cornell University is issuing show how vitally this nature teaching may be made to affect agriculture, though it is not in itself the teaching of agriculture. In one leaflet the teacher is instructed to have the children plant squash seeds, dig some of them up at intervals to learn how the seeds germinate, and watch what happens to the little plants as they push their way up through the soil and unfold their stems and leaves in the air. Four apple twigs form the subject of some other lessons, and it is wonderful how much a child can learn about the way trees grow from such simple materials. At another time the children are encouraged to plant little gardens and carefully watch some of the things which grow in them. Or they study some insect which preys upon fruit or make collections of the insects about their homes, or watch them to see whether they are doing things good or bad for the farmer.

Is it not likely that a child who is thus taught will soon begin to see a new value and dignity in farm life and to be less envious of the boy or girl who is shut up within the narrow confines of city streets most of the year? And if the farmer's boy learns how to accurately observe the processes of nature with which farm practice deals and the foes with which agriculture has to contend, are not the chances vastly increased that he will be successful in managing nature so as to get the greatest favors from this coy mistress of his life and fortune?

HIGH-SCHOOL COURSES IN AGRICULTURE.

With nature teaching in our common schools and training in the science of agriculture in our colleges, there would yet remain one vacant place in our scheme for a system of agricultural education suited to the varied needs of all our people. Between the college and the common school is the high school, normal school, or academy. Large numbers of farmers' boys and girls go to these schools, commonly located near their homes, who are unable to attend the longer and more expensive college courses. Surely some provision for agricultural instruction ought to be made in such schools. Thus far only a few attempts have been made in this country to provide agricultural instruction of the high-school grade. It is true that some of the agricultural colleges receive students directly from the common schools, but the constant tendency is to raise the grade of instruction in these institutions to a college basis and, under any conditions, they very imperfectly perform the duties of secondary schools of agriculture. The University of Minnesota has in recent years maintained a school of agriculture (see Pl. II) in which instruction in agriculture of a lower grade than that given in the college of agriculture has been successfully imparted. This school has proved quite popular. Some 300 students were in attendance last year, and it has been found desirable to offer courses for girls as well as boys. The State of Alabama has recently provided for the maintenance of a school of agriculture of secondary grade in each of the nine Congressional districts of the State.

The establishment of such special schools of agriculture of high-school grade is greatly to be commended. One of the best effects of such schools at the present time is to show the people what distinctions should be drawn between colleges and high schools for agricultural education. By the separation of these grades of instruction the colleges will be enabled to do their proper work more efficiently, and better opportunities will be secured for those students whose previous training only fits them for high-school work in agriculture. But it is not believed that these special agricultural high schools will fully meet the needs of our farmers for agricultural instruction of this grade. Any school so distant from the farmer's home as to necessitate long journeys and residence at the school for two or more years must necessarily be too expensive for most of the farmers' children, especially after they have reached an age when their services may be more or less utilized on the farm. What is needed is courses in agriculture in numerous schools to which farmers' children resort, near their homes, to "finish" their education after they are through with the common schools.

It is believed that some such plan as the following would be practicable and beneficial for a large number of schools and students: Many of the rural high schools, normal schools, and academies (that is, any schools of higher grade than the common or district schools) now employ at least one teacher qualified to give elementary instruction in one or more natural sciences. As compared with the more thorough courses given in the colleges the instruction in many branches, such as rhetoric, history, botany, and chemistry, which is given in the high schools, consists of an outline or skeleton course, presenting in a systematic way the main features of the science. In this way the pupil learns some of the most important principles and, what is of more consequence, gets an idea of the course and tendency of modern progress in these lines of knowledge. This may form the basis for more thorough training afterwards, but even if it goes no further than the high school, the mental horizon of the student has at least been broadened for all his life, and the chances are that he will prove a

FIG. 1.--DAIRY BUILDING, UNIVERSITY OF MINNESOTA.

FIG. 2.—GIRLS' HOME BUILDING, SCHOOL OF AGRICULTURE, MINNESOTA.

more progressive and successful man than if he had confined his education to the common school.

Now, what is being already done in other subjects in the high schools may easily be done in agriculture. When a teacher of natural science is being selected for such a school located in or near a rural community, let one requisite be that he shall have had training in the science and practice of agriculture, preferably at an agricultural college. Such a teacher will be able to offer, it may be as an optional study, an outline course in the theory and practice of agriculture. The farmer's boy or girl may then take this course in agriculture in connection with other courses at the high school without going far or long from home. If he has had nature teaching in the common school he will be all the better prepared for this secondary course in agriculture, and the more practice he has had on the farm the better able he is likely to be to appreciate and profit by a systematic course in agriculture in the high school. It is of course not pretended that this outline course can take the place of the longer and more thorough courses at colleges and special schools of agriculture, but it will be far better than no course at all. It will open the mind of the pupil to the wonderful progress which is being made in agricultural science and practice. It will enable him to take more thorough advantage of the information furnished through books, bulletins of experiment stations, farmers' institutes, home reading clubs, etc. It will come to him at a time of life when he is making choice of his life occupation, and it is believed it will be a powerful incentive to keep those boys on the farm who are fitted to get the most in every way out of a farmer's life.

CONCLUSION.

In 1896, out of a total population of some 70,000,000 in the United States, 16,000,000 young persons were enrolled in the schools and colleges, of whom three-fourths, or 12,000,000, were in places of less than 8,000 inhabitants. In schools having secondary grades, that is, high schools, normal schools, and academies, it is estimated, from somewhat imperfect statistics, that there were 600,000 pupils in 7,000 schools. Probably 400,000 of these secondary-school students were in 5,000 schools, located in places having less than 8,000 inhabitants. If agriculture could be generally taught in schools of secondary grade, it is obvious that the effect would be widespread. How much more widely such instruction might be diffused than it is at present may be inferred from the fact that in 1897 there were in all only 64 colleges having courses in agriculture, which were taken by 3,930 students.

It is evident we are making much progress in devising and carrying out wise plans for the education of the farmer. With nature teaching in the common schools, high and normal school courses in agriculture, colleges of agriculture, experiment stations, farmers' institutes, home reading circles, and the agricultural press, the farmer would have a quite complete system of education in his art. This would bring agriculture well into line with the great commercial and manufacturing enterprises of our day, which owe so much to technical education, and would greatly help to take away from agriculture the reproach of being a "belated industry."

EVERY FARM AN EXPERIMENT STATION.

By Ervin E. Ewell,

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INTRODUCTION.

For many years the complaint has been rife in rural communities that the young people look upon the vocation of their parents as uninteresting and excessively laborious, while yielding small financial return and affording little opportunity for amusement. Many a youth has put forth every effort to leave the farm in order to spend his life in some commercial, industrial, or scientific pursuit, only to discover late in life that he has isolated himself from the very center of nature's activities and has abandoned a world of opportunities for scientific study in order to enter upon a life in many ways narrower and more monotonous than the one he scorned in his earlier years.

This is an age of endeavor on every hand to apply the results of scientific research to daily life; an age when laymen are learning the language of science, and when the tomes of scientific literature are being translated into the language of the multitude. Science has thoroughly established its reign over the industrial and commercial worlds, and now with renewed energy seeks for new territory in the home life of the people. This is evidenced by the fact that technical schools are now offering regular courses of instruction for the preparation of teachers of "domestic science," who are to enter upon the task of teaching, in the common schools and elsewhere, the applications of physics, chemistry, and biology to the conduct of the household. The results of scientific advancement are permeating the whole social structure. Science is to the modern civilization what the heart and circulating blood are to an animal. As each heart beat sends a wave of blood that extends to the minutest capillary vessels, so each new discovery goes out from the little group of investigators as a mighty pulsation that sends an enlivening thrill throughout the entire civilized world—a thrill that is felt the more strongly by the individual the nearer he is in education and training to the authors of the discovery. Pulsations of this sort have been coming to the farmer with ever-increasing vigor for more than half a century; but the lessening of the distance between the mass of the rural population and the busy scientists has not kept pace with the rate of discovery.

APPLICATION OF SCIENCE TO AGRICULTURE.

The national Department of Agriculture, our agricultural colleges, experiment stations, granges, farmers' clubs, reading circles, and institutes, aided by writers on agricultural topics in books, periodicals, and the columns especially devoted to these subjects in the press of the country, have done much to foster an appreciation of the breadth and interest of the science of agriculture when studied for its own sake, for financial profit, for pleasure, or for the benefit of mankind. The usefulness of each one of these agencies is becoming greater every day. A very large proportion of a daily increasing store of knowledge, the result of years of research and experimentation, is thus being gradually wrought into the form of popular literature and made available to every farmer and farmer's son studious enough to seek them out and read them. We can scarcely hope that the time will come when every farmer in the land will be a graduate of an agricultural school, but it is quite possible that the vast majority of our rural population may speedily acquire the habit of spending the long winter evenings studying the fundamental principles of the natural sciences, in order that they may profit by the results of experiments made in all parts of the world. The winter is the time for planning the work of the busy summer days to follow. All available literature, old and recent, should be carefully and systematically searched for ideas that can be applied in the work of the following summer. It is scarcely possible to do this without learning something that will make the work of the future easier, pleasanter, and more profitable.

There is a very large proportion of the experimental work necessary to the speedy advancement of agriculture that can only be done by thoroughly trained scientists, working with costly and elaborate apparatus, and by carefully planned systematic methods. Another part can be done as well or even better on the farm. Even experiments of the first class have not fulfilled their usefulness until their results have been applied by the farmer in his practical work. Each quality of soil presents a distinctly different problem. There need never be any fear of lack of work for the trained scientists, for, no matter how diligent and fruitful their labors, one of the most conspicuous results of their work for many years to come must be a better appreciation of the great unknown still to be explored.

The farmer's greatest discouragement in entering upon scientific studies is the fact that the scientist speaks in a language unknown to him. The farmer and the scientist must meet halfway. The one must struggle to acquire as much as practicable of the technical language of science; the other must record his results in scientific language and also in the language of the layman. All persons working for the advancement of scientific agriculture should therefore renew every effort to narrow the gulf between the scientists and the hosts of practical agriculturalists, and to develop among the latter a better appreciation of their opportunities for conducting experiments that will be interesting and profitable for themselves, their neighbors, and their descendants. The farmer should be shown that the technicalities of agricultural science are not so intricate as they at first appear. A few hours in study will cause such words as nitrogen, potash, superphosphate, carbohydrate, etc., to acquire a world of meaning and interest. By devoting a few hours every week to the reading of agricultural literature, it is possible for every farmer to be informed in regard to the current advances in his industry. The expense of the necessary books and periodicals can be greatly lightened by organizing clubs and establishing libraries of agricultural literature. A very considerable part of the time of every scientific worker is taken up with the study of the reports of his fellow-workers. It is not only necessary that the farmer should become a student in order to begin experimental work in the right way, but he must remain a student in order to continue his trials of new methods with success and make his farm truly an experiment station.

THE READING CIRCLE AS A MEANS OF RURAL EDUCATION.

One of the most potent agencies that have been devised for popularizing agricultural science is the home reading circle. "Farmers' reading circles," or "extension departments," have been established in connection with the agricultural colleges of several States, among them Pennsylvania, New York, Michigan, Connecticut, and West Virginia. The first-mentioned circle is the oldest, and has considerably the largest membership. This circle and the Michigan circle alike offer five courses on crop production, horticulture, dairying, and like subjects, and when any student passes a satisfactory examination upon a given number of these subjects he receives a certificate.

The extension department of Storrs College in Connecticut offers one course for men and another for women, and sends a member of the faculty to deliver one or more lectures before each circle of ten or more. Commencement exercises are planned for June, 1898. After the text-book course is completed a library of 100 volumes will be placed at the disposal of the circle.

These schools number hundreds of students each in this extension work, and there is a prospect for a rapid increase of membership till nearly every farmer's home in these States will have such a student. The institution of such courses in other States is to be expected. Further information as to opportunities for farmers to study the sciences underlying their art may be found in a paper by A. C. True, Director of the Office of Experiment Stations, on "Popular education for the farmer in the United States," pp. 279–290, this volume. With such facilities every farmer may easily acquire sufficient scientific knowledge to conduct experiments profitably on his own land.

IMPORTANCE OF SCIENCE TO THE FARMER.

Whatever may be the ultimate uses of the products of the farm, agriculture is primarily engaged with the economical nutrition of plants and animals. Agricultural science deals with the relations of physics, chemistry, and the biological sciences to every phase of every problem that the farmer may meet in his daily work. There is ample material in the results of the investigations that have been made in any one of the many branches of agricultural science to illustrate the value of scientific study to the farmer, and to plan a long series of experiments that can be successfully carried out on any well-regulated farm. In the present paper the writer will consider the importance of certain chemical studies of plant nutrition, and describe a few experiments in this line that can be appropriately undertaken by the farmer.

All food for men and animals is directly or indirectly the product of vegetable life. Therefore, before the nutrition of animals and men can be achieved to the best advantage, a thorough acquaintance with the laws governing the nutrition of plants is necessary. For the successful production of any plant an abundant supply of every kind of food necessary for its growth must be present in a readily available form in the soil or in the air. It is just as impossible to grow plants in a soil containing only available nitrogen and potash, or lime and phosphoric acid, or silica and iron, as it is for a carpenter to build a modern frame house with only window glass and nails, or with only boards and mortar. It is just as useless to expect a plant to thrive in a soil deficient in potash, even though abundantly manured with nitrogen and phosphoric acid, as it is to expect the carpenter to build the house with a million feet of lumber and no nails. It is quite as futile to attempt to feed a plant nitrogen in the form of coarse leather scrap as it would be to furnish the carpenter the iron he is to use for nails in the form of pig iron. In brief, every vegetable structure is made up of certain indispensable chemical elements, which must be accessible in available form throughout the period of its growth. It is one of the most important duties of the agricultural scientist to learn what these indispensable elements are and how most economically to supply them in highly available form to growing plants.

PREPARATION OF THE PLANT'S FOOD IN THE SOIL.

The preparation, or rendering available, of plant food for the growing crop is just as important as is the preparation of food for human beings. Much has been learned during comparatively recent years in regard to the manner in which nitrogenous foods are prepared in the soil for the use of plants. While various organic compounds containing nitrogen and salts of ammonia appear to be assimilated to some extent by agricultural plants, it is nitric acid in the form of nitrates that is preeminently their best food. The nitrogen of ammonia salts and organic matter is rapidly changed to nitrates by the microorganisms of the soil, and thus prepared for the use of the plants by processes which have been clearly described in a paper by H. W. Wiley, chief of the Division of Chemistry, on "Soil ferments important in agriculture," in the Yearbook for 1895, pp. 69–102. The speed with which ammonia salts are changed to nitrates depends upon the presence and activity of the nitrifying organisms in the soil and the maintenance of the conditions which favor their growth. The nitrogen of organic matter must first be brought to the form of ammonia by the organisms of putrefaction before it can be nitrified. The proneness to putrefaction of any organic substance will therefore determine the availability of its nitrogen for the nutrition of vegetable life. The better suited an organic substance is for food for the organisms of putrefaction, the sooner will its nitrogen be changed to a form suitable to serve as food for the higher plants. In the light of these facts it is not difficult to understand why the nitrogen of an old shoe is less available as a plant food than the nitrogen of a piece of meat.

The important conditions governing the activity of the nitrifying organisms are little or no acidity and an abundant supply of air and moisture. The moisture, however, must not be so excessive as to prevent the air for any considerable period from permeating the soil.

Experiments made in the laboratory of the Division of Chemistry of the Department have shown the nitrifying organisms from widely separated regions of the United States to be so extremely sensitive to an excess of acid that this is a sufficient reason in itself for every farmer to try the effect of lime on all soils not known to be of a decidedly calcareous nature.

Experiments recently made in France by Dehérain show that stirring the soil greatly increases the rate of nitrification. This result suggests a series of interesting experiments that can be made on any farm. After the land has been plowed for any crop (preferably winter wheat) and harrowed in the usual manner to even up the surface, select a representative strip across the field and stir the soil of this strip to a depth of 3 to 4 inches with a cultivator or spring-tooth harrow every day or two throughout the entire period intervening between the plowing and the sowing of the seed. If there is any benefit to be derived from this treatment it should be manifest in the better growth of the crop. Its true value can of course only be found by comparing the cost of the extra work with the increased yield obtained. It is logical to suppose that any treatment of the soil which will hasten the formation of nitrates from the less available forms of nitrogen in the soil will insure a prompt and vigorous growth of the young plants.

FARM MANURES.

Every farmer has in the unmerchantable residue of his crops and in barnyard manure a valuable means of maintaining the fertility of his soil. If these materials are carefully and systematically returned to the land, the first purchase of commercial fertilizers can be postponed for a considerable time. On a well-managed farm it ought never to be necessary to purchase quantities of potash and phosphoric acid greatly in excess of the amounts actually sold as constituents of the products of the farm. These substances undergo no loss in the decomposition of carefully preserved manures and crop residues, and are usually not readily washed away by rain waters flowing over or percolating through the soil. With nitrogen it is quite different. This element is very likely to be lost in the decomposition of its organic compounds under the action of bacteria, and in the form of nitrates is very readily washed out of the soil. Of the elements necessary for the growth of plants and most likely to be deficient in the soil (potash, phosphoric acid, and nitrogen), from 60 to 90 per cent of the quantities contained in the food of animals are recovered in the manure. The fertilizer value of ordinary food for farm animals ranges from $1 to more than $20 per ton. In the case of many foods the fertilizing value may nearly or quite equal their commercial value. The manure should be considered just as much a part of the return from the feeding of farm animals as are meat, milk, labor, or salable animals. Indeed, the values of the manures produced by sheep, calves, cows, and horses have been stated at from $24 to $30 per year per 1,000 pounds of live weight, and for pigs at $60 per 1,000 pounds of live weight. These figures are based upon actual experiments reported by the Cornell Agricultural Experiment Station.

No farmer would think of allowing the unnecessary loss of a pound of meat, milk, or wool, or of a day's labor of one of his draft animals, but many of them allow as much as one-half of the value of their barnyard manure to go to waste each year. The importance of care in the preservation of manure has been emphasized in the publications of the Department and of the experiment stations of several of the States. Many experiments have been made in this country and in Europe to determine the nature, causes, and means of preventing the losses which occur during the collection, storage, and use of stable manure and crop residues. The causes of losses may be enumerated as follows:

(1) Imperfect collection of the liquid excreta, which possess even greater value than do the solid excreta.

(2) The decomposing action of microorganisms contained in the intestinal tract of animals and in the air, by which there is likely to be a considerable loss of nitrogen, either in the form of ammonia or in the form of uncombined nitrogen.

(3) The exposure of manure to the leaching action of rains or of rain water as it runs from the eaves of buildings, by which the loss of its valuable constituents is very great.

(4) All stable manures and the refuse of many farm crops (particularly straw) contain organisms which cause the liberation of nitrogen in the gaseous form, when grown in favorable media containing nitrates. There is, therefore, a constant danger that the conditions

of the soil may be favorable for the growth of these denitrifying organisms, and that they will cause a considerable loss of nitrogen by rapidly destroying the nitrates contained in the soil. These organisms decrease in number and activity when the manure is stored for some time. In view of these facts, it is evident that fresh stable manure and nitrates should never be applied to the soil at the same time.

(5) It has been the practice among some farmers to incorporate all the straw possible with manures, in order to facilitate the rotting of the straw and thus increase the availability of the plant food contained in it. Considering the objection to inoculating the soil with the denitrifying organisms contained in straw, the practice of plowing under large quantities of this material in the unrotted state is questionable.

COLLECTION AND APPLICATION OF MANURE.

The results of the most recent experiments indicate that manure should be collected in a pit having impervious walls and bottom; that it should be thoroughly compacted and kept well moistened; that it should be protected from the leaching action of falling rain and from streams of rain water flowing from the roofs of buildings or from higher adjacent ground. A farmer could not plan an experiment more interesting and instructive to himself and his neighbors than one designed to determine the relative fertilizing value of manure when carefully and when carelessly stored. The danger of loss in storing manures argues that it is best to apply them to the land as soon as possible. On the other hand, the presence within them of organisms capable of rapidly destroying nitrates already formed in the soil suggests that manures should be stored in such a manner and for such a time as will lessen or destroy the activity of this class of organisms. The bacteriologist, the chemist, and the practical farmer must join hands in trying to solve this problem, which is one of the most important in agricultural science. The scientists must seek out every organism found in manures, study the conditions which favor or hinder its growth, and determine the properties of the substances which are formed during its growth. The farmer, in the meantime, should make careful tests in the field in order to determine the applicability of a given result to his peculiar conditions. It is a comparatively easy task to manure one portion of a field with fresh manure and another portion with manure which has been stored under definite conditions for a certain time. For this purpose the manure produced by a given set of animals should be collected separately for a convenient period (one week, for example), stored where it can be kept moist, closely packed, and sheltered from the leaching action of rain. The storage period may vary from one month to one or more years. When the time for preparing the soil has arrived the manure should be collected for the same period of time as was the stored manure and from the same set of animals fed in the same way. The fresh and stored manures should each be applied to equal areas of land of the same kind. The crops should be harvested separately and the relative yields determined.

A similar experiment should be made with straw or with other crop residues which are not used for fodder or for the bedding of animals. The experiment can be conveniently made with land on which straw is to be used as a manure for winter wheat. While the animals are in the pasture during the summer most farms will have a shed which can be used for this purpose. Weigh one or two loads of straw and pile it up in this shed as early in the spring as it is no longer needed for sheltering the animals. Keep the pile of straw thoroughly moistened until it is time to prepare the land for sowing wheat. The more thoroughly and continuously moist the straw is kept the more rapidly it will decompose. When the time comes to plow for wheat select two convenient equal areas of similar soil and apply this decomposed straw to one and to the other a quantity of "bright," unweathered straw equal to the quantity of straw placed in the shed for decomposition.

In this experiment it is to be expected that, other things being equal, a somewhat better result would be obtained with the decomposed straw than with the fresh, because the rotting has increased the availability of the plant food contained in the former. This factor can be eliminated and a more positive test of the nitrate-destroying power of the fresh straw obtained by treating a portion of each of these experimental plots with liberal applications of nitrate of soda, superphosphate, and potassic manure. In the latter case, equal yields may be expected on both plots, unless the denitrifying organisms contained in the fresh straw cause a destruction of the soil nitrates.

A SUPPLY OF NITROGEN AT A MINIMUM COST.

We have seen that nitrogen is the element most likely to be lost in the storage of manures, and is the one most easily removed from the soil by percolating water. It also costs nearly three times as much per pound as do phosphoric acid and potash.

Nitrogen occurs as a constituent of a multitude of organic compounds, as ammonia or its salts, as nitrous and nitric acids, which combine with bases to form nitrites and nitrates, and as the uncombined nitrogen of the atmosphere. Combined nitrogen in any one of the first three forms, as offered for sale in high grade fertilizing materials, costs the farmer from 12 to 15 cents per pound. Luckily, we have a means of drawing a supply of this element from the immense store of uncombined nitrogen in the atmosphere. The medium by which we are able to bring this nitrogen into combination for the use of plants and animals is the nitrogen-fixing organisms found in the root nodules of leguminous plants (clover, beans, peas, vetches, lupines, serradella, etc.). These organisms and the advantages of leguminous crops for green manuring and for feeding animals have been frequently described in the publications of the Department and elsewhere. No opportunity should be lost, however, to emphasize the importance of this means of obtaining nitrogenous food for agricultural plants. Not only should leguminous plants be used in all cases for green manuring, but they should be grown as extensively as practicable for food for animals. They require little or no nitrogenous fertilization, produce fodders richer in nitrogenous matter than do the grasses and other nonleguminous plants, and for the same weight of food produce a more valuable manure.

There is one precaution necessary to insure the maximum amount of nitrogen being taken from the air by a given leguminous plant. The soil must contain a sufficient number of the particular variety of bacteria suited to form nodules on the species of leguminous plants to be grown. Pure cultures of the particular variety of organism suited to assist the growth of each species of leguminous plants are manufactured and offered for sale in Germany. These cultures have been tried for two years with varying results in England and on the continent of Europe for the inoculation of soils which are to produce plants of this order. Inoculation experiments have also been made by taking soil from fields on which a given leguminous plant has flourished and distributing it over the field on which the next crop of the same species is to be grown. The directions of Salfeld-Lingen for making inoculations with soil may be recommended for trial on the farms of this country. A translation of these directions, as published in Annales Agronomiques, follows:

RULES TO BE OBSERVED IN THE USE OF SOILS FOR INOCULATION OF OTHER SOILS WITH NITROGEN-FIXING ORGANISMS.[1]

(1) For the different varieties of clover, the soil to be used for the inoculation should be taken from a field on which clover has grown well, and on which the last crop of clover has not been followed by serradella, peas, vetches, or lupines.

(2) The same rule is to be followed for serradella, peas, and other leguminous plants.

(3) As the leguminous tubercles which contain, or have contained, the nitrogen-fixing bacteria are in the layer of arable soil situated at a depth of 2 to 8 centimeters (1 to 3 inches) from the surface, care should be exercised to take precisely this layer of soil for the inoculation. After the soil has been selected and collected it should be well pulverized and mixed to facilitate its spreading over the field to be inoculated.

(4) The soil to be used for the inoculation should be applied as soon as possible after its collection. It may be sown with the hand or with a fertilizer drill.

(5) If the soil can not be distributed immediately it is to be preserved in piles and protected from the cold by covering it with a layer of sod.

(6) It is important that these organisms, which possess no power of movement,

[1] Deutsche landwirtschaftliche Presse, 1897, No. 11; Ann. Agron., 1897, 23, 287–288.

be well distributed through the soil by a thorough harrowing, after the inoculating material has been distributed over the field, in such a manner that the bacteria will be brought into the layer of soil situated 2 to 8 centimeters (1 to 3 inches) below the surface.

(7) If kainite has been applied to the field it should be well harrowed in before sowing the soil to be used for inoculation.

(8) As has been stated above, the inoculating material should be mixed with the soil immediately after it has been sown. This is especially necessary when the weather is dry and the sun is very hot.

(9) Burying the inoculating material too deeply must be avoided. Deep working is only permissible after the inoculating material has been distributed through the upper layers of the soil by a thorough harrowing.

(10) When it is not necessary to transport the soil used for inoculation to a very great distance there should be no fear of using too much. At least 5,000 kilos may be used per hectare (4.5 tons per acre).

(11) In general, an inoculation is not necessary when a certain leguminous plant has already been cultivated with success on a given soil and no other leguminous plant has subsequently been grown on the same soil.

In making experimental inoculations it must be remembered that the best results can be expected only when the growing plants are abundantly supplied with available phosphoric acid and potash. In planning an experiment to determine the cause of the poor growth of any leguminous plant, the field, or a portion thereof, should be divided into eight parts. One series of four of these should be inoculated according to the above directions, and the other series of four left uninoculated. On one plot of each of these two series use no additional fertilizers; to another plot of each series apply a liberal dressing of superphosphate; treat the third plot of each series with an abundant application of some potash salt; to the fourth plot in each series add both phosphoric acid and potash. In addition, a narrow strip embracing portions of each of the eight plots can be appropriately treated with lime, unless the soil is known to be already well supplied with this substance.

USE OF "CATCH CROP" TO MAINTAIN A SUPPLY OF NITROGEN IN THE SOIL.

The ease with which nitrates are washed out of the soil by excessive rainfall indicates that the ground should be covered by crops that will use the soil nitrates for their growth during the fall and winter months in climates where there is an abundance of rain during this period of the year. Some crop should, therefore, be started in the late summer or autumn, before or after the removal of corn, potatoes, and similar crops. For this purpose leguminous plants are eminently suited, since they not only feed upon the nitrates formed during the summer, but they also have the power of feeding upon the nitrogen of the air. The time-honored practice of sowing clover with wheat in the spring is especially to be recommended, as the young clover plants develop rapidly after the removal of the wheat crop. By the judicious use of "catch crops" in this manner whenever the soil would otherwise lie barren, the supply of nitrogen already in the soil can not only be preserved, but it can be increased by drawing upon the unlimited store of atmospheric nitrogen. Plants thus produced may be used for feeding or may be plowed under as a green manure when the land is needed for the next crop.

MINOR SOURCES OF PLANT FOOD.

When the manure produced upon the farm is found insufficient, a careful study should be made of all available sources of plant food. Each farmer should consider the cost and suitability for his soil of every sort of fertilizing material obtainable. Farmers living near cities should consider the availability for their use of street sweepings and other forms of city refuse. When the farm wagon is sent to the city with a load of produce it is often a simple matter to take home a load of sweepings or other fertilizing material that would otherwise be used to fill up low ground or to pollute some small inland stream. Many of these materials will need to be composted in order to prepare them for application to the land. Any waste animal or vegetable matter not infected with the germs of some disease of man or animals can be appropriately used for the purpose. The making of composts will be found described in any good book on agriculture, but the chemical changes taking place in compost heaps, as well as the microorganisms which cause these changes, strongly call for further study. It may be stated for the present, however, that nitrogenous fertilizers which are already in condition to go on the field should never be composted, because of the danger of losing a part of their nitrogen. Almost any farmer, by carefully looking about him, can discover more or less plant food going to waste which can be obtained for nothing, or at a very small cost. Methods for composting animal refuse, etc., are fully described by Storer and other writers on agriculture.

COMMERCIAL FERTILIZERS.

When we recall that from 7 to 135 pounds of nitrogen, from 3 to 55 pounds of phosphoric acid, and from 3 to 36 pounds of potash are sold with every ton of produce leaving the farm, it is easily understood that sooner or later some of these important plant foods must be returned to the soil. But among the greatly diversified soils of our country there are some in which all of these ingredients do not become deficient at the same time. Some soils are especially well supplied with phosphoric acid, others with potash, and others with nitrogen, while still others are deficient in only one of these three elements of fertility. For example, Professor Hilgard mentions a California soil containing 1,400 pounds of sodium nitrate per acre in the first foot of soil.

It is therefore the duty of every farmer to determine the needs of each one of his fields and then to study the best means of supplying these deficiencies. It is to be hoped that we will soon be able to develop chemical methods for quickly determining what plant foods are lacking in a given soil. This, however, is impracticable in many cases at present. The results of fertilizer tests made at our experiment stations are of inestimable value, but it has not yet been possible to establish a station or substation on every variety of soil. Indeed, many farms include two or more widely different types of soil or of land so situated as to require different treatment. Taking into consideration the writings on agricultural science and the results obtained by the experiment stations, each farmer should inaugurate a series of experiments to determine the best system of fertilization and crop rotation for him to adopt. It must not be expected that a given practice of farming will be the best indefinitely. Father, son, and grandson can not expect successfully to grow the same crops, on the same soil, in the same rotation, and with the same manuring.

The relative prices of various farm products and of various commercial fertilizers change from year to year, and the successful farmer must change his practice accordingly. He must strive continually to improve his methods so as to realize the greatest margin between the cost of production and the selling price of his products.

As has been well established for several years, the four elements of plant food which he will chiefly need to consider are nitrogen, phosphoric acid, potash, and lime. The first three are usually the more important, but the fourth one can not be neglected except on soils known to contain it in abundance. Lime may be needed as a plant food, to correct excessive acidity, and to aid in the decomposition of the organic matter of the soil and the liberation of other plant foods. In purchasing fertilizers a guaranty of the percentages of the active constituents just named should always be insisted upon. In applying them to the soil a careful record should always be kept of the total quantity of fertilizer and the actual weight of each of the active ingredients actually applied to each acre or other definite area of land. Until the utility of a given method of manuring has been demonstrated beyond question the fertilizer should be omitted from a representative portion of the field, in order that the difference in the yield on fertilized and unfertilized portions can be observed. The only satisfactory way of determining this difference is to harvest separately and actually weigh and note the quality of the product from equal areas selected in fertilized and unfertilized parts of the field. The difference in value of the two yields can then be compared with the cost of the system of fertilization employed. Far too often the farmer is satisfied merely to note the difference in color or height of the crops growing on fertilized and unfertilized portions of the field.

When there is no other means of forming an opinion in regard to the nature of the supply of plant food in the soil of any farm, its fields should be divided into eight representative portions. These portions should be so arranged as to prevent as far as possible the vitiation of the results of the experiment by differences in the character of the soil. One of the portions of each field should be fertilized with nitrogen; a second, with phosphoric acid; a third, with potash; a fourth, with nitrogen and phosphoric acid; a fifth, with nitrogen and potash; a sixth, with phosporic acid and potash; a seventh, with nitrogen, phosphoric acid, and potash, and an eighth should be left unfertilized. In addition, lime should be applied to a strip of land so selected as to cross each of the plots just mentioned. The value of the experiment would be increased by dividing each of the plots into two portions and applying to one part just one-half of the dose of fertilizing material applied to the other part. This would give an indication of the proper quantity of plant food to be applied. Whenever leguminous crops can be made to form a part of a rotation, nitrogenous manures are preferably applied to the other crops of the rotation.

Any farmer desiring to undertake a systematic experiment of this kind should apply to the experiment station of his State for instruction in regard to the details of the work, especially in regard to any modifications of the experiment advisable for his particular locality.

FARM RECORDS.

The value of fertilizer tests and of all experimental work on the farm is largely lost if accurate and complete records are not kept of the conditions and results of each experiment. There is probably no other industry having an equal amount of capital invested in which as little bookkeeping is done as is the case with farming. The farmer should keep an accurate record of the crop growing on each field each year, the quantity and chemical composition of fertilizers used, the yield obtained, the cost of production, and the selling price of the product. Means of weighing are now at hand on a very considerable proportion of farms, and a little time is all that is needed to produce records that will become of inestimable value in a very few years.

Similar records should be kept of the results of feeding animals for the production of milk or meat. The quantity, kind, and value of the food, the length of the period of feeding, the weight, age, and cost of the animals at the beginning, and their weight and value at the end of this period should be noted in the case of animals fed for meat production. For dairy cows, the weight of milk, butter, etc., produced should also be noted.

All records should be kept which are necessary to enable the farmer to know at what cost he produces each bushel of wheat, corn, and oats, and each pound of meat, milk, butter, wool, etc.

OTHER LINES OF STUDY FOR THE FARMER.

Only one of the many branches of agricultural science has been drawn upon for illustrating the importance of scientific study to the farmer. We have considered at some length the value of a knowledge of the laws governing plant nutrition, a knowledge necessary for the successful production of plants suitable for the food and comfort of man and the domestic animals. It is not only necessary to know how to feed plants, but there must be methods for combating the numerous diseases that so often attack them. By studying the laws of animal nutrition the farmer will also be able to lower the cost at which he produces meat, wool, dairy products, eggs, etc., as well as to reduce the cost of producing and maintaining his draft animals.

THE FRUIT INDUSTRY, AND SUBSTITUTION OF DOMESTIC FOR FOREIGN-GROWN FRUITS.

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INTRODUCTION.

The fruit industry, considered from the commercial standpoint, is of recent development in the United States. The colonists of the Atlantic Slope and the Mississippi Valley found a great variety and abundant supply of wild fruits and nuts in the forests. Those who came from England and other North European countries found indigenous representatives of most of their familiar fruits and nuts about their new homes, together with many which were new to them. They had but to gather of the abundance which surrounded them in summer and devise means for storing it for winter use. The pioneers of the lower Pacific Coast, on the contrary, found few attractive indigenous fruits, and were dependent upon such as they introduced and cultivated for their fruit supply, which was, therefore, from an early day, chiefly exotic.

FRUITS FOUND AND USED BY THE EARLY COLONISTS.

The chronicler of the expedition sent out by Raleigh to explore in the vicinity of Hatteras said of the grapes observed there that he had visited those parts of Europe in which this fruit was most abundant, and that the difference in quantity in favor of Roanoke was quite incredible.

Ralph Lane, in reporting his observations in 1585–86, pronounced the grapes of Virginia to be larger than those of France, Spain, or Italy.

John Smith found "Chestnuts whose wild fruit equalize the best in France, Spaine, Germany, or Italy to their tast[e]s that had tasted them all." He early learned to discriminate between the green and the ripe persimmon, for he states: "Plumbs there are of three sorts. The red and white are like our hedge plumbs; but the other, which they call Putchamins grow as high as Palmeta. The fruit is like a medler; it is first green, then yellow, and red when it is ripe; if it be not ripe it will draw a man's mouth awrie with much torment; but when it is ripe it is as delicious as an Apricot." He mentions also chinquapins, cherries, crab apples, and grapes, of which last named the colonists made "neere 20 gallons of wine, which was neere as good as your French Brittish wine." He describes at length the Indian methods of drying nuts and persimmons for the winter supply and of preparing them for food, and mentions among other summer fruits "strawberries which ripen in April" and "Mulberries which ripen in May and June;" he also mentions gooseberries and raspberries as abundant.

The New England colonists made similar reports. In the words of one who was at Plymouth in 1622, "The chestnut, hazlenut, beechnut, butternut, and shagbark yielded contributions to the store of food laid up for winter. Wild cherries, mulberries and plums enlarged the variety of the summer's diet. Wild berries, as the strawberry, the gooseberry, the raspberry, the whortleberry, the cranberry, grew in plenty in the meadow and champaign lands. Vines bearing grapes of tolerable flavor flourished along the streams." Rev. Francis Higginson, writing from the Massachusetts colony in 1629, says: "Excellent vines are here, up and down in the woods. Our governor hath already planted a vineyard with great hopes of encrease; also mulberries, plums, raspberries, corrance, chestnuts, filberts, walnuts, smalnuts, hurtleberries, and hawes of white thorne, neer as good as our cherries in England, they grow in plentie here." William Wood, who came in 1629, reports, "There is likewise Strawberries in abundance, verie large ones, some being two inches about; one may gather halfe a bushell in a forenoone. In other seasons there be Gooseberries, Bilberries, Resberries, Treacleberries, Hurtleberries, Currants; which being dried in the Sunne are little inferior to those that our Grocers sell in England." He seems to have been a man of discriminating taste, for, unlike other writers of the period, he tempered his praise of some with condemnation of others, as in the following lines: "The Cherrie trees yield great store of Cherries which grow on clusters like grapes; they be much smaller than our English cherry, nothing neare so good if they be not fully ripe, they so furre the mouth that the tongue will cleave to the roofe, and the throat wax hoarse with swallowing those red Bullies (as I may call them), being little better in taste. English ordering may bring them to be an *English* cherry but yet they are as wilde as the *Indians*. The Plummes of the Countrey be better for Plumbs than the Cherries be for Cherries; they be black and yellow about the bignesse of a Damson, of a reasonable good taste. The white thorne affords hawes as big as an English Cherrie which is esteemed above a Cherrie for his goodness and pleasantnesse to the taste." In his account, "New England's prospect," we find that comparisons of latitude and climate were being made with a view to determine the possibilities of domestic wine production, for he says "vines afford great store of grapes which are very bigge, both for the grape and Cluster, sweet and good; These be of two sorts, red and white, there is likewise a smaller kinde of grape which groweth in the Islands, which is sooner ripe and more delectable; so that there is no knowne reason why as good wine may not be made in those parts as well as in *Burdenaux* in *France*. being under the same degree." * * *

Roger Williams found the strawberry "the wonder of all the fruits growing naturally in these parts. In some places where the natives have planted I have many times seen as many as would fill a good ship within a few miles compass."

William Penn, writing in 1683, mentioned chestnuts, walnuts, plums, strawberries, cranberries, whortleberries, and grapes as growing naturally in the woods, and questioned whether it was best to attempt to improve the fruits of the country, especially the grapes, by the care and skill of art or to send for foreign stems and sets, already good and approved. It seemed to him most reasonable to believe that a thing grows best where it grows naturally, and that it would hardly be equaled by another of the same kind not naturally growing there.

The abundant and varied supply of indigenous fruits in the Mississippi Valley and Lake regions is still a matter of recollection among the surviving pioneers and their descendants.

CULTIVATION OF NATIVE FRUITS.

Recorded efforts to improve the native fruits by cultivation are more numerous in connection with the colonies in Virginia and Pennsylvania than in New England.

The abundance of indigenous fruits along the James naturally suggested to the colonists the wisdom of attempting their cultivation, and efforts in this direction were encouraged by the Virginia Company. As the wine supply of the mother country came entirely from foreign lands the company sought to encourage the culture of the grape in the Jamestown colony. The first efforts in this direction seem to have been made with the native grapes, the productiveness, size, and quality of which were so highly praised by the early settlers.

Lord Delaware, who arrived in 1610, brought with him French vine dressers, who, soon after their arrival, proceeded to transplant the native vines. We have no record of the outcome of this experiment nor of that of Dale, who, soon after the settlement at Henrico, in 1611, established a vineyard of 3 acres, in which he planted the vines of the native grape to test their adaptability to the production of wines that could be substituted for those of France and Spain.

In 1619 the Virginia Company sent several French vine dressers, with many slips of the finest vines that Europe afforded. These vine dressers reported that the grapes of the colony far excelled those of their native Languedoc, both in abundance and variety, and that they had planted their cuttings at Michaelmas and obtained grapes from them in the following spring. By an act of the assembly of that year every householder was compelled by law to plant ten cuttings and to protect them from injury. He was expected at the same time to acquire the art of dressing a vineyard, either by special instruction or by personal observation. Such favor in the shape of bounties was bestowed upon those who actively engaged in vine culture that vineyards were established containing as many as ten thousand vines.

The wines sent to England failed to equal the expectations of the promoters, their inferior quality being ascribed at the time to the defective manner of manufacture. Some ascribed it to the perverseness of the vine dressers, who were thought to have concealed their knowledge out of spite against their employers, and by way of punishment the assembly refused to grant them permission to cultivate tobacco, to which crop they had probably turned to gain a subsistence.

Penn's inclination to favor the cultivation of native rather than introduced fruits has already been noted. But the failure of the native grapes to yield a good quality of wine whenever tried seems to have diverted attention from their improvement and that of other native fruits for about a century, and to have stimulated efforts to introduce the fruits of the Old World in the several colonies.[1]

INTRODUCTION OF EXOTIC FRUITS.

The first recorded effort at introducing foreign fruits was made by the Jamestown colonists in May, 1607. Within two weeks after their arrival on Jamestown Island they had cleared land for sowing English wheat, and had reserved a space for a garden, in which were planted seeds of fruits and vegetables not indigenous to the country, including the melon, the potato, the pineapple, and the orange. These had doubtless been obtained by the colonists at Dominica or elsewhere in the West Indies while en route. The fate of the effort, so far as the pineapple and orange are concerned, may safely be left to the imagination.

The importation of cuttings of European vines in 1619 has already been noticed. In 1622, in compliance with the request of the authorities of the colony, the Virginia Company made provision for dispatching to Jamestown a pinnace containing not only wheat and barley, but also garden seeds and scions of fruit trees.

What success attended this effort is not recorded, but it is not unlikely that the apples, pears, peaches, apricots, vines, figs, and other fruits which Smith stated in 1629 "some have planted that prospered exceedingly" resulted from it. Certain it is that in 1647 the apple is recorded as grafted upon wild stocks in Virginia, while in 1686 William Fitzhugh, in describing his own plantation, mentions "a large orchard of about 2,500 apple trees, most grafted, well fenced with a locust fence."[2] By the close of the seventeenth century there

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[1] For historical outline of improvement of native fruits, see "Century of American horticulture," by L. H. Bailey, in Florists Exchange for March 30, 1895.

[2] Letter of William Fitzhugh, April 22, 1686, Economic History of Virginia in the Seventeenth Century, by Phiiip Alexander Bruce, Vol. II, p. 243.

were few plantations in Virginia without orchards of apple, peach, pear, plum, apricot, and quince.

Frequent attempts were made to introduce in cultivation the fruits of the Mediterranean region. Importations of trees or cuttings of olives, lemons, oranges, pomegranates, and figs are frequently mentioned in the colonial records, but of these none but the fig is recorded as being successfully grown. Of this fruit, Smith wrote in 1629 that one Mistress Pearce, of Jamestown, an honest, industrious woman, had gathered from her garden in one year "neere an hundred bushels of excellent figges."

Of early introductions to New England, a memorandum was made March 16, 1629, "to provide to send for New England, Vyne Planters, Stones of all sorts of fruits, as peaches, plums, filberts, cherries, pear, aple, quince kernells, pomegranats, * * * also currant plants." It is a reasonable inference that these were sent, and that some of these and others succeeded with the colonists, for John Josselyn states in 1639 that the master of the ship in which he sailed from Boston October 11, 1839, "having been ashore upon the Governors Island, gave me half a score very fair Pippins which he brought from thence." After his second sojourn in New England, 1663–1671, he stated, "fruit trees prosper abundantly, Apple-trees, Pear-trees, Quince-trees, Cherry-trees, Plum-trees, Barberry-trees. I have observed with admiration that the kernels sown or the Succors planted produce as fair & good fruit without grafting as the Tree from whence they are taken; the Countrey is replenished with fair and large Orchards." "The Quinces, Cherries, Damsons, set the Dames a work; Marmalad and preserved Damsons is to be met with in every house." While on board ship, Josselyn was informed by one Mr. Woolcut (a magistrate in Connecticut colony) that he had made 500 hogsheads of cider from his own orchard in one year.

According to family tradition, a pear tree which stood near the mansion on Governor Endicott's farm was imported in 1630. Certain it is that Endicott soon after this propagated young trees (probably seedlings) and furnished them to other colonists both by gift and in exchange for land. Frequent importations of seeds, scions, and grafted trees, together with propagation from those already noticed, both by seeds and grafts, brought the orchards of New England up to such point that Dudley, in 1726, stated in a paper in the Philosophical Transactions, "our Apples are, without doubt as good as those of England, and much fairer to look to, and so are the Pears, but we have not got all the Sorts. * * * Our People of late years, have run so much upon Orchards, that in a village near Boston, consisting of about forty Families, they made near ten Thousand Barrels [of cider]."

Perhaps the earliest recorded grafted tree brought from Europe (that of Governor Endicott is stated to have been a seedling) was the

Summer Bonchretien, planted by Governor Stuyvesant in 1647 in New Amsterdam. It is said to have been brought from Holland, and its trunk remained standing on the corner of Third avenue and Thirteenth street, New York City, until 1866, when it was broken down by a dray. Many of the earliest introductions of named varieties of the pear, including White Doyenne, St. Germain, Brown Beurre, Virgouleuse, etc., were made by the French Huguenots, who settled about Boston and New York shortly after the revocation of the Edict of Nantes in 1685.

The early French colonists established orchards and vineyards along the rivers and lakes of the interior soon after their arrival. Through the agency of trappers and appreciative Indians, these fruits were soon widely distributed. Seedling trees of apple, pear, and peach were found bearing fruit in isolated localities throughout the Mississippi Valley and in the vicinity of the Great Lakes when the later settlers migrated there previous to the year 1800.

There is ample evidence that by the beginning of the present century few established homesteads in the Eastern United States were without a home supply of apples in their season, while many had peaches, pears, plums, cherries, and other fruits. But aside from the sale of cider made from apples, brandy from peaches, and, in a few localities, wine from wild or cultivated vines of the native grape, commerce in domestic fruits or their products could hardly be said to exist.

THE BEGINNING OF FOREIGN TRADE IN FRUITS.

The beginning of the foreign fruit trade of the United States is with difficulty distinguished at this time, but it seems to have started with the receipt of a shipment made in 1621 by the governor of Bermuda to the Jamestown colony. It consisted of "two great Chests filled with all such kinds and sorts of Fruits and Plants as their Ilands had; as Figs, Pomegranats, Oranges, Lemons, Sugar-canes, Plantanes, Potatoes, Papawes, Cassado roots, red Pepper, the Prickell Peare, and the like."[1] This was followed within a few months by the arrival in Bermuda from Virginia of "a small Barke with many thanks for the presents sent them; much Aquauitae, Oile, Sacke, and Bricks they brought in exchange of more Fruits and Plants, Ducks, Turkies, and Limestone; of which she had plenty and so returned."[2] As intercourse was frequent, there was undoubtedly a considerable import trade in such fresh fruits of the Tropics as would endure sail transportation between the more southern coast colonies and the West Indies, though little is on record to bear witness to the fact.

At what time the trade in the fruit products of southern Europe began is not known, but it was doubtless at an early day. The

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[1] Capt. John Smith's Works, p. 681.

[2] Ibid., p. 682.

inventory of the Hubbard store, York County, Va., in 1667, discloses the following items: "Twenty-five pounds of raisins, one hundred gallons of brandy, and twenty gallons of wine."

As most of the dried and preserved fruits of the Mediterranean region were then considered luxuries rather than necessities, it is likely that the trade in them did not become important until the colonies had accumulated considerable wealth. It probably became an important item before the Revolution, and was, no doubt, seriously interfered with during the second war with England. It is a tradition among the fruit dealers of New York City that when it was desired to celebrate the signing of the Treaty of Peace in 1814 by a grand banquet, only a half barrel of raisins and currants and a box or so of citron could be found in the city for the making of a plum pudding.[1]

In 1821, when the Treasury Department published its first statement of imports and exports, the imports of fruits and nuts, of which currants, raisins, figs, plums, prunes, and almonds are separately stated, amounted to 2,878,873 pounds, valued at $181,035.

At about this time notices of auction sales of the fruits mentioned, and of oranges, lemons, Malaga grapes in jars, tamarinds, citron, Madeira nuts, and filberts were of frequent occurrence in the market reports of New York City.

The export trade seems to have begun with the apple, as a large supply existed in close proximity to the seaport towns. Trade in this fruit with the West Indies probably developed early in the eighteenth century, though we have no record of shipments until 1741, when it is stated that apples were exported from New England to the West Indies in considerable abundance. No transatlantic shipment has been disclosed earlier than that of a package of Newtown Pippin of the crop of 1758 sent to Benjamin Franklin while in London. The sight and taste of these brought to John Bartram, of Philadelphia, an order for grafts of the variety from Franklin's friend Collinson, who said of the fruit he ate: "What comes from you are delicious fruit—if our sun will ripen them to such perfection." Subsequently a considerable trade must have resulted, for in 1773 it was stated by the younger Collinson, that while the English apple crop had failed that year, American apples had been found an admirable substitute, some of the merchants having imported great quantities of them. In his words: "They are, notwithstanding, too expensive for common eating, being sold for two pence, three pence, and even four pence an apple. But their flavor is much superior to anything we can pretend to, and I even think superior to the apples of Italy."

Statistics on the subject are lacking until 1821, when the total export of fruit included in the Treasury statement consisted of 68,443 bushels of apples, valued at $39,966.

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[1] Letter from Hon. Antonio Zucca, January, 1898.

STATISTICS[1] OF THE FOREIGN FRUIT TRADE.

Since 1821 it has been possible to trace with some degree of accuracy the course of the foreign trade in fruits. With this end in view, a table showing the imports for the fiscal year 1821 is given; also tables showing average annual quantity and value by decades and imports by years since 1891 of each fruit itemized in the Treasury reports.

Imports of fruits during the fiscal year 1821.

Fruits.	Quantity.	Value.
	Pounds.	
Currants	24,688	
Figs	259,617	
Plums and prunes	125,300	
Raisins in jars	1,030,240	
All other raisins	1,174,210	
Almonds	264,818	
	2,878,873	$181,035
Olive oil ... gallons	49,530	51,680

DRIED FRUITS.

RAISINS.

The largest item by far among the fruit imports of 1821 was raisins, more than three-fourths of the total quantity imported consisting of this fruit. During the decade ending 1840 the average annual quantity imported, as shown in the table, was nearly three times as great as during the first decade. Later the rate of increase was less, though imports continued to grow larger until the year 1884, when the maximum importation—56,676,657 pounds, valued at $3,545,916.15—was reached. Since that time, in consequence of domestic production, almost wholly in California, the imports have diminished to about one-fifth of the maximum in quantity and to a little less than one-seventh in value. The following tables show the average annual imports of raisins by decades, 1830 to 1890, and imports by years, 1891 to 1897, inclusive:

Average annual imports of raisins, by decades.

Decade ending—	Quantity.	Value.
	Pounds.	
1830	4,437,939	
1840	13,203,732	[1]$787,793.00
1850	13,492,060	580,488.00
1860	19,008,255	1,086,238.00
1870	21,468,783	1,279,256.00
1880	33,731,861	2,209,215.00
1890	41,817,016	2,646,226.00
1891-1897	18,473,610	878,713.87

[1]Average annual value for eight years, 1833 to 1840, inclusive.

[1] All statistics of imports prior to 1868 in these tables are from the Treasury statements of "imports;" beginning with that year they are from "imports for consumption."

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RAISIN GRAPES.

1. GORDO BLANCO, MUSCATEL. 2. ALEXANDRIA, MUSCAT.

Imports of raisins, by years.

Year.	Quantity.	Value.
	Pounds.	
1891	37,174,186	$1,962,642.55
1892	18,873,670	927,247.44
1893	23,598,985	1,125,522.60
1894	13,660,498	566,626.90
1895	13,888,095	593,118.64
1896	10,202,086	443,285.00
1897	11,917,756	532,554.00

The introduction of the raisin varieties of grape to California is credited by Eisen to Col. Agoston Haraszthy, who, in 1852, imported vines of the Alexandria *Muscat* from Malaga, and in 1861 brought cuttings of Gordo Blanco from the same place. Numerous importations were made in subsequent years by different persons, but not until 1863 is there record of the production of cured raisins. In that year the late Dr. John Strentzel, of Martinez, exhibited at the California State Fair specimens of Muscat raisins, together with the dried fruit of four other varieties of grapes, to show the contrast between raisins and dried grapes. In 1873, 6,000 boxes, mostly from two vineyards in Solano and Yolo counties, were produced. In that year the first planting of raisin varieties was made at Fresno, and at Riverside in the same year, after which time the increase in production was rapid, 20,000,000 pounds having been produced in California in the year 1889, according to Eisen.

According to the California State Board of Horticulture, the shipments of raisins out of the State in 1896 amounted to nearly 69,000,000 pounds, a quantity considerably less than that of the three preceding years. The largest crop yet marketed, that of 1894, is estimated at 103,000,000 pounds. So far as can be seen, the production is capable of indefinite future increase, the recent low price of the product alone holding it in check.

The varieties of grape chiefly grown for curing into raisins are Gordo Blanco, *Muscatel*, and Alexandria *Muscat*, small second-crop clusters of which, from John Rock, Niles, Cal., 1897, will be found illustrated on Pl. III. In addition to these, there is an increasing production of the Sultana and the variety known in California as "Thompson Seedless."

Recently the seeding of raisins by machinery has been successfully inaugurated, so that at the present time California "seeded" raisins are on sale in small packages in all the leading cities.

"CURRANTS."

Imports of "currants" (the small seedless raisins of Greece) have varied greatly in quantity and value from year to year, but have on the average shown a continuous increase in quantity and value until recently. The maximum quantity was reached in 1894, when, under stimulus of an expected levy of duty, the quantity imported reached 52,350,053 pounds, valued at $773,952. The maximum value occurred in 1891, when 42,849,314 pounds, valued at $1,577,852.15, were imported. The following tables show the average annual imports of currants by decades, 1830 to 1890, and imports by years, 1891 to 1897, inclusive:

Average annual imports of currants, by decades.

Decade ending—	Quantity.	Value.
	Pounds.	
1830	189,523	
1840	[1] 489,747	[1] $41,772.00
1850	1,334,631	60,860.00
1860	3,176,464	165,316.00
1870	5,886,839	196,447.00
1880	16,491,727	649,900.00
1890	28,189,074	1,022,075.00
1891-1897	34,505,448	872,941.02

[1] Average annual quantity and value for eight years, 1833 to 1840, inclusive.

Imports of currants, by years.

Year.	Quantity.	Value.
	Pounds.	
1891	42,849,814	$1,577,852.15
1892	36,665,728	1,209,095.75
1893	33,166,364	1,185,532.00
1894	52,350,053	773,952.00
1895	15,936,019	250,658.00
1896	32,351,985	540,694.25
1897	28,218,176	572,803.00

Currants, though long tested in a small way, have not up to this time been largely produced in this country. Vines of "Sultana" and "Corinth" grapes were imported as early as 1854 by the Patent Office and distributed in the "Middle and Western States," but like other varieties of the *vinifera* species did not succeed. At present prices there is little inducement for their production in California, but recent experience in certain localities in that State indicates that any marked rise in price would be followed by a considerable production of currants.

PLUMS AND PRUNES.

Plums and prunes to the quantity of 125,300 pounds were imported in 1821, and with the exception of the decade ending in 1850 a continuous and rapid increase in both quantity and value is shown by the annual averages until after 1890. The maximum importation occurred in 1888, when 82,914,579 pounds were received, valued at

$2,679,759.16, though the maximum value, $3,084,304.10, was attained in 1882. Since 1891 the decrease has been rapid, the quantity received in 1897 being less than one-eleventh and the value less than one-fortieth of that of 1892. The following tables show the average annual imports of plums and prunes by decades, 1830 to 1890, and imports by years, 1891 to 1897, inclusive:

Average annual imports of plums and prunes, by decades.

Decade ending—	Quantity.	Value.
	Pounds.	
1830	146,929	
1840	584,969	[1] $50,656.00
1850	398,422	32,233.00
1860	3,833,635	200,854.00
1870	6,333,531	318,405.00
1880	25,108,911	1,360,180.00
1890	56,928,640	2,214,184.00
1891-1897	14,323,463	682,626.56

[1] Average annual value for seven years, 1834 to 1840, inclusive.

Imports of plums and prunes, by years.

Year.	Quantity.	Value.
	Pounds.	
1891	41,012,571.0	$2,139,215.00
1892	10,374,874.0	496,078.72
1893	23,225,821.0	1,049,896.48
1894	8,749,349.5	413,769.51
1895	15,311,695.0	533,748.21
1896	852,944.0	71,512.54
1897	736,987.0	74,165.46

The importance and rapid increase of the imports of prunes led to early efforts at their production in this country. Coxe, whose work was published in 1817, describes as grown in his time two varieties, "Prune plum" and "Prune Suisse," but does not discuss their usefulness for drying.

In 1854, when scions of "Prune d'Agen" and "Prune Sainte Catherine" were imported by the Patent Office and distributed "principally in the States north of Pennsylvania and certain districts bordering on the range of the Alleghany Mountains, in order to be engrafted upon the common plum," great hopes were held that this region would soon produce an abundance of the cured fruit. It was estimated at that time that the State of Maine alone, where the curculio was rarely seen, was "capable of raising dried prunes sufficient to supply the wants of the whole Union."

But though the trees thrived and produced fruit, as in the case of the fig in the South, the climatic conditions of the Eastern United States were found unfavorable to the production of the cured product.

The commercial production of prunes in this country may therefore be said to trace to a package of scions brought to San Francisco from France in 1856 by Pierre Pellier, and by him sent to his brother Louis at San Jose, Cal. But not until 1870, according to Lelong, was a large orchard planted. This was near San Jose, and its success led to the planting of numerous others from 1878 to 1881, since which time the industry has been firmly established on the Pacific Coast. The first cured prunes were exhibited at the California State Fair in 1863, and are said to have been of the German variety. As recently as 1881 the output of the largest growers in California did not exceed 5 or 6 tons of cured fruit per annum. The California production for 1896 was estimated at 55,200,000 pounds, a quantity which will be largely increased in the near future by the product of trees already planted but not yet of bearing age.

Outside of California the principal prune production is in Washington, Oregon, and Idaho. The Italian prune (syn. *Fellenberg*) was introduced into Oregon from the Eastern States by Seth Lewelling in 1857, and is the leading variety grown outside of California. In recent years plantings of this and other sorts in the States mentioned have been very large. The latest available estimate at this writing of the crop of 1897 in Oregon and Washington places it at 12,000,000 pounds of cured fruit. It is safe to conclude that the present prune-producing capacity of the orchards of the United States exceeds 100,000,000 pounds of cured fruit annually. The leading varieties grown in California at the present time are Agen (syns. *d'Agen*, *Petite*, *Petite d'Agen*, *French*, *California*), Sergent, *Robe de*, and Golden Drop, *Coe* (syn. *Silver Prune*), while the leading variety of the more northern district is Italian (syn. *Fellenberg*). These, with Epineuse, *Imperiale*, a promising variety recently imported from France, are illustrated on Pl. IV. The specimens shown on the plate are from the following sources: Agen, Sergent, and Golden Drop, from Leonard Coates, Napa, Cal., 1897; Italian, from the late Seth Lewelling, Milwaukee, Oreg., 1891; Epineuse, from John Rock, Niles, Cal., 1897. Numerous other European varieties are grown in a small way, and a number of promising local seedlings are commercially planted in different sections.

FIGS.

Figs constituted an important item in 1821, when 259,217 pounds were imported, and notwithstanding a considerable domestic production in recent years, the average annual imports continue to increase. The maximum quantity was reached in 1896, when 11,635,493 pounds, valued at $629,488, were imported, though the greatest value in any year was that of 1882, when it amounted to $678,341.87. The

PRUNES.

1. EPINEUSE, IMPERIALE. 2. SERGENT, ROBE DE. 3. GOLDEN DROP, COE.
4. AGEN, SYNS. D' AGEN, PETITE D' AGEN, "FRENCH," "CALIFORNIA."
5. ITALIAN, SYN. FELLENBURG.

DRYING FIGS.

1. Smyrna.
2. Smyrna Section.
3. Adriatic.
4. Adriatic Section.

following tables show the average annual imports of figs by decades, 1830 to 1890, and imports by years, 1891 to 1897, inclusive:

Average annual imports of figs, by decades.

Decade ending—	Quantity.	Value.
	Pounds.	
1830	760,769	
1840	1,656,164	[1] $83,696.00
1850	1,569,201	81,435.00
1860	4,171,327	184,128.00
1870	3,565,301	185,262.00
1880	5,436,912	370,949.00
1890	7,942,451	497,204.00
1891-1897	9,630,155	548,812.00

[1] Average annual value for seven years, 1834 to 1840, inclusive.

Imports of figs, by years.

Year.	Quantity.	Value.
	Pounds.	
1891	9,063,653	$672,141.00
1892	8,324,861	510,591.03
1893	10,060,092	549,485.22
1894	7,930,316	372,613.50
1895	11,559,092	574,393.45
1896	11,635,493	629,488.00
1897	8,837,572	532,974.50

The early efforts at the production of figs have already been noted. Frequent importations of plants and cuttings of choice varieties were made, and at one time the hope was expressed that the South Atlantic and Gulf States would produce a sufficient supply of the dried fruit to supplant the imported article. Such has not been the fact, however, the humidity of the air during the ripening period having been found to prevent successful curing, though a family supply for immediate consumption and preserving has long been produced on the homesteads of many portions of that region. At Biloxi, Miss., and New Orleans, La., a considerable pack of canned and preserved figs is now made annually, the Celeste being preferred by canners for this use.

In California the fig was introduced by the Franciscan missionaries from Lower California, who, led by Junipero Serra, established a mission at San Diego in 1769 and later at twenty other points within the present boundaries of the State. The most widely grown and popular variety in the State until comparatively recent times was known as the California Black, or Mission, fig, but it has largely been replaced by the sort known in California as Adriatic, which, according to Eisen, was twice imported from Italy between 1867 and 1877. This variety (see Pl. V, specimen from G. C. Roeding, Fresno, Cal., 1897) is at present the most widely planted drying fig in California. It has many points of merit, but the fact that its quality when dried is inferior to that of the imported dried fruit from Smyrna has resulted in several efforts to introduce and grow the Smyrna types of fig.

A large importation of cuttings from Smyrna was made in 1882 by G. P. Rixford for the San Francisco Bulletin and distributed widely throughout the State. Since then other importations have been made, trees from which are growing at different places. Among these importations several valuable figs are found, one of which, at least, is of superior quality for drying; but so far as tested they fail to produce fruit unless artificially pollinated. It is now generally conceded that this type of fig can not be commercially grown except by the process of caprification, which is practiced upon it in Asia. A specimen, from G. C. Roeding, Fresno, Cal., 1897, of the Smyrna fig brought to full maturity by hand or "blowpipe" pollination in 1897 is illustrated on Pl. V. As more than three-fourths of our imports of figs are now of the Smyrna type, a prompt and thorough test of caprification would seem advisable. The present annual production of cured figs in California is about 2,500,000 pounds.

DATES.

The first statistics of date importations are found in 1824, when 44,426 pounds were imported. The average annual importation shows an increase in each period save that ending in 1850. The maximum for any year, both in quantity and value, occurred in 1891, when 20,091,012 pounds, valued at $661,596.41, were received. As no dates have yet been commercially grown in this country, the causes of the continuous decrease in imports since 1891 must be found elsewhere than in domestic production.

The following tables show the average annual imports of dates by decades, 1830 to 1890, and imports by years, 1891 to 1897, inclusive:

Average annual imports of dates, by decades.

Decade ending—	Quantity.	Value.
	Pounds.	
1830	[1] 44,426	
1840	[2] 429,355	
1850	[3] 362,227	[3] $5,056.00
1860	1,553,679	28,881.00
1870	1,718,248	41,103.00
1880	4,059,331	107,682.00
1890	8,884,713	284,132.00
1891–1897	15,193,490	422,913.37

[1] Quantity for one year, 1824.
[2] Average annual quantity for three years, 1831 to 1833, inclusive.
[3] Average annual quantity and value for eight years, 1843 to 1850, inclusive.

Imports of dates, by years.

Year.	Quantity.	Value.
	Pounds.	
1891	20,091,012.00	$661,596.41
1892	17,089,367.00	551,648.26
1893	16,248,515.00	494,628.51
1894	12,408,409.00	387,584.01
1895	14,716,765.00	308,595.45
1896	13,575,254.96	270,723.89
1897	12,225,111.00	285,617.06

TAMARINDS.

Tamarinds were first separately scheduled in 1873, when 54,429 pounds were received, valued at $2,422.10. There has been a regular increase in the annual average since that time, though the imports fluctuate greatly from year to year. There is no domestic commercial production of this fruit. The following tables show the average annual imports of tamarinds by decades, 1880 to 1890, and imports by years, 1891 to 1897, inclusive:

Average annual imports of tamarinds, by decades.

Decade ending—	Quantity.	Value.
	Pounds.	
1880	[1] 16,542	[2] $644.49
1890	[3] 52,145	1,976.11
1891–1897	....	2,891.10

[1] Average annual quantity for seven years, 1873 to 1876, inclusive, and 1878 to 1880, inclusive.

[2] Average annual value for eight years, 1873 to 1880, inclusive.

[3] Average annual quantity for five years, 1881 to 1885, inclusive.

Imports of tamarinds, by years.

Year.	Value.
1891	$6,233.00
1892	5,471.00
1893	1,401.00
1894	1,247.00
1895	470.00
1896	2,716.76
1897	2,609.00

Fresh Fruits and Fruit Products.[1]

ORANGES.

Auction sales of oranges from the Mediterranean were of frequent occurrence in New York City early in the present century, but no separate mention of oranges in the schedules of imports appeared until 1855, when their value is given as $476,694. During the four years that this fruit was separately scheduled the imports varied from that amount to $753,695 in 1860. From 1862 to 1882, inclusive, oranges are not separately stated; but in 1883, when the item reappears, it amounts to $3,010,662.56. This was the maximum, and was followed by a decline, which reached its lowest point in 1894. The great freezes of 1894 and 1895 were promptly followed by largely increased importations, which probably reached their maximum in 1897, when a value of $3,341,646.64 was reached. The following tables show the average annual imports of oranges by decades, 1860 to 1890, and imports by years, 1891 to 1897, inclusive:

Average annual imports of oranges, by decades.

Decade ending—	Value.
1860	[1] $625,024.00
1870 [2]	[3] 481,641.00
1880 [2]	----------
1890 [2]	[4] 2,298,447.34
1891–1897	2,054,408.92

[1] Average annual value for three years, 1858 to 1860, inclusive.
[2] Oranges were included with lemons and limes from 1862 to 1865, and with lemons from 1866 to 1882, inclusive.
[3] Value for one year, 1861.
[4] Average annual value for eight years, 1883 to 1890, inclusive.

Imports of oranges, by years.

Year.	Value.
1891	$2,330,127.71
1892	1,210,080.90
1893	1,696,277.24
1894	1,111,059.15
1895	1,997,515.31
1896	2,694,155.50
1897	3,341,646.64

The sour orange is supposed to have been introduced to Florida soon after the settlement of St. Augustine in 1565. The species found a congenial home, and was soon widely scattered throughout the

[1] Not including wine and brandy.

peninsula. The sweet orange was undoubtedly introduced at a later date, and being easily propagated both by seeds and buds was generally distributed throughout the settled portions before the beginning of the present century. Commercial orange culture as now practiced did not begin until after the acquisition of Florida by the United States, and at first was confined to such eligible sites as existed along navigable water which afforded transportation for the fruit. After the close of the late war the industry grew with wonderful rapidity as railroads and steamboats made possible the shipment of the fruit for longer distances. In the season of 1886–87 over 1,000,000 boxes were marketed, and by 1894–95 the annual crop amounted to over 5,000,000 boxes. Since 1894–95 shipments have been comparatively insignificant, but with favorable seasons may be expected to reach 1,000,000 boxes by the year 1900.

A considerable production of oranges was developed in a limited district in southern Louisiana previous to 1886, but since the freeze of that year the crop of that district has been of little commercial importance.

In California the orange was planted in the mission gardens at an early date, and according to a recent writer in the Fruit Trade Journal the first orchard was planted at San Gabriel in 1804. An orchard was planted at Los Angeles by Don Louis Vignes in 1834, and General Bidwell reported that in 1845 the three largest orange orchards there were those of Wolfskill, Carpenter, and Vignes.

The present era of commercial orange growing in California dates from the foundation of the Riverside colony in 1872. The orange was largely planted early in the history of the colony, and after the adaptability of the Bahia (syns. *Washington Navel*, *Riverside Navel*, etc.), two trees of which were sent to Riverside by Mr. William Saunders, of the Department of Agriculture, in 1873, was demonstrated, it soon became, as it continues to be, the leading fruit of the district. Oranges are grown commercially in several portions of the State, but chiefly in southern California. It is estimated that the crop now being marketed from the State will exceed 3,500,000 boxes.

Oranges are also commercially grown in Arizona, shipments aggregating 149 car loads having been made from Phœnix in a single week of December, 1897.

LEMONS.

Imports of lemons were first separately stated in 1858, when they amounted to $301,492. From 1862 to 1882, inclusive, lemons were not separately scheduled, but in 1883 the imports had risen in value to $2,555,787.49. The maximum was reached in 1896, when lemon imports amounted to $5,027,732.95. The tables on page 322 show the average annual imports of lemons by decades, 1860 to 1890, and imports by years, 1891 to 1897, inclusive.

Average annual imports of lemons, by decades.

Decade ending—	Value.
1860	[1] $345,957.00
1870 [2]	[3] 215,903.00
1880 [2]	
1890	[4] 3,024,557.95
1891–1897	4,450,725.74

[1] Average annual value for three years, 1858 to 1860, inclusive.
[2] Included with limes and oranges, 1862 to 1865, and with oranges from 1866 to 1882.
[3] Value for one year, 1861.
[4] Average annual value for eight years, 1883 to 1890, inclusive.

Imports of lemons, by years.

Year.	Value.
1891	$4,345,979.08
1892	4,560,261.17
1893	4,993,829.87
1894	4,284,815.92
1895	3,917,106.75
1896	5,027,732.95
1897	4,025,354.49

Lemon production on a commercial scale in Florida is commonly traced to the introduction of choice Mediterranean varieties by General Sanford about 1874. Much difficulty was for some years experienced in determining the proper methods of curing and marketing the fruit, and just as a reasonable degree of success was attained the freezes of 1894 and 1895 destroyed a very large proportion of the groves of the State. As the lemon is less hardy than the pomelo and orange, comparatively little interest in its culture has been manifested in Florida since 1895.

In California commercial lemon culture is also of comparatively recent date, a beginning having been made at National City by F. A. Kimball in 1869. It is estimated by the California Fruit Grower that on January 1, 1897, there were 1,197,098 lemon trees in orchards in the State, of which 231,510 were of bearing age. The crop of 1896–97 which, as nearly as could be determined, amounted to 462,900 boxes, is likely to show a large annual increase and to greatly reduce importations of this fruit.

LIMES.

Limes were first separately scheduled in 1858, when imports amounted to but $2,024. So far as can be ascertained, the maximum importation was reached in 1891, when the value was $59,867.35. A distinct decrease has occurred since then, the imports of 1897 amounting to but $28,700.29. The following tables show the average annual imports of limes by decades, 1860 to 1890, and imports by years, 1891 to 1897, inclusive:

Average annual imports of limes, by decades.

Decade ending—	Value.
1860	[1] $3,321.00
1870	[2] 10,170.00
1880	[3] 29,795.80
1890	48,765.70
1891-1897	41,437.46

[1] Average annual value for three years, 1858 to 1860, inclusive.
[2] Value for one year, 1861.
[3] Average annual value for nine years, 1872 to 1880, inclusive.

Imports of limes, by years.

Year.	Value.
1891	$59,867.35
1892	37,829.45
1893	47,196.36
1894	48,763.50
1895	28,103.63
1896	39,601.69
1897	28,700.29

Though grown in a small way in southern Florida since an early date, the lime has never risen to distinct commercial importance there, while in California, except possibly in a few specially favored localities, its cultivation for market has not been attempted.

IMPORTS OF ORANGES, LEMONS, AND LIMES COMBINED.

To show clearly the growth of the trade in the more important citrus fruits, tables showing the combined average annual imports of oranges, lemons, and limes by decades, 1860 to 1890, and imports by years, 1891 to 1897, inclusive, together with tables of such of the more important manufactured products derived from the fruits mentioned as are capable of segregation, are given as follows:

Average annual imports of oranges, lemons, and limes, by decades.

Decade ending—	Value.
1860	[1] $837,102.33
1870	[2] 1,347,660.46
1880	[3] 3,661,843.56
1890	5,245,829.89
1891-1897	6,546,572.07

[1] Average annual value for six years, 1855 to 1860, inclusive.
[2] Exclusive of limes, 1866 to 1870.
[3] Exclusive of limes for 1871.

Imports of oranges, lemons, and limes, by years.

Year.	Value.
1891	$6,735,974.14
1892	5,808,171.52
1893	6,737,303.47
1894	5,444,638.57
1895	5,942,725.29
1896	7,761,490.14
1897	7,395,701.42

Average annual imports of lemon and orange oil, by decades.

Decade ending—	Quantity.	Value.
	Pounds.	
1870	[1] 51,897.00	[1] $102,217.78
1880	72,186.51	182,447.15
1890	154,217.61	211,321.96
1891-1897	225,731.00	285,320.63

[1] Average annual quantity and value for six years, 1865 to 1870, inclusive.

Imports of lemon and orange oil, by years.

Year.	Quantity.	Value.
	Pounds.	
1891	179,412.33	$270,255.39
1892	215,794.88	402,907.00
1893	222,830.72	383,226.22
1894	212,876.00	240,487.00
1895	238,281.00	216,043.00
1896	206,656.13	214,302.00
1897	304,270.90	270,023.82

Average annual imports of lemon, lime, and sour orange juice,[1] by decades.

Decade ending—	Quantity.	Value.
	Pounds.	
1870	....	[2] $8,662.97
1880	[3] 345,568	59,916.51
1890	[4] 553,277	92,434.30
1891-1897	....	112,076.48

[1] Lemon and lime juice only, previous to 1891.
[2] Average annual value for two years, 1869 and 1870.
[3] Average annual quantity for eight years, 1873 to 1880, inclusive.
[4] Average annual quantity for three years, 1881 to 1883, inclusive.

Imports of lemon, lime, and sour orange juice, by years.

Year.	Value.
1891	$140,672.80
1892	156,832.75
1893	195,203.59
1894	71,021.00
1895	61,884.00
1896	84,073.25
1897	74,848.00

Average annual imports of orange and lemon peel, by decades.

Decade ending—	Quantity.	Value.
	Pounds.	
1870		[1] $1,383.25
1880	[2] 115,600	6,225.51
1890	[3] 218,500	5,076.25
1891-1897		13,540.34

[1] Average annual value for two years, 1869 and 1870.
[2] Average annual quantity for two years, 1873 and 1874.
[3] Average annual quantity for three years, 1881 to 1883, inclusive.

Imports of orange and lemon peel, by years.

Year.	Value.
1891	$5,222.14
1892	5,185.78
1893	7,742.45
1894	11,734.00
1895	20,579.02
1896	15,853.00
1897	28,466.00

The above tables show that the total imports of the three fruits named were valued in 1897 at $7,395,701.42. If to this be added the value of imports of the principal manufactured products derived from them, viz, juice, oil, and peel, together with a reasonable estimate for items like pomeloes, preserved citron, orange and lemon peel, etc., known to be included under other heads, we may safely conclude that the value of our imports of products of the genus *citrus* in 1897 exceeded $8,000,000.

BANANAS AND PLANTAINS.

The history of the development of the import trade in bananas is one of the most striking features of the American fruit trade. According to the Fruit Trade Journal, a lot of 30 bunches was brought in 1804 by Captain Chester, of the schooner *Reynard*. In 1830 the first cargo, which consisted of 1,500 bunches, was brought, and not until 1857 was a regular trade developed between Baracoa and Boston. This continued until 1869, when an additional source of supply was needed, and Mr. William C. Bliss, the pioneer in the Baracoa banana trade, obtained a small cargo of the fruit at Port Antonio, Jamaica, and left an agent there to encourage its production. In 1870 he secured three cargoes and in 1871 seven cargoes from the same port.

Imports of bananas are first noted in 1871, when they amounted to $229,924.12 in value, and gradually increased until 1882, when they suddenly increased to $1,190,591.43, an amount nearly two and a half times as great as the average annual imports of the preceding decade. This sudden increase was in large measure due to the short fruit crop of the season of 1881 throughout the Eastern United States. The banana trade received great stimulus and the imported fruit became known and appreciated in many sections where it had been but rarely seen before; after 1881 it grew rapidly until 1891. Since the latter date there has been an apparently steady, though slow, decline in value, probably due to the increased supply of domestic fruits of other kinds. The chief sources of supply are the Central American States, Colombia, and the West Indies for the Eastern United States, and the Hawaiian Islands for the Pacific Coast. The following tables show the average annual imports of bananas by decades, 1880 to 1890, and imports by years, 1891 to 1897, inclusive:

Average annual imports of bananas, by decades.

Decade ending—	Value.
1880	$461,735.49
1890	2,372,241.43
1891-1897	4,943,082.20

Imports of bananas, by years.

Year.	Value.
1891	$5,855,682.04
1892	5,000,389.65
1893	5,361,183.34
1894	5,121,180.27
1895	4,673,833.83
1896	4,503,358.51
1897	4,085,947.82

The only domestic commercial production of bananas is in southern Florida, and this can hardly be said to furnish a local supply in the localities where grown.

The imports of plantains, which amounted to $7,596.23 in 1872, gradually increased until 1888, when a maximum of $31,786.38 was reached. Since that year there has been a decline in the value of imports. The following tables show the average annual imports of plantains by decades, 1880 to 1890, and imports by years, 1891 to 1897, inclusive:

Average annual imports of plantains, by decades.

Decade ending—	Value.
1880	[1] $10,902.81
1890	22,258.40
1891-1897	24,292.97

[1] Average annual value for nine years, 1872 to 1880, inclusive.

Imports of plantains, by years.

Year.	Value.
1891	$27,829.09
1892	31,124.45
1893	24,749.75
1894	17,731.85
1895	22,106.39
1896	19,264.55
1897	27,244.76

The plantain, though more highly esteemed in tropical countries than the banana, has never attained popularity in this country.

PINEAPPLES.

In view of the development of commerce with the West Indies at an early day it is probable that the pineapple, notwithstanding its perishable nature, was one of the first fruits that reached the South Atlantic ports.

Imports were not separately scheduled until 1871, when they amounted to $187,960.93. The value of imports increased until 1876, when a noticeable decrease occurred, lasting until 1881, when the minimum, $121,659.70, was reached. After this they increased until 1894, when the maximum, $753,129.32, was attained. The following tables show the average annual imports of pineapples by decades, 1880 to 1890, and imports by years, 1891 to 1897, inclusive:

Average annual imports of pineapples, by decades.

Decade ending—	Quantity.	Value.
	Barrels.	
1880		$201,766.04
1890		345,319.29
1891-1897	[1] 271,635.53	541,009.33

[1] Quantity for one year, 1897.

Imports of pineapples, by years.

Year.	Quantity.	Value.
	Barrels.	
1891		$558,287.77
1892		746,560.90
1893		743,861.22
1894		753,129.32
1895		314,539.09
1896		332,067.54
1897	271,635.53	338,619.53

Cultivation of pineapples in a small way in Florida probably began at an early day. A note in the New England Farmer for 1850 says: "The cultivation of the pineapple has been commenced in Florida, and with a little protection occasionally in winter, it is believed this delicious fruit can be raised in that State in abundance." This probably referred to efforts in the vicinity of St. Augustine, where the winter temperature is now known to be too low for this species.

In 1860 planting began on the Keys and proved so profitable that the area devoted to it has steadily increased, while its culture has extended northward along both the Atlantic and Gulf coasts of Florida, and, with shed protection, has been very successful at several points in the interior as far north as Orlando. According to Webber, about 3,000,000 fruits were produced in 1894. The freezes of the winter of 1894–95 temporarily checked the output of this fruit, but the recovery has been so rapid that a largely increased production may be expected in the future.

The variety most widely grown is the Spanish, but there is an increasing proportion of larger and better varieties, including Queen, Abbaka, Smooth Cayenne, and Porto Rico.

In California, pineapple culture is yet confined to experimental plantings, which, in one or two localities, have been fairly successful.

GRAPES.

The imports of fresh grapes consist almost entirely of the large and meaty grapes of Almeria, commonly known in our markets as "Malagas." Auction sales of such in jars, at 35 to 40 cents per pound, were of frequent occurrence in New York early in the present century, but they are not itemized in the statement of imports until 1865, when their value was $17,645. After this the increase was rapid and reasonably constant until 1894, when a value of $816,602 was attained. The maximum quantity, as near as can be ascertained, was in 1892, when 228,934 barrels of about 40 pounds each were imported. The tables on page 329 show the average annual imports of grapes by decades, 1870 to 1890, and imports by years, 1891 to 1897, inclusive.

Average annual imports of grapes,[1] by decades.

Decade ending—	Quantity.	Value.
	Barrels.	
1870		[2] $69,393.13
1880		241,235.91
1890		357,622.82
1891-1897	[3] 189,742.17	502,234.70

[1] Includes grape juice or pulp from 1871 to 1883.
[2] Average annual value for three years, 1865, 1869, and 1870.
[3] Average annual quantity for six years, 1892 to 1897, inclusive

Imports of grapes, by years.

Year.	Quantity.	Value.
	Barrels.	
1891		$534,820.80
1892	228,934.00	478,118.50
1893	158,869.57	485,763.50
1894	224,468.32	816,602.00
1895	149,791.91	335,110.00
1896	205,524.75	490,788.09
1897	170,864.51	374,440.03

On account of their firmness and long-keeping quality, these grapes occupy a position in our markets peculiar to themselves. At the present time they can hardly be said to compete with any domestic product, though by aid of refrigeration some of the meaty and late-ripening sorts of the *vinifera* type may be expected to lessen the demand for "Malagas" in future.

Though efforts at the commercial production of this type in California for shipment in the fresh state late in the season have not, up to the present time, been eminently successful, no adequate reason is known for believing that they will not be so in future when the climatic and soil conditions essential to their successful growth are better understood.

OLIVES AND OLIVE OIL.

Imports of olives were not scheduled until 1869, when they amounted to $28,896.60. A rapid increase in the annual averages has occurred since that time, the maximum value for a single year being $510,534.88 in 1893. Since then there has been a distinct diminution in the value imported, largely because of domestic production. The tables on page 330 show the average annual imports of olives by decades, 1870 to 1890, and imports by years, 1891 to 1897, inclusive.

Average annual imports of olives, by decades.

Decade ending—	Value.
1870	[1] $23,130.32
1880	51,535.23
1890	133,019.48
1891–1897	375,511.03

[1] Average annual value for two years, 1869 and 1870.

Imports of olives, by years.

Year.	Value.
1891	$320,163.77
1892	417,881.55
1893	510,534.88
1894	378,863.41
1895	325,352.10
1896	347,344.70
1897	328,436.84

Olive oil was largely brought in at an early date, the imports of 1821 having been valued at more than one-fourth as much as all the fruit imports of the year. Previous to 1862 no distinction was made between oil suitable for food and the inferior grades, but so far as can be determined from the schedules there has been a much more rapid increase in the imports of salad oil than of the inferior grades since that time. The imports of salad oil for 1897 were considerably in excess of those of any former year, being valued at $1,146,494.52. The following tables show the average annual imports of olive oil in casks, or other than salad, by decades, 1830 to 1890, and imports by years, 1891 to 1897, inclusive:

Average annual imports of olive oil, by decades.

[In casks, or other than salad.]

Decade ending—	Quantity.	Value.
	Gallons.	
1830	77,523	[1] $36,424.00
1840	197,191	[2] 147,008.00
1850	83,589	54,385.00
1860	131,944	92,475.00
1870	[3] 155,849	[3] 127,578.00
1880	121,678	90,301.00
1890	[4] 556,149	511,140.00
1891–1897	698,512	321,588.00

[1] Average annual value for four years, 1821 to 1824, inclusive.

[2] Average annual value for seven years, 1834 to 1840, inclusive.

[3] Average annual quantity and value for three years, 1862 to 1864, inclusive; includes quantity and value of all olive oil.

[4] Includes all olive oil for the seven years, 1884 to 1890, inclusive.

Imports of olive oil, by years.

[In casks, or other than salad.]

Year.	Quantity.	Value.
	Gallons.	
1891	709,496.19	$458,079.55
1892	600,379.00	255,867.00
1893	986,379.00	481,171.00
1894	391,691.00	180,212.00
1895	829,889.00	336,909.00
1896	846,123.60	317,975.00
1897	525,630.00	220,903.00

The following tables show the average annual imports of olive oil in bottles, or suitable for salad, by decades, 1860 to 1890, and imports by years, 1891 to 1897, inclusive:

Average annual imports of olive oil, by decades.

[In bottles, or suitable for salad.]

Decade ending—	Quantity.	Value.
1860 dozens	[1] 142,311.00	[1] $297,266.00
1870 gallons	[2] 142,860.00	[2] 260,620.00
1880 do	183,248.00	336,555.00
1890 do	[3] 235,307.00	[3] 413,824.00
1891–1897 do	937,216.39	909,246.15

[1] Average annual quantity and value for six years, 1855 to 1860, inclusive.
[2] Average annual quantity and value for seven years, 1861 and 1865 to 1870, inclusive; quantity for 1861 stated in dozens.
[3] Average annual quantity and value for three years, 1881 to 1883, inclusive.

Imports of olive oil, by years.

[In bottles, or suitable for salad.]

Year.	Quantity.	Value.
	Gallons.	
1891	395,731.42	$516,190.89
1892	685,079.98	852,655.11
1893	693,759.51	902,076.45
1894	744,438.91	900,013.10
1895	777,047.54	953,832.65
1896	918,629.40	1,093,460.39
1897	945,828.00	1,146,494.52

As early as 1634 an attempt was made to introduce the olive to Virginia, and at frequent intervals down to the present century its culture was attempted at different points in that State. In 1755 it was introduced at Charleston, S. C., by Henry Laurens, and again at the same point in 1785 by an incorporated society for the promotion of agriculture. In 1769 it was introduced by Dr. Turnbull, an Englishman, who founded a colony of Greeks and Minorcans at New Smyrna, Fla.; but nowhere in the Eastern States has it become of commercial importance.

In 1769 olive seeds were planted at San Diego, Cal., and some of the trees which grew from them are still in existence. These and others about the California missions demonstrated the suitability of the soil and climate to olive production at an early day, but not until after the American occupation of the Territory did olive culture assume commercial importance.

In 1872 Mr. Ellwood Cooper, of Santa Barbara, planted olive trees, from the fruit of which he made oil in 1876, and since that time the olive has become a favorite tree with planters in several counties in the State. Statistics of production are not obtainable, but the output of oil and pickled olives is increasing largely each year. It is estimated by the California Fruit Grower that there are 1,400,000 olive trees in orchard in California at the present time.

The superior cleanliness observed in the manufacture of oil in California, together with the guarantied purity of the product, can hardly fail to cause the domestic article to largely supplant the imported oil in our markets in the near future. The consumption of pickled olives in the United States is increasing rapidly, and the recent introduction of the variety from which the celebrated "Queen" olives of Spain are made, together with the superior quality of the pickled ripe olives packed in California, are likely to result in the displacement of the imported article. Two varieties, the Mission and Sevillano, are illustrated on Pl. VI, specimens from John Rock, Niles, Cal., 1897.

Miscellaneous Fruits.

The following tables show the average annual imports of fruits not separately scheduled by decades, 1860 to 1890, and imports by years, 1891 to 1897, inclusive. The number of items included under each head has varied greatly at different times, and distinct comparisons of the periods specified can not be safely made.

Average annual imports of fruits in juice, and fruit juice, by decades.

Decade ending—	Value.
1870	[1] $48,146.31
1880	106,425.70
1890	233,219.74
1891–1897	127,753.52

[1] Average annual value for six years, 1865 to 1870, inclusive.

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OLIVES.

1. MISSION

2. SEVILLANO.

Imports of fruits in juice, and fruit juice, by years.

Year.	Quantity.	Value.
	Pounds.	
1891	240,089.96	$52,199.22
1892		124,362.45
1893		84,394.90
1894		71,123.51
1895		131,692.08
1896		207,931.03
1897		222,571.48

Average annual imports of fruits preserved in brandy, sugar, etc., by decades.

Decade ending—	Value.
1860	[1] $129,615 50
1870	181,937.15
1880	343,066,16
1890	620,641.28
1891-1897	561,903.70

[1] Average annual value for six years, 1855 to 1860, inclusive.

Imports of fruits preserved in brandy, sugar, etc., by years.

Year.	Value.
1891	$368,960.94
1892	934,537.27
1893	780,352.44
1894	479,604.11
1895	479,400.21
1896	442,911.60
1897	447,559.39

Average annual imports of green, ripe, or dried fruits, not elsewhere scheduled, by decades.

Decade ending—	Value.
1860	[1] $185,249.66
1870	84,704,89
1880	138,326.58
1890	374,675.49
1891-1897	405,420.15

[1] Average annual value for six years, 1855 to 1860, inclusive.

Imports of green, ripe, or dried fruits, not elsewhere scheduled, by years.

Year.	Value.
1891	$535,711.22
1892	294,568.24
1893	435,716.38
1894	321,050.56
1895	361,894.09
1896	490,709.39
1897	398,291.23

Nuts and Nut Products.

ALMONDS.

The first nut imported in large quantity was the almond, of which 264,818 pounds were received in 1821. From that date until 1843 no other kind of nut is scheduled. In 1859 the imports had risen to 5,439,210 pounds, valued at $444,757. Since 1865 shelled almonds have been separately scheduled, and the imports, in this form, which began with 116,899 pounds, valued at $17,660, in that year, have risen to 5,798,354 pounds, valued at $683,446.34, in 1897. The extraordinary increase since 1890 in the imports of shelled almonds, as compared with almonds not shelled, is believed to be largely due to the fact that the several rates of duty that have prevailed during that period have been proportionately higher on almonds not shelled than on shelled almonds. The following tables show the average annual imports of almonds by decades, 1830 to 1890, and imports by years, 1891 to 1897, inclusive:

Average annual imports of almonds, by decades.

Decade ending—	Quantity.	Value.
	Pounds.	
1830	637,866	
1840	2,240,451	[1] $197,059.00
1850	1,493,692	113,840.00
1860	3,352,759	254,859.00
1870	2,290,157	234,621.00
1880	2,514,072	266,551.00
1890	3,121,444	309,318.00
1891-1897	3,500,835	264,218.73

[1] Average annual value for seven years, 1834 to 1840, inclusive.

Imports of almonds, by years.

Year.	Quantity.	Value.
	Pounds.	
1891	3,390,924.50	$292,510.85
1892	3,451,840.50	290,744.20
1893	2,780,011.00	270,742.00
1894	3,305,360.00	259,139.69
1895	4,178,419.00	281,296.21
1896	3,202,684.16	210,690.15
1897	4,196,609.00	244,408.07

Average annual imports of shelled almonds, by decades.

Decade ending—	Quantity.	Value.
	Pounds.	
1870	640,530	[1] $107,743.00
1880	980,873	169,417.00
1890	1,684,410	276,470.00
1891-1897	4,020,227	611,908.00

[1] Average annual value for six years, 1865 to 1870, inclusive.

Imports of shelled almonds, by years.

Year.	Quantity.	Value.
	Pounds.	
1891	3,046,750	$615,418.97
1892	3,598,551	667,179.46
1893	3,758,500	664,562.27
1894	3,505,178	519,584.34
1895	4,188,831	561,064.67
1896	4,245,426	572,105.70
1897	5,798,354	683,446.34

On account of its close relationship to the peach, the almond was at one time regarded as a very promising tree for the Eastern United States. Previous to 1855, the Patent Office distributed an importation of soft-shelled almonds to growers throughout the Middle and Southern States. Its early blooming habit and susceptibility to injury by late frosts soon demonstrated the fact that though the tree succeeded it was valueless as a producer of nuts even in the Gulf States. In California many of the earlier efforts at commercial almond culture were unsuccessful, either because they were made with unreliable varieties or in unsuitable localities. But in 1885, when Mr. A. T. Hatch exhibited a collection of thin-shelled seedlings from the bitter almond which had proved to be of superior quality for market, and bore regular crops, new life was given to the industry.

The production in California now varies from 500,000 to 2,500,000 pounds per annum, and the quality of the product compares favorably with all but the best of the imported nuts. Specimens of a number of the leading varieties grown in that State from John Rock, Niles, 1897, A. T. Hatch, Suisun, 1891, and from Malaga, Spain, through Charles Heath, former United States consul at Catania, Sicily, 1892, are illustrated on Pl. VII.

Almonds are also successfully grown in rather limited areas in Texas, New Mexico, Arizona, Nevada, Utah, Idaho, and Oregon.

ALMOND OIL.

So far as known no almond oil is produced in the United States. The following tables show the average annual imports of almond oil by decades, 1870 to 1890, and imports by years, 1891 to 1897, inclusive:

Average annual imports of sweet almond oil, by decades.

Decade ending—	Quantity.	Value.
	Pounds.	
1870	[1] 15,228.00	[1] $4,888.68
1880	25,165.00	9,203.39
1890	40,599.00	10,531.62
1891–1897	88,138.92	17,729.37

[1] Average annual quantity and value for eight years, 1863 to 1870, inclusive.

Imports of sweet almond oil, by years.

Year.	Quantity.	Value.
	Pounds.	
1891	51,384.0	$12,248.95
1892	60,670.5	13,636.35
1893	212,919.0	39,583.50
1894	59,730.0	12,682.45
1895	74,195.0	13,103.80
1896	71,480.0	13,791.00
1897	86,594.0	19,059.59

Average annual imports of bitter almond oil, by decades.

Decade ending—	Quantity.	Value.
	Pounds.	
1880	3,454.76	$11,428.45
1890	3,573.58	8,969.59
1891–1897	6,632.92	10,604.53

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ALMONDS.

1. DRAKE. 1A. DRAKE KERNEL. 2. LANGUEDOC. 2A. LANGUEDOC KERNEL. 3. NONPAREIL. 3 A. NONPAREIL KERNEL. 4. PRIMA. 4 A. PRIMA KERNEL. 5. NE-PLUS-ULTRA. 5 A. NE-PLUS-ULTRA KERNEL. 6. IXL. 6 A. IXL. KERNEL. 7. JORDAN. 7 A. JORDAN KERNEL.

Imports of bitter almond oil, by years.

Year.	Quantity.	Value.
	Pounds.	
1891	4,795.00	$9,958.00
1892	6,149.00	11,023.00
1893	8,165.80	11,532.89
1894	4,101.00	6,981.00
1895	6,549.00	10,566.00
1896	6,195.75	12,141.83
1897	10,471.90	12,029.00

FILBERTS AND WALNUTS.

These nuts have been scheduled together, beginning with 4,890,385 pounds, valued at $118,721, in 1865. Since 1890 the shelled nuts have been separately scheduled. The greatest value imported in a single year was in 1891, when the imports of shelled and unshelled together amounted to $953,082.84. The apparent decrease in imports since that year is undoubtedly due to the largely increased domestic production of walnuts. Filberts are not grown on a commercial scale in this country. The following tables show the average annual imports of filberts and walnuts by decades, 1870 to 1890, and imports by years, 1891 to 1897, inclusive:

Average annual imports of filberts and walnuts, by decades.

Decade ending—	Quantity.	Value.
	Pounds.	
1870	[1] 3,993,921	[1] $170,089.65
1880	4,962,243	289,823.57
1890	9,523,104	548,694.82
1891-1897	[2] 12,894,106	635,150.56

[1] Average annual quantity and value for six years, 1865 to 1870, inclusive.
[2] 1891 to 1897, exclusive of shelled filberts and walnuts.

Imports of filberts and walnuts, by years.

Year.	Quantity.	Value.
	Pounds.	
1891	15,119,507.0	$872,043.84
1892	12,392,096.0	647,628.55
1893	11,960,846.0	673,705.00
1894	10,122,079.5	450,834.99
1895	11,670,895.0	530.922.13
1896	16,226,147.0	638,060.46
1897	12,827,174.5	632,858.99

Average annual imports of filberts and walnuts, shelled,[1] 1891 to 1897.

Period.	Quantity.	Value.
	Pounds.	
1891-1897	1,186,735	$134,374.35

Imports of filberts and walnuts, shelled, by years.

Year.	Quantity.	Value.
	Pounds.	
1891	511,709	$81,039.09
1892	863,309	98,417.00
1893	1,380,070	168,867.00
1894	1,008,626	116,573.00
1895	1,395,559	155,415.00
1896	1,658,069	169,014.50
1897	1,489,803	151,295.06

[1] Included with "filberts and walnuts" previous to 1891.

Although scattered trees of the Persian (English) walnut were planted in the Eastern United States at an early day, no commercial plantings resulted from them. Like the almond, their blossoms suffer from late frosts too frequently to permit regular crops, though in a few sheltered localities the trees are rarely injured, and are reasonably productive.

In California the walnut was introduced at the missions, and several commercial orchards are recorded by Lelong as having been planted from 1843 to 1865. The earlier plantings were of the "Mission," or "English" type, and in many localities the trees were found to lack productiveness. More recently, improved sorts producing more regular crops of "soft-shell" nuts were introduced, and since their general planting began walnut culture has greatly increased.

The crop of the State for 1896 was estimated to exceed 8,000,000 pounds, and is increasing steadily.

BRAZIL, OR CREAM, NUTS.

Brazil, or cream, nuts were first scheduled in 1873, when 3,690,908 pounds were imported, valued at $170,628. The imports have fluctuated considerably from year to year, the greatest value, $471,347, being in 1892. Since then they show a material decrease. The tables on page 339 show the average annual imports of Brazil, or cream, nuts by decades, 1880 and 1890, and imports by years, 1891 to 1897, inclusive.

Average annual imports of Brazil, or cream, nuts, by decades.

Decade ending—	Quantity.	Value.
	Pounds.	
1880	[1] 2,975,738	[1] $143,709.31
1890	[2] 3,802,099	188,613.32
1891-1897		330,514.71

[1] Average annual quantity and value for eight years, 1873 to 1880, inclusive.
[2] Average annual quantity for three years, 1881 to 1883, inclusive.

Imports of Brazil, or cream, nuts, by years.

Year.	Value.
1891	$394,273.00
1892	471,347.00
1893	424,893.00
1894	345,615.00
1895	181,146.00
1896	261,357.00
1897	234,972.00

Brazil, or cream, nuts are the product of a tropical species, and are not grown in any portion of the United States.

COCOANUTS AND COCOANUT OIL.

Imports of cocoanuts amounted in 1861 to $28,767, and show a great increase since that time. The following tables show the average annual imports of cocoanuts and cocoanut oil by decades, 1870 to 1890, and imports by years, 1891 to 1897, inclusive:

Average annual imports of cocoanuts, by decades.

Decade ending—	Value.
1870	$75,006.34
1880	302,296.81
1890	[1] 722,758.31
1891-1897	[1] 751,509.72

Imports of cocoanuts, by years.

Year.	Value.
1891	[1] $922,257.33
1892	942,559.78
1893	901,234.45
1894	845,169.54
1895	512,218.24
1896	540,083.21
1897	597,045.51

[1] 1890 to 1897, inclusive, includes desiccated cocoanut, etc.

Average annual imports of cocoanut oil, by decades.

Decade ending—	Quantity.	Value.
1870 ....gallons	[1] 61,402	[1] $43,301.00
1880 ....do	[2] 247,517	[2] 134,891.61
1890 ....pounds	[3] 12,572,520	550,958.63
1891-1897 ....do	22,666,083	1,049,507.60

[1] Average annual quantity and value for two years, 1864 and 1865.
[2] Average annual quantity and value for nine years, 1872 to 1880, inclusive.
[3] Average annual quantity for seven years, 1884 to 1890, inclusive.

Imports of cocoanut oil, by years.

Year.	Quantity.	Value.
	Pounds.	
1891	10,665,054	$560,833.00
1892	22,142,858	1,287,989.00
1893	27,684,788	1,242,542.00
1894	16,262,392	785,988.28
1895	31,722,014	1,340,208.00
1896	27,407,234	1,165,114.00
1897	22,778,247	963,879.00

The domestic production of cocoanuts, which is confined to the coast region of lower Florida, is unimportant. Imports of cocoanut oil, which were valued in 1864 at $23,942, rose to $1,340,208 in 1895, but show a decline in 1896 and 1897.

PEANUTS.

The imports of "peanuts and other ground nuts," which at one time constituted an important item, valued at $194,387 in 1864, have fallen to $2,106.85 in 1897, while the imports of the shelled nuts have fallen from 1,104,018 pounds, valued at $34,401 in 1872, to 1,060 pounds, valued at $9.14 in 1897. These decreases are due to increased domestic production. The following tables show the average annual imports of peanuts by decades, 1870 to 1890, and imports by years, 1891 to 1897, inclusive:

Average annual imports of peanuts and other ground nuts, by decades.

Decade ending—	Quantity.	Value.
	Pounds.	
1870	[1] 6,522,844	[2] $184,465.49
1880	1,849,645	46,662.16
1890	170,593	3,314.24
1891-1897	149,672	2,655.13

[1] Average annual quantity for six years, 1865 to 1870, inclusive.
[2] Average annual value for seven years, 1864 to 1870, inclusive.

Imports of peanuts and other ground nuts, by years.

Year.	Quantity.	Value.
	Pounds.	
1891	304,335	$6,552.99
1892	128,360	3,661.68
1893	73,344	1,006.72
1894	110,369	1,682.62
1895	103,674	1,215.48
1896	189,520	2,359.61
1897	138,102	2,106.85

Average annual imports of shelled peanuts and other ground nuts, by decades.

Decade ending—	Quantity.	Value.
	Pounds.	
1870	[1] 391,006	[1] $13,713.89
1880	375,342	14,974.95
1890	54,960	2,223.97
1891-1897	21,658	2,623.09

[1] Average annual quantity and value for five years, 1866 to 1870, inclusive.

Imports of shelled peanuts and other ground nuts, by years.

Year.	Quantity.	Value.
	Pounds.	
1891	148,350	$18,312.83
1892	------	------
1893	25	2.20
1894	157	9.00
1895	1,773	24.22
1896	243	4.24
1897	1,060	9.14

"ALL OTHER NUTS NOT OTHERWISE PROVIDED FOR."

The number of items included under this head varies at different periods. In 1843, when the caption "all other nuts not otherwise provided for," was first used, it included all nuts but almonds, and amounted to 1,133,302 pounds, valued at $34,535. Since then the more important kinds have been successively removed from this schedule. The most important item now included in it is probably the European chestnut, of which a considerable quantity is imported each year. The tables on page 342 show the average annual imports of "all other nuts not otherwise provided for" by decades, 1850 to 1890, and imports by years, 1891 to 1897, inclusive.

Average annual imports of "all other nuts not otherwise provided for," by decades.

Decade ending—	Quantity.	Value.
	Pounds.	
1850	[1] 2,456,890	[1] $73,898.00
1860	[2] 4,927,624	173,494.00
1870	[3] 2,156,176	124,119.00
1880	897,037	35,151.00
1890	808,068	32,461.00
1891-1897	1,944,493	61,678.91

[1] Average annual quantity and value for eight years, 1843 to 1850, inclusive.
[2] Average annual quantity for seven years, 1851 to 1857, inclusive.
[3] Average annual quantity for seven years, 1862 and 1865 to 1870, inclusive.

Imports of "all other nuts not otherwise provided for," by years.

Year.	Quantity.	Value.
	Pounds.	
1891	1,629,355.0	$54,156.45
1892	1,895,571.0	71,237.52
1893	1,891.979.0	72,359.83
1894	1,732,864.5	54,228.25
1895	1,652,184.0	48,618.49
1896	2,398,671.4	69,840.27
1897	2,410,832.0	61,311.58

The following table shows the imports of fruits and fruit products for 1897:

Imports of fruits and fruit products, 1897.

Fruits and fruit products.	Quantity.	Value.
Raisins .... pounds..	11,917,756.00	$532,554.00
Currants .... do....	28,218,176.00	572,803.00
Plums and prunes .... do....	736,987.00	74,165.46
Figs .... do....	8,837,572.00	532,974.50
Dates .... do....	12,225,111.00	285,617.06
Tamarinds		2,699.00
Oranges		3,341,646.64
Lemons		4,025,354.49
Limes		28,700.29
Lemon and orange oil .... pounds..	304,270.90	270,023.82
Lemon, lime, and sour orange juice		74,848.00
Orange and lemon peel		28,466.00
Bananas		4,085,947.82
Plantains		27,241.76
Pineapples .... barrels..	271,635.53	338,619.53
Grapes .... do....	170,864.51	374,440.03
Olives		328,436.84
Olive oil (other than salad) .... gallons..	525,630.00	220,903.00
Olive oil (suitable for salad) .... do....	945,828.00	1,146,494.52
Fruits in juice, and fruit juice		222,571.48
Fruits preserved in brandy, etc		447,559.39
Fruits, green, ripe, or dried, not elsewhere specified		393,291.23
Total		17,330,360.86

The following table shows the imports of nuts and nut products for 1897:

Imports of nuts and nut products, 1897.

Nuts and nut products.	Quantity.	Value.
	Pounds.	
Almonds	4,196,609.00	$244,408.07
Almonds (shelled)	5,798,354.00	683,446.34
Almond oil (sweet)	86,594.00	19,059.59
Almond oil (bitter)	10,471.90	12,029.00
Filberts and walnuts	12,827,174.50	632,858.99
Filberts and walnuts (shelled)	1,489,803.00	151,295.06
Brazil, or cream, nuts		234,972.00
Cocoanuts		597,045.51
Cocoanut oil	22,778,247.00	963,879.00
Peanuts	138,102.00	2,106.85
Peanuts (shelled)	1,060.00	9.14
All other nuts, not otherwise provided for	2,410,832.00	61,311.58
Total		3,602,421.13

The total value of the imports of fruits and fruit products and nuts and nut products in 1897 amounted to $20,962,781.99.

EXPORTS OF FRUITS AND FRUIT PRODUCTS.

The development of the fruit export trade of the United States is a subject of surpassing interest to the student of agricultural economics, but limited space forbids its extended discussion in the present paper. As has been noted, the export trade began with the shipment of apples and was for many years limited to that fruit. Shipments of ice from New England ports to the West Indies, which began in 1805, were accompanied by large quantities of apples, and soon after the extension of the ice trade to India and China, which occurred in 1830, American apples could be had in the ice ports of those countries.

It was stated in 1843[1] that the fruit dealers of Boston had at that time been shipping apples and cranberries to Europe for many years. In 1845 Newtown Pippins from the orchard of Robert L. Pell, of Ulster County, N. Y., which contained 20,000 trees, sold in London at $21 a barrel. At a later date shipments of the same variety and others from the Piedmont and mountain regions of Virginia were begun, and these districts have in recent years furnished the principal supply of "pippins" for export. Since 1881 the shipments of apples have constituted an important item of the transatlantic trade, which promises to show a steady increase in the near future. The Eastern States still furnish the larger part of the apples exported, but frequent shipments are now made from the great orchard districts of the Mississippi Valley, and some profitable export shipments have recently been made from the Pacific Coast.

[1] Transactions American Institute, 1843, p. 125.

In addition to apples, some other fruits, such as cranberries, peaches, plums, pears, and oranges, are shipped in the fresh state, the supply of all but the first named coming chiefly from California.

Exports of dried fruits were at first confined to the apple, and after the perfecting of the fruit evaporator, which occurred about 1870–1875, increased rapidly. The shipments of dried apples of the great crop of 1880 amounted to 22,623,652 pounds, valued at $1,247,891. Notwithstanding the attempted discrimination against them by foreign governments since that time, the wholesomeness and cheapness of American dried apples have caused a marked increase in their consumption abroad, as is evident from the large quantity, 30,755,401 pounds, valued at $1,340,159, exported in 1897. Since about 1895 increasing export shipments of dried apricots, peaches, and prunes have been made from California, and this branch of the trade promises soon to reach large proportions.

The development of the canning industry has resulted in a very great increase in exports of canned fruits, which were first scheduled in 1870, when they were valued at $81,735, less than one-twentieth of the value of the same item in 1897.

Exports of nuts were first scheduled in 1888 when they amounted to $27,784. The increase since that time has been reasonably steady and the shipments in 1897 reached a value of $125,805.

Pecans and shagbarks, which are largely used by confectioners, probably constitute the more important items under this head.

The following table shows the exports of fruits and fruit products for 1897.

Exports of fruits and fruit products, 1897.

Fruits and fruit products.	Quantity.	Value.
Apples .... barrels..	1,503,981	$2,371,143
Apples (dried) .... pounds..	30,775,401	1,340,159
Vinegar .... gallons..	93,969	11,572
Cider .... do....	637,672	77,695
Canned fruits	....	1,686,723
Preserved (other)	....	43,276
All other green, ripe, or dried fruits not elsewhere scheduled	....	2,172,199
Nuts	....	125,805
Total........	....	7,828,572

BIRDS THAT INJURE GRAIN.

By F. E. L. Beal,
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DAMAGE CAUSED BY BIRDS.

Aside from its importance as a principal source of food supply, the immense financial value of the grain crop of the United States gives a peculiar interest to any natural agency which affects its amount or quality. For this reason much time, labor, and money have been expended in the study of the insects injurious to grain and in devising methods to prevent their ravages. But insects are not the only members of the animal kingdom that have proved destructive to this crop. Several species of birds feed at certain times upon cereals, and in some places, where these birds breed in vast numbers, their depredations become serious. The total value of the grain product of the United States is, in round numbers, $1,000,000,000 per annum. Any agency which reduces this value by only 1 per cent involves a loss of not less than $10,000,000, a sum sufficiently large to startle a thoughtful person.

Several species of birds have been accused of serious depredations upon grain—either by attacking the seed at the time of planting or soon after germination, or by preying upon the immature or ripened crop. In the eastern part of the country the common crow is the most conspicuous example, while in the Mississippi Valley and farther west several species of blackbirds (*Icteridæ*) have at times made such havoc as to cause serious apprehensions.

The redwing and the yellowhead usually nest near water, and, when possible, directly over it. For this reason the prairie ponds and sloughs of the Upper Mississippi Valley, often of vast extent, afford such favorable breeding grounds that the region has become the theater of their greatest activities. It is the gathering place of the immense flocks which have often struck terror to the heart of the farmer as their countless hosts settled upon his fields. The nesting period is in May and June, and by the end of the latter month, or soon after, the young are on the wing. Since this is the time when the grain begins to ripen, it is natural for the old birds to lead their young to the fields for food. The molting season follows immediately after the duties of reproduction have ended, and is a trying one to the already debilitated parents. Under these circumstances the abundant and easily obtainable supply of nutritious food afforded by the grain-fields comes to the birds like a friend in need and enables them to recruit their exhausted energies.

CAUSE OF INCREASED NUMBER OF BLACKBIRDS.

It is highly probable that the changing of the original prairies into fields of grain has contributed to the increase of blackbirds by furnishing an abundant and sure supply of food at a time when it is most needed. Many instances can be pointed out where birds have increased in numbers since the settlement of the country, owing to the increased food supply resulting from cultivation; and in some cases, at least, this increase has taken place in spite of the fact that the birds were extensively shot for food. While the native prairies produced an abundance of forage for the larger ruminants and small rodents, they did not offer a great variety of plants having seeds large enough to be suitable for bird food. The immense areas of wild rice in the swamps and marshes, on the contrary, furnished a bountiful supply upon which the birds originally subsisted. Cultivation did not disturb this source of supply, but added another far more productive, and one which ripened at a considerably earlier date; for wild rice does not mature till September, while wheat and oats are available in July, and winter rye and wheat in June. Under these circumstances a great increase in the number of birds would seem to be a foregone conclusion, and in many States, notably those of the Mississippi Valley, the various species of blackbirds have at various times and places exceeded the number required to fulfill the best economic conditions, and the result has been to a greater or less extent disastrous. It does not necessarily follow that these birds are wholly harmful to the interests of man; it merely shows that it is possible to have too many of them, that is, too many of the particular species which feed so largely on grain. In States where these birds are less abundant but little damage is done.

An investigation of the food habits of blackbirds shows that during the breeding months, and also to some extent during the entire warm season, all of the species subsist largely on insects. When this is considered in connection with the fact that many of the species feed largely upon seeds of troublesome weeds, especially in winter, there is reason to believe that they really subserve a useful purpose in the economy of nature. They only become harmful when, by increasing out of proportion to their environment, the proper balance of organisms is disturbed.

THE MORE IMPORTANT GRAIN-EATING BIRDS.

In the following pages some of the more important species of grain-eating birds are discussed, and their special ravages pointed out.

THE CROW.

The common crow (*Corvus americanus*) ranges over the United States east of the Great Plains, more sparingly over the rest of the country, and to the northward extends beyond our borders. East of the Alleghany Mountains, and especially in the New England and other Atlantic States, the crow has long been known as a "thief of cornfields," having been so christened by the aboriginal inhabitants. The greatest damage is done in spring, when the birds pull up the sprouted grain. Dry, hard corn is not palatable food for the crow, as has been shown by experiments with a caged bird. In seasons of scarcity ripe corn is sometimes eaten, but is not preferred. Corn that has been softened and sweetened by the process of germination, on the contrary, is a favorite food and is eagerly sought. In the earlier days, when crows were more numerous and cornfields less so, the farmers had a constant struggle during the first two or three weeks after the corn appeared above the ground to save it from the crows. Various devices in the way of scarecrows were designed to frighten the marauders away, but most of them were only indifferently successful. More recently the plan of coating the seed corn with tar has been extensively used, and with better results. In the experience of the writer, not a single kernel of tarred corn was disturbed, while rows of untarred seed immediately adjoining were almost entirely destroyed. It has been asserted by some people that the crow pulls up corn not for the sake of the kernel, but for the grubs that may be found in the manure about the roots. Careful investigation has disproved this assertion. Crows do eat the sprouted kernels, although they also devour grubs unearthed at the same time, for they are great lovers of insects and their larvæ. But the result to the farmer is the same, and it is poor consolation to know that if the corn had not been eaten by the crow it would have been killed by the grub.

Some complaints have also been made that crows eat corn in the "milk" or "roasting-ear" stage, and from that time on until it is ripe. It is evident that much more extensive ravages would be necessary at this stage to cause as much damage as that incident to pulling the sprouted seed. As a matter of fact, reports do not indicate extensive injury of this kind.

In the Mississippi Valley the crow does not appear to have attracted so much attention as in the East. During a residence of eight years in Iowa the writer never heard any complaints of injury to grain, nor did he observe any cases of this kind. Yet, some damage has been done, and instances of serious loss are on record, usually, however, arising from tearing open the husks and pecking the soft kernels. In these cases the ears thus opened are exposed to the weather, and often rot from being wet by rains.

Food habits of the crow.—Investigations of the food habits of the crow, based on an examination of the contents of 909 stomachs,[1] show

[1] "The Common Crow of the United States," by Walter B. Barrows and E. A. Schwarz, Bulletin No. 6, Division Ornithology and Mammalogy, U. S. Department of Agriculture, 1895.

that about 29 per cent of the food for the year consists of grain, of which corn constitutes something more than 21 per cent, the greatest quantity being eaten in the three winter months. All of this must be either waste grain picked up in fields and roads, or corn stolen from cribs or shocks. A good deal is taken also in the three fall months, when corn is soft; and May, the month of sprouting corn, shows a slight increase over the other spring and summer months. The two months of July and August are the only ones in which wheat is eaten to any important extent. Only small quantities of other grains are taken.

On the other hand, the loss of grain is offset by the destruction of insects. These constitute more than 23 per cent of the crow's yearly diet, and the larger part of them are noxious. If we add the mice, rabbits, and other harmful mammals destroyed, we have a total of about 25 per cent of the food consisting of animals whose destruction is a benefit to the farmer. With the well-known propensity of the crow for searching highways and byways, stock yards and pastures, it must be admitted that at least one-half of the grain eaten is waste, the consumption of which entails no loss. The remainder of the crow's diet consists of wild fruit, seeds, and various animal substances which may on the whole be considered neutral. From this point of view it is evident that what grain the crow takes from the available crop is well paid for by the insects destroyed.

THE CROW BLACKBIRD.

The crow blackbird (*Quiscalus quiscula* and subspecies) is distributed over the United States east of the Rocky Mountains, and remains through the year in most of its range south of Illinois and Pennsylvania. With the possible exception of New England, where it occurs only locally, it is one of the most abundant species. It nests in trees or bushes, and usually seeks the neighborhood of man for its breeding places. In the vicinity of cities it builds in parks and cemeteries, and in the country comes to the farm for the food that may be found in the garden, pigpen, and stock yard. It nests also in bushes along the banks of brooks, and obtains much food from the shores of streams and ponds. For a month or more after the breeding season is over it is rarely seen about its usual haunts. During this period (the time of molting) it gathers in flocks and retires to some secluded place where it remains during August, reappearing in full force about the first of September. At that time the flocks are usually large, and when they attack a field of ripening grain the result is disastrous.

Food habits of the crow blackbird.—Crow blackbirds are fond of grain, and being of good size and abundant, evidently have the power to do great harm. Moreover, the examination of more than 2,000 of their stomachs shows that grain forms 45 per cent of the food of the year, and that corn alone constitutes 35 per cent. From this it might be expected that they would attract much attention from grain growers, and such is the case. Hundreds of communications have been received testifying to their destructiveness; yet many of these acknowledge the fact that blackbirds eat a large quantity of insects, especially during the breeding season, and that many insects are fed to the young. This last is also borne out by stomach examination. A review of the yearly diet shows that the greater part of the corn eaten is taken during the fall and winter months. That eaten in winter and early spring (March and April), except the small quantity taken from corncribs, must be waste grain, or picked up in places where grain is left in the shock for a long time. No one will begrudge the birds the corn gathered from the hog lot or about the cattle crib, but when they attack the ripening grain in September it is a different story, and in cases where the birds are so abundant that they take a large part of the crop, it will be difficult to persuade the unfortunate farmer that they did enough good earlier in the season to pay for his loss. There can be little doubt that in many parts of the country these birds are too numerous for the farmer to realize the best results from their services.

THE RED-WINGED BLACKBIRD.

The red-winged blackbird, red-shouldered blackbird, swamp blackbird, or "American starling," as it is variously called (*Agelaius phœniceus* and subspecies), is distributed over all of the United States, and breeds throughout this region except along the extreme southern border. As the bird almost invariably chooses a nesting site near water, if not directly over it, the species is usually absent during the breeding season from large areas of arid land, though cases have been noted where nests were found at a distance from anything in the nature of marshes or swamps.

Breeding places.—Ideal nesting sites for this species are found in the prairie region of the Upper Mississippi Valley and in the vicinity of the Great Lakes. The abundant marshes and small "sloughs" or ponds of the prairies furnish just the conditions required, and consequently the species is everywhere common. East of the Alleghanies suitable breeding places are less numerous, being for the most part restricted to swamps and the immediate vicinity of streams and lakes. With fewer nesting sites there are fewer birds, and consequently less damage to grain crops. In New England few complaints have been made, but some damage has been done where grainfields are near the natural haunts of the birds, especially in sections near the seashore, where marshes afford good breeding places. The immense quantity of wild rice that grows along the Atlantic seaboard has, perhaps, served to some extent to draw them away from the grainfields of the interior, as their ravages are much less noticeable in the Eastern States than in those of the Mississippi Valley.

From most of the States drained by the Mississippi River and its tributaries complaints both numerous and loud have been received of the ravages of the redwings. The vast marshes of the northern part of this region and the small prairie ponds found everywhere are the recruiting grounds for immense flocks, whose numbers are almost beyond estimation. When these hordes settle upon a field of ripening grain, not only is much of the grain itself eaten, but the straw is broken down and rendered difficult to cut. So extensive are some of the flocks that if undisturbed for a few days they eat or destroy a large percentage of the grain.

Food habits of the red-winged blackbird.—In investigating the food habits of the redwing over 700 stomachs were examined. These were collected in every month of the year, and show that a little more than 13 per cent of the year's food is grain. This is a remarkably small percentage when it is considered that this bird has been the subject of more complaints on the score of grain eating than any other species. In order to understand thoroughly the grain-eating propensities of the redwing, a special study of its food for the five months from May to September, inclusive, has been made. Of the stomachs taken in May, 46 per cent contained grain. This percentage falls to 11 in June and then rises in July and culminates in August at 72, after which it decreases rapidly. The average for the five months is 46 per cent, that is, in every 100 birds taken 46 have eaten grain. If now we examine the grain-eating record as exhibited by the quantity of that food the results are quite different. In May grain constitutes 21 per cent of the food by bulk; in June it decreases to 5 per cent; in July it rises to its maximum of 42 per cent; in August it falls off slightly, after which it rapidly decreases and disappears. The average consumption of grain for the five months is 25 per cent of the whole food. Again, if the two months of July and August are considered alone, it is found that out of every 100 birds 68 have eaten grain, but that the grain constitutes only 40 per cent of the total food for the two months.

Percentage of grain destroyed by birds in the Mississippi Valley.—Still further restricting the study to birds taken in the Mississippi Valley in the same five months as above, the percentage of grain eaten shows an important increase. During these months 173 birds were collected in the States of Indiana, Illinois, Wisconsin, Minnesota, North Dakota, South Dakota, Iowa, Nebraska, and Kansas. This number, though small, is sufficient to serve at least as a clue to the food during the period covered. Grain was eaten by 60 per cent of the birds collected in May, by 46 per cent of those taken in June, by 80 per cent of those taken in July, by 81 per cent of those taken in August, and by 45 per cent of those taken in September. Of the food of those taken in May, 27 per cent was grain of various kinds; in June, 23 per cent; in July, 51 per cent; in August, 45 per cent, and in September, 24 per cent, or an average of 34 per cent of grain for the five months. When it is remembered that the food of the crow blackbird over the whole of its range, and during the whole year, consists of grain to the extent of 45 per cent, it seems strange that the redwing should be able to create so much more havoc, when we find that its food during the five grain-raising months, and in the greatest grain-raising States, consists of only 34 per cent of grain. This renders more impressive the fact that the harm done by the redwing does not arise so much from the excessive quantity eaten by the individual as from the overwhelming number of individuals, which in the aggregate cause an enormous destruction of grain.

Percentage of weed seeds destroyed by birds.—Of the different kinds of cereals, oats is the favorite with the redwings, constituting more than half of the grain eaten. Corn stands next in order, and wheat last of all. At the same time many noxious insects and much weed seed are destroyed. The former amounts to over 26 per cent of the year's food, the latter to nearly 57 per cent. Seeds of noxious weeds, eked out by grain found scattered in the fields, forms the almost exclusive diet of these birds during the colder months. Even in August, when the destruction of grain is at its height, weed seed forms more than 30 per cent of the food.

THE YELLOW-HEADED BLACKBIRD.

The yellow-headed blackbird (*Xanthocephalus xanthocephalus*) is abundant in the Mississippi Valley, less common in the far West, and occasionally straggles eastward to New England and the District of Columbia. As a rule, it is not as abundant as the redwing, with which it is almost identical in feeding habits, even in its preference for oats and in its fondness for weed seeds. In complaints made against the redwing the yellowhead is frequently included as equally guilty. During the breeding season it is a hearty insect eater, and a number of the stomachs examined contained the remains of the well-known "army worm" (*Leucania unipuncta*), which was also found in stomachs of the redwing. Of the other insects eaten the majority are harmful.

THE RUSTY GRACKLE.

The rusty grackle (*Scolecophagus carolinus*) of the Eastern United States and Brewer's blackbird (*S. cyanocephalus*) of the West are similar birds, whose habits of associating in large flocks would indicate that they could do great damage to grainfields if they chose to visit them for food. Stomach examinations show that the eastern bird lives to a great extent upon animal substances, principally insects, and as the species retires to the extreme northern edge of the country and beyond to breed, it does not appear in most of the grain-raising States until the crops of wheat and oats have been harvested. It feeds to some extent on corn, but the damage appears to be slight. Brewer's blackbird, on the contrary, breeds over the greater part of its range and only retires from the northern part during a short time in winter. It is more of a grain eater than the rusty grackle and does considerable damage in wheat-growing areas in the far West. Like the rusty grackle, it is a great consumer of insects.

THE COWBIRD.

The cowbird (*Molothrus ater*) is another species of wide distribution and great abundance, especially in the Upper Mississippi Valley. As these birds associate in flocks they might do much damage to grain, but their well-known habits are to search along roads, stock yards, and pastures rather than in open grainfields. For this reason they have not been observed to do much damage.

VARIOUS OTHER DESTRUCTIVE BIRDS.

In addition to crows and blackbirds, several birds have attracted notice in different parts of the country by their grain-destroying proclivities. The common mourning, or turtle, dove (*Zenaidura macroura*) is known to feed extensively upon grain, especially wheat, and where the species is abundant sometimes becomes a serious nuisance. Stomach examinations show that these birds eat practically no animal food, but subsist almost entirely upon hard seeds, those of our most common weeds constituting their principal food supply during the winter months. They do most harm in spring, when they feed upon newly sown grain. That wheat is their favorite cereal is shown by the fact that many of their stomachs are entirely filled with it. As doves rarely associate in large flocks, they are not likely to become such serious pests as some of the gregarious species, and means might be readily devised for preventing their ravages during the short period in which they occur.

In some portions of California complaints have been made that the valley quail (*Callipepla californica vallicola*) destroys wheat to a serious extent, but this appears to be local rather than general.

The horned larks (*Otocoris*) are small, obscurely colored birds that breed on most of the plains and deserts of the Western United States, and winter in immense numbers in the Mississippi Valley region and to a less extent in other parts of the country. In wheat-growing sections they do some damage to newly sown grain. But like the doves, their habits are not such as to seriously menace the grain crop. Several other native birds have at times caused complaints on the score of grain eating, but these cases seem to be unusual.

The Mongolian, or ring-necked, pheasant (*Phasianus torquatus*), and possibly one or two other species which were imported into the Northwest Coast region about fifteen years ago, have since increased to such an extent that they threaten to become a pest by their inroads upon the grainfields. Already numerous complaints have appeared in the newspapers of that region, showing that the harm done by these birds will somewhat modify the benefit that can be derived from them as game birds. Accurate data upon this point, however, are not at hand.

DIFFICULTY OF PREVENTING DESTRUCTION CAUSED BY BIRDS.

In a treatise on the destructiveness of grain-eating birds it is natural that the reader should expect at least a suggestion of a remedy. Unfortunately it is much easier to point out the evil than to prescribe the cure. Stomach investigation shows conclusively that birds do not subsist upon grain alone, even at times when it is possible to obtain it. Moreover, the greatest amount of grain is not eaten at harvest time, but during the winter months, when other food is scarce and waste kernels can be picked up in the fields. If any kind of grain is preferred by a certain species, we should expect the bird to subsist upon that grain almost exclusively when it can be obtained, that is, at harvest time. That this is not the case, is shown by the fact that many birds of the same species have been shot at the same time in a grainfield, and while some stomachs were full of grain, others were only partly filled, and still others were wholly filled with other food. So many cases of this kind have occurred that it seems practically certain that few birds willingly subsist exclusively upon any kind of grain for a considerable length of time. With many species this is in notable contrast to their marked fondness for the seeds of certain useless plants, upon which at some seasons they subsist almost entirely.

If it be admitted that birds do not as a rule display an inordinate appetite for grain, the question naturally arises: What is the cause of the tremendous ravages they sometimes commit? Both stomach examination and field observation point to the same answer: Too many birds of the same or closely allied species are gathered together within a limited area.

As already pointed out, the Upper Mississippi region presents such exceptionally favorable breeding grounds for blackbirds, especially the redwing and yellowhead, that they swarm there in countless numbers. Settlement and cultivation have not yet encroached materially upon their haunts, but have added a source of food, which, coming before the great natural supply, has served to render the race more vigorous and prolific.

An attempt to exterminate these species would be not only ill-advised but hopeless. States have offered bounties for their destruction without perceptibly thinning their ranks. Is there, then, any remedy for the evil? The writer is forced to confess that he has none to suggest, except in the case of crows and blackbirds that pull up sprouting corn. This can be prevented by thoroughly tarring the seed, which, if properly done, neither injures its vitality nor prevents the use of machinery in planting. There is, however, some hope for the future, though perhaps a distant one. While the advance of civilization has thus far not affected these birds or their haunts, the time must surely come when it will. Increased density of population will broaden the area of cultivation, and this in time must lead to the draining of the smaller marshes and ponds, thus turning over to agriculture much land that has heretofore been worse than waste, since it has served as a breeding ground for the birds that have destroyed the crops. With the breeding places more restricted and an environment otherwise changed by increased population, the number of birds must surely decrease, and in time the proper equilibrium will be restored. In the meantime, it behooves the farmer to apply such remedies as the exigencies of the case suggest, and where these gregarious species are overabundant it might be well to exempt them from the general protective laws, in order that each landholder may be free to protect himself as best he can.

LAWNS AND LAWN MAKING.

By F. Lamson-Scribner,
Agrostologist.

INTRODUCTION.

There are few subjects relative to grasses of more general interest than that of lawns. Nothing is more beautiful than a well-kept lawn, whether it be of large or small extent. Even the small plots fronting city dwellings are points of attraction when covered with a soft, even turf. Lawns are the most fascinating and delightful features in landscape gardening, and there is nothing which more strongly bespeaks the character of the owner than the treatment and adornment of the lawns upon his place. How to establish lawns and the varieties of grasses best suited for the purpose are among the most frequent inquiries received by the Division of Agrostology. It is the general desire to have a lawn made quickly, to have the turf fine as well as permanent, and these results are often expected under impossible conditions. Fineness and permanency may be secured, but they are results which can not be obtained by hasty and unskilled preparation. A perfect lawn can not be made in a season, and the highest excellence sought comes only through intelligent care for a period of years. A green surface may be secured within a few months under favorable conditions, but a soft, velvety turf, which is both a delight to view and to walk on, comes only with years of patient care.

With the object of obtaining as full data as possible regarding the methods employed in the establishment and maintenance of lawns in various parts of the United States, a circular of inquiry was addressed to the superintendents of public parks and others known to be engaged in this work. Replies were received from points covering a range from Maine to Washington and southward to Florida, Texas, and southern California.[1] The series of questions asked embraced the leading features of the work under discussion, and it is upon the replies received from these correspondents, together with the personal observation and experience of the writer, that this paper is based. The topics presented in the circular were:

(1) The preparation of the land for lawns.

(2) The kind or kinds of fertilizers used in the preparation of the soil, and subsequently upon the lawns.

(3) The variety used where there is much shade.[2]

(4) The variety or kind of seed used.

[1] Thanks are here expressed to all who so kindly and fully responded to this circular.

[2] Construed by some to refer to fertilizers, which was really intended, and by others to the kind of grass used.

(5) The amount of seed used per acre, or for a given number of square yards.
(6) The time of seeding.
(7) The number of cuttings in a season.
(8) The chief obstacles to be overcome in the formation of a perfect lawn.
(9) What grass, if used alone, is regarded as best for general use?

PREPARATION OF THE LAND.

In what follows, proper grading and thorough drainage are presupposed. A well-drained soil is of the first importance and is absolutely necessary to success. Where the process of grading has involved much filling in, time should be allowed for the settling of the soil, and during this period a hoed crop may be cultivated on the land to advantage. If the land is very weedy, the cultivation of corn or potatoes for a season will assist in reducing the stock of weeds. It must be remembered that the lawn when once formed is to remain undisturbed; the sward is to be permanent, and hence the importance of most thorough preparation of the soil. In most cases, particularly in the Eastern and Northern States, a liberal application of fertilizers is necessary. If the land is native sod, this should be top-dressed in the fall with well rotted stable or barnyard manure, and the sod then turned by plowing. The decomposition of this sod will add to the soil that most valuable fertilizing element, humus. In the following spring a top-dressing of old, well-composted manure should be applied at the rate of 8 to 12 cords to the acre, according to the natural fertility of the soil, and the land cross plowed. The surface then should be made as fine as possible by repeated harrowings and thorough rolling before the seed is sown. The deeper the soil is stirred in plowing the better the results and the less care will be required in keeping the grass in good condition.

The nature of the subsoil has great influence upon the growth of the grass and the permanence and beauty of the lawn. Over a light and gravelly subsoil the grass is not infrequently destroyed by summer drought. The best soil for the formation of the lawn is a fine, sandy loam over clay subsoil. Where the effects of heat and drought are most severely felt, the soil must be most deeply and thoroughly worked in its preparation. It not infrequently happens in the case of dooryards and plots surrounding city and suburban residences that the soil is largely composed of the earth excavated in making the foundations. This earth is entirely unsuited for the growth of grass, and, where a lawn is desired, should be entirely removed or covered to a sufficient depth with fine earth rich in humus, to insure the healthy and permanent growth of the grass. This added soil should be at least 1 foot in depth, and a depth of 2 feet will repay the extra labor in the final results.

In the Western States and in the South it is not customary to stir the soil so deeply as recommended above. The practice, however, can well be applied in most localities in the South, but in the West, where the soil conditions are essentially different from those in the East, the method pursued must be governed by the local requirements. A coarse, uneven soil will only yield coarse grasses and a finely worked soil and evenly worked surface will produce the finer sorts, which alone are desirable.

FERTILIZERS.

Reference has already been made to the use of well-rotted barnyard or stable manure in the preparation of the land for lawns. This is the best fertilizer to apply when it is to be plowed under, but only old and well-composted manure should be used. When such can not be obtained, commercial fertilizers may be substituted, and with these a liberal supply of lime and bone meal can be worked into the soil before seeding. Where it is necessary to apply fertilizers after the grass has started in order to maintain fertility, land plaster, bone meal, nitrate of soda, and hard-wood ashes are most commonly employed. A fall dressing of clear sheep manure, 3 to 5 tons per acre, followed by an early spring dressing of unleached hard-wood ashes (containing 8 per cent potash) at the rate of 3 to 5 tons per acre, according to the fertility of the soil, is advised by one correspondent.

A common practice is to top-dress lawns in the fall or early winter with a fine compost, adding in the spring a dressing of bone meal and hard-wood ashes; in the place of the fall dressing of compost, hard-wood ashes may be substituted. A too frequent use of hard-wood ashes, however, is to be avoided, as it will induce the growth of clover at the expense of the grasses. Bone meal, hard-wood ashes, and lime are the fertilizers most generally used to maintain the fertility of the lawn, whether shaded or exposed to the sun. When the soil has been properly prepared and enriched, there is little difficulty in securing a good growth of grass under trees if the branches are not too low.

SELECTION OF LAWN GRASSES.

The value and beauty of a lawn depends upon the color, texture, and turf-forming habit of the grass selected. A grass may be of good color but harsh in texture and incapable of producing a turf, or it may form a good sward and have a satisfactory texture, but be deficient, or even unsightly, in color.

TURF-FORMING GRASSES.

The quality of forming turf is of first importance in the selection of a lawn grass, for unless it possesses a good turf-forming habit it can have no value as a lawn grass, however excellent it be in color or texture. The turf-forming grasses are chiefly natives of the moist, temperate regions of the world. In the semiarid districts of the West and Southwest the grasses are for the most part "bunch grasses," growing in isolated bunches, forming no continuous turf such as is seen in the pastures and meadows of the East. In the Tropics, excepting upon the higher mountains, turf-forming grasses are almost unknown, the native species belonging chiefly to the class termed jungle grasses.

Only those grasses with creeping rootstocks or with a prostrate creeping habit of growth form a continuous turf, and hence are the only varieties furnishing lawn grasses. Orchard grass has no place upon the lawn, because it is a bunch grass, and however closely clipped and frequently rolled it maintains its characteristic tussock-like growth, as shown on Pl. VIII, fig. 2, which represents a small area of closely mown orchard grass, seen from above. The mass of leaves are grouped in tufts, or bunches, and parts of three of these tufts are shown in the illustration, which is an engraving from a photograph taken in the turf garden of the Connecticut Agricultural Experiment Station. In marked contrast with orchard grass, both in uniformity of surface and fineness of leafage, is Kentucky blue grass, shown for comparison on Pl. VIII, fig. 1.

Kentucky blue grass forms sod by its creeping rhizomes, which are all under ground. These send up at frequent intervals leafy shoots, which form the turf of the lawn. Under the most favorable circumstances these leafy shoots are rarely so numerous or fine as to make the soft springy turf so much desired in lawns. This latter quality is possessed in a marked degree by some of the finer varieties of the fescues and bent grasses. Bermuda grass, carefully managed, makes a fine elastic turf, pleasant to walk on, scarcely inferior to some of the finer varieties of creeping bent.

Turf grasses are the pasture grasses of the New England and Middle States. Nowhere will we find a better turf, of finer or more even texture or more pleasant to walk on, than in some of the pastures near the New England coast, which have been grazed by sheep for the past hundred years or more. Where these pastures have been grazed the closest and trampled the most there will be the closest and most even turf, composed generally of a single variety of grass. Such turf as we are considering (turf suitable for lawns) is produced either by the grazing of stock, particularly sheep, or by the frequent and intelligent use of the lawn mower and the roller. The value of sheep in turf formation is recognized by the managers of public parks and has been taken advantage of by some. This is notably the case in Central Park, New York, and Druid Hill Park, Baltimore. (See Pl. IX, figs. 1 and 2.)

COLOR.

A deep rich emerald green is the shade most desired in a lawn grass, as it is generally pleasing and certainly the most beautiful of all tints. No grass in the Northern and Middle States fills this require-

FIG. 1.—A TURF OF KENTUCKY BLUE GRASS (AS SEEN FROM ABOVE, DESIGNED TO SHOW TEXTURE).

FIG. 2.—A TURF OF ORCHARD GRASS (AS SEEN FROM ABOVE, DESIGNED TO SHOW CHARACTER OF TURF FORMED).

FIG. 1.—THE LAWN MOWERS, OR TURF MAKERS, OF CENTRAL PARK, NEW YORK.

FIG. 2.—THE LAWN MOWERS, OR TURF MAKERS, OF DRUID HILL PARK, BALTIMORE, MD.

ment so well as Kentucky blue grass; the color of this grass when grown under favorable circumstances may be regarded as the standard upon which to base comparisons. Different varieties of Kentucky blue grass show slight variations in color, some being lighter than others, but upon the whole the deep rich shade of green may be relied upon. Some of the fescues possess an equally deep shade of green, but the best turf-forming varieties of this class usually have a grayish tint which is more or less objectionable. Creeping bent and Rhode Island bent are much alike in color, but they are considerably lighter than Kentucky blue grass, and should this be regarded a fault it is fully counterbalanced by their finer texture and superior turf-forming habit. Italian rye grass has a good color, and the fine-leafed variety of perennial rye grass is by no means an inferior lawn grass. The color of these rye grasses is not very different from that of Kentucky blue grass, but there is a marked difference in the appearance of the herbage; the surface of the leaves of perennial rye has a shining or polished appearance not apparent in Kentucky blue grass. The color of Bermuda grass during the summer season is highly pleasing, but it turns brown upon the approach of cold weather, making it an undesirable lawn grass excepting in the warmer parts of the South, unless it be for residences occupied only during the summer months. It is a common grass in the vicinity of Washington, D. C., where it is locally known as wire grass, and frequently appears as a weed upon blue-grass lawns. Its presence in such lawns is not usually detected until under the first frosts the Bermuda turns to a light brown, when it becomes conspicuous by disfiguring the appearance of the turf. The color of St. Augustine grass is inferior to that of Bermuda, but that of Louisiana grass, sometimes used as a lawn grass in the far South, is quite equal to it in point of color.

TEXTURE.

Reference has already been made to the degree of fineness of several varieties of grasses, but the narrowness of the leaf blade does not always determine the texture. Some of the varieties of fescues have exceedingly narrow or thread-like leaves (Pl. X, fig. 1), but the turf formed by them may be harsh and unpleasant to the touch. Other grasses again may have comparatively broad leaves, which are soft and flexible, and the turf they produce may possess a desirable texture. Bermuda grass under the lawn mower yields a turf of excellent quality, the short, leafy stems become densely crowded, forming a soft, cushion-like sward (Pl. XI, fig. 2). St. Augustine grass is much inferior to Bermuda in this respect, and Korean lawn grass, which may be cultivated in Southern latitudes, has coarse, somewhat rigid leaves, and is decidedly harsh. Buffalo grass (Pl. XI, fig. 1) makes a fine, soft, and pleasing turf, so far as its texture is concerned, and when procurable may be substituted for Bermuda, as it will thrive in drier situations or in more arid climates. The texture of Kentucky blue grass (Pl. VIII, fig. 1) is only fairly good, and while we have selected Kentucky blue grass to represent the standard of color, the standard of texture must be represented by the fine and soft bent grasses (Pl. XII, figs. 1 and 2). They make a turf soft as velvet. A uniform turf of creeping bent (Pl. XII, fig. 1), carefully managed, carries with it the idea of richness represented by costly garments or rich tapestries and carpets.

These illustrations of turf formed by cultures of single varieties of grass should be compared with that composed chiefly of Kentucky blue grass and white clover (see Pl. X, fig. 2). The uniform and even character of the former is exhibited in striking contrast with the latter, which is uneven, irregular, and far less pleasing to the eye.

VARIETIES.

The principal lawn grasses of this country are Kentucky blue grass, creeping bent, and Rhode Island bent, the first a species of Poa (*Poa pratensis*), the latter belonging to the genus Agrostis (*Agrostis stolonifera* and *A. canina*). White or Dutch clover is often sown with Kentucky blue grass, and this mixture is not objectionable, because the shade of green in the clover is nearly the same as that of the grass. There are several of the fine-leafed fescues, the names of which are not well known, which are also valuable lawn grasses in the regions where Kentucky blue grass may be grown. It can not be too strongly emphasized that the best lawns—those presenting the best turf and greatest uniformity in color and texture—consist of pure cultures of single varieties.

Other grasses occasionally recommended for lawns, especially in "lawn-grass mixtures," are Canadian blue grass, crested dog's-tail, creeping fescue, rough-stalked meadow grass, meadow foxtail, velvet grass, and sweet vernal grass. It is only necessary to say here regarding mixed seeds for lawns that under certain conditions, as in woodland parks, which will be grazed rather than subject to the lawn mower and roller, or upon terrace slopes and road embankments, mixtures may be used.

Canadian blue grass is a native, and when properly handled makes a beautiful, deep, rich bluish-green sward. It is especially valuable for holding terraces, even better suited for this purpose than Kentucky blue grass.

Crested dog's-tail grass is a soft, rather fine-leafed grass, which has been sparingly cultivated in this country. By some it is regarded an excellent lawn grass, but it has no qualities superior to the lawn grasses recommended above, excepting perhaps for shaded places, and in most respects is inferior to them. It may be used in mixtures for woodland parks.

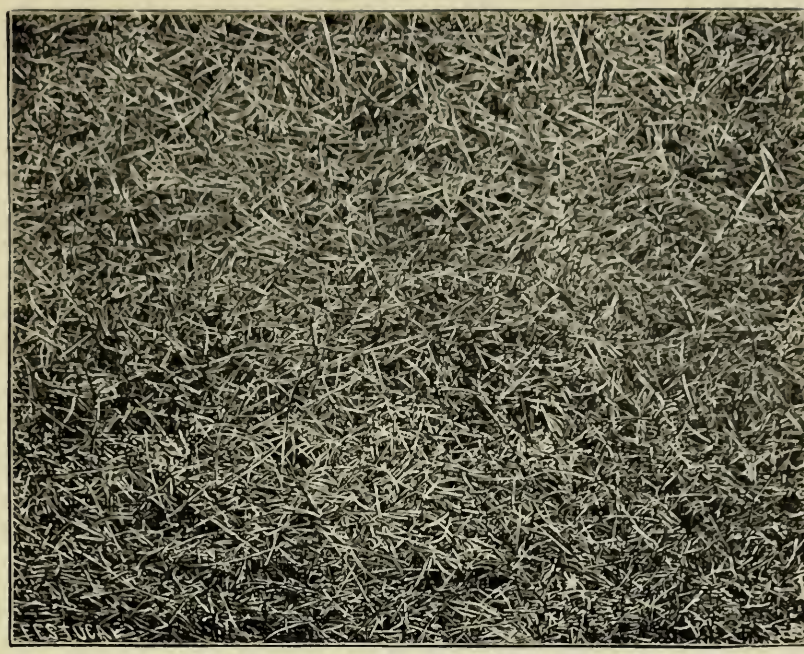


FIG. 1.—A TURF OF FINE-LEAFED FESCUE GRASS (AS SEEN FROM ABOVE, DESIGNED TO SHOW TEXTURE).

FIG. 2.—A TURF OF MIXED GRASSES AND WHITE CLOVER (AS SEEN FROM ABOVE, DESIGNED TO SHOW TEXTURE).

FIG. 1.—A TURF OF BUFFALO GRASS (AS SEEN FROM ABOVE, DESIGNED TO SHOW TEXTURE).

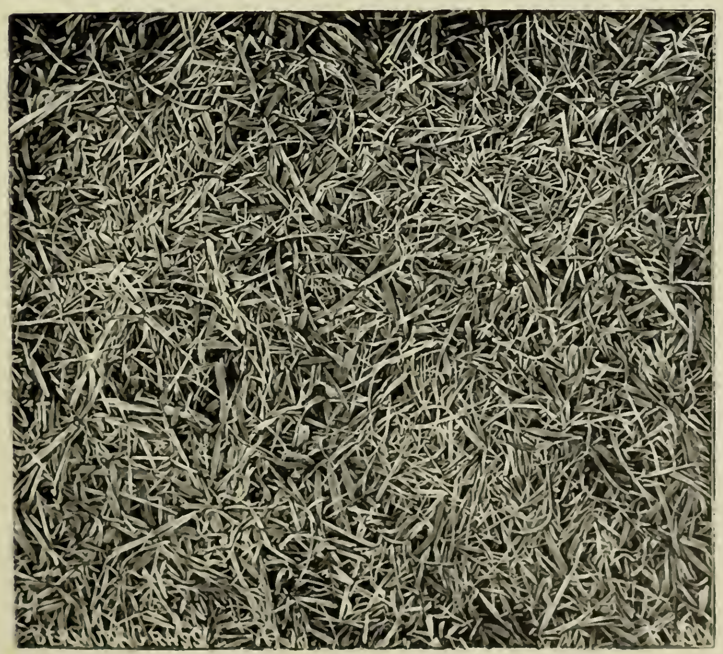


FIG. 2.—A TURF OF BERMUDA GRASS (AS SEEN FROM ABOVE, DESIGNED TO SHOW TEXTURE).

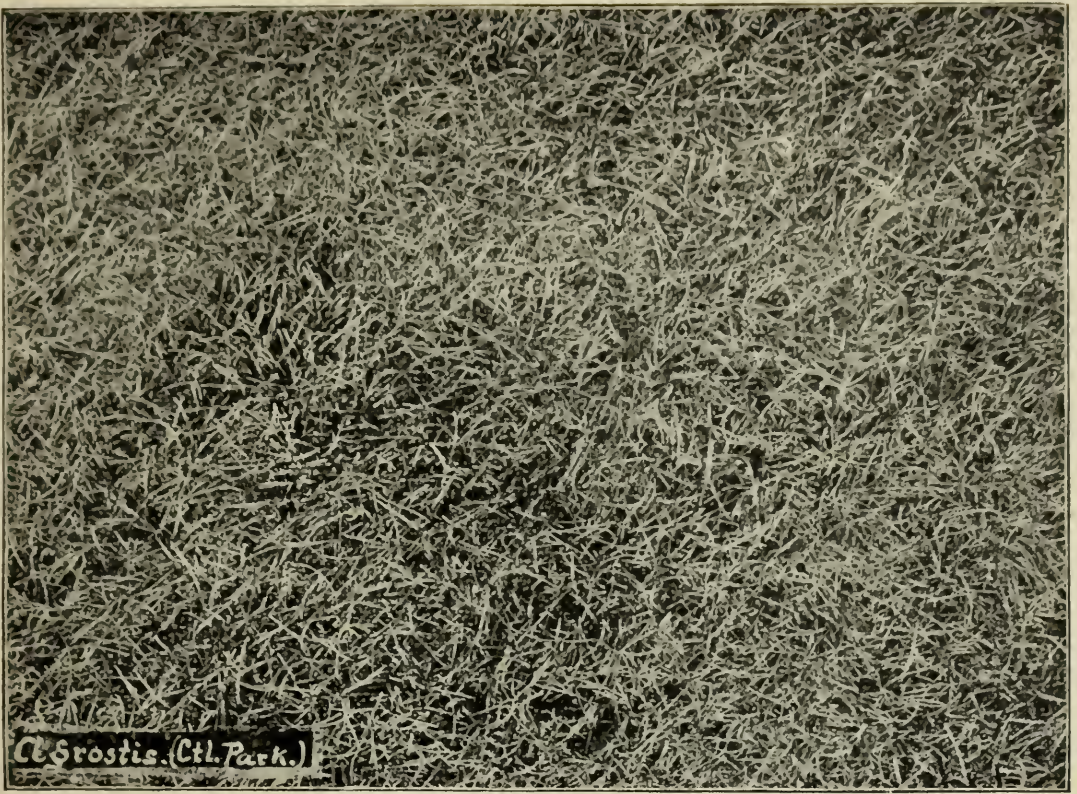


FIG. 1.—A TURF OF A FINE-LEAFED BENT GRASS (AS SEEN FROM ABOVE, DESIGNED TO SHOW TEXTURE).

FIG. 2.—A TURF OF A COARSE-LEAFED BENT GRASS (AS SEEN FROM ABOVE, DESIGNED TO SHOW TEXTURE).

Creeping fescue makes a fair turf and may be used upon sandy soils, although its use is not recommended. Nowhere can be found blue-grass lawns of finer appearance, either in color, purity, or texture, than in some of the yards in Provincetown, Mass., where the soil is sandy in the highest degree.

Rough-stalked meadow grass is adapted to low-lying, damp, and more or less shady situations.

Meadow foxtail grass has been recommended for addition to mixtures of lawn-grass seed for Northern and Middle States. It makes a fairly good turf when sown alone and properly treated, but its use is not recommended excepting in damp, shaded situations.

Velvet grass, or velvet lawn grass, as it is sometimes called, can only be classed as a weed when growing upon lawns. Its presence in the lawn only serves to disfigure it.

Sweet vernal grass adds no feature of value to the lawn, and should never enter into any lawn mixtures, even where the use of mixtures may still be persisted in.

The use of white, or Dutch, clover in connection with Kentucky blue grass is common. When these two are combined they may be mixed at the rate of 6 to 8 pounds of white clover to 25 or 30 pounds of Kentucky blue grass.

LAWN GRASSES FOR THE SOUTH.

In the far South and Southwest, where Kentucky blue grass and the bent grasses can not be successfully grown, other turf-forming grasses must be sought. There are several of these grasses which will withstand warm temperate or subtropical climates. The best known of these is Bermuda grass. This grass makes a very beautiful, deep green, fine turf under the lawn mower, and thrives in the heat of midsummer. In the latitude of the District of Columbia, when treated as other turf-forming species, it has exhibited its good qualities to perfection. Excepting in the far South, however, it is not a desirable lawn grass, as it quickly turns brown upon the approach of cold weather and is rather late in becoming green in the spring.

There is a variety of Bermuda grass occurring in some parts of Florida, where it has attracted attention under the name of St. Lucie grass. It is regarded as a more desirable grass for lawns than the ordinary form, because it does not root so deeply and is less liable to become a pest by spreading into cultivated fields.

Another grass largely used in the South Atlantic and Gulf Coast regions for lawns is St. Augustine grass, or, as it is locally known, Charleston lawn grass (the Buffalo grass of Australia). This grass will grow in more moist situations than Bermuda, and is the species chiefly used in some of the Southern cities, as, for example, Charleston, S. C. Although similar in habit of growth to Bermuda, it has much coarser stems, the leaves are broader and more rigid and of less pleasing color, being much lighter in tint, and it requires more care in its management.

Both Bermuda and St. Augustine grass are used for lawns in Jacksonville, Fla., the former being selected for the higher, drier places and the latter for locations where the soil is somewhat moist. Texas blue grass may prove to be a valuable lawn grass for the South. Its color is excellent, texture fairly good, and it is at its best during the winter months.

SELECTION OF SEED.

The greatest care should be taken to procure seeds of the very best quality of the variety desired. The highest priced seed is the cheapest in the end. A cheap grade may always be looked upon with suspicion, and is usually dear at any price, and the sowing of seed of any grade upon a poorly prepared seed bed is wasteful.

It has long been a common practice to use a variety of seeds or so-called "lawn mixtures" in seeding down lawns. Those advocating these mixtures argue that there is no one grass which will suit the ordinary lawn maker, as he wants a lawn quickly, he wants a lawn fine, and he wants it to be permanent, results which it is claimed can only be obtained by mixtures. Further, it is asserted that the variety in the mixture best suited to the soil and climatic conditions will eventually run out the others, and the lawn will finally become composed of a single species. This course will manifestly cause a delay in securing a satisfactory turf, and when there are several varieties of grasses combined the liability of introducing weed seeds is greatly increased.

One of the chief features of beauty in a lawn, as already stated, is uniformity of color, and this can not be obtained by a mixture of varieties of grasses; the color will always be mottled and irregular. Under the most favorable conditions it is difficult to procure absolute uniformity in color, for there is likely to be variation in the shade of tint between individuals of the same species.

Uniformity of texture is impossible where two or more varieties of grasses are sown; no two species possess exactly the same degree of fineness, and even individual plants or strains of the same species are apt to vary in this particular.

The mixing of creeping bent with Kentucky blue grass is like mixing the good with the bad, and such a combination has a real disadvantage, which is particularly manifest in the later autumn months when the distinctive coloring of these two grasses is especially pronounced. The lawn composed of these two species is then almost unsightly because of its decided mottled appearance; the dark green of the blue grass stands out in striking contrast with the paler color of the creeping bent. For the same reason, white clover should never be sown with the bent grasses.

AMOUNT OF SEED USED PER ACRE.

The amount of seed to be used will depend somewhat upon the character of the soil, but more particularly upon the quality and kind of the seed used. The seed, of course, should be sown much more thickly than for hay production, and allowance has to be made for the thoroughness with which the seed has been cleaned from chaff. Rhode Island bent and creeping bent are both likely to contain a large amount of chaff and imperfect seeds, and the quantity of seed sown should be sufficient to make allowance for this. Under the new methods of cleaning seeds of Kentucky blue grass, the chaff is almost entirely removed, but in the case of this grass there is often a lack of vitality, or germinative power, and it is always best to use a liberal quantity in seeding down the lawn.

Mr. William Doogue, superintendent of public grounds, Boston, sows 4 bushels of Kentucky blue grass and redtop mixed in equal parts, to which about 6 pounds of white clover have been added, to the acre, or 1 peck to 300 square yards. Owing to the great variation in the weight per bushel of grass seeds of the same kind (due to the presence of more or less chaff), it is best to base the amount upon weight rather than measure, and from 50 to 60 pounds of seed of fine quality is not too much to use upon an acre of ground, or 1½ pounds to 100 square yards, poor land requiring more seed than fertile land. Some advise as much as 100 pounds of seed to the acre.

TIME OF SEEDING.

In the State of Washington the time for seeding is given as from September until April; in Florida during the wet season, from June until September. It may be stated here, however, that in the latter State seed is rarely used, as the lawn grasses are St. Augustine and Bermuda, which are usually propagated by cuttings. In North Carolina, March is specified as the time for sowing lawn grass seed. In New England the seed may be sown from the middle of April to the middle of May or from the middle of August to the middle of September.

If the seed is sown in the spring, it should be as early as possible, or as soon as the land is in condition to receive it, in order that the young plants may become sufficiently well established to withstand the often dry and hot summer months. This applies, of course, to regions where Kentucky blue grass or the bent grasses are used for lawns. Another advantage of very early spring planting is that it enables the grass to get ahead of the annual weeds, which are not usually troublesome before midsummer. If seeding is done in the fall, it is necessary to sow the seed sufficiently early to enable the grass to become well rooted before severe winter weather sets in. Young seedlings are likely to be killed by winter freezing or thrown out of the ground and destroyed by frosts. Fall planting has this advantage, that the grass, if it passes through the winter successfully, is in condition to crowd out weeds the following season, and at the same time be sufficiently well rooted to resist summer droughts.

MANNER OF SEEDING.

The seed must be sown or scattered evenly over the surface if a patchy and unsightly growth is to be avoided. It is best to select a time when there is little or no wind, and, if possible, immediately previous to an expected rain. Care must be taken not to cover the seed too deeply. A very light raking or brushing may be allowed, and is even advantageous, but generally rolling will be sufficient. The rolling is necessary to make the surface soil firm, to press the seeds into close contact with the earth, and to render the surface smooth and even. The germination of the seed largely depends upon the depth to which it is covered. An eighth of an inch of earth is ample covering for most grass seeds, while Kentucky blue grass is said to germinate best when exposed to the light, and consequently not covered at all.

TRANSPLANTING TURF.

When there is a ready and abundant water supply turf may be transplanted at any time, and the same may be said in regard to seeding; good lawns may be made whenever the soil is in good condition.

Where pure cultures can be obtained, which is very rare, unless they have been previously prepared, the turf of Kentucky blue grass or bent grass may be used in making a lawn. This turf, if in ample quantity, may be carefully cut and transplanted to the lawn, covering the surface of the latter completely, being well pressed down upon the previously prepared earth. Where the supply of pure turf is limited, but still can be obtained, it may be cut into small pieces 2 or 3 inches square, and these set out at intervals of 6 to 8 inches, being pressed into the soil about one-half inch below the uncovered surface, which will eventually settle a little, and if the soil has been properly prepared the growth of the grass will soon cover the ground and make a satisfactory sward much more quickly than can be obtained by seeding (see Pl. XIII, fig. 1). This method has the advantage, too, of insuring the production of exactly the kind of turf desired, a result not always obtained by sowing seed. A lawn of limited extent planted in this way at Washington, D. C., early in September was fairly well covered with grass by December 1.

Where there are steep slopes to be covered, as in the formation of terraces, it may be impossible to establish a turf by seeding, owing

FIG. 1.—TRANSPLANTING TURF AT THE TURF GARDEN, SOUTH MANCHESTER, CONN.

FIG. 2.—LAWN IN PUBLIC GARDENS, BOSTON, MASS.

to the liability of the seed bed being washed down by rains. In such cases it becomes necessary to use sods or turf, which should be cut in long strips and laid at right angles to the slope. When the incline is very steep the sods must be fixed or held in place by wooden pins 10 or 12 inches long, driven in at more or less frequent intervals, according to the necessities of the case.

The using of turf of mixed grasses, such as is usually obtained when an order is given for turfing a lawn, is not to be recommended. Such turf can never be made to present a satisfactory appearance, and will always be a source of annoyance and trouble. It is only when turf of good quality can be procured that it should be used at all, even along walks and around flower beds. Here the use of poor turf would be no better than seeding.

MOWING THE LAWN.

The number of times the lawn should be cut will depend very much upon the character of the season or the amount of irrigation. In the turf garden of the Connecticut Experiment Station the grass is cut eighty times or more during the season. Ordinarily, in parks at least, the lawn is mown every week or ten days, although in some sections where the soil is good and there is a continuous growth of grass the lawn mower is kept constantly going. The oftener the lawn is mown and the more frequently it is rolled the better and finer the turf. The grass should not be allowed to attain such a growth that when cut there will be any decided change in color. The lawn should be kept close cut, and this can only be done by frequent mowings. During the dry summer months it is best not to cut so close as in the spring or fall; this applies to parks and lawns of large extent. Too close cutting in midsummer is apt to expose the roots to the burning influence of the summer sun. Mowing should begin as soon as growth starts in the spring, and ought to be discontinued in the regions where the winters are severe by the first of September or October.

OBSTACLES TO BE OVERCOME.

The principal obstacles to be overcome in the establishment of a perfect lawn are poor soil, bad drainage, dry weather, inadequate water supply, and weeds. Poor soil and drainage are overcome by thorough preparation and enrichment of the land, as already pointed out. When this has been properly done the other obstacles mentioned are of small moment even if dry weather prevails. On a well-drained and well-pulverized soil the grass is in a position to withstand drought. In other words, the ill effect of inadequate irrigation may be largely overcome by this initial preparation of the soil.

Until the turf is well formed constant attention is necessary to prevent the invasion of weeds. They should be removed upon their first appearance, and in no case allowed to gain a foothold, for when once established their removal becomes very laborious. Annual weeds, like foxtail and crab grass, may be removed readily, but perennials, such as dandelions and plantains, are more difficult of eradication, and where weeds of this character have been allowed to become at all abundant, the simplest remedy, generally speaking, is to plow the land and start afresh. Crab grass is becoming a very serious pest in lawns in the Central States. This grass seeds freely and grows best during the hottest midsummer months when Kentucky blue grass and the bent grasses are vegetating but little. The seeds appear to be scattered everywhere; they germinate quickly, and where there is the least bit of room available upon the lawn, crab grass seizes upon it, and soon, by its persistence and vigor of growth, will cover considerable areas by crowding out other grasses. Crab grass is likely to be overlooked when it first appears, but later in the season, at the beginning of cool weather, it turns brown and reveals itself by disfiguring the lawn with more or less extended patches of dead vegetation. There is hardly anything more unsightly in the lawn than this dead growth of crab grass. In the early spring the areas which crab grass occupied the previous season are usually filled by the little annual spear grass or by chickweed or other quick-growing weeds of various kinds. When the lawn is infested with crab grass, it should be removed by pulling or raking, fertilizers added, the ground reseeded and rolled. In the vicinity of Washington, D. C., Bermuda grass often becomes a pest upon blue-grass lawns, and like crab grass, its presence is not usually detected until the cool weather of autumn, at which time its leaves and stems turn brown; it is then readily distinguished from crab grass by its much lighter color. When the lawn has once become infested with Bermuda grass, there is little else to be done but to encourage its growth or to plow up the land and reseed, being careful at the same time to remove all Bermuda grass stems and roots; crab grass is an annual and is removed with less difficulty.

A species of *Paspalum* is often a troublesome weed upon lawns, particularly from Pennsylvania southward. It is not uncommon to see this grass usurp all the space in small dooryards or grassplots. It is a rather hard and wiry-stemmed grass, with comparatively broad leaves, and is totally unfit for making turf. It is, however, more easily removed than Bermuda grass. Another common weedy grass found in lawns and dooryards is goose grass (*Eleusine indica*). It is a coarse annual, and in its persistent growth is scarcely less annoying than crab grass. Lawns infested by it should be treated in the same way as recommended for crab grass. There are many grasses which are likely to spring up in the lawn if opportunity is given them, and it is quite rare to find a lawn entirely free from weeds.

FIG. 1.—A LAWN AT NEWPORT, R. I.

FIG. 2.—A BIT OF LANDSCAPE WITH SHADED LAWN, FAIRMOUNT PARK, PHILADELPHIA, PA.

A PERFECT LAWN.

It will be understood from what has been said, that the selection of the variety in making a lawn must depend upon circumstances and the taste of those for whom the lawn is made. The varieties suited to temperate climates, not subject to excessive drought or where water may be employed, are Kentucky blue grass, Rhode Island bent, and creeping bent. For shaded streets and parks, hard fescue and various-leafed fescue, especially the latter, may be used to advantage; and in northern latitudes, woodland meadow grass is a desirable variety for shaded situations. In the warmer portions of the South, Bermuda and the variety known as St. Lucie grass stand first; and when the soil is somewhat moist or very sandy, St. Augustine grass may be substituted. Curly mesquite is recommended for trial in the warmer regions of the Southwest, too dry for the successful cultivation of Bermuda. The three grasses last named are most readily propagated by transplanting the rooted stems. Under favorable conditions these grasses will spread rapidly and soon cover the soil with a turf varying in fineness according to the species. Among the finest lawns in this country are some of those at Newport, R. I. The best of these are composed almost entirely of either creeping bent or Rhode Island bent. There is ample moisture, and no labor is spared in keeping the surface in perfect order by frequent cuttings and rolling and by removal of all weeds. Nothing can be more beautiful than these broad, unbroken stretches of velvet-like sward. (See Pl. XIV, fig. 1.)

A perfect lawn consists of the growth of a single variety of grass with a smooth, even surface, uniform color, and an elastic turf which has become, through constant care, so fine and so close in texture as to exclude weeds, which, appearing, should be at once removed. Briefly, such a lawn may be secured by thorough preparation of the soil and the application of suitable fertilizers; by seeding with pure seed of the highest quality; by proper attention to irrigation and the maintenance of fertility; by the prompt removal of weeds, and, finally, by the frequent and intelligent use of the roller and lawn-mower.

REPLIES TO CIRCULAR LETTERS OF INQUIRY.

In the beginning of this paper reference is made to the replies received in answer to a circular letter issued by the Department relative to the subject of lawns. It can not fail to be of interest to quote here some of these replies, and it is to be regretted that only a few can be presented. These, however, represent widely distant and diverse sections of the country. The numbers preceding the paragraphs in the replies correspond to the questions in the circular mentioned on pages 355 and 356.

From Mr. William Doogue, superintendent of public grounds department, Boston, Mass.:

(1) That the conversion of land into suitable soil for a permanent, satisfactory lawn depends wholly upon the condition of the land to be utilized. If the land consists of a natural deep alluvial soil, with a clayey subsoil basis, the work of conversion should be a comparatively easy task. Early in September the land should receive a deep subsoil plowing, turning down the sward in every case to enable it to decompose and become fibrous and alluvial. As early as practicable in the spring the whole surface should receive a coating of five-year-old composted cow manure, at the rate of 10 to 12 cords to the acre. It should then be cross plowed.

(2) The manure, however, should be applied intelligently, and not promiscuously, according to the fertility of the soil. A shallow soil, resting upon a silicious or sandy bottom, is totally unsuitable, while a light soil, resting upon a friable or clayey bottom, generally insures a satisfactory lawn. If the land is covered with a vegetable deposit which has accumulated an accretion of matter for years, from falling leaves, etc., it is all the more preferable. Hard, dry soils or stiff clays, where great detrition frequently takes place, are undesirable. Wet lowland should be well underdrained and sweetened. Lowland which has been previously cultivated may be chosen when it has a good depth, is easily drained, and is capable of being improved by the application of suitable manures. Worn-out land is an unprofitable and uncertain quantity to experiment with. For fall dressing, clear sheep manure, 3 to 5 tons per acre, is the best. For early spring dressing, Canada hard-wood ashes, 8 per cent potash, from 3 to 5 tons per acre, according to the fertility of the soil.

(3) A liberal allowance of Canada hard-wood ashes where there is much shade.[1]

(4) Kentucky blue grass and redtop, equal parts, 4 bushels per acre, of pure, clean seed, with about 6 pounds of Dutch white clover added.

(5) One peck of seed will sow 2,722 square feet; 1 bushel will sow 10,890 square feet; 4 bushels will sow 43,560 square feet. Kentucky blue grass mixed with white Dutch clover is preferable, although I have had excellent success with redtop and white clover.

(6) The time of seeding in the spring is from the middle of April to the middle of May; for fall seeding, it is from the middle of August to the middle of September.

(7) The number of "cuttings" depends wholly upon climatic influences. From the first of May to the middle of October we average weekly "cuttings."

(8) If the foregoing directions are adhered to there will be no obstacles to overcome.

The questions propounded in your circular lead me to presume the employment of intelligent and skilled labor in the execution of the minor details of harrowing, leveling, grading, seeding, rolling, and, finally, the general contour of the landscape, etc., which should be in perfect harmony with the mansion and surrounding embellishments.

From Mr. C. D. Beadle, Biltmore, N. C.:

(1) The preparation of the ground being the most important step in making a lawn in western North Carolina, we endeavor to thoroughly plow and subsoil the area to be seeded and to finely pulverize a few inches of the surface, making the

[1] See report of superintendent of Greenwood Cemetery, New York, upon this subject.

mechanical condition as nearly perfect as possible. During the progress of the operations above outlined liberal quantities of fertilizers are thoroughly incorporated.

(2) Lime, well-rotted manure, bone meal.

(3) We make no change.

(4) Kentucky blue grass (*Poa pratensis*) and a little white clover (*Trifolium repens*). If very quick results are desired the introduction of the redtop (*Agrostis vulgaris*) will greatly hasten the effect, but this species is inclined to be very short lived at Biltmore.

(5) Three or 4 bushels per acre.

(6) March.

(7) As often as a cutting will improve the appearance, taking the precaution, however, to leave the grass a little long during the late fall as a protection in winter.

(8) Proper drainage and fertility of the soil, and especially to get the surface all alike as to its fertility.

(9) Kentucky blue grass (*Poa pratensis*) decidedly, with us.

From Mr. A. F. Harley, city engineer, Jacksonville, Fla.:

(1) We find it most economical to keep the land perfectly clean, that is, to remove all growth that may be made during the first season from that portion of the land we expect to plant in grass.

(2) We fertilize the land during this period with stable manure and ashes from our crematory.

(3) In low and wet land would advise planting the St. Augustine grass and in lighter soils the Bermuda grass.

(4) We hardly ever use seed, preferring in every instance to plant the grass in rows.

(5) See reply to No. 4 above.

(6) During the wet season, from June until September.

(7) Our lawn mowers are in constant use.

(8) The land to be clean, that is, capable of producing no other variety than that planted.

(9) For general use, I would recommend Bermuda grass.

From Mr. J. F. Foster, general superintendent and engineer, South Park commissioners, Chicago, Ill.:

(1) About 8 to 10 inches of the best vegetable mold that can be obtained in this locality at a reasonable cost is spread upon the surface graded for lawns, and if not of the best quality, rich manure from the stock yards is spaded into it. It is well pulverized, rolled, and seeded.

(2) The only fertilizer that we have used is manure from the stock yards, which has been piled up five or six years, and is very rich. This is spread upon the lawns to a depth of perhaps one-half inch every two years.

(4) Fancy-chaff redtop, Kentucky blue grass, white clover, and fancy redtop, in proportions of 39, 81, 12, and 42, respectively, based on weight.

(5) About 4 bushels to the acre.

(6) During the month of April.

(7) The number of cuttings during a season varies greatly, a good growing season probably twelve times.

(8) Weeds, poor earth, and want of water.

(9) Kentucky blue grass.

From Mr. A. J. Graham, superintendent department of parks, Denver, Colo.:

(1) In our country we have the original prairie composed of buffalo grass, sage brush, cactus, sunflowers, etc. We break that in fall or early winter and sow rye, if broken early; if late, sow spring rye or oats. That keeps down weeds and pulverizes the soil. If in a hurry for a lawn, plow in the rye or oats in August, and prepare for a lawn, which mainly consists in grading and pulverizing the soil.

(2) I find it more beneficial in this climate to top-dress with well-decomposed manure rather than plow it in, as it stimulates the young grass, and at the same time retains the moisture, which is a great item in our dry climate, where we have to produce lawns entirely by irrigation. Our soil here is rich enough to produce fine lawns without the aid of manures, but top-dressing of barnyard manure or ground bone gives it a fine velvety appearance.

(4) We use Kentucky blue glass with a mixture of white clover.

(5) About 80 pounds to the acre.

(6) We sow on or about the 20th of August. A great many are sown in the spring, but one is then apt to be bothered with weeds. No weeds in the fall.

(7) We cut every week from the first of May to the middle of September. Our grass grows very fast, owing to keeping it wet, which we have to do.

(8) The chief obstacles are ground squirrels, gophers, and ants, but they finally disappear, owing to the moisture—they all like dry surroundings.

(9) If I should use one kind of grass, I would say Kentucky blue grass.

From Mr. F. N. Little, superintendent department of public parks, Seattle, Wash.:

(1) Thorough cultivation, with proper precautions for drainage, even admixture of the fertilizers that may be used, and thorough rolling both before and after seeding.

(2) On light sandy soil, which is the prevailing soil here, we have to depend largely on barnyard manure for putting humus into the soil. Where the soil is good loam we use the commercial fertilizers with good results, the absence of weed seeds being a valuable economic feature. After the lawn is established, we top-dress alternate years with ground bone and blood and bone.

(3) *Dactylis glomerata.*

(4) For ordinary purposes a mixture of *Poa pratensis*, *Festuca pratensis*, *Anthoxanthum odoratum*, and *Trifolium repens*, the latter being used as a protection to the other seeds in late sowing. For dry soils without sprinkling we are experimenting with the various fescues in conjunction with *Trifolium repens;* but we have no definite results to report.

(5) From 50 to 60 pounds per acre.

(6) From September until April.

(7) Average forty cuttings per annum.

(8) Uneven character of soils and extirpation of obnoxious weeds.

(9) *Poa pratensis.*

From Mr. George E. Kesler, secretary and engineer board of park commissioners, Kansas City, Mo.:

(1) Plowing, harrowing, and the rolling of surfaces is the usual method of preparation, plowing rarely more than 8 inches deep.

(2) Fertilizers are rarely used in preparation of the soil, and beyond moderate use of stable litter, bone meal and wood ashes are separately used to slight extent.

(3) Blue grass (*Poa pratensis*) is decidedly the best in shade.

(4) Blue-grass seed is used almost exclusively; occasionally an admixture of white clover.

(5) From 4 to 5 bushels per acre.

(6) The best time, for seeding in this climate, is late summer.

(7) As the number of cuttings in the season depend so much upon variable conditions, it is impossible to answer this clearly.

(8) Chief obstacles to formation of a perfect lawn are weeds and wild grasses; among these the worst is the foxtail.

(9) Blue grass used alone is decidedly the best of all.

From Mr. William Page, general superintendent park department, St. Louis, Mo.:

(1) Our lands consist mostly of yellow clay, the top of which we give a heavy dressing of old rotten cow dung.

(2) For fertilizers we use bone meal and old rotten manure.

(3) We avoid having lawns with too many trees; otherwise use the same fertilizers.

(4) We mostly use Kentucky blue-grass seed.

(5) We use 21 pounds to 1 acre.

(6) We do our seeding mostly in February and March.

(7) Grass is cut on the lawns every ten or twelve days, according to dry or wet weather.

(8) The chief obstacles to getting perfect lawns are: Poor, musty seed, gophers and moles, low wet grounds, using new manure full of cut worms and containing too much seed of weeds.

(9) Blue grass has proved to be the best for sole general use.

From Mr. Henry L. Haynes, chairman park commission, Austin, Tex.:

(1) The preparation of the land consists in thoroughly breaking up with a turning plow to a depth of about 6 inches and thorough harrowing.

(2) Our soil having every element necessary, fertilizers are not used.

(3) Answered in No. 2.

(4) Bermuda is our standard lawn and park grass, and is established by sodding and by rootlets, especially the latter, when planting largely.

(5) Answered in No. 4.

(7) From two to four cuttings, except where used for lawn or park, when the lawn mower should be used almost constantly, causing a dense growth and a smooth and carpet-like surface.

(8) Drought is the only obstacle whatever, as Bermuda grass thrives here on very poor soil when watered during our long dry spells.

From Mr. J. F. Mendenhall, secretary commissioner of parks, Los Angeles, Cal.:

In reply to your queries, there is nothing in the establishment or maintenance of lawns in the parks or private homes of this city different from the plan pursued in the Central States. Blue grass is always used, generally alone, but sometimes with white clover. The latter never dies (if watered), and will kill out almost anything else. It is absolutely necessary to water lawns in this country during the dry season, and this is usually done once or twice a week. We have what is called Bermuda grass, which is about to take all our lawns, and is not desirable, but will grow anywhere, killing out the blue grass. Seed comes through the water ditches.

(1) Same as in Eastern States.

(2) Old manure, bone dust, etc., same as used on best Eastern lawns.

(3) Australian rye; blue grass.

(4) Blue grass (Kentucky fancy).

(5) One pound fancy blue grass to 100 square feet.

(6) Early fall or spring; any time will do, except hottest weather; must be sprinkled every few days.

(7) About 25 on good lawns.

(8) Nothing special.

(9) Blue grass.

OBJECT-LESSON ROADS.

By Roy Stone,
Director of the Office of Road Inquiry.

INTRODUCTION.

Following the maxim that "Seeing is believing," the object-lesson method has long been favored in all educational work. This method is especially valuable in teaching the importance of good roads and the possibility of obtaining them.

In many parts of the United States the roads are torn up with the outcoming frost in the spring, soaked with the autumn rains, frozen into ridges in winter, and buried in dust in the summer, making four regular seasons of bad roads, besides innumerable brief "spells." For men accustomed all their lives to these conditions it is hard to believe that country roads anywhere can actually be good all the year round. The lecturer on good roads, therefore, is listened to like one who tells fairy stories or travelers' tales of distant lands; but put down a piece of well-made macadam road as an illustration and let the people try it in all weathers and no lecturer is needed. The road speaks for itself, all doubts disappear, and the only question raised is how fast can it be extended and how soon can the improvement become general. When members of the legislature of Virginia visited the roads of New Jersey in the early spring they found them covered with newly fallen snow, which the farmers removed so as to show the firm, smooth surface underneath. This demonstration and the fact that wet snow did not make the macadam road muddy were worth more than any amount of argument, and the Virginians went home to their impassable highways converted to road improvement.

Fully impressed with the importance and value of this object lesson in teaching, States which are making the most definite progress in rebuilding their roads are taking pains to scatter the work in small sections, although in many cases this plan does not secure the greatest direct benefits in the actual use of the roads.

STATE AID TO ROAD BUILDING.

The road-improvement law in Massachusetts requires the State roads to be fairly apportioned among the different counties. This provision, together with the smallness of the sum annually appropriated, has made necessary what the State highway commission calls "a fragmentary distribution of State highways." The amount of road to be built in one locality was limited at first to the maximum of 2 miles. The present road map of the State, therefore, shows these roads only as spots apparently scattered over the State, although the intention is, of course, to join them ultimately into systematic lines. The effect of this distribution has been to give the whole people of the State some knowledge of the value of improved highways, and this knowledge has manifested itself in annually increased appropriations of State funds for this purpose.

The State-aid law of New Jersey allowed the application of the State's contribution to any section of road not less than a mile in length where the local property owners were ready to contribute 10 per cent of the total cost. This law has had much the same effect as that of Massachusetts, and has so disseminated a knowledge of the value of road improvement throughout the State that the appropriations for State aid have steadily increased, and the people in many localities, who were formerly opposed to any State action, are clamoring for the State's assistance.

The State of Connecticut has followed the same plan as that of New Jersey, and the State of Rhode Island has limited its construction to half-mile samples, one in each of the different towns.

FEDERAL ASSISTANCE IN MODEL ROAD BUILDING.

The Office of Road Inquiry, recognizing the value of the object-lesson method of giving instruction, by direction of the Secretary of Agriculture, sent the following letter to the presidents of all agricultural colleges and directors of experiment stations:

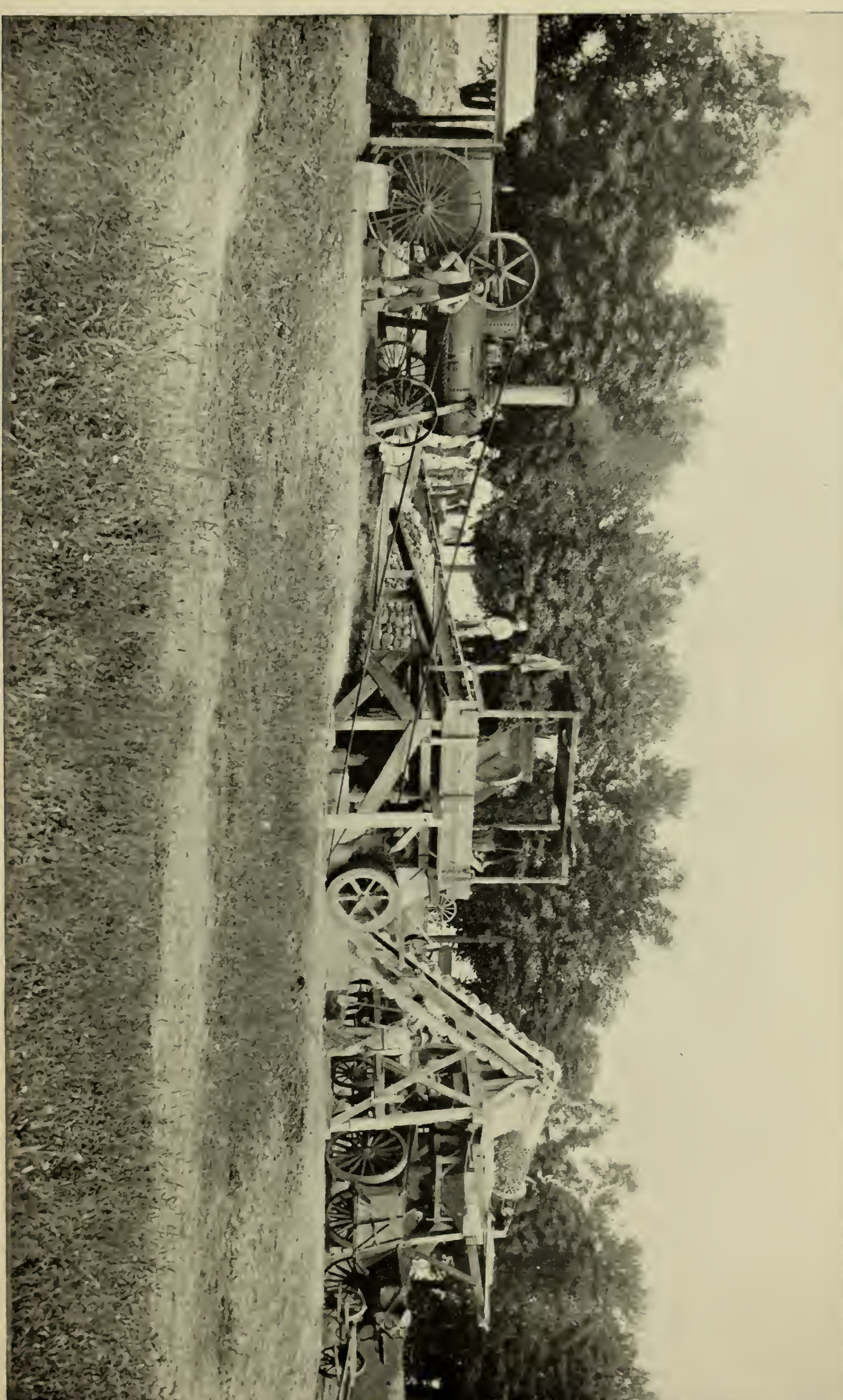
GENTLEMEN: Congress, in making successive appropriations for inquiries relating to public roads, has in each case authorized the Secretary of Agriculture to "assist the agricultural colleges and experiment stations in disseminating information upon the best methods of road making," but no practical progress has been made in this branch of the work.

The Secretary, in his annual report for 1895, says:

"It is proposed during the coming year to secure the cooperation of agricultural colleges and experiment stations in the object-lesson method of disseminating this information. They will be taught to construct model roads on the farms of their experiment stations or on their college grounds, where they can be regularly used, and thus become a lesson to all the farmers who visit them."

My own report for 1896, referring to the same subject, says:

"It is to be regretted that no definite progress has been made in this direction, although a strong interest has been manifested in the proposal by the officers and directors of the colleges and experiment stations. Object-lesson roads should be made with great care, not merely to serve as samples of the best that is practicable, but to be so adapted to the several locations as to show the best uses of the local materials. For this purpose a careful inspection and study of each locality must be made by a competent engineer of more than ordinary experience and judgment in road building. This has been impracticable under the present appropriation, but it may be profitably combined in the future with the proposed duties of the itinerant representatives of the office. A beginning can be made in this direction under the present appropriation, and a full development in the following year if the appropriation is sufficient. It is believed that for the expense



ROAD BUILDING BY U. S. DEPARTMENT OF AGRICULTURE AT GENEVA, N. Y., SHOWING CRUSHING PLANT.

of the actual road building a cooperation can be established that will distribute the cost so that it may fall very lightly upon all concerned. The State, county, township, and neighborhood in which the experiment station is located will all have an interest in the work, and the college and station will doubtless render assistance, so that a very moderate contribution on the part of the Government, together with the necessary supervision of construction, will be all that is necessary on its part."

Before formulating any definite plans to be presented to the Secretary for the purpose, I would be very glad to have the views and suggestions of as many of the presidents of the colleges and directors of stations as are disposed to join in this undertaking. My own idea at present is to organize an outfit of one or two car loads of the most approved road-building machinery, including rock crusher and screens, road rollers, etc., and to send it from college to college where preparations have been made for actual road construction, accompanied by one or two skilled operators and a competent road engineer to direct the work. (See Pl. XV.)

It is more than probable that the use of the machinery will be contributed by the various road-machine builders, and that transportation could be procured, by proper effort, for the mere cost of haulage. The expense to the Government in that case would be only that of the engineer, one or two machine operators, and some incidentals, local contributions furnishing the road materials, common labor, fuel, etc., including of course the grading down of hills, if that should be required.

This plan would establish a very wide cooperation, comprising the Department, the railroads, the machine builders, the various local road authorities, the colleges, stations, and interested individuals. It would thus make the expense of building a sufficient section of road very easy to be borne, and would enable a small expenditure by the Government to accomplish much practical benefit.

In many, and perhaps most, cases it would be better to rebuild a section of the public highway near the college or station than to build on their grounds. In that case, the length to be built should be sufficient to be of actual use and value to the public as well as to the institution.

During the construction, lectures could be delivered by the engineer in charge, with practical illustration of the various progressive details by means of the work in progress.

The time occupied in making a section of half a mile to a mile of road would be from two to three weeks. The winter season would be used for work in the Southern States and the summer in the Northern.

I would be glad to have a general reply to this letter without waiting for details. If a sufficient number favor the plan, I will send a supplemental inquiry covering the detailed information needed from the various localities.

LOCAL COOPERATION WITH THE GOVERNMENT.

Very favorable replies to the above letter were received from nearly all the colleges and experiment stations, making it very evident that the cooperation proposed would be readily secured, and promising much for ultimate success.

The Secretary of Agriculture having signified his approval of this practical line of work, arrangements were made as early as possible for commencing operations. No funds having been provided by Congress for actual road construction, the office was obliged to curtail all of its other expenditures in order to accomplish even a small amount of work in this direction. The following special reports show something of the work done during the season of 1897:

NEW BRUNSWICK, N. J.

Nichol avenue.—At New Brunswick, N. J., Nichol avenue leads from a main road or street in the southeastern section of the city to the State experimental farm. The portion improved is 660 feet in length, beginning at the street and ending at the gateway of the farm. The roadbed, with its general grade, was followed and dressed up with an American road machine. The shoulders were made up from the natural soil taken from the sides of the road, the soil being red clay, resting on red shale foundation. The stone used was the New Jersey trap rock, brought by rail from the Rockyhill quarries. The stone had to be unloaded from the cars and hauled to the crusher. This extra hauling added to the cost. The crusher used was a No. 3 Champion. The distance from the crusher to the road where the stone was used was about $1\frac{3}{4}$ miles. The stone fell short and work had to be suspended for several weeks, so that much of the effect of filling or binding material was lost by not being rolled and wetted as it was put on. All the stone used was crushed, excepting about 20 cubic yards, which was purchased already crushed to finish the road. The total cost of the stone was $146; that of labor, sprinkling, rolling, and cartage $175; the cost per linear foot being $48\frac{2}{3}$ cents. The stone was laid 8 feet wide and 6 inches thick.

College avenue.—There was also undertaken on College avenue, New Brunswick, N. J., in connection with the college, a piece of road, but owing to the difficulty of obtaining materials at the proper time it was only partially completed under the supervision of the Government, and was afterwards finished by the local authorities. The report of Dr. Scott, president of the college, speaks very favorably of the condition of the road, but says the total cost was slightly in excess of the original estimates. This section of road, however, included a large amount of excavation, partly in rock, grading, resetting of curbs, laying gutters, and changing pipes and sewer openings. The length laid was 500 feet and the width 40 feet. The depth of stone laid varied from 8 to 10 inches. The material was brought by rail from Rockyhill, N. J. The total cost was $2,103.39 for 20,000 square feet. The gutters were laid with trap blocks, at an extra cost over cobblestones of $255. Deducting this amount, the remaining cost was 80 cents per square yard. (See Pl. XVI, fig. 2.)

GENEVA, N. Y.

The following report upon the experimental road at Geneva, N. Y., is made by Mr. E. G. Harrison, special agent and road expert of the Office of Road Inquiry:

At the invitation of Mr. S. D. Willard, and Dr. W. H. Jordan, director of the New York Agricultural Experiment Station, I visited Geneva, N. Y., in the spring

FIG. 1.—WORKING THE ROAD MACHINE.

FIG. 2.—ROAD BUILDING BY U. S. DEPARTMENT OF AGRICULTURE FOR NEW JERSEY AGRICULTURAL COLLEGE AND EXPERIMENT STATION, NEW BRUNSWICK, N. J.

of 1896, with a view of arranging to put in a sample of road from the experiment station to Arch bridge, on Castle street, in that town. I looked over the road and gave a rough estimate of the cost, viz, $7,000 to $8,000. Two of the largest real-estate owners along the line were called on, and each agreed to give $1,000, or more if necessary. It was then agreed to lay the matter before the village corporation and ask for an appropriation of $3,000 or $4,000. Other leading citizens were seen, and they agreed that the village should be a contributor.

On May 14 I went, at the request of citizens of Geneva and Dr. Jordan, to Geneva and remained until the 18th of the same month. I talked with a number of citizens in reference to the sample road. By request, on the 17th, I addressed a meeting of the citizens called by the board of trade to consider the matter. They unanimously resolved to vote for the appropriation of $3,000 at a tax meeting to be held the next day. On May 18 a citizens' tax meeting was held for the purpose of appropriating money for the expenses of the village. I addressed the meeting and explained the conditions upon which the Government would supervise the building of a sample road. The appropriation of $3,000 was carried by a vote of 60 to 4.

Machinery employed in making the road.—The machinery sent to Geneva for this work comprised a No. 4 Champion Crusher (see Pl. XV), driven by a 20-horse engine, with elevator, screens, and special receiving pockets, furnished without charge by the Good Roads Machinery Company of Kennett Square, Pa.; also two special distributing carts, one steel Champion road machine (see Pl. XVI, fig. 1), one roller, and a grading plow, all furnished by the same company, and a 20-ton steam roller, furnished on the same terms by the Buffalo-Pitts Company, of Buffalo, N. Y. The steam roller was equipped with spikes for loosening the old road or any hard material found in grading. The total value of the plant furnished was between $6,000 and $7,000. Before commencing work, the Director of the Office of Road Inquiry induced the parties interested to cut down Maxwell Hill, which was the only heavy hill on the line, to a 5 per cent grade.

This road was an expensive one, owing in part to the fact that it was a city street, requiring attention to sewers and gas and water pipes, and also requiring grading to a nicety not necessary in a country road. The grading also was very difficult, owing to the fact that the road had been graveled for many years with very coarse material, including a large amount of cobblestones. It was designed to make a good smooth dirt road alongside of the stone road, and to do this required that all cobblestones or coarse gravel be removed. The expense was further increased by the necessity of hauling most of the field stone which were used for the foundation over a distance of several miles and bringing the trap rock surface material a distance of over 300 miles from the Palisades of the Hudson River.

The length of road was increased by extending the work from Arch Bridge to Main Street, making a little over $1\frac{1}{2}$ miles in all.

There were many delays here also in supplying the material, and the work which was begun on July 16 was not finished until November 8, the crusher having worked about one-half of that time. The foundation was entirely of crushed field stone laid 5 inches thick with a surfacing of trap rock 3 inches thick.

During the construction of this road it was visited by many hundreds of farmers from different portions of the State, including officials from half the counties of the State.

Cost and wearing qualities of the road.—Professor Jordan, of the New York Agricultural Experiment Station, in a letter to the special agent, gives a statement of the contributions, cost, and present condition of the road, as follows:

Receipts.

Town of Geneva	$3,000.00
Town board	2,905.59
New York Experiment Station	1,040.73
W. and T. Smith Co	1,000.00
T. C. Maxwell & Bros	1,000.00
W. H. Smith	100.00
	9,046.32

Disbursements.

1,214 yards trap rock	$2,898.31
1,683 yards field stone	1,668.00
Grading hill	679.44
Teams, men, tools, etc	3,800.57
	9,046.32

The new road seems to be meeting with favor. That portion on Castle street from Mr. Mellin's to the Octagon House is very satisfactory indeed. The 300 feet which was surfaced with field stone shows very plainly the inferior quality of the stone, but it is, nevertheless, fairly good. The only unsatisfactory piece is that portion between the brick pavement and Main street. * * * A good deal of mud has been carried on to it, and when this was just dry enough it has appeared to roll up on the wheels and take some of the surfacing of the road with it.

The road is getting a very large amount of use. During the past few weeks it has been the only place where the horsemen could drive, and every one who has a load to draw and can go over that road does so. You probably know that the town of Geneva has purchased the road machinery.

WARREN, PA.

Mr. E. G. Harrison, road expert of the office, reports on a section of road constructed at Warren, Pa., during the county fair, as follows:

The road improved was a section beginning at the western end of the county bridge and running south toward the cemetery, along the west side of the Allegheny River.

A roadway 12 feet wide was constructed for 450 feet and continued with a width of 8 feet 200 feet farther. The shoulders and side roads were made of very coarse washed gravel, from which many large, round stones had to be removed. The stone used for construction was kindly donated by the Philadelphia and Erie Railroad Company. It was found in the gravel pit about a half mile from the road. The stone was not at all suitable for surfacing, being mostly soft sandstone. It was found impracticable to remove the hard stone and keep them separate from others. The stone crusher was loaned by the road commissioners of Mead township. There was no screen, and a rotary screen could not be attached. A small chute screen was furnished by the American Road Machine Company of Kennett Square, Pa. This only separated the ground from the broken stone. In this way stone of different sizes were used, some of the large ones being broken with hammers on the roadbed. The crusher had not been used for over two years, and the engine was much out of repair, causing considerable delay. The roller, of 4½ tons weight, was furnished by the city of Warren; also a distributing wagon. The total cost outside of repairs to machinery and transporting the same was $185. The cost per linear foot of the 12 feet wide section was 31.8 cents and of that 8 feet wide 21 cents, the latter being at the rate of $1,108.80 per mile. If 5 or 10 miles had been made the cost would have been less than $1,000 per mile. It will be seen that where field stone are given free, and the hauling is not over a mile, a road suitable for a farming community can be built at a comparatively small cost. The county commissioners contributed $100 of the cost of this road. They sent circulars to all the townships inviting their road officials to witness this road construction. Eighteen townships were officially and unofficially represented during the exhibition, besides visitors from other counties.

ILION, N. Y.

Upon the completion of the Geneva road application was made by the authorities of Ilion, N. Y., for assistance in building a sample macadam street in that village. This locality, like Warren, not having an agricultural college or experiment station, the Government could give no financial aid, but assisted with such advice and encouragement as could be given without cost. The Office of Road Inquiry procured the necessary machinery from the same parties who furnished the Geneva outfit, and recommended the employment of the superintendent engaged by the Geneva authorities and his assistant.

This road has been completed to the great satisfaction of the authorities and citizens, but the details of construction and cost have not yet been reported.

It must be remembered that in the construction of this road, as well as of the others mentioned, only one or two experts were taken to the locality, and in each case a new gang of green men was trained into the work of road construction. This, of course, while highly beneficial to the local communities, is not an economical method of road construction; any contractor having the aid of the same free use of machinery, with a trained gang, would work to a better advantage.

AGRICULTURAL COLLEGE, KINGSTON, R. I.

The road now in process of construction at Kingston, R. I., is to be a single track stone road, 8 feet wide, with an earth road alongside, and will be made of granite from the quarries and fences on the college farm. It is to be a macadam road with a few spots of telford where the ground is naturally wet. This road is not expected to cost over $1,000 per mile. The machinery is furnished by the Good Roads Machinery Company. At the present writing the foundation of the road is nearly completed.

FLORENCE, N. J.

In addition to the roads named a road of novel construction at Florence, N. J., has been kept under observation, and the report of its condition by Mr. Harrison follows. The great abundance of furnace slag in the country makes it important to test thoroughly the use of this material for road building, and while it is not likely to prove valuable for the surfacing of roads, the indications are that it will make an excellent permanent foundation where it can be covered by good stone or gravel.

This road, running from Florence Station, N. J., on the Pennsylvania Railroad, to Burlington township line south of R. D. Wood & Co.'s iron furnace, is one of the Burlington County State-aid roads. It is 1¾ miles long. By the advice of the Office of Road Inquiry of the United States Department of Agriculture, a portion of this road was constructed with a slag base or foundation. As a representative of the office, I visited the road several times during its construction. The work was under the direction of Charles T. Harrison, engineer for the county of Burlington, and was begun April 1, 1897. It was finished about July 1, 1897.

The slag used was from the iron works of R. D. Wood & Co. The slag was taken from the base of iron pots. It cools rapidly when brought to the air and is of the nature of glass. The large lumps, being brittle, are readily broken. On about a half mile of this road the foundation, 6 inches in depth, was laid of this slag upon a bed mostly of dry and loose sand. Some of the slag was put down as telford foundation, laid by hand, the sharp protruding points being broken off, voids filled with small pieces, and earth spread on as a filler. On this the surface layer of 4 inches of 1½-inch trap rock was put, covered with coarse sand and ground stone for filling and binding, and rolled to a smooth hard surface. Only a small portion was laid as telford on account of the sharp edges of slag cutting the hands of the workmen. The greater part of the half mile of slag foundation was broken with hammers to 2-inch size and put on 6 inches in depth, well covered with sand and earth, and well rolled and compacted before the surface of trap rock was put on. The balance of the road, 1¼ miles, was macadam, constructed of trap rock.

I examined the road September 18 last, and found it as good as when first constructed. The part of the road built with slag foundation was just as smooth and hard as the part constructed entirely of stone. The part made of slag foundation was that nearest to the iron furnace, where all the heavy teaming is done, and was constantly traveled every working day by heavy two-wheeled carts carrying from 1 to 2 tons, and four-wheeled wagons with iron pipes weighing several tons. Thus far there is every reason to believe the slag foundation, which is indestructible by the elements, will remain firm and hard, as no wheels will come in contact with it.

The cost of this road with slag foundation was 44 cents per square yard, while that portion having a stone foundation was 54 cents.

ENGLISHTOWN, N. J.

The bog iron-ore road at Englishtown, N. J., built under similar circumstances as the furnace-slag road at Florence, N. J., and under observation by the Office of Road Inquiry for experimental purposes, is also reported upon by Mr. Harrison, as follows:

This road runs from the village of Manalapan to the railroad station at Englishtown, and is 3.81 miles long. The bed or foundation is of bog iron ore found in that vicinity. Its width is 12 feet, while the depth of foundation is 6 inches. It was put down in two courses of sufficient depth to make 3 inches each after rolling. The roller used was a horse roller of 6,000 pounds. Water was applied in sufficient quantities to secure a firm set. Upon this foundation there was placed a 2-inch layer of Jamesburg gravel, which was also rolled. About one mile was made wholly of gravel, the haul of iron ore being too long to be practicable. The contract price of this road was 21¾ cents per square yard for paving, and the total cost $7,599.99, including grading and underdraining.

Bog iron ore does not make a good surface for a road, as it crushes easily under wheels and goes into dust, but it makes an excellent foundation for either gravel or stone.

Inquiry was made of a number of the citizens of this section and they all expressed themselves as pleased with the road.

INTERSTATE OBJECT-LESSON ROADS.

It is the intention of many States besides Massachusetts, either by connecting their detached sample roads or by laying down long lines to be built as a whole, to establish State roads upon the principal routes of travel, which shall be object lessons on a large scale. The legislature of New York has frequently had under consideration the subject of a network of roads connecting all of the county seats by north and south and by east and west lines. The same or similar plans have been proposed in Pennsylvania, Maryland, and California. Other States have proposed to limit these object lessons to a single road running lengthwise of the State or two lines crossing each other at the capital. Should these plans be put into execution, it will be very important that these roads in the different States should be made to connect at the State lines and thus form interstate roads.

NATIONAL OBJECT-LESSON ROADS.

It would greatly increase the value of the interstate roads and stimulate a general public interest in road building if some of these lines could be so connected or combined as to form, in a measure, a national system, such as was planned and partly built by the Government in the early days of this century. The most effective lines that could be adopted for this purpose would be an Atlantic and a Pacific Coast line, joined by a continental highway extending from Washington to San Francisco. (See map, fig. 1.) The greater part of the Atlantic Coast line already exists in a more or less passable condition. A Pacific Coast line, 750 miles in length in California, has been mapped out by the highway commission of that State. That portion of the continental line between St. Louis and Kansas City is already located as the first great State highway of Missouri. The remainder of the total of 5,000 miles will be on lines naturally connecting great cities. Such a road as this, to be built by the several States within their own borders and by the Government through its lands and reservations, would be an invaluable lesson, not only as to the direct benefits of road improvement and the methods of accomplishing it, but as to the enhancement in value of property along its lines. In many States it would doubtless be built on the assessment plan, distributing the cost over many years, but ultimately placing it upon the adjoining and neighboring property specially benefited. The benefits of a national highway worthy of the name would extend for miles on either side of it, and would greatly exceed the cost of the road.

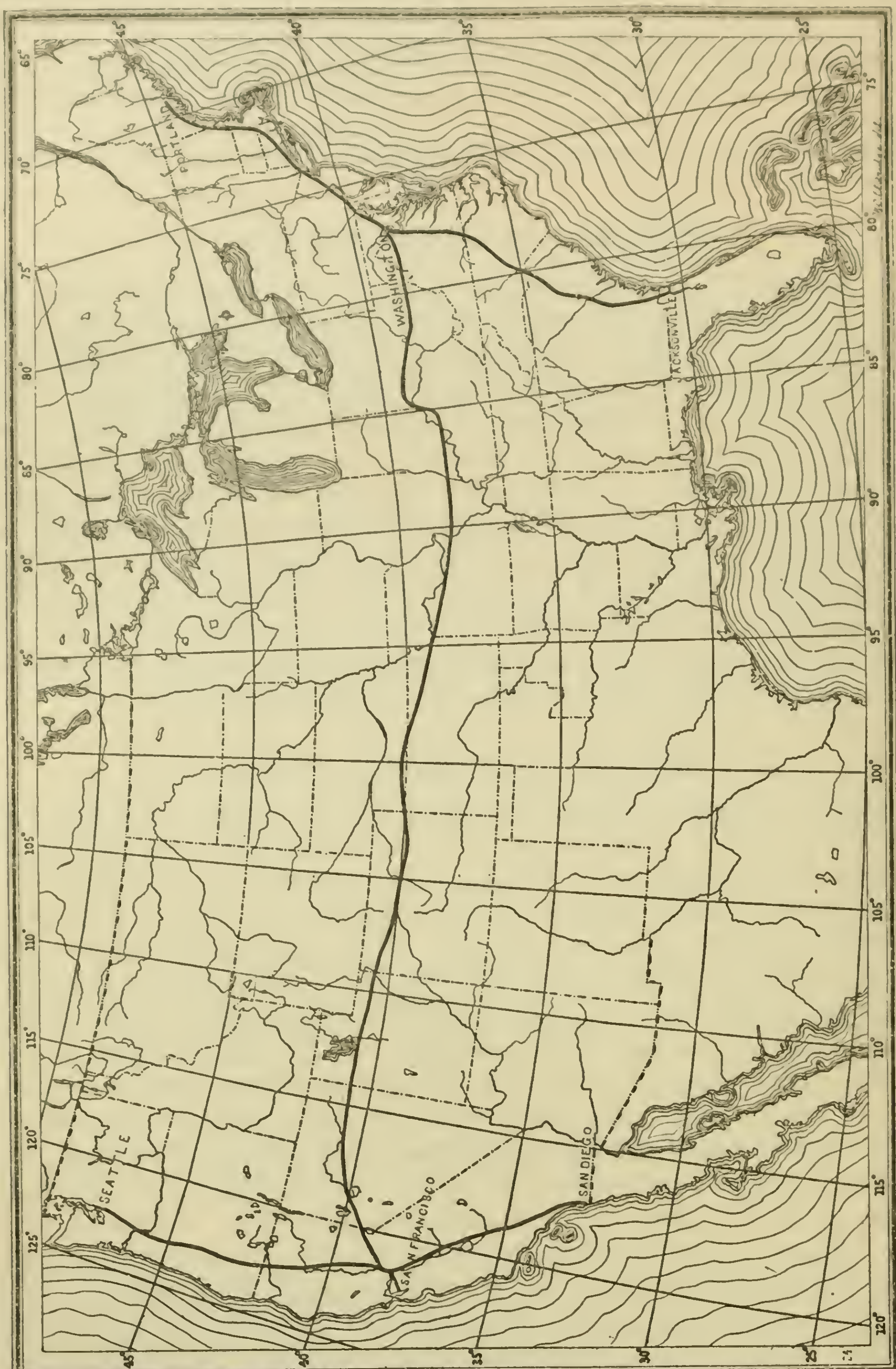


FIG. 1.—A national object lesson—suggestion for a coastwise and continental highway.

The lines indicated would traverse the whole, or portions, of about two-thirds of the States of the Union, and their construction would naturally be followed by that of parallel lines, making a complete national system including all the States.

HYBRIDS AND THEIR UTILIZATION IN PLANT BREEDING.

By WALTER T. SWINGLE and HERBERT J. WEBBER,
Special Agents, Division of Vegetable Physiology and Pathology.

INTRODUCTION.

Probably no question is of so much interest and importance to farmers and gardeners as the improvement of cultivated plants. Since the time of von Mons and Knight, the early part of the present century, this phase of plant culture has received considerable attention, but probably much less than it deserves. The experience of gardeners the world over has shown clearly that the possibilities in the improvement of our useful plants are almost unlimited. In the words of H. L. de Vilmorin, "No limit can be fixed as to the improvements which may be expected from care, thought, and selection. The gains of the last dozen years may surely be taken as the forerunners of better things." The last half century has witnessed unprecedented extensions of the areas devoted to agriculture, and this has led to a demand, still imperfectly satisfied, for new sorts of cultivated plants adapted to the particular conditions of climate and soil in each new region.

The great variety of soil and climatic conditions which this country affords renders it necessary to have many sorts of cultivated plants differing in their requirements. For instance, a tomato of the greatest worth for growth in the State of New York may be totally unfit for general culture in Florida, and the same is true in the case of almost all cultivated plants. The sorts cultivated in New York are almost wholly different from those cultivated in the South and the West.

The revolution in methods of transportation effected during the present century has multiplied many fold the areas which can be devoted to intensive forms of agriculture, such as fruit growing, market gardening, floriculture, etc., and the increasing aggregation of population in cities has led to a much greater demand for such products. These causes have also brought about an unceasing demand for sorts of superlative excellence which will warrant the expense and trouble of the most intensive culture.

Again, the maximum productiveness in most of our cultivated plants has not been reached, and much can still be gained in this direction. In striving to produce improved sorts, the size and shape of fruit or seed, color, quality, and a host of other features must also be taken into account.

Doubtless many exceedingly valuable sorts remain to be introduced from other parts of the world, but even here the art of the plant breeder will in the end be necessary to secure in these plants variations particularly adapted to the new conditions to which they are exposed when removed from the regions where they originated.

In breeding plants two methods are commonly relied upon: (1) Variations arising naturally, supposed to be induced directly or indirectly by environment; and, (2) variations induced by crossing different varieties, species, or even genera. The first of these methods was discussed by one of the writers in the Yearbook of the Department for 1896, pp. 89–106, and the second will be considered here.

Inasmuch as the sexuality of plants was unknown, or at least very imperfectly understood, prior to the last two centuries, while a knowledge of the sex distinction of animals dates from the dawn of human history, it is not surprising that while the hybridizing of animals was well understood by the ancients they did not know that crossing was possible with plants. Experimental proof of the sexuality of plants was published for the first time by Camerarius, December 28, 1691, and only after this discovery was the function of pollen and its necessity for seed formation understood. About twenty years later Thomas Fairchild, an English gardener, made the first recognized plant hybrid by crossing the carnation with the sweet william. (Pl. XVII shows a hybrid carnation.) The plants grown from the hybridized seeds, known as Fairchild's sweet william, were cultivated at least a hundred years under the same name, and possibly are still in cultivation. The first careful studies of hybrid plants were made by Koelreuter in 1760, and not till nearly the middle of this century was his work surpassed.

In general, hybrids can be produced only between obviously related plants. With some plants, such as oaks and verbenas, hybrids are not of uncommon occurrence in nature, while with many others, indeed in the majority of cases, no spontaneous hybrids are known. Among plants which have been cultivated for a considerable period, however, it is not unusual for closely related species to cross, and the same is true even in certain species distinct enough to be classed in different genera, the latter forming the so-called bigeneric hybrids.

What can be accomplished by close application to the work of plant breeding is shown by the extraordinary results obtained in this country by Burbank and Munson; indeed, no feature of agricultural, horticultural, or floricultural work is more fascinating or more promising of valuable results.

WHAT ARE HYBRIDS?

The term hybrid is by many applied only to the offspring obtained by crossing two plants or animals sufficiently different to be considered by naturalists as distinct species, while the terms mongrel and cross

HYBRID CARNATION.

1. Scott, Female Parent 3. Hybrid. 2. McGowan, Male Parent

are used to designate the offspring of two races or varieties of one species. It was formerly supposed that all hybrids were more or less sterile, in contradistinction to mongrels, which were believed to be very fertile. It has been found, however, that many hybrids, in the narrow sense, are very fertile, and that some mongrels are nearly sterile. Since it is impossible to indicate by any two words, such as hybrid or mongrel, the various degrees of difference of the forms crossed, the word hybrid is here used, comformably to the Century Dictionary, as a generic term, to include all organisms arising from a cross of two forms noticeably different, whether the difference be great or slight. Adjectives are sometimes used to indicate the grade of the forms crossed, such as racial hybrid, bigeneric hybrid, etc. Where a hybrid of two species is crossed with a third species, a trispecific hybrid results.

The offspring produced by the union of two plants identical in kind, but separated in descent by at least several seed generations, is often called a crossed, cross-fertilized, or cross-bred plant, but it is not a hybrid, as the essential character of a hybrid is that it results from the union of plants differing more or less in kind, or, in other words, is the result of a union between different races, varieties, species, genera, etc. On the other hand, flowers impregnated with their own pollen, with the pollen of another flower on the same plant, or even with pollen from another plant derived from the same original stock by cuttings, grafts, etc., are said to be self-fertilized, and the offspring resulting from such unions are also termed self-fertilized plants. With some plants, such as tobacco and wheat, self-fértilization is the rule. In many cases, however, the flowers are so constructed that cross-fertilization is favored, as in corn, rye, etc., and in some cases cross-fertilization is necessary, all possibility of self-pollination being precluded, as in the case of hemp and other plants having the male and female flowers on separate individuals.

METHODS USED IN HYBRIDIZING PLANTS.

The process of hybridizing plants is in itself neither difficult nor mysterious, it being simply necessary to understand the general structure of the flower to be used. The flowers of tomato, pear, and orange may be taken as illustrating the common forms, although, of course, very many modifications occur. The envelopes of these flowers, as in the case of the flowers of most cultivated plants, consist of two whorls of modified leaves (figs. 3 and 5). The outer whorl, which is known as the calyx, is commonly green like the foliage and is divided into several distinct or more or less united lobes or sepals (figs. 3 and 5, *cx*), while the inner whorl, or corolla, is usually of some bright color other than green, and its different divisions or lobes are known as petals (figs. 3 and 5, *c*). In some cases, as in the lily, the calyx and corolla are of the same color, so that they are not easily distinguishable; while in still other cases, as in oaks, walnuts, etc., the corolla is entirely wanting.

The essential, or sexual, organs of the flower, the stamens and pistils, are found inside the calyx and corolla, and it is with these organs that the hybridizer is most concerned. The stamens, or male organs, of the plant (figs. 3 and 5, *s*) are usually several in number, and are composed of an upper swollen portion, the anther, which is borne on a more or less slender stalk called the filament. In some flowers, as in those of the tomato, the filament is very short (figs. 3 and 5), and in others is entirely wanting, the anthers being borne at the base of the corolla. The very numerous small, yellow, powdery grains of pollen, which constitute the male fecundating elements, are borne in sacks in the anthers. When the anther matures these sacks burst open and the pollen is exposed. A quantity of this pollen must be transferred, either by natural or artificial means, to the stigma of the female organ in order to insure fecundation. The application of pollen to the stigma is designated pollination, and successful pollination—that is, the application of pollen to the stigma, followed by f e c u n d a t i o n—is termed fertilization.

FIG. 2.—Newly opened bud of Lorillard tomato, showing stage in which flower should be emasculated. (Natural size.)

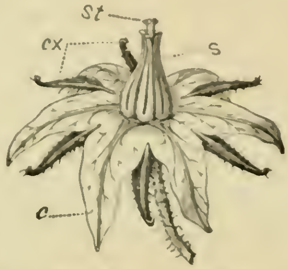


FIG. 3.—Mature flower of Lorillard tomato: *cx*, calyx; *c*, corolla; *s*, stamens; *st*, stigma. (Natural size.)

FIG. 4.—A flower of Lorillard tomato emasculated ready for pollination. (Natural size.)

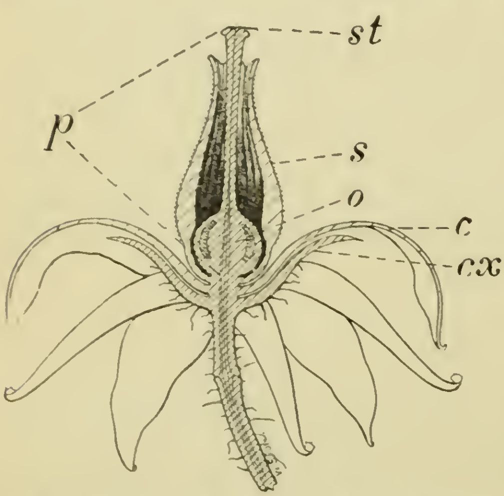


FIG. 5.—Section of a tomato flower: *cx*, calyx; *c*, corolla; *s*, stamens; *p*, pistil; *o*, ovary; *st*, stigma. (Twice natural size.)

The pistil or pistils (fig. 5, *p*), which are the female organs, occupy the center of the flower and are surrounded by the stamens. The upper portion of the pistil is usually somewhat swollen and more or less rough. It is on this portion of the pistil, known as the stigma (figs. 3 and 5, *st*), that the pollen must fall to produce fecundation.

In the majority of plants the stamens and pistils are produced in the same flower, as in the tomato and orange (figs. 3 and 7); but in certain plants they are produced in different flowers on the same plant, as in walnuts, castor beans, etc., or on different plants, as in the willow, poplar, etc.

In undertaking to hybridize plants artificially, it is well to remember that in many plants the stamens and pistils when in the same flower mature at different times—a provision to insure cross-pollination (the application of the pollen of one flower to the stigma of another). In a large majority of such cases the stamens ripen first, discharging their pollen before the pistil is receptive. The most important feature in the work of crossing is to exclude from the stigma all pollen except that which it is desired to use. As Darwin says, in reference to the breeding of animals, "The prevention of free crossing and the intentional matching of individual animals are the corner stones of the breeder's art." The prevention of self-pollination (the transfer of pollen to the stigma of the same flower) in perfect flowers, that is, flowers containing both stamens and pistils, necessitates the careful opening of the flowers intended for hybridi-

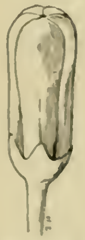


FIG. 6.—Orange flower bud, showing stage which should be selected for emasculation. (Natural size.)

FIG. 7.—Mature orange flower. (Natural size.)

FIG. 8.—An emasculated orange flower: *a*, shows where anthers were detached. (Natural size.)

zation while they are still immature, and the cutting or pulling off of the anthers before they burst and allow the escape of the pollen. This process is termed emasculation. In the tomato the stamens and pistils do not mature until after the calyx and corolla become partially expanded. In this case the stamens should be cut off near the base (fig. 4) with a small pair of scissors shortly after the bud opens (fig. 2), a process which is in this case somewhat difficult.

In the manipulation of orange flowers mature buds nearly ready to open are selected (fig. 6), and the tips of the corolla carefully pried apart until the stamens are exposed. In these flowers the anthers are attached to the filaments by very slender threads, which are easily broken (fig. 7), so that the simplest method of removing the stamens is to pull them off with fine-pointed forceps. The latter may also be conveniently used in prying apart the corolla lobes of the bud. During the process of emasculation in this and all other cases great care must be exercised not to open the stamens and accidentally pollinate the flower. All insects must be watched and carefully excluded. Fig. 8 shows an emasculated flower ready to bag.

After emasculating the flower a bag of some closely woven cloth or of paper should be carefully passed over the twig bearing the flower and tied around the stem below the flower in such a manner as to effectually exclude all insects and foreign pollen (Pl. XVIII, fig. 1). The manila paper sacks used by grocers are employed almost exclusively for this purpose. In a few days after emasculation and bagging, when the pistils have had time to mature, the sacks must be removed and the pistils pollinated, after which the sacks should be replaced as before and allowed to remain until fecundation has taken place and all danger from the action of foreign pollen is over. In most cases the sacks should then be removed, as they are likely to injure the development of the fruit. In some cases, as in the orange, where the pistil is nearly mature when the bud is opened, the pollen may be applied to the stigma when the flower is emasculated, thus avoiding the trouble of opening the bag later. The flowers selected for emasculation and hybridization should be full-sized, perfect in all respects, and conveniently situated. Those on the end of a twig frequently set fruit best. All the flowers on the branch which are not used should be cut off. Frequently several flowers of the same age can be selected on the same branch, emasculated, and inclosed under the same bag.

In hybridizing, many different methods are followed in applying the pollen. In most cases where an abundance of pollen can be secured the freshly burst anthers from one plant may be taken with fine-pointed forceps and rubbed over the stigma of the other until sufficient pollen has been transferred. This is probably the easiest and safest method in most cases. Some hybridizers transfer the pollen with a small ladle or camel's-hair brush, and occasionally this method may be found somewhat convenient, especially where the pollen is brought from some distance and has largely escaped from the anthers.

After each pollination it is of the utmost importance to label the bag in such a way that there will be no question as to what it contains. These labels should be allowed to remain after the bag has been removed. As fruits like apples, oranges, etc., approach maturity it is very desirable that they be inclosed in gauze bags firmly tied to the branches (Pl. XVIII, fig. 2). Such bags allow the normal development of the fruit, protect it from being picked accidentally, and in case the fruit falls prematurely preserve it in connection with the label.

WHAT PLANTS CAN BE HYBRIDIZED?

It is a fact of prime importance that plants so different as to be classed by botanists in widely different families never yield offspring when crossed; for example, it is impossible to successfully cross Indian corn and lilies or the apple and walnut. Usually plants diverse

FIG. 1.—ORANGE FLOWER INCLOSED IN PAPER BAG AFTER EMASCULATION.

FIG. 2.—NEARLY MATURE HYBRID ORANGE INCLOSED IN GAUZE BAG TO PREVENT LOSS BY DROPPING.

FIG. 3.—RASPBERRY-BLACKBERRY HYBRID "PRIMUS" AND PARENTS: F, CALIFORNIAN DEWBERRY (RUBUS URSINUS), FEMALE PARENT; H, HYBRID; M, SIBERIAN RASPBERRY (R. CRATÆGIFOLIUS), MALE PARENT (ABOUT ONE-FOURTH NATURAL SIZE). (AFTER BURBANK.)

enough to be considered as belonging to clearly distinct genera, even though of the same natural family, are perfectly sterile when crossed; for example, Indian corn yields no offspring when cross-pollinated with wheat, nor does wheat when crossed with oats, although all belong to the great family of grasses. Plants belonging to the different cultivated races or to natural varieties of the same species are almost invariably fertile when crossed. Indeed, as will be shown later, they are sometimes more fertile when crossed with a related species than when fertilized by their own pollen. Different species of plants closely enough related to be placed in the same genus by naturalists are very often, though by no means always, capable of being hybridized.

Gaertner found that "one of the tobaccos, *Nicotiana acuminata*, which is not a particularly distinct species, obstinately failed to fertilize or to be fertilized by no less than eight species of Nicotiana." Darwin states that "in the same family there may be a genus, as Dianthus, in which very many species can most readily be crossed; and another genus, as Silene, in which the most persevering efforts have failed to produce between extremely close species a single hybrid." Again, there is considerable diversity in results in certain reciprocal crosses between the same two species. "*Mirabilis jalapa* can easily be fertilized by the pollen of *M. longiflora*, and the hybrids thus produced are sufficiently fertile; but Koelreuter tried more than two hundred times during eight following years to fertilize reciprocally *M. longiflora* with the pollen of *M. jalapa*, and utterly failed," as have also many other hybridizers. Frequently even very closely related species absolutely refuse to cross. According to Bailey and Pammel, this is true of the pumpkin (*Cucurbita pepo*) and squash (*C. maxima*). It is nevertheless true that hosts of very distinct species hybridize readily, and quite a number of cases are known where species belonging to different and quite distinct genera have hybridized, producing the so-called bigeneric hybrids. For instance, wheat and rye, and wheat and barley, belonging to closely related genera, cross with difficulty, and Luther Burbank has succeeded in obtaining a hybrid of strawberry and raspberry.

Focke cites the following instances of hybrids produced by crossing species belonging to different families: *Gladiolus blandus* Sol., belonging to the lily family, crossed with pollen of a species of Hippeastrum, belonging to the Amaryllis family, produced seed which yielded four plants. Again, six flowers of *Digitalis ambigua* Murr (Figwort family) when crossed by Campbell with the pollen of *Sinningia speciose* (Gloxinia family) gave three seed capsules, from which several plants were obtained. Hybrids between plants belonging to different families are, however, very rare. The results obtained by hosts of experimenters and practical gardeners show conclusively that the majority of closely related species can be readily crossed, while very distinct species and species belonging to distinct genera can be crossed in only comparatively few cases. It is impossible to predict what plants may or may not be hybridized.

In breeding cultivated varieties it has commonly been supposed that seedless plants, like the pineapple and navel orange, could not be utilized because of their seedlessness. The writers have found, however, that in each of these plants abundant seeds are produced when the flowers are crossed with pollen from distinct sorts (Pl. XIX, fig. 2). This suggests that fruits which are normally seedless may frequently be used to advantage in hybridizing experiments, particularly when it is desired to secure improved seedless varieties. For instance, a pomelo with few or no seeds might possibly be obtained by hybridizing the common pomelo with the navel orange.

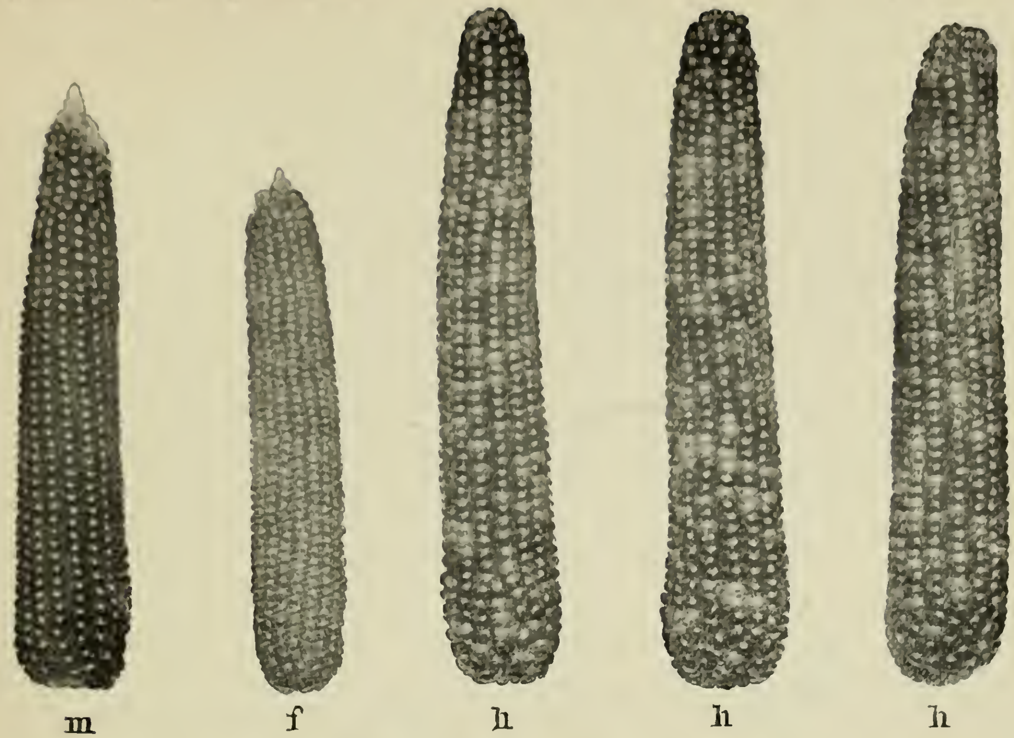
HYBRIDS INTERMEDIATE BETWEEN THEIR PARENTS.

The characters of hybrids are almost always intermediate between the forms crossed, although sometimes they resemble one parent exclusively. As a rule, hybrids between distinct species are intermediate in the first generation and often exactly midway between their parents in all characters, while those between races or varieties of one species are variable in the first generation. Macfarlane has shown that not only do the hybrids he studied occupy a mean position as regards habit, size, shape of leaves, time of flowering, etc., but also in microscopic peculiarities of structure. For instance, the starch grains of *Hedychium gardnerianum* are small, flat, triangular plates, measuring from $\frac{10}{1000}$ to $\frac{12}{1000}$ of a millimeter from base to apex (fig. 9, *a*), and those of *H. coronarium* are ovate and measure from $\frac{32}{1000}$ to $\frac{60}{1000}$ of a millimeter in length (fig. 9, *b*), while in a hybrid of these two species known as *H. sadlerianum*, the starch grains are intermediate in size and shape (fig. 9, *h*). The thickened cells of the bundle sheath of the root of the so-called *Philageria veitchii*, a bigeneric hybrid (Pl. XX, fig. 3, *h*) are intermediate, not only in size and shape, but also in the number of laminations, between *Philesia buxifolia*, the male parent (Pl. XX, fig. 3, *m*), and *Lapageria rosea*, the female parent (Pl. XX, fig. 3, *f*). A skeletonized leaf of the same hybrid is shown on Pl. XX, fig. 4, *h*, in comparison with its parents (Pl. XX, fig. 4, *m* and *f*).

Other hybrids, though appearing strictly intermediate at first sight, are found on careful examination to possess, side by side, structures or organs characteristic of the parents and not intermediate between them; for instance, on the leaves of a hybrid of the gooseberry and black currant Macfarlane found the simple hairs of the former species and also the oil-secreting, shield-shaped hairs of the latter, though both were but half the size of those on the parents. In leaves of the York-Madeira grape, a hybrid of the summer grape (*Vitis æstivalis*) and the fox grape (*V. labrusca*), Millardet found sunken stomata, or breathing pores, like those in the former species, projecting ones like those in the latter, and many intermediate forms.

FIG. 1.—CANES OF THE SECOND GENERATION OF A BLACKBERRY-RASPBERRY HYBRID, ALL GROWN FROM SEED OF ONE PLANT. (AFTER BURBANK.)

FIG. 2.—SEEDLING PINEAPPLES, THE OFFSPRING OF MORE THAN USUALLY SEEDLESS PLANTS RENDERED FERTILE BY POLLINATION WITH ANOTHER SORT: 5, EGYPTIAN QUEEN CROSSED WITH SMOOTH CAYENNE; 9, ENVILLE CITY CROSSED WITH SMOOTH CAYENNE; 21, ENVILLE CITY CROSSED WITH PUERTO RICO



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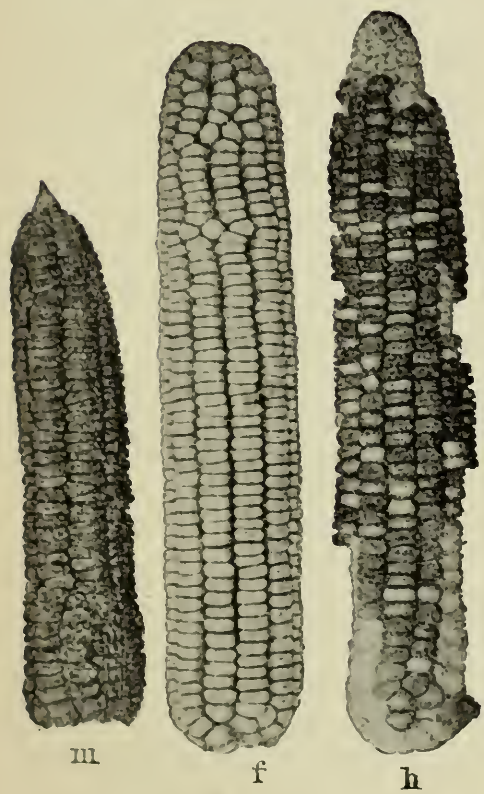

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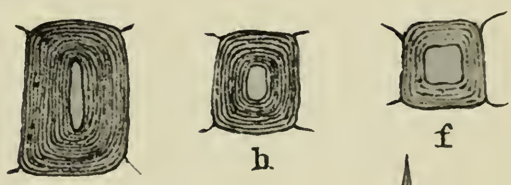

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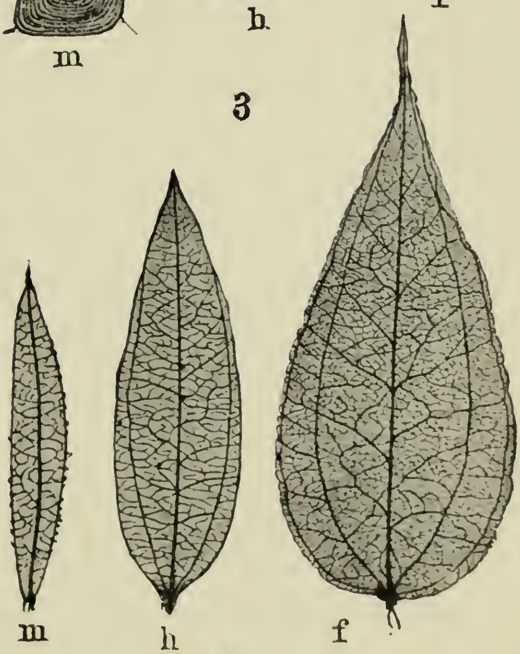

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FIG. 1.—Indian corn, showing increase in size resulting from crossing different sorts: *m*, male parent, Queens Golden; *f*, female parent, common Pearl; *h h h*, cross-bred ears of first generation. (After McClure.)

FIG. 2.—Indian corn, showing immediate effect of foreign pollen: *m*, male parent, Black Mexican; *f*, female parent, White Dent; *h*, ear of White Dent pollinated with Black Mexican, showing immediate result of the cross. (After McClure.)

FIG. 3.—Bundle-sheath cells of roots of hybrid and parents, showing intermediate nature of hybrid: *m*, *Philesia buxifolia*, male parent; *h*, hybrid; *f*, *Lapageria rosea*, female parent. (After Macfarlane.)

FIG. 4.—Skeleton leaves of hybrid and parents, showing the intermediate character of hybrid: *m*, *Philesia buxifolia*, male parent; *h*, hybrid; *f*, *Lapageria rosea*, female parent. (After Macfarlane.)

Not infrequently the color of the flowers of a hybrid is not a uniform blend between those of the parents, but the two parental colors occur side by side in patches. This is exemplified by many of the hybrid carnations obtained by crossing Scott and McGowan. One of these hybrids, produced by Mr. E. C. Rittue, gardener of the Division of Vegetable Physiology and Pathology, is shown on Pl. XVII, fig. 3, though the bands of reddish color in this case are not exactly the same tint as the pink flowers of the male parent Scott. Strasburger has aptly said that in such cases "the hybrid is a sort of mosaic made up of portions of the two parents."

The hybrid may in rare instances show parts of considerable size resembling almost exactly similar parts of one of the parents, while other parts of the hybrid may show an equally striking resemblance to the other parent. Instances of this are furnished by some grape hybrids, as will be explained more in detail in speaking of some practical utilizations of hybrids.

FIG. 9.—Starch grains of hybrid and parents, showing the intermediate character of hybrid: *a*, *Hedychium gardnerianum*, one parent; *h*, hybrid; *b*, *H. coronarium*, other parent. (Multiplied 500 diameters. After Macfarlane.)

As will be shown in the following pages, hybrids which were uniform and intermediate in the first generation usually vary greatly in the second and later generations, often consisting of a few forms nearly like the parents, and numerous forms representing all grades of intermediates. In some hybrids this variability is shown in the first generation. In most cases, however, such hybrids are still intermediate between the parent forms, inasmuch as they represent merely combinations of parental characters differently localized and in different proportions. Occasionally characters are shown by hybrids which can not be referred to either parent. These will be discussed later.

STERILE AND FERTILE HYBRIDS.

Hybrids arising from the union of widely different parents are very commonly sterile, often producing little or no good pollen, and sometimes, though not so often, having defective ovules and refusing to bear seed even when pollinated from one of the parent species. On the other hand, the offspring of two closely allied parents is usually fertile, often more so than the normal offspring. Formerly it was supposed that all hybrids between distinct species were sterile, but this is by no means always the case. Very frequently they are fertile with their own pollen and still more frequently with that of either parent species. The bearing of sterility on the practical utilization of hybrids in plant breeding is discussed on pages 408 and 409.

DIFFERENCE BETWEEN FIRST AND LATER GENERATIONS OF HYBRIDS.

The distinction between the first and second generations, when the hybrid is fertile, is often very marked, and this must be constantly kept in mind in order to have a clear understanding of the nature of hybrids and to be able to utilize them to the fullest extent possible in plant breeding. The first generation of the hybrid is constituted by the plants grown from the seeds produced by the cross-pollinated flower, and in very many instances, though not all, the different individuals are nearly uniform and approximately intermediate in character between the parents. Naudin, one of the most careful and trustworthy writers on plant hybrids, says: "I have always found in the hybrids which I have obtained myself and of which the origin was well known to me, a great uniformity of aspect among the individuals of the first generation coming from the same cross, no matter how many of them there were." Naegeli, however, who is an equally good authority, says: "The hybrids of varieties are especially liable to variation. When one variety is fertilized with another the descendants are often so various and so rich in forms that no plant is exactly like another." This apparent contradiction is explained by the fact that Naudin hybridized almost exclusively clearly marked species, while in the paragraph quoted Naegeli referred to offspring of two varieties or races of one species, and considers their behavior different from that of specific hybrids. Naegeli says further that "in general the hybrids in the first generation vary the less the more distantly related the parent forms are, that is, the specific hybrids vary less than the varietal hybrids, the former often being characterized by great uniformity, the latter by great diversity of form." If these hybrids of the first generation be self-pollinated or crossed among each other the progeny resulting constitutes the second generation.

Hybrids between widely different parents, when fertile, usually yield descendants showing very great diversity of character, or, as expressed by Naegeli, "the variability in the second and succeeding generations is the greater the more completely it was wanting in the first generation." Whenever, then, we cross widely diverse plants and obtain hybrids intermediate in character and all nearly alike in the first generation, we may expect these hybrids, if fertile, and self-pollinated or crossed among each other, to yield descendants showing great diversity of character. This principle is of great importance in the practice of plant breeding, as will be more fully shown later. Should the first generation not yield the desired new forms or combinations of parental characters, the possibilities are by no means exhausted, but it is quite possible that the descendants of these hybrids will yield valuable sorts. Sometimes the most extreme diversity of character does not appear until the third or even later generations of the hybrid, but often the hybrid plants in the third generation are much like the particular forms of the second generation, from which they descended.

To bring out more clearly the behavior of hybrids in successive generations, their grouping on this basis has been attempted below. The aim has been to select examples under the different categories as well authenticated as possible and clearly illustrating the point under discussion, but here, as elsewhere, no attempt whatever has been made to enumerate all hybrids which are referable to the several groups.

GROUPING OF HYBRIDS ACCORDING TO AMOUNT AND NATURE AND THE TIME OF APPEARANCE OF RESEMBLANCES TO PARENTS.

GROUP *Fertile hybrids, uniform and intermediate the first generation, but very diverse in the second and later generations, often showing both parental forms and very many grades of intermediates.*

This is certainly the most common type of hybrids between species not very closely related, but is rarer when two closely related varieties or races of one species are crossed. The following example is given by Naudin: Closely related tropical species of thorn apple (*Datura metel* and *D. meteloides*) were crossed and the first generation consisted of three plants, all alike and approximately intermediate, possibly resembling the mother species (*D. metel*) more than the father (*D. meteloides*). In the second generation the uniformity observed in the first generation was entirely wanting. Of forty-two plants, twelve were exactly like the original mother species; twenty-eight were intermediates, showing various proportions of the parent characteristics, and consequently not resembling each other; and two resembled exactly the original paternal species.

In the third generation hybrids are often still more variable than in the second generation, as, for example, according to Naudin, *Nicotiana rustica*, when fertilized by *N. paniculata*, yielded uniform and intermediate plants the first generation, and twelve plants in the second generation, very different from each other, which gave in the third generation (grown from five lots of seed taken from five of the most diverse plants of the second generation) "all the variations observed in the second generation and many new ones." Furthermore, the five lots considered separately were not more uniform than all taken together. Seeds collected from one plant produced very tall and very short individuals, some having broad and some narrow leaves, either smooth or velvety or crinkled or even; some of the plants had long-tubed and some short-tubed flowers, which were more or less sterile or absolutely sterile; some matured almost all their fruit and others did not mature any, and so on. It is a fact worthy of notice that in almost every case the most fertile plants were those most like *Nicotiana rustica*, those having long-tubed flowers, resembling the original hybrids of the first generation, being either entirely sterile or but very slightly fertile.

GROUP 2.—*Fertile hybrids which are strictly intermediate between the parents, not only in the first, but also in succeeding generations.*

Such hybrids as these, capable of propagating true to seed and not showing great variability in the second generation, are rare. Darwin states that Dr. Herbert showed him "a hybrid from two species of Loasa which, from its first production, had kept constant during several generations." Another very interesting example is the hybrid berry "Primus" (Pl. XVIII, fig. 3), derived from the Western dewberry (*Rubus ursinus*) crossed with the Siberian raspberry (*R. cratægifolis*).

This particular plant was the only fertile one among all the hybrid seedlings of the cross. Of this berry Burbank says: "None of its seedlings for any tested number of generations ever revert to the character of its parents on either side." Possibly hybrids propagating true to seed often occur when very nearly identical races of cultivated species are crossed; even then, however, variations may be very numerous the second generation, but difficult to detect, because occurring entirely within the range between the only slightly differing parents.

GROUP 3.—*Sterile intermediate, more or less uniform hybrids.*

Sterile hybrids are very commonly the result of a union of widely different parents, being very rarely produced by crossing closely related forms. It is interesting to note that the first hybrid plant of which we have any record, a cross between a carnation (*Dianthus caryophyllus*) and a sweet william (*D. barbatus*), produced by the gardener, Thomas Fairchild, in London, at the beginning of the eighteenth century, was nearly sterile. However, it proved to be a valuable sort and was propagated by cuttings for more than a hundred years.

Koelreuter, the first careful observer of plant hybrids, produced many hybrids that were sterile. For instance, a hybrid of *Nicotiana paniculata* and *N. glutinosa*, intermediate in many characters, was absolutely sterile. Luther Burbank recently produced an interesting sterile hybrid between the raspberry and strawberry. Of this he says: "Out of seven or eight hundred of these curious hybrids, not one has ever produced a berry, though blooming with the greatest profusion, and as the blooms fade a bunch resembling a miniature strawberry forms, but never matures. The hybrids when young are practically strawberry plants, but with age produce canes 5 or 6 feet high, multiplying by curious underground stolons. The leaves are invariably trifoliate and the canes are thornless or nearly so."

Focke says that "the commonest consequence of hybrid fertilization is the imperfect formation of the pollen grains in the hybrid plants. Often the anthers of the hybrid are empty, containing no pollen at all, or they are small and do not open." All students of hybrid plants agree that the pollen is much more likely to be imperfect than the ovules, and in some cases where the pollen is worthless the ovary is capable of maturing seeds if fertilized with pollen from the parent species. Some hybrids show sterility by producing no flowers. This is said by Focke to be the case with certain hybrids of Rhododendrons, Cereus, and Hymenocaulis. This is rare, however, and very many hybrid plants are characterized by excessive rather than by diminished flowering.

A remarkable case of a nearly sterile hybrid, which even when fertilized by the parent form yielded seed but rarely, and then in very small numbers, but which nevertheless was bred into a perfectly fertile variety propagated only by seed, is furnished by the so-called *Ægilops speltæformis*, a wheat-like hybrid obtained by pollinating *A. triticoides* with wheat. *A. triticoides* is itself a hybrid of *A. ovata*, a small grass occurring wild in southern Europe, and common wheat. The hybrid *A. triticoides* grows spontaneously in southern Europe along the edges of wheat fields. About fifty years ago Esprit Fabre grew this hybrid from a seed of *A. ovata*. It was afterwards produced artificially by many experimenters, proving conclusively that it is a hybrid of wheat and *A. ovata*. Fabre carefully hunted for seeds of this hybrid (*A. triticoides*), and finally in 1838 was successful. From this seed he grew plants which were very different from *A. triticoides*, being more wheat-like and more fertile. After several years' cultivation he obtained, furthermore, a fertile cereal still more like wheat, propagating true to seed, which he called "Ægilops wheat." The seeds of this were sent to many botanic gardens of Europe, where the plant was found to be as constant and fertile as a true species, and was named *A. speltæformis* by Jordan. Fabre's account of the origin of this cereal was doubted by many botanists, but was afterwards found to be correct. It had been grown more than forty years when Focke's work was published, and was said by him to have remained constant, except in the case of occasional specimens which varied in productiveness.

This example shows that it is sometimes possible to breed races propagated by seed from almost sterile hybrids. When hybrids are capable of being propagated by cuttings, grafts, bulbs, etc., however, it is, of course, possible to propagate absolutely sterile hybrids extensively.

GROUP 4.—*Sterile hybrids not uniformly intermediate, but variable, or at least occurring in two forms.*

The hybrids of this character are certainly very rare, but few cases being referred to in literature. They are interesting in showing that variability in the first generation may occasionally occur in the offspring of species so distinct as to yield sterile hybrids, although such variability is usually found only in the highly fertile offspring of closely allied species or varieties of one species. Gaertner crossed two species of tobacco (*Nicotiana quadrivalvus* with pollen of *N. macrophylla*) and obtained hybrids of two different forms, the flowers and long, narrow leaves of the commonest form resembling the mother, while the character of the flowers and leaves of the rarer form was more like the father species. This hybrid was found to be completely sterile.

Another even more remarkable case is that of certain hybrid foxgloves. Koelreuter, Gaertner, and Focke observed that the hybrids of *Digitalis purpurea* crossed with *D. lutea* produced, in addition to a more or less constant intermediate form, a number of forms very different in appearance. Focke observed among the hybrids which grew spontaneously from a cross-fertilized capsule that he had neglected to harvest when ripe, a number of aberrant forms, the most remarkable of them resembling in all particulars a different species (*Digitalis tubiflorum*). All artificially produced hybrids of these two species have been found to be completely sterile to the pollen of the parent species. The hybrids also occur in nature, in which case they are said to sometimes bear seed.

GROUP 5.—*Fertile hybrids or mongrels not uniformly intermediate in the first generation, but often reverting in this generation more or less completely to the parent forms and showing all grades of intermediates.*

Hybrids belonging to this group are almost always the offspring of two closely related species. It is, in fact, difficult to find examples of hybrids between very distinct species which in the first generation revert more or less completely to both parents, and at the same time exhibit in much the larger number of the offspring numerous grades of intermingling. This is, however, a very common phenomenon among the offspring of cultivated races of the same species, even when so different as to present to the eye very little similarity. This difference in the character of the offspring resulting from a cross between species as compared with a cross between races of cultivated plants, is very striking and very important. Gaertner, who is said to have made no less than ten thousand crosses, was so impressed by this fact that he stated it as a principle, that hybrids between different species were uniform in the first generation, while mongrels, produced by the crossing of varieties, varied greatly. Focke, the author of the most comprehensive summary of the knowledge of plant hybrids, considers this statement too broad. He says: "If one by variety means unstable garden mongrels, then this rule is valid. If one, however, means by variety constant forms of pure descent, then it is certainly untrue." Hybrid offspring of distinct species are, however, not always constant in the first generation. For instance, if the evening-blooming

Lychnis (*L. vespertina*) be crossed with the pollen of ragged robin (*L. diurna*), hybrids are produced which are very variable in the breadth of the leaves, color of the flowers, and other characteristics.

In hybrids of different species which vary in the first generation it is more common for most of the forms to resemble the one or the other parent, very few being intermediate. Darwin cites the following case: "Major Trevor Clarke crossed the little glabrous-leaved annual stock (Matthiola), with pollen of a large, red-flowered, rough-leaved biennial stock called *cocardeau* by the French, and the result was that half the seedlings had glabrous leaves and the other half rough leaves, but none had leaves in an intermediate state. That the glabrous seedlings were the product of the rough-leaved variety, and were not accidentally of the mother plant's own pollen, was shown by their tall and strong habit of growth. In the succeeding generations raised from the rough-leaved crossed seedlings some glabrous plants appeared, showing that the glabrous character, though incapable of blending with and modifying the rough leaves, was all the time latent."

Some examples of such hybrids, which were sterile, have been noted in group 4. Almost all who have worked extensively in hybridizing plants have noted the curious fact that races of cultivated plants, even though very diverse, produce very variable hybrids in the first generation, while usually by crossing wild species closely resembling each other hybrids are obtained which are constant in the first generation.

A striking case of the variability of the offspring of two crossed races of plants is furnished by Indian corn. When two sorts, differing decidedly in color or texture of the kernel, are crossed the offspring frequently varies exceedingly. Kellerman and Swingle sometimes found both parental forms and also very numerous and diverse intergrades occurring on the same ear, the kernels varying greatly in character. Sometimes, on the other hand; all the kernels on a single ear were alike or nearly so, but the different ears varied in character, the majority being intermediate between the parents, while a few bore a greater resemblance to one or the other parent, sometimes showing almost no influence from the cross.

In general, the behavior of the second and later generations of hybrids variable in the first generation is exactly analogous to that of the hybrids mentioned in group 1, that is, they tend to be still more variable than in the first generation, though they sometimes begin to come more or less true to seed in the second or third generation. It often seems as if hybrids of this group gained, as it were, one generation over those of group 1, and vary in the first instead of the second generation. It is probable that this variability in the first generation of the offspring of crosses between very closely allied races of plants is also present, but is sometimes masked, because the two parent forms are so nearly alike that the intergradations are not easily recognizable. In view of this fact, it is highly probable that in breeding plants which are to be propagated by seed it will always be necessary to practice in-and-inbreeding and selection before any new strain obtained by crossing nearly identical sorts can be relied upon to come true.

GROUP 6.—*False hybrids, resembling the one parent exclusively and showing no trace of the characteristics of the other, although often somewhat more vigorous and less fertile than normal offspring.*

It is not uncommon in hybridizing to obtain offspring resembling the maternal plant almost exactly. This has usually been attributed to the imperfect exclusion of the pollen of the mother species and consequent mixed fertilization. Naudin gave many instances where, in addition to the hybrid intermediate in character between the parents, a number were obtained exactly resembling the mother species. In one case where he crossed two thorn apples (*Datura stramonium* with pollen of *D. ceratocaula*), the capsule thus fertilized remained very small and produced but few seeds, of which many were imperfect and almost all failed to germinate the next spring. Of about sixty apparently good seeds, only three grew, and from these two plants were grown to maturity. These plants were exactly like the mother plant, but were nevertheless abnormal, because of their unusual height, being nearly twice that of the mother species, and also in dropping all the flowers produced in the lower forks. Such increased vigor and partial sterility were observed by Naudin in all intermediate hybrids of Datura, but in this case the plant resulting from the cross showed no trace of the characters of the father species, and its seeds, when planted the following year, yielded the ordinary form of the mother plant.

In a remarkable series of experiments on the various species of strawberries, conducted by Millardet, he found that most species when intercrossed yielded hybrids resembling one parent or the other. Out of six species experimented upon, only two, the Chilian and Virginian strawberries, yielded intermediate offspring when crossed. In some cases the reversion was principally to the paternal type, proving beyond question that the false hybrids resulted from a true process of fertilization, and not from any accidental access of pollen of the mother species to the crossed flowers, which was practically precluded by the careful manner in which Millardet conducted his experiments. His hybrid No. 11, grown in 1884, was obtained by crossing the White Four-Season strawberry (a white-fruited cultivated form of *Fragaria vesca*) with pollen of the "Chili velu" (a cultivated form of *F. chiloensis*). From this cross four hybrids were obtained, "of which one exactly resembled the mother species, except that the fruits were red [probably a case of reversion], while three others reproduced exactly the type of the paternal species, from which it was almost impossible to distinguish them. The three plants resembled each other very closely. All three were moderately fertile." Two of these hybrids were crossed and yielded in a second generation three plants, which were like the paternal species, *F. chiloensis*. In most cases, however, Millardet found that false hybrids resembled the mother species exclusively and that their seed when planted also reproduced the mother species true in the great majority of cases.

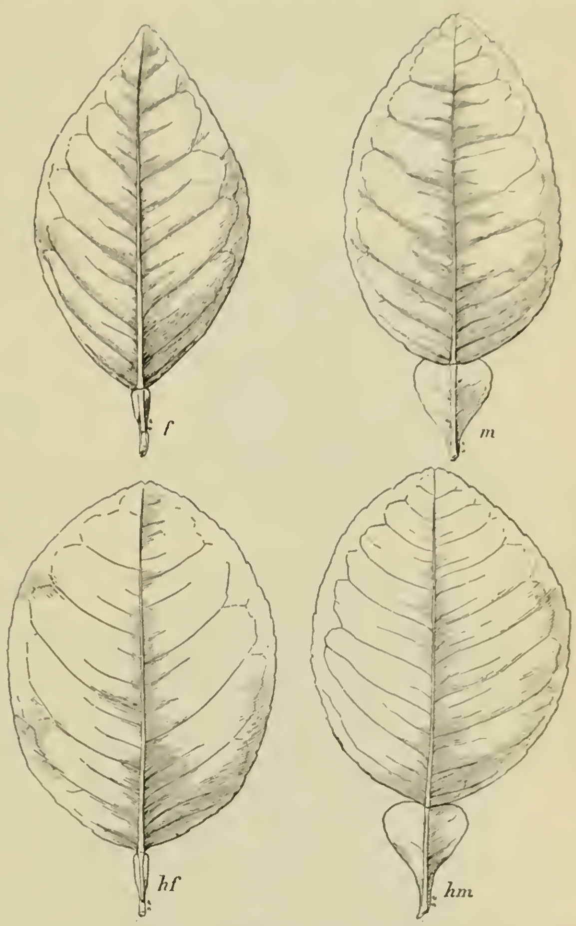

FIG. 10.—Leaves of orange and pomelo and of their hybrids of the first generation, showing close resemblance to one or the other parent: *f*, St. Michael Blood (*Citrus aurantium*), female parent; *m*, Bowen pomelo (*C. decumana*), male parent; *hf*, hybrid, resembling female parent; *hm*, hybrid, resembling male parent. (About two-fifths natural size.)

In experiments in crossing citrus fruits, carried on in Florida during the last few years, the writers have observed among the hybrids of the common orange (*Citrus aurantium*) and the pomelo (*C. decumana*) and those of the common orange and the Japanese orange (*C. nobilis*) a marked tendency to resemble the one parent to the exclusion of the other. In almost all cases, however, some of the offspring resembled one parent and some the other, in this differing somewhat from the results of Millardet with strawberries, in which in many instances he found all the hybrids to resemble the mother species. An example of these apparently false hybrids is shown by fig. 10, where *f* represents the leaf of the parent orange; *m*, the leaf of the pomelo which furnished the pollen; *hf*, leaf of one of the hybrids which resembles the mother species almost exactly; and *hm*, leaf of the hybrid which resembles the father species. It is of course probable that these apparently false hybrids may show traces of the other parent in the fruit when produced, although as yet none are evident in the foliage.

It may be readily surmised that this group of hybrids, if they can be called hybrids, are not as a rule very promising to the practical plant breeder. It is, however, highly probable that even the hybrid forms of this character which resemble the one or the other parent exclusively will be more likely to yield valuable variations than those propagated in the normal way. For instance, Millardet found in some of his false hybrids of strawberries referred to above, especially when *Fragaria elatior* was used as the seed-bearing parent, that many of the descendants, otherwise like the mother species, differed in bearing perfect flowers instead of having male and female flowers on different plants.

DESCENDANTS OF HYBRIDS.

In the preceding pages all references to the second and subsequent generations of hybrids are exclusively to plants fertilized with their own pollen or with the pollen of other hybrids of the same origin. It frequently happens, however, that hybrids are very easily fertilized

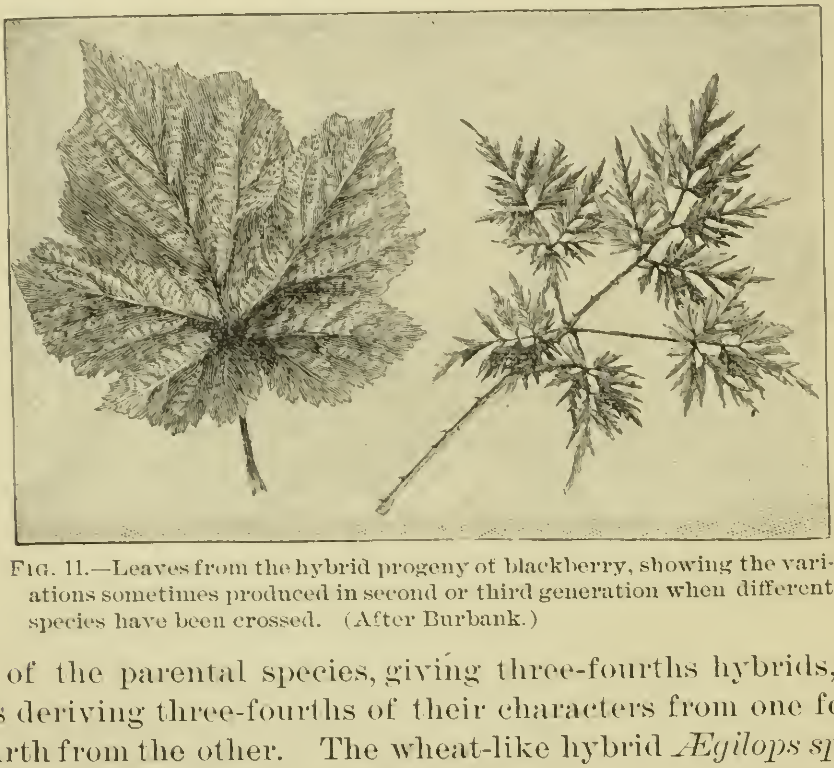

FIG. 11.—Leaves from the hybrid progeny of blackberry, showing the variations sometimes produced in second or third generation when different species have been crossed. (After Burbank.)

by one of the parental species, giving three-fourths hybrids, that is, hybrids deriving three-fourths of their characters from one form and one-fourth from the other. The wheat-like hybrid *Ægilops speltæformis*, described on page 394, is of this character, as are also many of the hybrids of the European and American grapes recently originated in France. Ganzin produced la Clairette Dorée by first fertilizing Aramon, a race of *Vitis vinifera*, with the pollen of an American species, *V. rupestris*, which is resistant to Phylloxera. One of these hybrids was crossed with the European vine, this time Grosse Clairette being the father. The resulting cross yielded the Golden Clairette, a valuable new sort, apparently highly resistant to Phylloxera. Although only two species of grapes were crossed to produce this, it being three-fourths *V. vinifera* and one-fourth *V. rupestris*, three races, or so-called varieties, were united, making it a triracial hybrid.

Frequently plant breeders cross hybrids with a species different from either of the parents, in this way obtaining trispecific hybrids. Many grape hybrids are of this nature. By crossing two hybrids having different parentage quadrispecific or quadriracial hybrids are obtained. Wichura even obtained hybrid willows combining no less than six species.

From the very careful studies of Wittrock it appears that many pansies are complex hybrids, combining four species, and some few sorts are combinations of no less than six distinct species. Even this, however, does not fully indicate their complexity, since some of the constituent species comprise several different varieties which have also entered into the parentage of the modern pansy. Moreover, these numerous parental forms from spontaneous and artificial crossing have been combined in every conceivable proportion by pansy fanciers. Such complex hybrids are often of great value to the plant breeder and will undoubtedly be produced in constantly increasing numbers as the art of plant breeding becomes more highly developed. They are most valuable in plants which can be propagated by cuttings or grafts, since they often vary exceedingly when propagated from seed.

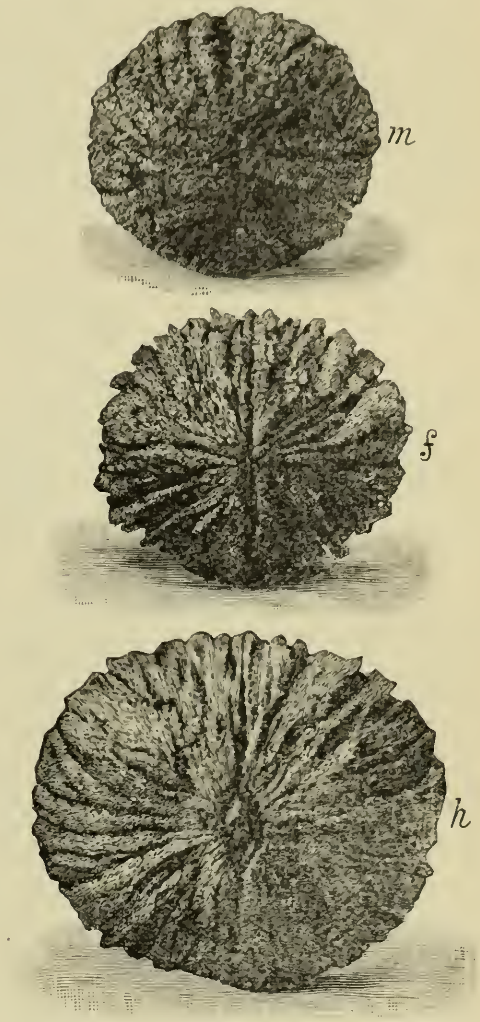

FIG. 12.—Hybrid walnut and parents: *m*, Californian black walnut (*Juglans californica*), male parent; *f*, Eastern black walnut (*J. nigra*), female parent; *h*, hybrid. (Natural size. After Burbank.)

ATAVISTIC AND NEW CHARACTERS IN HYBRIDS.

In the preceding pages we have considered the time of appearance of resemblances to the parent species, whether in the first or later generations of the hybrid. Combinations of parental characteristics in all possible ratios have been shown to occur in the second generation of most hybrids which are fertile, and to occur often in the first generation of offspring resulting from crossing closely related races of cultivated plants. The multitudinous variations thus produced are sometimes of great worth, but are merely new combinations of characters already existing in the parent plants. There is evidence, however, that sometimes hybrids or their offspring present characters presumably belonging to remote ancestors (atavistic), or entirely new characteristics not referable to any progenitor. A striking instance of atavism is reported by Saunders, who says: "In a cross between Red Fife, male, and an Indian wheat known as Spiti Valley, female, both beardless, several distinctly bearded sorts were produced in the second generation." Now, it is highly probable that all wheats were originally bearded, as are still many of the sorts and most of the cereals belonging to related genera. Moreover, Pickering gives a bearded ear as the oldest Egyptian hieroglyphic for wheat. In the above instance, therefore, the hybrids of the second generation probably reverted in part to remote ancestral characters not present in either parent. Of course, the partial or complete reversion to the characters of grand-parental species in the second generation has already been shown to be characteristic of most hybrids resulting from a union of two clearly distinct species.

FIG. 13.—Hybrids of hardy trifoliate orange and common sweet orange: *a*, leaf resembling common orange; *b*, seedling distinctly intermediate in character; *c*, leaf resembling trifoliate orange.

The appearance of new characters, or at any rate of characters developed far more than in either parent, is not uncommon among hybrid plants, as will be discussed more fully later on. Slightly greater size and vigor are so common as to constitute the rule, as will be shown below.

PREPONDERANCE OF ONE SPECIES IN DETERMINING CHARACTER.

One parent species, whether the one bearing the seeds or the one furnishing the pollen, often outweighs the other in determining the character of the hybrid. Gaertner and Focke found in almost all cases that the hybrids of the foxgloves *Digitalis lutea* and *D. purpurea* were more nearly like *D. lutea* in every respect than *D. purpurea*, no matter which was used as the seed-bearing plant. Perhaps the best example of this preponderance of some species over others is furnished by Naudin's hybrids of *Nicotiana langsdorffii*, *N. persica*, and *N. commutata*. The last species is very nearly intermediate between the two first named, but is not identical with the hybrid which Naudin made between them. Now, *N. persica* and *N. commutata* were crossed reciprocally, yielding in both cases practically identical hybrids, all of which were very uniform and resembled *N. persica* decidedly more than *N. commutata*. *N. langsdorffii* was also crossed reciprocally with *N. commutata*, and, as with the hybrids just mentioned, the offspring in both cases showed a preponderating influence of *N. langsdorffii*, no matter whether it bore the seeds or furnished the pollen. *N. langsdorffii* and *N. persica* when crossed yielded hybrids resembling the former in their wide-spreading branches, but were very strictly intermediate in other characters. All these hybrids were perfectly fertile. It would seem that *N. persica* and *N. langsdorffii* were much more potent in controlling the characters of the hybrid offspring than *N. commutata*.

It is often assumed that when wild species are hybridized with cultivated races of plants the influence of the former preponderates in the characters of the hybrid. On the other hand, Lynch reports a hybrid of Senecio "between *Senecio multiflorus* (female) and several colour forms of the 'cultivated Cineraria'" where a "predominating influence of the 'cultivated Cineraria' in this and also in the reverse cross upon the colour and size of the flower heads was observed."

In plant breeding it will doubtless often be necessary to make successive crosses of the hybrid with the one parental form which is largely obliterated by the preponderating influence of the other in order to obtain the desired combination of characters.

DIFFERENCE BETWEEN RECIPROCAL HYBRIDS.

Two hybrids from the same parents, the father species of the one being the mother species of the other, are known as reciprocal hybrids. In the majority of cases there is no constant difference between the hybrids resulting from reciprocal crossing. Naudin found repeatedly that they could be distinguished only by the labels. There are, however, some instances given by competent authorities where such hybrids do present differences. Probably the best-authenticated case of this kind is that of certain hybrid foxgloves. Gaertner found, for instance, decided differences between reciprocal hybrids of *Digitalis ambigua* and *D. lanata*, the flowers resembling those of the mother species more closely in each case. Focke noted that *D. purpurea* fertilized with pollen of *D. lutea* gave offspring invariably having more highly colored flowers than the reverse hybrid.

Caspary found that the water lilies *Nymphæa rubra* and *N. dentata* when crossed gave offspring which in each case more closely resembled the mother species in the shape of the first few leaves, though the later leaves were alike in both hybrids.

Millardet, who has originated and studied thousands of grape hybrids, states that it appears that the paternal species preponderates in most hybrids of the grape, but that this has not been studied sufficiently to render it certain except in crossing the European vine with the American *Vitis rupestris*. He says further that "the hybrids of Aramon (or any other European sort) obtained by fertilizing it with Rupestris * * * resemble Rupestris much more than Aramon." The reciprocal hybrid, on the contrary, resembles Aramon more than it does Rupestris. In the first case the hybrids may almost if not wholly equal the father species in resistance to Phylloxera, but are inferior in prolificness, in the size of the bunches, and in the size and quality of the berries. The reciprocal hybrid has very little resistance to Phylloxera, but in fecundity, size of the bunches, and size and quality of the berries, leaves very little to be desired. Sometimes two species can be crossed only in one way, as, for example, the four-o'clocks *Mirabilis jalapa* and *M. longiflora* yield offspring only when the former is pollinated with the latter.

It is, of course, clear that no conclusions as to the relative influence of the mother and father in the production of a hybrid can be drawn unless both hybrids are produced. Many supposed rules as to the part played by the male and female elements, respectively, in determining the character of the offspring are false, having resulted from the observance of hybrids where the one or the other species was prepotent, and would have been so whether bearing the seed or furnishing the pollen.

As a rule, plant breeders can expect but little from reciprocal crossing, but when the desired form can not be obtained by the first cross a reverse order should be tried. Species which refuse to hybridize in one direction may sometimes yield offspring when the plants are reversed.

PREPOTENCY OF THE POLLEN FROM ONE PLANT OVER THAT FROM ANOTHER.

It has been observed by nearly all plant hybridizers that where two kinds of pollen are applied simultaneously to the pistil, the character of the offspring often shows that only one kind was effective in producing fecundation; in other words, one kind of pollen was prepotent. Prepotency of pollen is probably due to the greater speed with which fecundation is accomplished, that is, to there being a shorter interval of time between pollination and fecundation with pollen of the one plant than with that of the other. Gaertner crossed two species of tobacco, *N. rustica* with pollen of *N. paniculata*, and after one hour, one and a half hours, and two hours applied pollen of *N. rustica* (the mother species) to the same pistils, already dusted with pollen of *N. paniculata*. In the first case, repollinated after one hour, the fairly well-filled capsules contained seeds which produced only the pure mother species; in the second case, repollinated after one and a half hours, the imperfectly formed capsule contained seeds most of which produced the pure mother species, but also two or three hybrids; and in the third case, repollinated after two hours, the very imperfect capsules contained but few germinable seeds. all of which produced hybrids.

A more remarkable case is reported by Darwin, who says:

> The stigmas on two lately expanded flowers on a variety of cabbage called Ragged Jack, were well covered with pollen from the same plant. After an interval of twenty-three hours pollen from the Early Barnes cabbage growing at a distance was placed on both stigmas, and as the plant was left uncovered pollen from other flowers on the Ragged Jack would certainly have been left by the bees during the next two or three days on the same two stigmas. Under these circumstances. it seemed very unlikely that the pollen of the Barnes cabbage would produce any effect ; but three out of the fifteen plants raised from the capsules thus produced were plainly mongrelized, and I have no doubt that the twelve other plants were affected, for they grew much more vigorously than the self-fertilized seedlings from the Ragged Jack planted at the same time and under the same conditions.

As a rule, a plant's own pollen is prepotent over that of a different species, and consequently in hybridizing it is necessary to castrate the flower in the bud to prevent self-pollination. Even if the pollen of the form used in crossing were prepotent over the plant's own pollen, it would still be necessary to prevent self-pollination, since it might have occurred long enough before the foreign pollen was applied to have had time to produce fecundation.

INCREASED VIGOR OF HYBRIDS AND CROSS-BRED PLANTS.

That unusual vigor of the offspring results from crossing slightly diverse plants has been thoroughly proved by the striking researches of Darwin and others. It has been said by Naegeli that "the consequences of fertilization reach their optimum when a certain mean difference in the origin of the sexual cells is attained," and by Fritz Müller that "every plant requires, for the production of the strongest possible and most prolific progeny, a certain amount of difference between male and female elements which unite. Fertility is diminished as well when this degree is too low (in relatives too closely related) as when it is too high (in those too little related)." Darwin says, "The offspring from the union of distinct individuals, especially if their progenitors have been subjected to very different conditions, have an immense advantage in height, weight, constitutional vigor, and fertility over the self-fertilized offspring from one of the same parents."

Attention has been called by Willis to three factors in the gain resulting from cross-fertilization, viz: *a*, fertility of mother plant; *b*, vigor of offspring, and *c*, fertility of offspring. The relative value of these factors varies with different plants. In the carnation, for instance, factor *a* of cross-fertilized plants was 9 per cent greater than in self-fertilized plants, *b* was 16 per cent greater, and *c* was 54 per cent greater; in tobacco, factor *a* was 33 per cent less than in self-fertilized plants, but factor *b* was 28 per cent greater and factor *c* 3 per cent greater. Even when the fertility of the mother plant is greatly reduced by hybridizing with a distinct species and the hybrids themselves are sterile or very infertile they nevertheless often show extraordinary vigor, that is, *b* is often greater in hybrids than in pure-bred plants, but factors *a* and *c* are usually less. In plant breeding the importance of this increased vigor is very great, and the subject will be taken up later in this paper.

DIRECT ACTION OF FOREIGN POLLEN ON PARTS OF THE MOTHER PLANT.

This phenomenon, called xenia by Focke, is one of the most remarkable observed in plant hybridization, and is considered by many as not yet proved. In some cases, however, the evidence is so extensive and so complete that it is scarcely possible to doubt that this effect does occasionally occur. The best proved instance of the immediate action of pollen is that of Indian corn. As early as 1724, Dudley said that "*Indian Corn* is of several Colours, as blue, red, and yellow; and if they are planted separately, or by themselves, so that no other Sort be near them, they will keep to their own Colour, i. e., the blue will produce blue, the white, white, &c. But if in the same Field you plant blue Corn in one Row of Hills (as we term them) and the white, or yellow, in the next Row, they will mix and interchange their Colours; that is some of the Ears of Corn in the blue Corn Rows shall be white or yellow; and some in the white or yellow Rows shall be of a blue Colour." In 1816, Dr. Savi, according to Darwin, "sowed yellow and black-seeded maize together, and on the same ears some of the grains were yellow, some black, and some mottled, the differently colored seeds being arranged in rows or irregularly."

The most convincing series of experiments was carried out by the famous French plant breeder, Henry L. de Vilmorin, in 1866. In the spring of that year he planted a dozen varieties of maize from 1,000 to 1,300 feet apart, which distance was found sufficient to prevent spontaneous intercrossing by wind-blown pollen. The ears to be crossed were enveloped in thin flannel, which excluded pollen perfectly, for such ears, if not artificially pollinated, never gave a single kernel. To have a standard for comparison, an inclosed ear of each sort was artificially pollinated from the same sort. The ears thus obtained were imperfectly filled, but the kernels reproduced all the characters of the seed planted. On the other hand, when inclosed ears were artificially crossed "with pollen from another sort * * * * the ears often but not always contained kernels showing the characteristics of their male parent. The proportion of such grains when they existed was very inconstant, being liable to vary from 1 to 60 per cent." The effect was limited to changes in the color of the kernels. In most cases the pollen of a black corn was used in crossing, and this color exists in the substance of the kernel. No conclusions were drawn except from plats of maize, the ears of which, when left exposed or fertilized with their own pollen, reproduced without change the sort planted.

In 1867 Hildebrand reported an experiment in crossing corn, using a yellow sort for the female and a dark-brown sort for the male. Realizing that the older experiments had been faulty, since no proof was given that the sort used as the female parent was pure and might not be showing the effect of a previous cross, he pollinated some of the plants of the yellow sort with their own pollen and obtained ears "all the kernels of which were exactly like the mother grains." On the other hand, two ears obtained by fertilizing the yellow sort with pollen of the dark-brown sort "had about half the kernels like those of the mother sort, or a little lighter, while the other half, scattered about among them, were a dirty violet color. On these latter, therefore, the pollen of the brown-kerneled sort had exercised a direct transforming influence."

Very many experimenters in the United States have reported instances of the immediate influence of foreign pollen on the kernels. Sturtevant observed this action at the New York Experiment Station in 1883, and Burrill reported instances of such current influence in 1887, Tracy in 1887, Kellerman and Swingle in 1888, and Hays in 1889. In 1892 McCluer published an account of his experiments and two good photographic plates showing the results. Fig. 2 of Pl. XX is taken from one of these plates, and shows the extraordinary effect that Black Mexican sweet corn (*m*) exerted on the kernels of a white dent variety (*h*), although in shape and size the ear resembled the mother sort exactly (compare *h* with *f*).

In spite of the fact that no proof is given in any of the American works that the sorts planted were free from the influence of possible crossing of previous years, yet in the light of the experiments of Vilmorin and Hildebrand, which were especially planned to exclude this source of error, we can not doubt in the majority of cases where a modification of the kernels on the female plant was due to the appearance of features characteristic of the sort which furnished the pollen, that this effect was really due to immediate action of foreign pollen and was not the result of some previous cross. This effect does not, by any means, always occur, but is more marked in some races (as sweet corn and pop corn) than in others (as flint corn).

The immediate effect of foreign pollen on the color of the seed coats of peas was observed as early as 1729, and repeatedly since then, being reported by such experimenters as Gaertner and Berkeley. Laxton observed not only an effect of the foreign pollen on the color of the seed coats, but also on the pod in some instances. His observations were confirmed by Darwin, so far as the change in color of the seed coats was concerned.

Giltay recently published very satisfactory evidence of the immediate effect of foreign pollen on the color of the kernels of rye. There are many cases on record of supposed action of foreign pollen on fruits or other parts of the mother plant far removed from the developing embryo, and though it is possible that such action occurs in some cases, most of the evidence is faulty in that there is a possibility of the effect observed being due to a previous cross or to spontaneous variation or "sporting." These curious effects of foreign pollen, though of the greatest interest to the student of heredity, are not as yet known to be of any great practical importance.

GRAFT HYBRIDS.

The evidence of the existence of graft hybrids, though becoming stronger every year, can hardly be said as yet to be conclusive. The ability of scions of certain variegated plants to communicate their variegation to the stock on which they are grafted, however, has been established by numerous observations, some made as early as 1700 by Wats, but especially by the careful experiments of Morren and Lindemuth. Variegation is, however, by some believed to be a disease which in some manner spreads through the tissues of the stock. In regard to graft hybrids Darwin says:

> The most reliable instances known to me of the formation of graft hybrids is one recorded by Mr. Poynter, who assures me, in a letter, of the entire accuracy of the statement. *Rosa devoniensis* had been budded some years previous on a white Banksian rose; and from the much enlarged point of junction, whence the Devoniensis and Banksian still continued to grow, a third branch issued which was neither pure Banksian nor pure Devoniensis, but partook of the character of both.

Recently Daniel published records of many experiments tending to show that in the cabbage family there may occur an effect of the stock on the scion to such an extent that the seeds formed by the scion will produce plants intermediate in character between the two plants united. For example, he grafted flower shoots of the tender kohl-rabi on a hardy cabbage, hoping to secure a hardy sort of kohl-rabi. The seeds produced by self-pollination (the kohl-rabi flowers having been bagged to exclude insects) yielded plants differing in aspect from the mother sort of kohl-rabi and resembling somewhat the cabbage used for stock. Still they had swollen stems useful for forage, were very hardy, and yielded from four to five times as much fodder as other sorts of cabbages able to stand the same degree of cold.

In consideration of Daniel's remarkable results the study of graft hybrids should be renewed, since the value of such hybrids in practice would be considerable could they be produced with certainty.

PRACTICAL UTILIZATION OF HYBRIDS IN PLANT BREEDING.

While very many of the best sorts of our cultivated plants have been produced by careful hybridization, yet it must be admitted that a surprisingly large number of our fruits have been produced in other ways, or at least are not known to be of hybrid origin. However, many of the chance and select seedlings, as they are termed, although not known to be of hybrid origin, are doubtless second and later generations of hybrids. Valuable hybrids are occasionally produced accidentally, a fact which still more strongly emphasizes the great advance which may be expected when the skill and industry of the trained plant breeder are applied to the work of hybridization.

Judging from some of the wonderful results which have been obtained from hybridization, it would seem that almost any desired variation can be produced if a sufficient amount of time, patience, and skill is brought to bear on its production.

VARIABILITY INDUCED BY HYBRIDIZATION

In breeding plants it is necessary to secure great variability in order to have many different forms from which to select. In the first generation hybrids are commonly intermediate in character between the two parents, as shown above, but in the second and later generations they almost invariably break up, giving many combinations of the parental characters in many proportions. Crossing these hybrids with other species or races greatly increases the range of variability which may be expected, and is a feature of great importance to the plant breeder, as it gives more opportunities of securing the combination of characters desired. If a particular combination of the characters of the parents is desired, as is usually the case, it is of the greatest importance that the necessity of planting second and later generations be recognized. Burbank says: "I expect but little result from the first generation, but after that great variations often continue to appear for several generations." In the case of hybrids between very closely allied species and between different races of the same species greater variation may be expected in the first generation, as explained above, but nevertheless, in such cases also, the second and later generations may give still more variations, and should not be neglected. The canes from different individuals of the second generation of a hybrid between the blackberry and raspberry, shown on Pl. XIX, fig. 1, illustrate in a striking manner the great variation which may be expected to occur in later generations of hybrids, as do also the leaves of a hybrid blackberry shown by fig. 11.

Many plants, poor or worthless in themselves, may be of great value to the hybridizer because of ripening earlier or later, and being more hardy or better adapted to certain soils than the good sorts, since by hybridizing these with good sorts valuable new forms may be obtained.

In plants propagated by seed the variability and instability of hybrids is to some extent a disadvantage, since a hybrid seedling may show a desirable combination of characters which in the next generation will entirely disappear.

VEGETATIVE PROPAGATION IN COMPARISON WITH SEMINAL PROPAGATION.

In the practical application of hybridization in plant breeding it is important to recognize clearly the distinction between plants propagated by seed and those which may be propagated vegetatively, that is, by cuttings, buds, grafts, suckers, etc. Hybrids are notoriously unstable, and variations shown by them are in almost all cases lost or greatly modified in the next generation. In no case can they be depended upon to reproduce true to seed until tested, and therefore any desirable variation produced by hybridization in plants propagated by seed must be "fixed" or rendered hereditary through the seed, as explained in the next section, before it can be of any value. On the other hand, the process of fixation is not necessary in plants propagated vegetatively. In such plants the scions, cuttings, or suckers used in propagation are taken from the individual plant showing the desired qualities, and the new plants, being merely portions of the original seedling, retain all its characteristics. As Burbank says, "by persistently selecting the best of one chosen special type the variety can be fixed, but of course in the case of plants propagated by division this is of no consequence, as the superlatively valuable one remains constant and the others are discarded."

FIXATION OF DESIRABLE VARIATIONS.

When a hybrid possessing desirable characters is produced from plants propagated by seed it is almost invariably necessary to render these characters hereditary by careful selection and in-and-inbreeding. Darwin says:

> Florists may learn * * * that they have the power of fixing each fleeting variety of colour if they will fertilize the flowers of the desired kind with their own pollen for half a dozen generations and grow the seedlings under the same conditions. But a cross with any other individual of the same variety must be carefully prevented, as each has its own peculiar constitution. After a dozen generations of self-fertilization it is probable that the new variety would remain constant even if grown under somewhat different conditions.

When a desirable hybrid is produced, it should be fertilized with its own pollen, the seeds thus produced planted, and the seedlings selected which most perfectly show the characters which it is desired to fix, after which these selected seedlings should be inbred and a third selection made, and so on, until the desired characters are produced true in all the seedlings. In case a desirable hybrid is found to be sterile to its own pollen, it should be fertilized if possible with pollen taken from similar hybrids showing the same variation.

In the continual self-fertilization practiced in fixing variations there is doubtless much loss of vigor. In some cases this might be avoided by making numerous hybrids between several different sets of individuals of the same sort but not closely related (that is, separated by numerous seed generations), so that several unrelated hybrids, showing practically the same combination of characters, could be obtained. These hybrids could be bred together and rigidly selected each generation, until all the seedlings produced show the desired combination of characters. However, in order to avoid the greater possibility of losing the variation, it is probably best in all cases to self-fertilize, if possible, a portion of the flowers.

ADVANTAGES AND DISADVANTAGES RESULTING FROM STERILITY.

The sterility of hybrids, mentioned on page 391, is in many cases a great hindrance to their utilization in plant breeding, particularly in races propagated by seed. Even partial sterility is often a great drawback to fruit production, and may in some cases preclude the use of otherwise valuable hybrids. If the fine European sorts of grapes are hybridized with American species resistant to Phylloxera there is no difficulty, according to Millardet, in securing hybrids sufficiently resistant and which will bear fruit of the desired quality. The great difficulty in such cases is that the hybrids in most instances are partially sterile and thus not sufficiently prolific to be valuable. Reduced fertility, however, may in some cases be overcome to some extent. According to Darwin, "if even the less fertile hybrids be artificially fertilized with hybrid pollen of the same kind their fertility, notwithstanding the frequent ill effects from manipulation, sometimes decidedly increases and goes on increasing."

Partial sterility, manifested by a lessened production of seed, is sometimes not accompanied by any diminished yield of fruits, and is therefore in such cases a positive advantage if the plant can be propagated vegetatively. This is in particular true of certain table fruits, such as oranges, pineapples, etc. In some instances sterile hybrids may be produced in any desired number by making more crosses of the parent plants. In some cases sterile hybrids, propagated vegetatively, may be valuable for stocks on which to graft other sorts, as they are commonly very vigorous, a feature which is of importance here. They may also be valuable for their wood, as in the case of Burbank's walnut, described on page 411, or for foliage plants, forage plants, etc.

It must not be supposed, however, that all hybrids are in some degree sterile. In very many instances the opposite is true, the cross resulting in increased fertility. Fritz Müller found some species of Abutilon to yield capsules containing more seed when hybridized with another species than when cross-pollinated from another plant of the same species. Additional fertility may thus be expected in certain hybrids and their progeny, notwithstanding that sterility is in many cases the rule.

HYBRIDS MOST USEFUL TO THE PLANT BREEDER.

The majority of hybrids between distinct species are in the first generation intermediate between the parent species, resembling each plant in about equal degree, and in some cases there appears to be a perfect blending of the characters. Such hybrids may frequently be of use to the plant breeder in securing the amelioration of certain undesirable qualities. Valuable sorts of flowers intermediate in color and shape, and fruits intermediate in odor, flavor, texture, color, etc., may be secured in this way.

In many hybrids the individual characters of each parent remain distinct, though intimately associated, forming the so-called mosaic hybrids (p. 391). Such is the case in variegated flowers, where the color of each parent usually reappears, but in distinct blotches (Pl. XVII, fig. 3). Again, the leaf may resemble one parent and the fruit the other, and in still more extreme cases the entire top, the foliage, appearance and quality of the fruit, etc., of the hybrid may resemble one parent mainly, while in hardiness, vigor, resistance to disease, etc., it may resemble the other parent.

It is upon these large-pattern mosaic hybrids that the plant breeder must depend largely for valuable results. Many hybrids of this nature are described on the following pages; for instance, the French grape hybrids, possessing the resistance to Phylloxera of certain American grapes; the hybrid pansies, possessing the odor and perennial habit of one of the parents; the hybrid Turkish tobacco, having to a large extent the flavor and aroma of the Havana tobacco, one of the parents, etc.

The occurrence of apparently totally new characters, distinct from those of either parent, as a result of hybridization, has not been generally emphasized as a factor in plant breeding. However, some of the striking modifications obtained by plant breeders can hardly be considered other than as new characters. What new characters can be obtained can not be predicted from the parents selected for hybridizing, and while such characters can not be expected to occur commonly, yet that they do occasionally appear can not be doubted. Illustrations of such striking new characters, which show the extraordinary results that may occasionally be obtained by hybridizing, are the excessive size and rapidity of growth of Burbank's hybrid walnuts; the size and time of fruiting of the raspberry-blackberry hybrid "Primus;" the excessive increase in quinine content in the hybrid Cinchona (*C. ledgeriana*); the remarkable increase in starch content of Cimbals' potato Präsident von Juncker, etc., described in detail on pages 411, 417 and 418.

Focke announces as a general principle that "monstrous or abnormal forms of floral organs are much more common in hybrids than in individuals of pure descent," and states further that double flowers are especially frequent in hybrid plants. Such examples could be multiplied indefinitely, but enough have been cited to show that these striking new characters are of superlative interest to the plant breeder.

SOME SPECIAL FEATURES OBTAINED BY HYBRIDIZATION.

INCREASED SIZE AND VIGOR.

Hybrids between very different species are said to be often very weak when young, and also difficult to grow successfully. In some cases, however, crosses between very different species give unusually vigorous offspring. Burbidge says: "I have in several cases noted the healthy, vigorous appearance of Mr. Dominy's hybrid and bigeneric hybrid orchids compared with the parent plants." Darwin subscribes to the same view in the statements that "true hybrids raised from entirely distinct species, though they lose in fertility, often gain in size and constitutional vigour," and that "Clotzsch crossed *Pinus sylvestris* and *P. nigricans*, *Quercus robur* and *Q. pedunculata*, *Alnus glutinosa* and *A. incana*, *Ulmus campestris* and *U. effusa*, and the cross-fertilized seeds, as well as seeds of the pure parent-trees, were all sown at the same time and in the same place. The result was that after an interval of eight years the hybrids were one-third taller than the pure trees."

Burbank's numerous hybrids furnish many instances of excessive increase in vigor, size of fruit, etc., resulting from crossing distinct species. A hybrid between the English walnut (*Juglans regia*) and the Californian black walnut (*J. californica*) possesses extraordinary vigor of growth, which may render it of exceptional value as a lumber and ornamental tree. "The hybrid grows twice as fast as the combined growth of both parents. The leaves * * * are from 2 feet to a full yard in length. * * * The wood is very compact, with lustrous, silky grain, taking a beautiful polish, and as the annual layers of growth are an inch or more in thickness and the medullary rays prominent, the effect is unique." Another of Burbank's hybrid walnuts, obtained by crossing the black walnut with pollen of the Californian black walnut, produces fruit of excessive size, it being much larger than those of either parent (fig. 12).

The raspberry-blackberry hybrid "Primus," produced by crossing the Western dewberry (*Rubus ursinus*) with the Siberian raspberry (*R. cratægifolius*) is also an interesting case. In his description of this hybrid berry, Burbank says: "It is also remarkable that the hybrid should ripen its fruit several weeks before either of its parents, and excel them much in productiveness and size of fruit, though retaining the general appearance and combined flavors of both" (Pl.

XVIII, fig. 3). Slightly increased size and vigor frequently result from crossing closely related sorts and species, as we shall see later, but the excessive increase in size in the above-described walnuts and raspberry-blackberry hybrids can hardly be considered otherwise than as a new character.

From the preceding statements, it seems certain that even crosses between distinct species may frequently produce offspring of greatly increased vegetative vigor, and that this vigor may often be of the greatest consequence in the breeding of plants, enabling the hybrid to endure much better than either of the parent species the deteriorating effects of unsuitable soils or climates. A case in point is that of *Primula venzoi*, the hybrid offspring of *P. tyrolensis* and *P. wolfeniana*. According to Kerner, both parent species are difficult to rear in gardens, even when the greatest care is bestowed upon their cultivation. The hybrid *P. venzoi*, however, will flourish in extreme luxuriance if planted close to them in the same soil and under the same external conditions.

In some cases the increase in vegetative vigor secured by crossing distinct species is at the expense of fertility, but this is by no means true in all. Focke says that "it was formerly thought that the diminished sexual fruitfulness is compensated by a greater vegetative luxuriance, a statement the untenableness of which, as Gaertner showed, is most plainly demonstrated by the fact that many of the most fruitful crosses (Datura, Mirabilis) are also distinguished by a most gigantic growth." On this subject Fritz Müller also says: "So far as my experience goes, the hybrids which grow the most luxuriantly are generally the most fruitful."

From results obtained by Millardet, it would seem that in some cases the exceptional vigor due to hybridization of distinct species might be secured without a noticeable change in the species which it is desired to breed true. These are the so-called false hybrids discussed above, resembling one parent exclusively. Thus, Millardet hybridized two strawberries (*Fragaria vesca* with *F. elatior*) and obtained five very vigorous and fruitful hybrids of the *vesca* type. Seeds from these hybrids were planted and the plants of the second generation, also of the pure *vesca* type, were remarkably vigorous

The beneficial effect of fertilizing plants with pollen of different individuals of the same species was conclusively proved by Darwin, and is now well understood. That unusual vigor frequently results from crossing plants of closely related sorts or different strains or races of the same species, and that this may be of great use in increasing the vigor and yield of many of our common cultivated plants, has not been so thoroughly realized; indeed the great economic importance of this fact has been largely overlooked. The increased vigor produced by crossing different sorts is well illustrated by Darwin's results in crossing tobacco, which is commonly self-fertilized.

He found that simple cross-fertilization with the same strain had but little effect, but when the flowers of slightly different sorts or strains were crossed the resulting seedlings showed the effect of the cross in an extraordinary degree. "This was shown in several ways—by the earlier germination of the crossed seeds, by the more rapid growth of the seedlings while quite young, by the earlier flowering of the mature plants, as well as by the greater height which they ultimately attained. The superiority of the crossed plants was shown still more plainly when the two lots were weighed, the weight of the crossed plants to that of the self-fertilized in the two crowded pots being as 100 to 37. Better evidence could hardly be desired of the immense advantage derived from a cross with a fresh stock."

In cases where there is no particular object in keeping the varieties pure, a marked increase in yield may be obtained by using crossed seed. The valuable practical results which may be secured in this way are indicated by results obtained at the Illinois Experiment Station by Morrow and Gardner in crossing various sorts of corn. Of fifteen cross-bred corns tested, twelve gave a decided increase in yield over that of the parent sorts, ranging from 2 to 86 per cent in individual cases. In three cases a decrease in yield of from 8 to 20 per cent resulted. In the fifteen cases taken together an average increase in yield of about 16 per cent was secured. In some cases the cross-bred corns were grown the second generation without crossing and showed a decidedly larger yield than the parent varieties. A number of crossing experiments of a similar nature had previously been made by McClure with corn and practically the same results obtained. "The corn grown from the crossed seed was in nearly all cases clearly increased in size as a result of crossing" (Pl. XX, fig. 1). "Nearly all the corn grown a second year from the crosses is smaller than that grown the first year, though most of it is yet larger than the average size of the parent varieties."

In the majority of cases crossing distinct sorts improves the vigor and results in greatly increased yield. By selecting varieties which give increased yields uniformly when crossed and crossing these for seed corn it seems certain that the average yield can be greatly increased. Securing seed corn from a cross of any two sorts desired is not a difficult or expensive process, being easily accomplished by planting the two desired sorts in alternate rows and removing the tassels, as soon as they appear, from the one to be used as the female parent. The ears that form on the rows from which the tassels have been removed will have been crossed with pollen from the variety from which the tassels have not been removed. The seed corn should therefore be selected from the ears produced on the detasseled rows. The field planted to the two varieties, as above described, to secure crossed seed should be somewhat isolated from other cornfields, and should be of sufficient size to produce the necessary quantity of seed.

The only extra cost incurred in producing seed corn in this way is the cost of detasseling the alternate rows, as ears will form on both as usual.

In case of fruits and plants propagated vegetatively by suckers, cuttings, grafts, etc., increased vigor obtained in this way could probably be retained indefinitely and would be of the greatest value. It is probable also, as Darwin suggests, that increased fertility and yield would be secured by obtaining seeds of the same sort grown for some time at a distance under different conditions and planting in alternate rows with home-grown seed, so that the different strains would be crossed. The increased vigor resulting from crossing closely related sorts may be of the utmost importance in aiding plants to resist disease. Knight found this to be the case with certain wheats which he obtained by crossing different sorts. He says: "In the years 1795 and 1796, when almost the whole crop of corn in the island [Great Britain] was blighted, the varieties thus obtained, and these only, escaped in this neighbourhood, though sown in several different soils and situations."

The increased vigor and fruitfulness which almost invariably result from crossing closely related sorts or varieties is a principle of the utmost importance in our common agricultural practices, for we greatly need more vigorous forage plants, timber and shade trees, vegetables, etc., and more prolific grains and fruits.

BREEDING HARDY SORTS.

Tender plants may be rendered more resistant to cold by crossing them with hardy species or races. Thus, according to Verlot, the forms of *Rhododendron arboreum* are rendered hardier by crossing with *R. catawbiense*. Macfarlane has called attention to the hardiness of a hybrid between the hardy *Montbretia pottsii* and *Tritonia aurea*, which latter is easily injured by cold. He says, referring to the winter of 1891–92: "The corms of the first [*Montbretia*] appear scarcely to have been injured. Those of the hybrid have been largely killed off, at least to the extent of 60 per cent, while Tritonia, never hardy in exposed ground, has survived only where it is planted against, and can creep along, the outer side of a hothouse wall." A second case is also described by Macfarlane where a hybrid between a hardy and a tender species is intermediate in hardiness between the two. He says: "*Philesia buxifolia* is a hardy plant and resists well our winter colds. *Lapageria rosea* requires the temperature of a cool hothouse to flourish, while the hybrid succeeds if kept protected from frost and the more cutting winds. In the southern counties of Britain it lives and flowers out of doors."

Originating hardy races of cultivated plants is a line of work of great worth, rendering it possible to cultivate valuable kinds farther north than they have been in the past, and lessening the danger from the sudden and great changes of temperature to which they are exposed in many parts of the United States.

In view of the great injury caused to orange and lemon trees in Florida, Louisiana, and California by the severe freezes which occasionally occur, it would be of immense value if good sorts of oranges and lemons which are more resistant to cold than any now existing could be produced. Fortunately, the Japanese trifoliate orange (*Citrus trifoliata*), although its fruits are small and of little value except for preserves, is deciduous and so hardy that it can be grown without protection as far north as Philadelphia. The experiments of the writers have proved that hybrids may be made successfully between this hardy species of Citrus and the good sorts of oranges and lemons commonly grown. Furthermore, some of these hybrid plants show by their irregularly trilobed leaves (fig. 13) that they are intermediate in character between the parents, and do not exhibit the overwhelming preponderance of one or the other parent shown by the hybrids of the orange and pomelo described on page 397. If these hybrids are produced in sufficient numbers we may reasonably expect to find among the many some having the desired combination of characters, that is, the hardiness of the trifoliate orange and the size and quality of fruit of the ordinary orange and lemon. Since these hybrids are difficult to produce, their seeds, if any are developed, should be planted in order to secure numerous plants of the second generation, which are not only easier to obtain, but are in general more variable and consequently more likely to yield the desired forms. The problem here is very similar to that which the French hybridizers have successfully solved in obtaining hybrid grapes combining the resistance to Phylloxera of the American grape and the quality and size of fruit of the European grape (p. 416). An increase in hardiness of plums, peaches, pears, and, indeed, of hosts of our most valuable crops, would be of immense value and could doubtless be secured by hybridization and selection.

ADAPTATION TO WARMER CLIMATES.

In the previous section, methods of obtaining hardy sorts by hybridization was discussed. With many plants it is just as important to secure sorts adapted to growth in warmer climates, making possible the southward extension of the territory in which the plant can be cultivated profitably. The Kieffer and Le Conte pears furnish excellent illustrations of valuable sorts of this kind. These pears are almost certainly hybrids between the Chinese sand pear (*Pyrus sinensis*) and the common European pear (*P. communis*), since both were grown from seeds of the sand pear obtained from trees which were surrounded by various European pears. The partial self-sterility of the sand pear and the great ease with which cross-pollination is effected by insects thus leaves but little doubt that the seeds were the result of accidental hybridization. The Chinese sand pear is cultivated mainly as an ornamental tree and for stocks on which to bud other sorts, the fruit being of very poor quality.

The adaptability of the Kieffer and Le Conte pears to growth in warmer climates is doubtless derived from the mother, the Chinese sand pear, from which parent is probably derived in part the unusual vigor and resistance to disease. On the other hand, the quality of the fruit was largely derived from the common pear.

These two hybrid sorts have practically revolutionized pear culture in the southern part of the United States, having extended the range of profitable commercial pear growing hundreds of miles southward. Waite says in regard to this: "No single element has exerted more influence on pear culture in the Eastern United States than the introduction of the oriental species of pear. The Kieffer and Le Conte have so far brought about most of the changes. From Virginia and southward to the orange region of Florida these two varieties have monopolized the pear growers' attention. In fact, they have made the Southern pear culture." Still greater improvements may be expected when extensive and carefully planned experiments can be carried out in hybridizing the oriental and European pears.

SORTS RESISTANT TO DISEASE.

It has long been known that certain races and sorts are less subject than others to some diseases, but it was only recently that this fact was brought into prominence, and is largely the result of efforts of the French vineyardists to secure grapes immune from Phylloxera, black rot, chlorosis, etc. The extensive grape industry of France was threatened with destruction by Phylloxera, an insect affecting the roots of the vine, until it was learned that certain American species, as *Vitis riparia* and *V. rupestris*, were practically immune from it. This has led to the fine European varieties being grafted extensively on these resistant stocks. A "direct producer"—that is, a variety propagated by cuttings and not budded or grafted—was thought desirable, however, and large sums were expended by the French Government and by private individuals to secure by hybridization sorts having the Phylloxera-resistant character of the American grapes and the fine fruit of the European. Several very excellent hybrids have been obtained which possess these characters, so that it is very probable that direct-producing sorts, meeting all the demands of different regions, can be secured. Millardet, who has been very active in this investigation, says: "The great difficulty is not to obtain resistance to Phylloxera and to mildew, nor even to obtain size and quality of fruit, but to secure the fertility of the plant." The relative susceptibility of the various grapes to black rot has also been studied, and it seems probable that this destructive malady may be prevented successfully by securing resistant sorts. According to Ratoin, no native French grapes are entirely immune. Jurançon Noir is the most resistant, as when surrounded by rotting grapes it did not lose a tenth of its bunches; Blanquette de Limoux is as good as Jurançon, two sprayings being sufficient to save a crop where the whole vineyard is composed of this sort; Hybrid J 503 of Couderc, a black grape, obtained by crossing *V. rupestris* and Petit Bouschet, is immune; 4401 of Couderc, a hybrid of *V. rupestris* and Chasselas rose, is very resistant, and Seibel No. 1 is also of this category. In 1888 M. Fournié sowed seed obtained by crossing *V. riparia*, *V. rupestris*, and Portugais Bleu, and secured a hybrid which is very resistant to Phylloxera and chlorosis, and seems to be entirely immune from fungous diseases. Placed among vines ravaged by black rot in Lot-et-Garonne it remained perfectly healthy without treatment. It is, moreover, a sort that yields well, forty-five bunches being counted on a single plant. Degrully reports that Couderc's hybrids of Cunningham and Folle and Cunningham and Aramon are very resistant to black rot. The almost absolute immunity of Cunningham seems to be easily communicated to its hybrids.

Chlorosis, a disease induced by planting on soils containing an excess of lime, may also be avoided by using resistant varieties. According to Roy-Cevrier, Couderc's hybrid 1202 of Mourvedre and Rupestris is very well adapted to calcareous soils and is resistant to chlorosis.

In resistance to disease very marked differences exist in certain species and races of oranges. For instance, the sour orange is practically immune from mal-di-gomma, and the disease is largely controlled by budding the sweet orange on this stock. The sour orange is also largely immune from blight, and it is probable that a blight-resistant sort of the sweet orange could be obtained by crossing with it. Again, the Drake Star, a very excellent late orange, but a shy bearer, has been found by the writers to be almost entirely immune from "rust," which is caused by a surface-feeding mite (Phytoptidæ). Other rust-resistant sorts could probably be obtained by crossing the Drake Star with other sweet oranges.

Sorts somewhat resistant to disease can be found among almost all our cultivated fruits, and from the results obtained in France with the grape it seems probable that many plant diseases could be successfully controlled by breeding resistant sorts.

INCREASED PERCENTAGE OF STARCH, SUGAR, ETC.

That very valuable improvements may be made in this direction is clearly shown by the results of Cimbals, a celebrated German plant breeder, in the improvement of the potato. "The well-known sort Magnum Bonum yields about 60 cwt. per morgen [about five-eighths of an acre], with 15 per cent starch content, that is, 9 cwt. starch, and Cimbals' new sort, 'Präsident von Juncker,' yields 140 cwt. per morgen, with 26 per cent starch content, that is, over 36 cwt. starch." Not only was an increased yield obtained in this latter case, but the per cent of starch was increased very decidedly, so that the yield of starch was four times as great—a very important feature, particularly in Germany, where potatoes for distilleries, starch factories, and other industrial purposes are sold according to starch content.

Kuntze described a remarkable Chinchona (*C. ledgeriana*) supposed to be a hybrid of *C. pavoniana* and *C. weddelliana*, which shows an extraordinarily large quinine content. It is a mosaic hybrid, having the parental characters dissociated to a considerable extent, that is, showing side by side, and the bark often contains from 5 to 13¼ per cent of quinine (13½ per cent corresponds to 17.83 per cent sulphate of quinine), or "from three to four times as much quinine as other rich barks." This hybrid is sterile and difficult to propagate, so Kuntze recommends its production by seed obtained by artificially crossing the parent species.

The sugar content of the sugar beet has been largely increased by Vilmorin, mainly by careful selection of seed. It is very probable that important results could also be obtained in the United States by hybridizing the best sorts existing. The protein content of some of our important food plants, and the camphor, rubber, and tannin content of plants cultivated for these products, could doubtless be greatly increased by hybridization and selection.

CHANGE OF SEASON AND OF DURATION OF LIFE.

Frequently the time of blooming and fruiting may be changed by hybridization, and thus the season prolonged and sorts secured which bloom or fruit at times different from the blooming or fruiting time of existing sorts, which is a feature of great practical importance in fruit and flower industries. Burbank's blackberry-raspberry hybrid "Primus," described on page 411, is an excellent illustration of this result.

In many annual and biennial plants an extension of the period of growth and of production of flowers or fruit, rendering them perennial, would be a great acquisition. This could probably be obtained in many instances without detriment to the flower or the fruit, by crossing such plants with related perennial species. "Foremost among the problems to be solved by the pansy raisers," says Wittrock, "we must place the question of making the pansy perennial instead of annual or biennial. A remarkable step in this direction has already been taken by the English and Scotch pansy growers, who, with very good results, have used the perennial *Viola cornuta* for crossing with garden pansies." The perennial habit of the tufted pansies, or violas, was derived from the English *V. lutea* and the Pyrenean *V. cornuta*, which were crossed with the garden pansies.

ACQUISITION OF ODOR.

There is evidence which shows that odorless plants have been rendered fragrant by hybridizing with scented species or varieties. According to Wittrock, pansies have been considerably improved in this respect by crossing various sorts with the fragrant *V. cornuta*. Violetta, a fragrant sort, was produced by crossing *V. cornuta* with pollen of the pansy Blue King. Sensation, another scented variety, was also produced by crossing *V. cornuta* and the pansy. Wittrock, who is probably the best authority on violets and pansies, says: "No pains have been spared of late by the pansy cultivators of Great Britain to increase the charm of the pansy by obtaining perfume as well as beauty, but by a more extensive use of the odoriferous alpine species (*V. cornuta* L. and *V. lutea* Huds., var. *grandiflora* (L.) Vill.) for hybridization doubtless much may still be done in this direction."

BETTER QUALITY AND FLAVOR.

Probably the most satisfactory method of obtaining improved and unique flavor is through the variations produced by crossing different races or species. The exceedingly valuable results which may be obtained in this way are shown by what has been accomplished in the improvement of the quality of smoking tobaccos. The various forms of Havana tobaccos, because of their superiority to all others, have been used in crossing with other varieties to improve their flavor. The most valuable results which have been obtained in this way, according to Comes, "are certain Turkish tobaccos, which unite marvelously the suavity of aroma of the Havana with the mild flavor of the Macrophylla," a mild-flavored, large-leafed tobacco. The various forms of the famous Jenidje of Drama and of Aya Soluk are cited by Comes as examples. Thus far almost no attempt has been made in America to improve the cultivated races of tobacco by hybridization. Recently very numerous and extensive experiments have been made in Florida to grow the famous Cuban Vuelta Abajo tobacco. All attempts thus far have been directed to securing from Cuba seed of the sort desired, and cultivating and curing the crop as nearly as possible in the same way as is done in Cuba. It seems probable, however, that even more valuable and far-reaching results might be obtained by infusing the quality of the Vuelta Abajo into some of the best widely cultivated native sorts by hybridization. In this way the hardiness of our native sorts might be combined with the flavor and quality of the Vuelta Abajo, thus making it possible to grow superior smoking tobacco over a widely extended area.

Many of our fruits and nuts are capable of marked improvement in the same way. The modifications in flavor and color which may be obtained, if not superior to the parent sorts may at least form interesting and valuable novelties. The Transcendent crab apple, a hybrid between the common apple and the Siberian crab apple; the Soulard and kindred crab apples; hybrids between the apple and the native west American crab apple, etc., are illustrations of valuable combinations in quality, flavor, and size obtained among fleshy fruits by hybridization. The Le Conte and Kieffer pears already referred to are also examples of this effect.

BREEDING BETTER STOCKS.

One of the most promising lines of work for the plant breeder is the origination of sorts of plants to be used exclusively for stocks. Hybrids of unusual vigor, even though absolutely sterile, may prove of great value for stocks if they are capable of being propagated vegetatively. Millardet says that some of his hybrids of the European and American vines exhibit a "degree of vigor which is simply incredible." Some of those sown in 1883 were 2 and one even 3 inches in diameter in 1889. Some of Ganzin's observations go to show that the European vine thrives better on such hybrid stocks than on the pure American species, having more affinity for the former.

The importance of breeding sorts of the vine adapted to particular soil conditions has long been recognized by the French viticulturists. Degrully called attention to some hybrids of the European grape with *Vitis berlandieri* as having great resistance to chlorosis, a disease due to excess of lime. Several of them were able to thrive in soils containing 50 to 60 per cent of lime and some few even where there was 60 to 63 per cent. Munson has done valuable work in this line in America, but much still remains to be accomplished. The Marianna plum, which is propagated extensively from cuttings to serve as stocks for other plums, is a hybrid supposedly of Mirobolan and Chickasaw plums. A very considerable increase in productiveness and extension of the area of cultivation of our most valuable fruits may be expected when stocks are bred as carefully as are at present the sorts used for grafting on them.

THE NEEDS AND REQUIREMENTS OF A CONTROL OF FEEDING STUFFS.

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INTRODUCTION.

In recent years there has been a steady increase in the production of commercial feeding stuffs and in their use by farmers. These products are furnished principally by oil mills, starch and glucose factories, flouring mills, distilleries and breweries, and similar industries. They are by-products of these industries, and as the extent and variety of these industries have increased, the amount of by-products has been swelled to enormous proportions. A new series of products has appeared almost annually, so that while a dozen years ago the different kinds could almost be counted on the fingers of both hands, to-day they present a bewildering array of different kinds and trade names, many of the latter quite delusive.

A portion of these products is exported to foreign countries, but the larger amount is used at home. As farmers, particularly in the East, have come to buy commercial fertilizers to supplement the supply of barnyard manure made on the farm, so in the matter of feeding stuffs they have come to buy concentrated materials to piece out the grain and coarse fodder which they raise. These concentrated materials are used more particularly to increase the protein in the feed, and so make better balanced rations.

CONDITION OF TRADE IN FEEDING STUFFS.

While we have no statistics as to the amount of commercial feeding stuffs used by the farmers of this country, it has been stated on good authority that the money expended for them "exceeds many times the amount spent for commercial fertilizers;" hence, the interests involved in the trade in commercial feeding stuffs are greater than in the case of commercial fertilizers. But the trade in feeding stuffs is in a similar condition to that in fertilizers twenty or twenty-five years ago.

Before the fertilizer trade had reached a tenth of the present proportions of the trade in commercial feeding stuffs, the need of some sort of control of fertilizers in order to protect the farmer had been realized. Laws were passed requiring dealers to guaranty the composition of fertilizers, and providing an inspection or control of the goods.

The trade in commercial fertilizers is now on a reliable and business-like basis. The intelligent buyer may know just what he is paying for, and has a confidence in the trade born of a knowledge that a strict control is maintained which renders any attempt at gross fraud impracticable. The fertilizer control has proved a most valuable safeguard to farmers, and, aside from the saving in dollars and cents, has done much to instruct them in the composition and use of fertilizers.

The benefits of the fertilizer control are now generally recognized. The arguments in favor of it are equally applicable to a control of commercial feeding stuffs. This is apparent from the present extent of the trade in these products, the number of different kinds on the market, the selling price of the material, and the liability to variation in composition due to a number of causes. The farmer can not afford to take the risk of buying high-priced commercial feeding stuffs by name only any more than he can fertilizers, and it is as impracticable for him to secure analyses of each shipment of feeding stuffs as of fertilizers.

The principal food ingredients of commercial feeding stuffs are protein, fat, and carbohydrates (fiber and nitrogen-free extract). Of these, the first two deserve special attention, as the coarse fodders grown on the farm furnish carbohydrates in large quantity. Protein is the material out of which muscle and tissue are formed. It is absolutely necessary in the food in order to supply the material for repairing the waste of the body and making growth. The fat and the carbohydrates are used in producing fat in the body and in furnishing heat and energy; but fat is regarded as about two and one-half times as efficient as carbohydrates in the production of energy. Hence, while the fat and the carbohydrates serve a similar purpose in nutrition, and so may replace one another, neither of them can take the place of protein. The protein more than any other ingredient should be considered in buying concentrated feeding stuffs, for it is largely to make up the deficiency of most farm products in protein that commercial feeds are bought and fed.

DIFFERENCE IN COMPOSITION OF COMMON FEEDING STUFFS.

The variation in composition of common feeding stuffs is very large, as will be apparent from studying any compilation of analyses. Wheat bran, for example, varies in protein all the way from 12 to 19 per cent; wheat middlings, from 10 to 20 per cent; wheat screenings, from 8 to 17 per cent; and buckwheat middlings, from 25 to 31 per cent. Cotton-seed meal ranges from 23 to 50 per cent in protein, and from 9 to 18 per cent in fat; new-process linseed meal, from 27 to 38 per cent in protein, and from 1.3 to 4.4 per cent in fat; peanut meal, from 37 to 52 per cent in protein, and from 6 to 18 per cent in fat, and the various materials sold under the name of gluten meal have been found to vary from 21 to 39 per cent in protein, and from 6 to 20 per cent in fat.

A part of this variation is due to differences in water content, but even on the dry-matter basis the range in composition is very wide. This is but natural, since the by-products are obtained from a large number of factories, and a difference or a change in the process of manufacture has its effect on the composition of the by-product. An instance of this is the refuse from the manufacture of glucose from corn. A few years ago a by-product from this industry, under the name of gluten meal, was placed on the market and soon met with extensive sale. The material varied considerably with the process of manufacture, and certain trade names were given to the products from different factories. As a result there were soon numerous brands of gluten meal, varying all the way from 21 to 39 per cent in protein and from 3.4 to 20 per cent in fat. Between the old process and the new process Chicago gluten meal, there is an average difference of 7 or 8 per cent in protein, due to a more thorough removal of the starch from the corn and possibly to a saving of gluten formerly lost in the manufacturing process. Between different brands of gluten meal there is a difference in food constituents amounting to several dollars a ton, a difference perhaps equal to that between the various brands of so-called "potato manure" or other fertilizers for special crops. The popularity of gluten meal has led to the name being applied to the by-products from other industries, as distilleries.

Later another class of feeding stuffs known as "gluten feed" was introduced, which was likewise a by-product of the glucose manufacture. It consists of the hulls, germs, and gluten of the corn, mixed and coarsely ground together. These gluten feeds contain more fiber and fat and less protein than the gluten meals. Analyses of a large number have shown them to range all the way from 19.5 to 28 per cent in protein and from 7 to 12.6 per cent in fat, the average of a large number of analyses being 24 per cent of protein and 10.6 per cent of fat. In this class, also, changes in the process of manufacture have had a marked effect upon the composition of the feed. For instance, old-process Buffalo gluten feed contained about 23 per cent of protein and 12 per cent of fat, while that made by the same company under an improved process contains about 27 per cent of protein and only a little over 4 per cent of fat.

In addition to the gluten meals and feeds there are now a large number of materials of similar character on the market sold under the names "glucose meal," "cream gluten," "gluten flour," "grano gluten," "golden gluten" (a dried distillery refuse), "glucose feed," "glucose refuse," "sugar feed," "sugar meal," "maize feed," "corn germ," "corn-germ meal," "starch feed," and even others. With this array of names the confusion has become complete. Only the person familiar with the processes of manufacture can tell to what class the different materials belong, and in some cases the names appear to have been purposely made delusive. As the materials range in protein all the way from less than 10 to nearly 40 per cent, there is a chance for great deception or misunderstanding in buying without a knowledge of the composition. Six samples of Atlas gluten meal (a distillery by-product) were found by the Massachusetts Experiment Station to vary from 22.6 to 37.3 per cent in protein content, a difference of nearly 300 pounds of protein per ton of the meal, or nearly as much protein as is contained in a ton of average wheat bran.

NAMES DELUSIVE.

In 1896 the Massachusetts station analyzed seven samples of cotton-seed meal which were sold at from $1 to $2 less per ton than prime meal, on the ground that they were a little "off color." They were not only quite dark in color, but contained a varying amount of hulls ground with the kernels. "The larger part of them were really not worth much over one-half as much as prime meal."

Within a few years a product known as "cotton-seed feed" has been placed upon the market and has been tested at a number of the agricultural experiment stations. This purports to be a mixture of 5 parts of the hulls with 1 part of cotton-seed meal by weight. It has been found to correspond more nearly to a coarse fodder than to a grain feed; and although it differs in appearance from cotton-seed meal, the purchaser is likely to be misled by the similarity of the name and to think it a richer feeding stuff than it really is.

Under the name of "peanut meal" a material has been sold consisting of ground peanut hulls or shells, and even less valuable as a food than cotton-seed hulls. As peanut meal, which consists of the kernel of the peanuts from which the fat has been partially extracted, is one of the richest feeding stuffs we have, containing over 47 per cent of protein, the use of the name in this case was clearly fraudulent. "Peanut feed," which appeared to be the peanut shells finely ground with a small mixture of inferior nuts, was found at the Massachusetts station to be only 32 per cent digestible, and to contain over 50 per cent of woody fiber.

These facts serve to illustrate that in the case of a new feeding stuff the name is no guide to the character or the probable feeding value of the material.

CONDIMENTAL FEEDING STUFFS.

From time to time various mixed or "condimental" feeds are extensively advertised with extravagant claims as to their effect upon the general health of animals and their general feeding value, or their ability to increase milk production. Tonic or medicinal properties are claimed for many of them. They frequently contain a large quantity of salt, as is shown by the high percentage of ash, and sometimes a harmless quantity of fenugreek or substances of doubtful medicinal value. The average composition of a number of these materials analyzed within the past few years by several of the experiment stations is given, as follows:

Composition of some condimental and mixed feeding stuffs.

Feeding stuffs.	Water.	Ash.	Protein.	Fat.	Fiber.	Nitrogen-free extract.	Remarks.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	
Pratt's Cattle Food	10.77	6.27	14.42	6.92	5.37	56.25	Cost, $6 per 100 lbs.
Weston's Condition Powders	10.80	8.08	15.53	5.46	3.33	56.79	Cost, 50 cents per package (3 pounds).
Climax Food	9.26	18.09	12.74	3.23	5.60	53.08	Cost, $8 per 100 lbs.
Paino's Stock Feed	11.25	10.07	11.25	10.34	10.09	47.00	Cost, $23 per ton.
Nutriotone	7.88	19.78	20.93	6.56	6.08	38.77	Average of 4 samples. Cost, $250 to $500 per ton.
T. B. Milk Producer	9.88	3.50	27.26	6.05	5.06	48.25	Cost, $23 per ton.
Economic Feed VI	10.70	4.75	22.81	5.90	6.90	48.94	Cost, $25 per ton.
Koji Feed	8.00	6.61	19.01	4.22	16.27	45.89	Cost, $16 per ton.
Proteina	8.57	2.35	23.19	7.97	9.68	48.24	Average of 5 samples. Cost, $24 to $25 per ton.
Special Cow Feed	10.68	1.86	13.56	6.10	6.77	61.03	Cost, $24 per ton.
Pratt's Food for Horses and Cattle.	10.80	4.22	16.99	5.83	4.90	57.26	
U. S. Milling Co.'s Special Mill Feed.	8.00	3.03	14.94	6.05	4.27	63.71	Cost, $21 per ton.
Blatchford's Calf Meal	8.10	4.30	25.60	4.50	4.60	52.90	
Cattle Feed	9.24	3.78	12.12	3.62	7.80	63.44	Cost, $17.40 per ton.
Hall's Dairy Ration	9.35	8.50	19.40	10.43	7.90	44.42	Cost, $22 per ton.
Imperial Feed	9.54	4.58	16.89	4.51	6.20	58.28	Average of 2 samples.
Thorley Feed	8.80	11.14	20.34	7.80	4.54	47.38	
Blatchford's Feeding Powder	[1] 10.00	6.12	26.04	6.23	8.64	42.97	
Cleveland Concentrated Meal	10.66	4.40	25.51	6.32	6.83	46.28	Cost, $28 per ton.
Cleveland Standard Dairy Feed.	10.88	5.56	26.47	5.37	8.77	42.95	Cost, $28 per ton.
Excelsior Feed	7.08	4.12	9.06	5.04	13.61	61.09	
Hall's Dairy Feed	7.20	6.10	20.80	9.50	10.20	46.20	

[1] Assumed; analysis in original given on the dry-matter basis.

Not one of the above feeds is equal to new-process linseed meal in percentage of protein. The nutritive value of the majority of them is between that of wheat bran and gluten feed, although several are inferior to wheat bran in composition.

A test of "Nutriotone" at the Vermont Experiment Station failed to substantiate the claims that it would increase the quantity and improve the quality of the milk. Similar results followed a more recent trial at the Maine station. Sir John B. Lawes, of the experiment station at Rothamsted, England, many years ago showed condimental cattle foods to be of no advantage to healthy stock.

Experience has shown the uncertainty of buying the mixed feed, ground feed, chop, etc., put out by large factories. These frequently consist of mixtures of grain of inferior quality with more or less refuse material. The feed from oatmeal factories has been found to contain as high as 60 per cent of hulls. At the best such mixed feed is of uncertain and varying composition.

ADULTERATION OF FEEDING STUFFS.

In this country not much is heard of adulteration of feeding stuffs, and very little has been done in studying their purity at the experiment stations further than determining the composition by analysis. How much of the variation observed is due to adulteration or to deceptive practice in manufacture it is impossible to say. There is little ground, however, for suspecting manufacturers of intentional adulteration of this class of materials.

In Europe, where considerable attention has been paid to studying the purity of feeding stuffs, some remarkable cases of adulteration have been disclosed. The brans have so frequently been found to be adulterated that the German stations are continually cautioning their constituents against buying wheat or rye brans except on a guaranty of composition. In some sections nearly all the bran has been found to be adulterated. Other classes of feeding stuffs have been found to be extensively adulterated, and also to contain injurious weed seeds, as ergot, molds, and other fungi, and to be in bad condition. It is said that in general, adulteration and contamination of commercial feeding stuffs are much more common in Germany than in the case of commercial fertilizers.

CONTROL OF FEEDING STUFFS ABROAD.

To meet the requirements for greater security in buying concentrated feeding stuffs a voluntary control, similar to that of commercial fertilizers, has been arranged for in several of the European countries. Under this control the principal dealers in concentrated feeding stuffs place themselves under the control of the experiment stations, agreeing to guaranty the percentages of protein and fat and to pay an indemnity to purchasers in case the experiment stations find their goods below the guaranty. It has been found more difficult to arrange for this voluntary control of feeding stuffs than was the case with fertilizers. The need of a more comprehensive and binding plan is keenly felt by the experiment stations in Germany.

The fertilizer and feeding stuff act of England, passed in 1893, is for the most part merely a purity law. It does not require the stating of composition, but calls for an invoice giving the name and nature of the article and the material from which it is made, and guarantying that no other substances or seeds have entered into its composition.

LEGISLATION IN THIS COUNTRY.

In this country Prof. Charles A. Goessmann, of Massachusetts, has been one of the prime movers in agitating the matter of the control of feeding stuffs. In numerous publications he has shown the uncertain condition of the trade in concentrated feeding stuffs, and urged that such feeding stuffs be sold on a guaranty of composition and the trade controlled by an inspection.

In 1895 a law was passed in Connecticut to prevent the adulteration or misbranding of "every article used for food or drink by man, horses, or cattle." It provides $2,500 a year for the State experiment station to maintain an inspection. It also provides that the station may adopt or fix standards of purity, quality, or strength when such standards are not specified or fixed by statute. In executing this inspection the station has confined its attention almost entirely to articles used as human food. The amount appropriated for the purpose necessarily limits the field which can be covered.

In the winter of 1897 the State legislature of Massachusetts passed an act authorizing the experiment station to collect and analyze samples of concentrated feeding stuffs sold in the State and publish the results. While the law does not require that the name and composition of concentrated feeding stuffs be placed upon the package, the station has urged that this be done, and a number of the larger jobbers have agreed to adopt the suggestion. It is believed that the advantage from such an arrangement will become so apparent as to make more effective legislation possible.

The same year the State of Maine passed "an act to regulate the sale and analysis of concentrated commercial feeding stuffs." This act defines the term "concentrated feeding stuffs," and requires that the percentages of protein and fat in such feeding stuffs be guaranteed. It provides for an inspection of this class of feeding stuffs by the experiment station and the publication of the results. The expense of the inspection is to be maintained by the tonnage tax of 10 cents. Fines are provided for failure to comply with the terms of the law. The law covers all feeding stuffs except hay and straw, whole seeds and meals of wheat, rye, barley, oats, Indian corn, buckwheat, and broom corn, and brans and middlings.

The laws in Massachusetts and Maine went into effect during the summer and fall of 1897. It is understood that legislation is contemplated in other States. It is generally recognized by intelligent farmers and the leaders in agriculture to be a marked step in advance, and it is believed that, as in the case of the fertilizer control, it will gradually spread to other States

DESIRABILITY OF A FEEDING-STUFF CONTROL.

The intelligent farmer of to-day has got beyond trading "sight unseen" or "buying a cat in a bag" when it comes to fertilizers, and he will not long be satisfied to follow this plan in buying commercial feeding stuffs when he comes to realize the true state of affairs. He has already learned the meaning of protein, fat, and carbohydrates and their uses in feeding, and he will not long be content to submit to an arrangement by which he must pay for these materials on an entirely arbitrary basis without knowing just what he is getting in return. He will insist, sooner or later, that manufacturers must state what they sell and sell what they state.

The desirability, as far as the farmer is concerned, of requiring a guaranty for the richer commercial feeding stuffs and those most subject to variation would seem to be apparent. Such a guaranty naturally implies a control to make it effective. The method of voluntary control practiced in Europe does not seem adapted to this country, and legislation will be necessary in the different States, as in the case of the fertilizer control. Such legislation should require that on every package of concentrated commercial feeding stuff the trade or other name of the material and the name of the manufacturer be stated, together with a guaranty of the approximate percentages of protein and of fat which the material contains. It should provide for the inspection and analysis of these materials, and this control would naturally be placed in the hands of the agricultural experiment stations, which are the authorized representatives of the farmers' interests in scientific matters in their respective States. The necessary expenses of the inspection may be defrayed, as in the case of the fertilizer control, either by direct appropriation for that purpose or by a license fee or tonnage tax. The Maine feeding-stuff law imposes a tonnage tax of 10 cents, while the laws of Massachusetts and Connecticut provide for State appropriations. Whether or not the expenses of the control should be borne by the manufacturers of feeding stuffs is an open question. At all events, the tax or fee on commercial feeding stuffs should not be in excess of the amount required for executing the law.

It is recognized as very desirable that the legislation relative to feeding stuffs in different States should be as similar in requirements as is practicable. If possible, the States in different sections of the country should enact feeding-stuff laws with practically the same general requirements as to the statement to be placed on the package and the terms of the guaranty. The complication which has arisen from the wide difference in requirements of the fertilizer laws of different States is an illustration of the desirability of greater uniformity. Similarity on the general terms of requirement would materially simplify compliance with the law on the part of large dealers who sell in a number of different States, and would make less difficulty on the part of those charged with its administration.

SOME INTERESTING SOIL PROBLEMS.

By Milton Whitney,
Chief of the Division of Soils.

INTRODUCTION.

The vast scope and importance of agriculture in the United States at once lends interest to any investigation which promises to aid in increasing the productiveness of our soils. Owing to the great variety of conditions, however, which may be presented, the solution of any particular problem is usually of somewhat local application; but to the vast number of Eastern agriculturists, dependent on the vagaries of summer rains, there is no problem so important as the maintenance of a proper supply of water in the soil. Unfortunately, the extreme complexity and lack of homogeneity of Eastern soils, together with our peculiar climatic conditions, surround the solution of this problem with great difficulties.

As a rule, soil problems in the extreme West are simpler and easier to study than anywhere else in the country. In the first place, the soils themselves are more uniform in their texture, and the climatic conditions are more stable. Hilgard has called attention to the fact that, under the conditions prevailing where the rainfall is scanty, rocks have disintegrated with comparatively little decomposition, so that the soil grains are still composed of the several minerals of which the original rock was made up. This disintegration in most cases has reached to a considerable depth and results in soils having similar physical properties to great depths. There is seldom a difference between the soil and subsoil, as there is under the more humid climate of the East. The soils generally are silty in character and contain relatively little very fine material having the properties of clay.

The relation of some of these soils to water and to crops is very remarkable. They absorb moisture so readily, lose it through evaporation so slowly, and yet supply the needs of plants so regularly and abundantly, that they can stand long periods of drought, during which the crops continue to grow without any signs of suffering for lack of water. These properties are so marked, that if properly understood they will undoubtedly throw an important light upon the general principles of the relation of soils to moisture. For this reason they are of unusual interest to students of agriculture, and it is hoped that a simple presentation of the subject will arouse an interest in those who have ready access to the soils in question, and encourage a thorough and detailed study of the reasons for the extraordinary properties the soils possess.

The facts are not new. The farmer in these favored sections is as familiar with the fact that certain soils will withstand droughts of six months' duration as our Eastern farmer is that his crops require rain at intervals of a week or ten days. Hilgard has in numerous publications called the attention of the scientific world to the facts. They are so unusual, however, and so unlike the conditions in the Eastern portion of our own country or of Europe, that too much attention can not be drawn to them nor too much thought and study be given to the explanation of the conditions.

The accompanying tables give a summary of the rainfall and relative humidity at a number of places in the West toward which attention should be directed. The records were furnished by the Chief of the Weather Bureau, who states that the summary is made up from data which is very incomplete and in many ways unsatisfactory, so that too much reliance can not be placed upon the records, nor can the conditions at different places be compared with any degree of exactness. They are sufficiently exact, however, to serve the present purpose.

Mean annual and seasonal rainfall.

Locality.	Rainfall. Annual.	Rainfall. May to September.	Rainfall. July and August.	Remarks.
	Ins.	*Inches.*	*Inches.*	
Tulare, Cal	7.0	0.6	Trace.	Conditions in the San Joaquin Valley, Cal., where crops are only grown under irrigation.
Fresno, Cal	9.3	0.7	Trace.	
Mohave, Cal	5.0	0.3	0.1	Conditions on the desert in southern California, where crops are not grown at present.
Chino, Cal	15.7	0.3	0.1	Conditions in southern California, where crops are grown on certain soils without irrigation.
San Bernardino, Cal	16.6	0.9	0.2	
Claremont, Cal	18.0	1.2	0.2	
Pomona, Cal	19.4	0.6	Trace.	
Merced, Cal	10.3	1.0	Trace.	Conditions in California, Washington, and Montana, where wheat is grown on certain soils without irrigation.
Stockton, Cal	13.2	0.9	Trace.	
Wallawalla, Wash	15.4	4.5	0.8	
Bozeman, Mont	18.2	12.2	2.3	
Pullman, Wash	22.8	5.3	1.1	
Miles City, Mont	12.8	6.7	1.3	Conditions in Yellowstone Valley, Montana, where crops are grown under irrigation.
Bismarck, N. Dak	18.5	11.5	4.3	Conditions in North Dakota, where wheat is grown without irrigation.
Fargo, N. Dak	19.5	13.9	5.6	
Jamestown, N. Dak	20.3	11.8	4.2	
Wadsworth, Nev	4.1	1.0	0.3	Conditions in Nevada, where crops are only grown under irrigation.
Tecoma, Nev	5.0	1.7	0.4	
Reno, Nev	5.3	0.4	0.0	
Humboldt House, Nev	5.6	1.2	0.0	
Golconda, Nev	5.9	2.0	0.2	
Elko, Nev	6.3	1.6	0.3	

IRRIGATED LANDS OF THE SAN JOAQUIN VALLEY, CALIFORNIA.

The conditions at Tulare and Fresno, Cal., are typical of a large area under irrigation in the San Joaquin Valley. Around Fresno some of the soils possess in a remarkable degree the property of transporting water for the use of crops. The soil of the locality has become so filled with water through overirrigation that the older and well-established vineyards no longer need irrigation. Vineyards and fruit trees grow most luxuriantly without irrigation and with no rain whatever during the growing season. As a matter of fact, however, while water is not applied directly to the surface of the ground, the canals are allowed to run, in order to supply the new vineyards which are being set out. These canals, as a rule, are somewhat higher than the surrounding fields on account of the sediment which they have brought down, and which has been partially thrown out on the banks. It is generally believed that the maintenance of the water supply in the soil is dependent really on the water running through these canals. The seepage from the canals is undoubtedly very great. It is stated that if the flow should at any time be obstructed in a canal and the water held there, that it would be absorbed by the soil and completely disappear in the course of two or three days, provided the supply also was cut off. It is the impression there that if canals are running on two sides of a section, that is, a mile apart, the soil between them will be sufficiently watered. This has not been exactly determined, but is stated in order to give a general idea of the magnitude of this subject of subirrigation, as it is called. It seems perfectly incredible that the lateral movement of water could be so great in these soils as to supply the need of plants for half a mile on either side of an irrigation ditch. If these soils were packed into cylinders and water applied in the ordinary manner of a drainage experiment, it is certain that the movement would not be so extremely rapid as this would indicate. There is nothing special in the texture of the soil to indicate such an unusual property as it would have to possess in order to secure the magnitude of the lateral movement which the facts indicate. The standing water is not so very near the surface of these lands. One would have to go probably from 12 to 25 feet in digging a well to get a sufficient supply of water. It may be that the seepage from the canals merely maintains this underground supply, and that the soil has the power of drawing water up from that distance to supply the needs of crops. However improbable the facts may appear, nevertheless they exist, and a careful study of the conditions can not fail to throw light upon important properties of soils, of which, at any rate, we do not appreciate the full value.

SOILS REQUIRING NO IRRIGATION NOR RAINFALL DURING THE GROWING SEASON.

At the four stations selected from southern California, namely, Chino, San Bernardino, Claremont, and Pomona, there are certain soils upon which crops are grown without irrigation. There are on an average between 17 and 18 inches annual rainfall at these places, the most of which falls during the winter months. Less than an inch of rain falls on the average during the five months of the growing season, from May to September, inclusive. The Weather Bureau records for the present season show that there has been no rain in Pomona since April. Tobacco set out since the rains stopped and with no irrigation matured a crop aggregating a considerable yield per acre, and then matured a sucker crop, which was cut toward the last of September. These two crops of tobacco were grown with no rainfall during their period of growth, with but little attention to cultivation, and yet were luxuriant and healthy. The soil was still moist just below the surface. No apparent reason for this is revealed by examination of the soil itself, which consists of a light loam inclining to rather a coarse, sandy structure. It is in an artesian district, but the surface wells are 30 or 40 feet deep, showing that there is no standing water near the surface of the ground. At Chino sugar beets are grown without irrigation under the average conditions here reported. At Pomona orchards and vineyards flourish for months without any rainfall whatever, and with no standing water within 20 or 30 feet of the surface of the ground.

WHEAT LANDS.

In the great wheat areas in the northern part of the San Joaquin Valley of California, in the Palouse district around Pullman, Wash., and on the foothills at Wallawalla, Wash., and at Bozeman, Mont., the soils produce fine crops of wheat without irrigation. In Montana and Washington the crop is harvested during September or the very last of August. It is therefore strictly a summer crop, and is produced during the months for which the records are here given. The soils all have, undoubtedly, the power of retaining the winter rains and of giving the moisture up to the crops as it is needed. The rainfall amounts to from 13 to 18 inches, and most of it falls during the winter months. With so little rainfall it is doubtful, and by many it is thought to be wholly improbable, that any of the water leaches downward through the soil and runs off in the country drainage. By far the largest portion at any rate, and probably in most cases all, of the rainfall evaporates from the surface of the ground or is transpired by the growing crop.

In the humid regions of the Eastern States, with 40 inches of annual rainfall, half of this leaches down and runs off in the drainage. This leaves but 18 or 20 inches of rainfall there for the use of crops. This is a familiar fact, and under the conditions it is perfectly possible to make a crop if the rainfall is well distributed. The soils have no such power, however, as they have in the extreme West of retaining moisture, a drought of a few weeks' duration in the East doing more harm to the crop than a drought of the same number of months would do in these Western soils. The soils at Pullman are typical of these fine wheat lands, in that they are very deep and there is no difference between the soil and the subsoil, to a great depth at least. The soil is a fine loam, derived from the disintegration of basaltic rocks. The wells are from 30 to 40 feet deep, occasionally 200 feet. The surface soil dries out during the summer to a considerable depth and dry dust is left on the surface. This dry surface, however, seems to protect the soil from excessive loss of moisture through evaporation and to conserve the moisture for the use of the crop.

The foothills soil of Bozeman, Mont., produces without irrigation a very sure crop of hard wheat. In the valley between the mountains, with but little difference in the elevation and within 1 or 2 miles, the valley soil has to be irrigated several times during the season, and the wheat produced is a soft wheat. Surely there are no more interesting conditions affecting the relation of soils to water and to crops than those present in these two soils at Bozeman, and their investigation should throw much light on this interesting subject.

It is interesting to compare the conditions prevailing over the noted wheat areas of the Red River and Jamestown valleys of North Dakota. At Fargo and Jamestown there is an average of about 20 inches annual rainfall and about 2 inches per month during the crop season, so that the rainfall is very well distributed throughout the year. At Bismarck, with the same rainfall and apparently the same distribution, the conditions are altogether different, and there are soils upon which the crop is always uncertain. There is thus shown to be a great difference in the relation of these wheat soils to water. There are only certain kinds of soils which have that extraordinary power of conserving the moisture for the use of crops possessed by the soils at Pullman, the foothills soil at Bozeman and Wallawalla, and the soils of the northern part of the San Joaquin Valley.

DESERTS.

The Weather Bureau records show that on the Mohave desert the average annual rainfall is about 5 inches. Only three-tenths of an inch falls during the season from May to September. The Weather Bureau records show that no rain fell at Mohave during the present season from the first of May to the middle of September. The soils were examined about the middle of September at least 20 miles from the mountains in the midst of a level plain. It was expected that it would be necessary to go to a considerable depth in order to find moist soil.

The surface of the desert is covered with a rather coarse sand, somewhat compact below the surface of the ground. This compact sand is frequently exposed as the loose surface sand is blown off. Contrary to expectation the soil at a depth of from 12 to 18 inches below the surface was still quite moist, in spite of the fact that no rain had fallen for at least five and a half months. The surface wells vary in depth from 6 to 30 feet, occasionally being 200 feet deep. On certain parts of the desert it is the common practice to dig holes 6 or 10 feet deep and allow them to fill up with water for the use of the stock. The distance to water varies according to the nature of the soil, just as it does in the humid portions of the country. The soils in which the water is close to the surface are, as a rule, impregnated with alkali. There is an artesian belt under a portion of the desert. The amount of moisture found in this land was probably not sufficient to support a crop of any of our commercial plants, and what moisture there was, was alkaline, but the fact of there being any moisture at all, with no rain for such a long time, is a matter of the greatest surprise, and is a subject worthy of very careful investigation.

Investigation showed the same conditions to exist on the Nevada and Utah deserts between Reno and Ogden. The annual rainfall is between 5 and 6 inches, the seasonal rainfall about 1 or 2 inches on the average. During the present season there has been no rainfall since the first of May at Tecoma, where a careful examination was made, except a single shower two or three days before the examination. This was not sufficient to have penetrated to any great extent. The soil here is quite alkaline, and is covered with an alkali crust in many places. The alkali consists mainly of common salt, although there are in places considerable quantities of sodium carbonate (black alkali) and some sodium sulphate. In a cellar 5 feet deep the soil on the sides and bottom was quite moist, and the owner of the place stated that it was never dry. Borings made to a depth of several feet in this soil showed that the moist soil extended down to a considerable depth, probably down to water level. There was a well at this place about 30 feet deep. It is stated that water can be found on these deserts about 30 feet below the surface, although the water may be so strongly impregnated with salts that it is unfit for use. The average depth of farm wells throughout the whole of the United States would probably be not far from 30 feet. How is it that these desert soils, 500 miles away from any considerable rainfall area, approach the normal conditions in this respect? In the second place, how is it that with standing water at about the same depth below the surface, and with hardly a tenth of the annual rainfall, these soils are still moist within a comparatively few inches of the surface after five or six months of dry weather?

If the amount of water in these desert lands was supplemented by an amount which would make the quantity equal to that contained in the wheat-producing soils already referred to, and if this water was added at one time during the winter season, could crops be profitably grown upon the soils without subsequent irrigation? These and various similar questions force themselves upon the mind in contemplating the conditions which prevail in these districts. There are here opportunities to study the relation of soils to moisture and crop production which are not offered in any other section of the United States. An investigation of these conditions will undoubtedly throw light upon many problems upon which the development of agricultural methods will depend, and these problems can be studied best under the peculiar conditions of soil and climate prevailing in the West.

THE LOW RELATIVE HUMIDITY.

A fact which makes more remarkable this extraordinary power of the soils to absorb and retain a sufficient quantity of water for the needs of crops for five or six months after the rain ceases is the very low relative humidity of the atmosphere. Records of the relative humidity have been taken from only a few of the places under consideration, and these are given in the following table:

Mean annual and seasonal relative humidity.

Locality.	Annual.	May to September.	July and August.
	Per cent.	*Per cent.*	*Per cent.*
Tulare, Cal	58	42	35
Wallawalla, Wash	62	47	39
Miles City, Mont	65	52	46
Bismarck, N. Dak	72	67	65
Humboldt, Nev	48	36	31

The mean relative humidity of New England for July and August, 1897, determined from the reports of seven Weather Bureau stations, was 85 per cent. At Wallawalla the mean relative humidity from May to September was only 47 per cent, and for July and August 39 per cent. It is hardly conceivable that under these extremely dry conditions the foothills soil could maintain sufficient water from the winter rains to supply the loss due to evaporation from the surface of the soil and to transpiration by the plant for months after the rain had ceased to fall. At Tulare the mean relative humidity during the growing season is 42 per cent, and 35 per cent during the months of July and August—conditions which practically prevail at Fresno. Nevertheless, at Fresno, with nearly the same rainfall and where crops must transpire great quantities of moisture into the dry atmosphere, the soil maintains an adequate supply of moisture for the plants, provided the water continues to run in the canals, although these may be as much as a mile apart.

At Visalia the mountain streams run out and disappear. They are absorbed in the light, loamy soil. The area upon which these conditions exist is said to be about 24 miles square. Vineyards and orchards grow on this soil in the most satisfactory way without irrigation, although there is no rainfall during the growing season. It is a natural oasis in the midst of the dry plains, and is characterized by a fine growth of native trees.

At Humboldt, on the Nevada desert, the relative humidity from May to September is about 36 per cent, and in July and August 31 per cent. The conditions over the Mohave desert are probably not dissimilar from those at Humboldt and Tulare. How is it possible, under the conditions of extremely low rainfall and this low relative humidity, for the soil to retain moisture within 12 or 18 inches of the surface for months after the rains are over?

LINES OF INVESTIGATION.

It must be possible to determine the cause of the great power these soils have of retaining moisture and of supplying it rapidly and regularly to the crops as it is needed. If such power can be imparted to other soils of a droughty character, especially to our soils in the East, it will be of immense value to the farmer. It is clearly apparent from a careful consideration of the conditions presented here, that we know very little of the possibility of the water-holding power of soils and the control of soil moisture. An investigation of these conditions in the section under consideration will throw light upon the problem which can not so readily be secured under any other conditions. There are many young men in the West developing the work of the experiment stations who are already interested in the general subject of soil investigations and earnestly desirous of seeing certain lines of work and of investigation determined for them to follow out. To them, therefore, the study and investigation of the above problem is earnestly commended. Others can investigate the effect of the methods of cultivation, the effect of fertilizers, and the effect of the rotation of crops, but no one has such a good opportunity to study the relation of soils to water and the conservation and movement of water in the soil as those located in the arid regions of the West.

The first question to solve is the distribution of the rainfall. It is important to determine the depth to standing water, that is, the average depth of wells. Then it is very important to know whether any portion of the rainfall passes down into this stratum and runs off into the drainage. The electrical method of moisture determination is admirably adapted to the study of this problem. Electrodes should be buried in the soil at intervals to a depth of from 15 to 20 feet, the interval between the electrodes varying from a few inches immediately below the surface to 4 or 5 feet at the greater depths. The resistance at the deeper electrodes should be determined about once a week. The movement of water, if it takes place at all, will probably be very slow at that depth, but any change will certainly be revealed by corresponding changes in the electrical resistance of the soil. If the electrodes are well placed in the soil at intervals of a few inches in the upper layers and of a few feet in the lower strata, the distribution of the rainfall in the soil may be very carefully studied throughout the year. It would be well worth while to install a very complete system of electrodes; for with the periodic rains there is no doubt a great wave of water going down into the soil, reaching its maximum and minimum at certain depths at different times of the year. The form and the magnitude of this wave is very important.

If the annual rainfall does not descend low enough to form any connection with the underground water drainage, is it possible that 12 to 18 inches of rainfall, occurring during the winter months, is sufficient to maintain crops for five or six months of dry weather with a low relative humidity and often high temperature of the atmosphere, without any additional water supply from any source? In other words, does the crop live on the rainfall which is stored and maintained for its use, or is it dependent partly upon seepage waters which move in from the surrounding country?

Is it possible that in the arid conditions existing over the desert areas there is a slow and continuous movement of water upward from artesian or other sources below the influence of the local climate? The accumulation of alkali on the surface of many of these desert lands seems to point to the gradual but infinitely slow movement of water upward from the lower depths of the earth. Does such a movement really exist, and is it of sufficient magnitude to be taken account of in the practical cultivation of the lands?

The problem presented by these soils as at present understood may perhaps be illustrated by a hypothetical experiment: If a large galvanized iron tank 15 feet deep and 15 feet square were filled with the soil of the Palouse region in its natural condition in the field, and an amount of water equal to 18 inches of rainfall were added to this soil after a crop had been removed or during the winter months, would crops suitable to that climate, including small grain and fruit trees planted after the watering had been done, grow to maturity during the summer months in spite of prevailing high temperature and low relative humidity, without any additional water being added throughout their growing season? Would 18 inches of rainfall be sufficient for this? or 16? or 14? or 12? or 10? In fact, we come finally to this question: What is the minimum requirement of these soils to enable them to support a field crop?

The conditions are so uniform that it would be easy to figure quite closely on this. It is already recognized in practice that some soils, especially those in the more southern districts, retain enough of the winter rains for a crop like wheat, which matures early in the summer, but do not maintain quite enough to mature a crop of corn, which extends on into the late summer and fall in an active growing condition. It was even stated this summer that the crop suffered in certain localities in southern California in August and September, owing to a shortage of half an inch in the April rainfall.

It is not all soils by any means, even in the same district, that show this remarkable power of conserving moisture, and the different soils possess it in different degrees. It does not seem to be a matter of texture, as there is no marked difference between the foothills soil, which will retain the moisture, and the valley soil, which needs irrigation.

It is not sufficient that a soil should be very retentive of moisture and hold a large portion of the rainfall. It must conserve this moisture, there must be little evaporation from the surface, but at the same time it must move readily and rapidly up to the roots of plants to supply their needs. These requirements must be great under the almost tropical arid conditions of the summer climate of those localities. It is, therefore, not only the water capacity of the soil, but also the ability of the soil to supply this water to the crop as needed, which determine its agricultural value.

The following table gives the annual and seasonal rainfall at a large number of stations of the Weather Bureau adjacent to the localities which have been discussed. These are arranged in order of the rainfall during the season from May to September. It is interesting to study this material, together with the practice of agriculture at the different places.

Mean annual and seasonal rainfall.

Locality.	Annual.	May to September.	July and August.
	Inches.	*Inches.*	*Inches.*
Mohave, Cal	5.0	0.3	0.1
Chino, Cal	15.7	0.3	0.1
Reno, Nev	5.3	0.4	0.0
Yuma, Ariz	2.8	0.5	0.4
Tulare, Cal	7.0	0.6	Trace.
Pomona, Cal	19.4	0.6	Trace.
Fresno, Cal	9.3	0.7	Trace.
Los Angeles, Cal	17.2	0.7	0.1
Stockton, Cal	13.2	0.9	Trace.
San Bernardino, Cal	16.6	0.9	0.2
Wadsworth, Nev	4.1	1.0	0.3
Merced, Cal	10.3	1.0	Trace.
Humboldt, Nev	5.6	1.2	0.0
Claremont, Cal	18.0	1.2	0.2
Elko, Nev	6.3	1.6	0.3
Tecoma, Nev	5.0	1.7	0.4
Carson City, Nev	12.1	1.7	0.4
Golconda, Nev	5.9	2.0	0.2
Winnemucca, Nev	8.5	2.0	0.2
Ellensburg, Wash	9.0	2.0	0.3
Phœnix, Ariz	7.1	2.8	2.0
Ogden, Utah	14.0	3.4	0.6
Spokane, Wash	18.6	3.7	0.7

Mean annual and seasonal rainfall—Continued.

Locality.	Annual.	May to September.	July and August.
	Inches.	*Inches.*	*Inches.*
Grand Junction, Colo	9.0	4.0	2.2
Wallawalla, Wash	15.4	4.5	0.8
Colfax, Wash	23.0	5.1	0.9
Fort Lapwai, Idaho	17.2	5.1	1.0
Fort Spokane, Wash	11.8	5.2	1.1
Pullman, Wash	22.8	5.3	1.1
El Paso, Tex	8.9	5.9	3.5
Salt Lake City, Utah	18.7	6.3	2.2
Boulder, Mont	9.6	6.6	1.7
Miles City, Mont	12.8	6.7	1.3
Fort Missoula, Mont	16.1	6.7	1.7
Helena, Mont	13.2	6.8	1.7
Greeley, Colo	11.4	6.9	2.9
Medora, N. Dak	11.9	7.0	1.8
Fort Custer, Mont	13.2	7.8	2.0
Fort Keogh, Mont	12.6	8.0	2.1
Denver, Colo	14.3	8.0	3.1
Pueblo, Colo	12.0	8.5	4.3
Fort Collins, Colo	14.0	8.6	3.1
Santa Fe, N. Mex	14.6	9.0	5.4
Glendive, Mont	15.8	9.5	2.1
Bozeman, Mont	18.2	11.2	2.3
Bismarck, N. Dak	18.5	11.5	4.3
Jamestown, N. Dak	20.3	11.8	4.2
Fargo, N. Dak	19.5	13.9	5.6

THE TEXTURE OF THE SOILS.

A large number of soil samples were collected from North Dakota, Montana, Washington, California, and Nevada during the season of 1897. A description of some of the most interesting of them is given, as follows:

3279. Two miles west of Mapleton, Cass County, N. Dak. Typical Red River Valley wheat land. Sample collected between depths of 15 and 36 inches.

3264. Four miles north of Jamestown, Stutsman County, N. Dak. Prairie. Wheat land of Jamestown Valley. Depth, 9 to 24 inches.

3291. Bismarck, Burleigh County, N. Dak. Sandy prairie. Depth, 15 to 40 inches. Wheat fails on this soil three out of five years.

3285. Steele, Kidder County, N. Dak. Prairie. Depth, 20 to 30 inches. Wheat fails three out of five years.

3322. Eleven miles west of Billings, Yellowstone County, Mont. From prairie above the ditch. Depth, 12 to 24 inches. Wheat can not be produced on this soil without irrigation.

3331. Two miles east of Pullman, Whitman County, Wash. Typical Palouse country wheat land. Depth, 0 to 36 inches. Produces large and very sure crops.

3348. Wallawalla, Wallawalla County, Wash. Valley land. Depth, 0 to 12 inches. This soil is extensively irrigated and cultivated in truck and fruit. Wheat is very uncertain on this soil without irrigation.

3352. Seven miles east of Wallawalla, Wallawalla County, Wash. Typical foothills soil, upon which large and sure crops of wheat are produced without irrigation. Depth, 0 to 12 inches.

3394. Six miles north of Fresno, Fresno County, Cal. Sandy loam. Depth, 0 to 36 inches. This soil requires no irrigation except that the water runs through the ditches throughout the season to supply lands lying beyond.

3416. Visalia, Tulare County, Cal. Depth, 0 to 12 inches. Very fine fruit land, and requires no irrigation.

3378. Tulare, Tulare County, Cal. Alkali land. Depth, 1 to 24 inches. This land requires irrigation for all crops.

3432. Three miles southeast of Pomona, Los Angeles County, Cal. Sandy land. Depth, 2 to 36 inches. Second crop of tobacco being harvested from this land since last rain; soil still moist below the surface, and tobacco is quite vigorous. Crops need no irrigation.

3388. Lancaster, Los Angeles County, Cal. Barren land of the Mohave desert. Depth, 3 to 36 inches. No crops grown without irrigation.

3419. Tecoma, Elko County, Nev. Black alkali land. Depth, 12 to 24 inches. From the Nevada desert. No crops grown without irrigation.

The following table shows the results of the mechanical analyses of the above samples:

Mechanical analyses of soils.

No.	Locality.	Description.	Moisture in air-dry sample.	Organic matter.	Gravel (2-1 mm.).	Coarse sand (1-.5 mm.).	Medium sand (.5-.25 mm.).	Fine sand (.25-.1 mm.).	Very fine sand (.1-.05 mm.).	Silt (.05-.01 mm.).	Fine silt (.01-.005 mm.).	Clay (.005-.0001 mm.).
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
3279	Mapleton, N. Dak.	Red River Valley.	7.84	7.72	0.03	0.07	0.18	0.94	11.51	25.94	6.06	38.00
3264	Jamestown, N. Dak.	Prairie	4.48	4.33	0.86	2.10	6.37	16.69	21.70	14.57	2.75	25.55
3291	Bismarck, N. Dak.	Sandy prairie	2.54	6.02	1.74	6.61	10.67	4.23	28.91	21.17	1.79	16.48
3285	Steele, N. Dak.	Prairie	4.46	5.18	0.00	0.09	0.42	1.87	41.18	22.97	3.58	19.57
3322	Billings, Mont.	do	2.98	4.40	0.00	0.00	0.16	7.96	28.79	34.45	4.67	17.25
3331	Pullman, Wash.	Palouse district—basalt.	5.51	5.08	0.03	0.16	0.16	0.85	27.94	35.80	5.77	18.57
3348	Wallawalla, Wash.	Valley land	4.12	3.08	0.00	0.15	0.41	3.22	35.24	37.73	3.54	12.63
3352	Wallawalla, Wash.	Foothills soil	3.95	5.66	0.00	0.06	0.08	1.05	25.12	42.12	4.24	17.50
3394	Fresno, Cal	Sandy loam	1.61	2.52	0.43	3.40	16.14	30.95	15.90	12.72	1.58	14.60
3416	Visalia, Cal	Loam	2.85	5.85	0.03	0.18	0.61	5.41	34.28	34.28	3.50	14.20
3378	Tulare, Cal	Alkali land	2.72	4.44	0.64	2.57	6.22	12.46	22.79	21.36	6.51	21.05
3432	Pomona, Cal.	Sandy land	1.00	1.94	6.03	10.11	17.26	21.92	20.98	13.13	1.93	5.33
3388	Lancaster, Cal.	Mohave desert	1.77	3.81	0.34	0.89	1.67	7.86	35.12	28.43	3.45	18.63
3419	Tecoma, Nev.	Nevada desert.	3.17	6.43	0.07	0.13	0.37	5.24	44.96	17.94	5.00	17.93
	Average		3.50	4.75	0.73	1.89	4.33	8.62	28.17	25.90	3.88	18.37

ADDITIONAL NOTES ON SEED TESTING.[1]

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INTRODUCTION.

The interest in seed testing appears to be greater at the present time than ever before in the history of American agriculture. This is due, no doubt, largely to the special investigations along this line which have been made by the Department of Agriculture in the last four years. For some time previous to the inauguration of this work by the Department, various State experiment stations devoted more or less time to making vitality tests of vegetable seeds, paying little attention, however, to the scientific side of the subject. Early during the present year the committee appointed by the Association of American Agricultural Colleges and Experiment Stations devised rules and adopted a standard apparatus for testing agricultural seeds. Since that time a number of the stations have entered upon the work systematically in response to an increasing demand among their patrons for more definite knowledge concerning the purity and vitality of the seeds which they desired to plant.

The fundamental principles and methods of testing seeds have been given at some length in former papers, together with figures and descriptions of the apparatus in ordinary use. This paper will deal mainly with special apparatus, methods, and expedients which have been suggested in the course of regular work in this division. First, however, attention is called to the important feature of field tests, which is generally slighted by seed control stations.

FIELD TESTS.

Probably since the earliest development of the seed trade in America, and certainly for more than a hundred years, dealers in vegetable seeds have made preliminary tests of their stocks to ascertain the vitality. These tests have usually been accompanied by experiments in small fields or gardens, called "trial grounds," to determine the genuineness of the variety, it being well known that there is a great tendency in different strains of cultivated plants to depart from a desired type owing to the frequent variation in soil, climate, and

[1] The previous papers have been "Pure seed investigation," Gilbert H. Hicks, Yearbook Department of Agriculture for 1894, pp. 389–408, and "Testing seeds at home," by A. J. Pieters. Yearbook Department of Agriculture for 1895, pp. 175–184.

seasons. Usually the more highly bred the variety, the greater is this liability to vary. Hence, in these field tests careful selection is made, in order to maintain the characteristics of the type. Inferior plants, termed "rogues," are weeded out, while plants which show peculiar characters of a desirable nature, either with respect to earliness, vigor, or yield, are marked and their seed carefully saved to be used in the production of new types or "varieties," as they are loosely called. Unfortunately, there is but little uniformity among seedsmen and growers in their ideas of the limits of different types, so that a Golden Wax Bean, for example, offered by one seedsman, while possessing the general features of the variety sold under that name by other members of the trade, may depart widely from the original form in certain particulars, until we may have almost as many kinds of Golden Wax Bean as there are growers of this variety. On the other hand, it is too often the case that the only difference in the variety offered for sale consists in the name, and Smith's Golden Wax Bean upon being tested in the field proves to be identical with the "variety" catalogued as Jones's Golden Wax Bean.

Were it not for the careful selection practiced by seedsmen in their trial grounds and the close attention which many of them pay to the seed crops which are grown for them in different parts of the country, all semblance to uniformity in type would soon depart from our standard vegetables, and the result would be great deterioration in quality and productiveness. Owing to the special training and experience of the seedsman in this matter and the superior facilities which he usually has for obtaining stock which possesses certain desired characters, the ordinary farmers and gardeners will probably find it better, as a rule, to purchase their vegetable seed from a reliable dealer, one who grows his own seed and tests it from year to year in his trial grounds. For many reasons such a seedsman has a decided advantage over the ordinary planter in the ability to furnish reliable seed of any desired strain.

The inherent tendency of all plants to vary, added to the influence of different conditions of growth, especially when the soil and climate are widely different from those where the seed was grown, make it almost imperative for the gardener to test his seed in a trial ground of his own, where the conditions are the same as in the fields where his crops are likely to be grown for sale. Many "truckers" grow their own seed after having secured a strain which is peculiarly adapted to their own land and market. This custom, however, does not seem practicable for the great majority of seed buyers who grow vegetables for their own tables. Hence, the advisability, in such cases, of purchasing seed from dealers who either grow their own stock or test all of it under practical field conditions. Seedsmen whose wares are derived mainly from foreign sources or from American-grown plants which have not been inspected by themselves or their agents, labor under a decided disadvantage in comparison with those who grow their own seeds principally.

In view of these facts we would strongly recommend to every farmer and gardener who desires to plant only the best varieties of seed that, in addition to obtaining what knowledge he can from his seedsman and experiment station concerning his seeds, he set apart a small corner in his garden or field for experimental purposes, and there carefully test each variety. Such a trial ground would furnish him and his family a great deal of information which could be obtained in no other way. In this small patch of ground some of the "novelties" advertised by seedsmen could be tested with special reference to one's own climate and soil. Owing to the natural conservatism of the farmer, there is a tendency in many communities to grow the same varieties and strains of vegetables that have been grown in that locality for years. Introductions of new and valuable things occur largely by chance, if at all; whereas, were each farmer to conduct a small trial ground as here recommended, there would soon be in many cases a marked improvement in the varieties and strains of cereals and vegetables planted in his locality. Careful observations, including measurements, should be frequently made on the plants growing in this trial ground, and these should be noted. This work might be done in many cases by the farmer's wife or older children. We venture to predict that a departure from the routine methods of farm work like this would often result in solving the problem how to keep the boys on the farm. At the same time it would increase the efficiency of the farmer's work, and frequently secure an addition to his income.

APPARATUS FOR SEED TESTING.

Since seed testing was inaugurated by the Department it has been found that in some cases special apparatus or methods are desirable to expedite the test while not sacrificing anything of its accuracy. A few suggestions along these lines may be of interest, especially to seedsmen and experiment station workers.

Germinating chamber.—The standard germinating chamber adopted by the Association of Agricultural Colleges and Experiment Stations cooperating with the Department of Agriculture has already been figured and described.[1] After a thorough trial this germinator has been found entirely satisfactory for seed testing. Brass shelves have been substituted for the original ones made of galvanized iron, since the latter are apt to rust sooner or later. This improvement brings the cost of the germinating chamber up to $79.50. A germinator costing $62.50, with fewer openings, but similar in every other respect, except that the door is of copper, lined with asbestus and mineral wool, and

[1] "Rules and apparatus for seed testing," Circular No. 34, Office of Experiment Stations, pp. 5-7.

without panels or glass, has been designed by us for seed testing alone. In this chamber the seeds are constantly in the dark, which is one of the normal conditions of germination. Some experimenters, indeed, claim that certain grass seeds germinate best in the light, but it is believed that equally good results can be obtained by alternating the temperature.

Blotting paper.—Damp blotting paper has proved the most efficient substratum for germination tests, as a general rule, but it does not answer very well for some very fine, slow-germinating seeds like tobacco and June grass, owing to the fact that the blotters adhere too closely in such cases to permit the proper circulation of air. This difficulty may be largely obviated by placing narrow strips of glass between the folds.

Plaster of paris germinating dishes.—Porous clay dishes of various design and depth have been recommended to secure proper moisture conditions in seed testing. In some of the European seed control stations the germinating dishes of this description, invented by Dr. F. Nobbe (see Yearbook Department of Agriculture, 1894, p. 404), are used. In our laboratory, however, Nobbe's dishes have given lower results than any other form of apparatus tried. The ordinary porous saucers sold by florists have been found inadequate on account of their variable porosity. Probably this difficulty would be lessened if they were dried in the sun instead of in kilns. Experiments are now being conducted by the division with small porous dishes made of plaster of paris (fig. 14), which appear to possess the right degree of porosity, and, what is of still greater importance, the variation in porosity between any two saucers made of this material is exceedingly slight, if any. To make these dishes, the plaster of paris should be thoroughly mixed with water until it is about the consistency of cream. It is then poured into a mold (fig. 15), which consists of a bottom of hard wood with grooves near the edges to admit the sides, which are detachable. When in place, these sides are held firmly by hooks and staples. The top consists of a pane of glass the same size as the bottom. Attached to its center by Nonpareil glue is a small, round, shallow, flat-bottom glass dish—for example, a Petri dish, which projects into the soft plaster of paris to the required depth. These molds can be made by anyone, and of any desired size. These plaster of paris saucers when in use are set in water in a pan in the germinating chamber to about one-third of their depth and the seeds sown in the bottom without any covering.

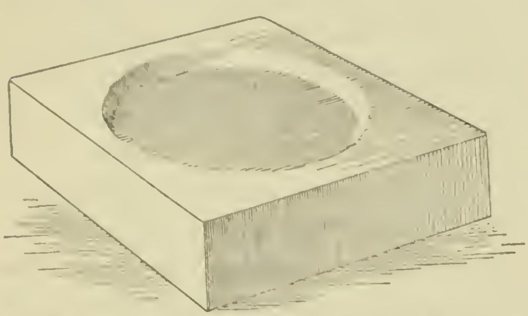

FIG. 14.—Plaster of paris germinating dish.

Mirror box for grass-seed tests.—In making purity tests of the seeds of many grasses it is difficult to discriminate by ordinary methods between sound seed and empty glumes. This difficulty is obviated in some foreign seed control stations by means of the so-called "Spiegelkasten," or mirror box. A modified form of this box (fig. 16) has given better satisfaction than the original design, and can be easily made and with little expense. It consists of a box of hard wood, half an inch thick. It is 12 inches long, 8 inches wide, and 6½ inches high, the front being open, and the top consisting of a pane of ordinary glass.

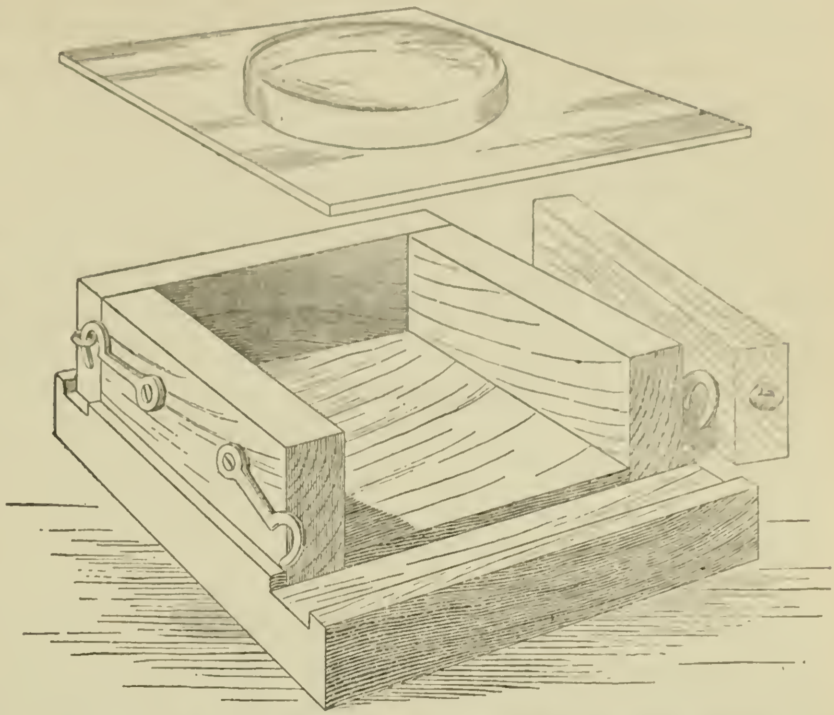

Fig. 15.—Mold for making plaster of paris germinating dishes.

The inside of the box is painted a dead black. Attached by hinges to the upper margin of the box in front is a rectangular piece of black binders' board, 12 by 8 inches in size. A smaller piece of similar board, 8 inches square, is attached to each end of the box at its upper edge. These boards are for the purpose of excluding all extraneous light. In the center of the box is a mirror about 10 by 7½ inches in size, so pivoted that it can be turned at different angles and

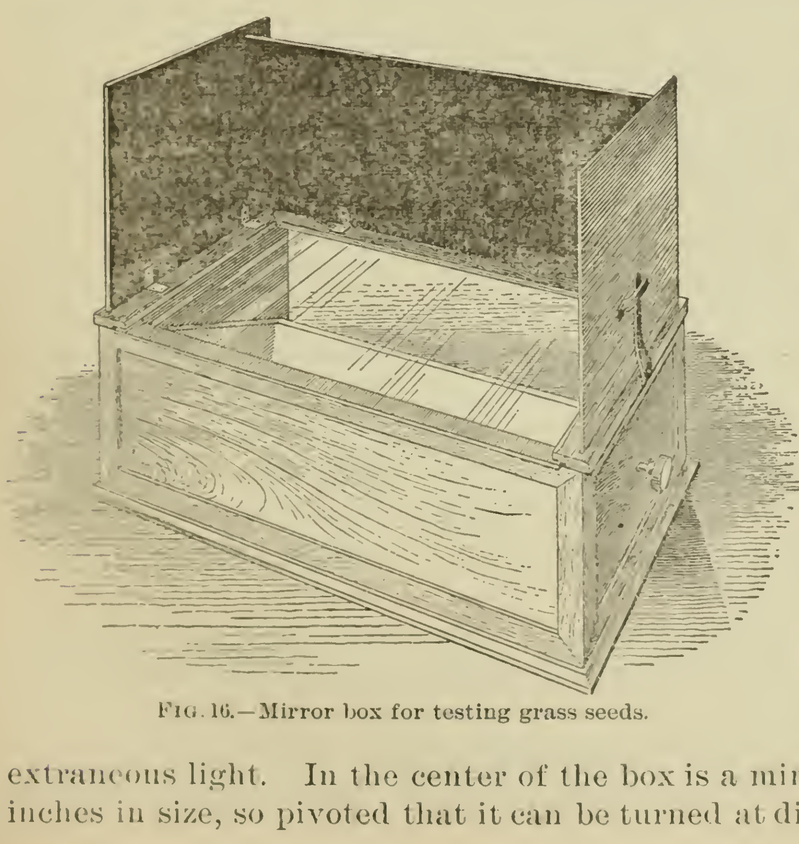

Fig. 16.—Mirror box for testing grass seeds.

reflect the light which enters the open side of the box up through the glass top.

Grass "seeds" are spread thinly over the surface of the glass top, and the mirror adjusted so as to throw the light up through the seed. The operator faces the apparatus with the open side opposite to him and toward the light. The mirror should be so arranged that it will not throw any light into the operator's face. With this apparatus the outlines of grass seeds within the glumes can be clearly seen, and the chaff can be removed with the other impurities of the sample.

A much simpler method of identifying the sound seeds in grasses consists in the use of a pane of glass, over the surface of which the seed, thoroughly wet, has been thinly spread. This glass is held up to the light, and with the forceps the good seed may be easily picked out. It would be well for the purchaser of grass seed, especially of meadow foxtail, awnless brome, and velvet grass, to make use of this simple test. For laboratory purposes the mirror box is to be greatly preferred, since the seed can be handled much better when dry.

High temperature.—To secure the temperature of 30° C., for six out of each twenty-four hours, as recommended for the seeds of many grasses, celery, parsley, parsnip, pepper, and some cucurbits, very good results may be obtained by the use of an ordinary drying oven provided with an asbestus bottom and shelves of galvanized iron or copper wire.

METHODS ADOPTED FOR DIFFERENT SEEDS.

Asparagus.—The endosperm, or food material, of the asparagus seed, is horny, and absorbs water with difficulty. Under ordinary methods this seed germinates irregularly, and in order to obtain the full germinative value, the test must be continued much longer than is desirable. In the meantime various molds develop upon some of the seeds, causing their decay. Soaking this seed in water kept at 30° C. for twenty-four hours materially hastens its germination, while a much larger percentage of seeds sprout. At the end of twenty-four hours seeds thus soaked are somewhat swollen and they begin to sprout in two days, while unsoaked asparagus seeds do not begin to germinate until the sixth or seventh day. Even with this treatment the germination of asparagus seed is somewhat irregular, though not nearly so much so as when soaking is not resorted to. Clipping this seed with a sharp knife sometimes hastens its germination, but care must be taken not to cut the germ. To avoid this, clip the concave side at the scar or hilum.

Beans.—As a rule, no difficulty is experienced in sprouting the seed of beans. In the case of Lazy Wife Pole, Improved Golden Wax, and Henderson's Bush Lima, we have sometimes found it necessary to clip the seed at one end, simply cutting through the outermost coat. In several instances, without such treatment, seeds of these varieties remained in the germinating chamber for forty-eight days, a very small percentage only having germinated, most of the ungerminated being hard and sound. More than 90 per cent of the same varieties, when clipped, germinated in four days. Beans should not be soaked in water before the germination test.

Beet.—This seed germinates well under ordinary methods, but care must be taken in counting out the sprouts to remove the entire seed, germ and all, otherwise the sprout will start out again and may easily be mistaken for an original one.

Cabbage.—Narrow strips of blotting paper should be placed along the edges between the folds, to prevent the seeds from rolling out. Similar methods should be adopted in the case of all spherical seeds.

Celery.—Great difficulty is frequently experienced in getting good results with this seed in a germinating chamber, and upon the whole it is better to rely upon greenhouse tests. Seed has been kept in the chamber for a number of days without sprouting, and then transferred to sand in greenhouse flats with excellent results, over 70 per cent of the seed germinating after this transfer was made. In one case where the test had been continued in the chamber for forty-nine days without sprouting, 85.2 per cent germinated after having been planted in the soil. This result seems to be invariable. Thus far, our experiments indicate that the most successful germination of celery seed requires either an alternating temperature (30° C. first six and 20° C. the remainder of the twenty-four hours) or the presence of light and a free circulation of air under a constant temperature, as the following table will show:

Germination of celery seed.

Manner of test.	Number of tests.	Day of observation.												Per cent.	Average per cent.
		1	2	4	5	6	7	8	9	11	12	13	14		
Number of seeds sprouted in dark, between blotters, alternating temperature[1]	1	0	0	0	0	14	21	21	28	25	4	4	10	63.5	64.75
	2	0	0	0	0	20	25	25	21	26	7	3	5	66.0	
Number of seeds sprouted in dark, between blotters, constant temperature (20° C.)[1]	1	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
	2	0	0	0	0	0	0	0	0	0	0	0	0	0.0	
Number of seeds sprouted on sand, constant temperature (20° C.), in light[1]	1	0	0	0	0	46	39	20	12	11	2	3	3	68.0	67.75
	2	0	0	0	0	31	34	27	20	20	1	1	1	67.5	
Number of seeds sprouted on surface of blotters, constant temperature (20° C.), in light[1]	1	0	0	0	0	13	24	31	26	23	7	4	4	66.0	71.75
	2	0	0	0	0	24	43	34	20	22	3	1	8	77.5	
Number of seeds sprouted in sand, in flats in greenhouse	1	First sprouts on seventh day												70.0	71.5
	2	First sprouts on seventh day												73.0	

[1] In germinating chamber.

NOTE.—The third and tenth days being Sundays, no observations were made, the number of seeds sprouted on the tenth day being included in the count of the eleventh day. Two hundred seeds were used in each test. Glass strips were placed between the blotters.

It should be observed that between blotters at a normal temperature not a single seed had sprouted at the end of fourteen days.

Corn.—This seed does well in blotters, but usually germinates about a day earlier in canton-flannel folds. The same is true to a certain extent of other seeds of similar size, such as beans, peas, cowpeas, etc. Wrinkled kernels, as those of sugar corn, require a longer time and more moisture for sprouting than smooth kernels. The same holds good of wrinkled varieties of peas.

Lettuce.—Soak the seeds in water at about 23° C. for five hours, then transfer them to blotters, which should be kept very wet for the first forty-eight hours. With this method at least 80 per cent of the seed should germinate within two days. Soaking lettuce seed in hot water even for a short time, or in cold water for ten or twelve hours, seems to injure the seed. Some lettuce seeds germinate readily without this treatment; but it has been found that no reliance can be placed upon germinating tests of lettuce seed unless previously soaked as directed.

Okra.—This seed has a very hard coat, and with ordinary methods germinates very slowly. It may be soaked in water at 50° C. for five hours, but a better percentage of germination is secured by clipping the seed on the end opposite the scar. A method better adapted for the ordinary gardener consists in soaking okra seed in water at a temperature of about 22° C. for twenty-four hours before planting.

Onion.—Good onion seed should germinate well without special treatment; but molds seem to develop more quickly upon this than upon any other kind of vegetable seed. Hence, it is desirable to hasten germination, if possible. The latter may be accomplished without injuring the seed by soaking it for an hour in a solution consisting of one part bichloride of mercury to one thousand parts of water. Onion seed germinates best at a temperature of about 18° C. and with a moderate amount of moisture.

Parsley.—Like celery, parsley germinates better in sand than between blotters. In the chamber tests of this seed much time is required. The seed begins to germinate about the seventh day, and may continue to sprout up to the twenty-eighth day or even longer. Molds do not seem to hinder the germination of parsley seed. In counting these seeds, which are really fruits, care should be taken to avoid error, since the fruits are borne upon the plant in pairs and frequently remain attached after the seed is thrashed.

Parsnip.—Requires the same treatment as parsley.

Salsify.—Germinates better between folds of canton flannel or asbestus in the Geneva pan than between blotters.

Watermelon.—Much difficulty has been experienced in testing this seed, which usually does not germinate well in the chamber at the ordinary temperature of 20° C. No method thus far tried has proved entirely successful, but alternation of temperature has given the most satisfactory results.

Tobacco.—Tobacco seed does not sprout well, as a general thing, between blotters. Very good results can be obtained by spreading it on the bottom of porous saucers made of plaster of paris or of sun-dried clay. These are set in water in the germinating chamber and kept at a constant temperature of 20° to 21° C. Care must be taken that the water is not deeper than the thickness of the bottom of the saucer in all tests of this kind.

Vicia villosa.—Requires no special treatment if the seed is fresh, in which case it usually begins to sprout in two days. Old seed, however, requires clipping.

TESTING FLOWER SEEDS.

More trouble is likely to be encountered in testing seeds of flowers than those of vegetable and forage plants. This may be due to several reasons: First, with the exception of sweet peas, nasturtiums, and other common flowers, for whose seeds there is a constant and large demand, there is always a possibility that the stock from which the tests are made is not perfectly fresh; old seeds, being less vigorous than fresh ones, germinate more slowly, hence are more apt to decay, even when especial care is taken. Second, owing to the great variety of orders represented in our ornamental plants it is impossible to apply the same uniformity of methods in testing such seeds which one would use in the case of common vegetable and field seeds. Third, most of our garden and field plants have been grown for seed purposes for many years, which has produced in them a tendency to bear vigorous seed; on the other hand, ornamental plants are frequently propagated by cuttings, and in comparatively few instances has the habit of forming vigorous seed been as well established. Fourth, owing to the relatively small importance of flower seeds but little attention has been given to scientific methods of testing them, although gardeners and florists are well informed on the proper ways to grow such seeds in the soil. During the past two years the Department has made several thousand tests of different varieties of flower seeds, and it seems advisable to give a summary of our experience in this matter at the present time and to invite suggestions and criticisms from any who have had similar experience.

We presume the majority of seedsmen test their flower seeds in soil, but it will be seen from the table which follows that the germinability of nearly all of the ordinary flower seeds of trade can be adequately ascertained by means of a germinator or "water" test. If soil is used it should be of a very light loamy nature, previously sifted and sterilized. Pure, sterilized sand may also be employed. The soil or sand is placed in common greenhouse flats, the proper drainage conditions having been secured. Caution must be exercised in planting the seed and the most favorable depth for each variety employed. In general, it may be stated that the seeds should not be planted deeper than twice their diameter. The soil should be thoroughly and uniformly moistened at the start, and it is advisable to cover the flats with newspapers to reduce evaporation. No general directions can be given in regard to temperature. In most instances, however, the same temperature should be maintained that is used in making ordinary tests.

Methods for testing flower seeds.

Kind of seed.	Seed bed.	Duration of test.	Remarks.
		Days.	
Adonis autumnalis	G[1]	30	Seeds should be clipped; germinate very slowly.
Ageratum	C[2]	10	Owing to the impossibility of cleaning thoroughly by machinery this seed usually contains about 50 per cent of chaff. The good seeds remaining germinate promptly.
Agrostemma coronaria (Rose campion.)	C	10	
Althæa rosea (Hollyhock.)	G	16	Commercial seed germinates rather slowly and irregularly. If tested soon after maturity it sprouts without difficulty.
Alyssum maritimum (Sweet Alyssum.)	C	10	
Aquilegia (Columbine.)	G	16	Similar to Althæa in behavior.
Amarantus tricolor (Joseph's Coat.)	C	10	
Antirrhinum (Snapdragon.)	G	16	
Brachycome iberidifolia	C	10	
Calendula officinalis (Pot Marigold.)	C	10	
Callistephus (China Aster.)	C	10	
Canna	C	14	Seeds give a higher percentage of germination if clipped. Canton flannel preferable to blotters.
Celosia cristata (Cockscomb.)	C	10	
Centaurea cyanus (Cornflower.)	C	14	
Cobæa scandens	C	10	Germinates vigorously when fresh. If tested in soil, seeds should be planted on edge.
Collinsia	G	16	
Convolvulus tricolor (Dwarf Morning-Glory.)	C	14	

[1] G = sand or soil in greenhouse flats.
[2] C = blotters in germinating chamber, unless otherwise stated.

Methods for testing flower seeds—Continued.

Kind of seed.	Seed bed.	Duration of test.	Remarks.
		Days	
Cosmos hybridus	C	10	
Datura cornucopia	G	23	Germinates slowly and irregularly. Should be placed in hot water at 95° C. and allowed to cool to about the temperature of the room.
Delphinium (Larkspur.)	G	16	Same treatment as Datura.
Dianthus (Pink and Carnation.)	C	10	
Digitalis (Foxglove.)	C	10	
Gaillardia	G	16	
Godetia	C	10	
Gomphrena globosa (Globe Amaranth.)	C	10	
Helichrysum (Everlasting.)	C	10	
Iberis (Candytuft.)	G	16	
Impatiens (Balsam.)	C	10	
Ipomœa quamoclit (Cypress Vine.)	C	14	
Ipomœa Bona-nox (Moonflower.)	C	10	Seeds should be clipped.
Lathyrus latifolius (Perennial Pea.)	C	21	
Lathyrus odoratus (Sweet Pea.)	C	10	
Linum grandiflorum (Ornamental Flax.)	C	14	
Lupinus (Lupine.)	C	10	Germinates better if clipped.
Matthiola (Ten Weeks Stock.)	C	10	
Maurandia	G	23	Germinates with difficulty. Seeds should be planted very shallow and kept constantly, but slightly, moist.
Mirabilis (Four o'Clock.)	C	10	
Nemophila	G	16	
Œnothera (Evening Primrose.)	G	16	
Papaver (Poppy.)	C	10	Avoid excessive moisture. Place glass strips between the blotters to admit sufficient air.
Pentstemon	G	16	
Petunia	C	14	
Phlox	G	16	
Platycodon	C	14	
Portulaca	C	10	
Reseda odorata (Mignonette.)	C	10	
Ricinus (Castor-oil plant.)	C	10	

Methods for testing flower seeds—Continued.

Kind of seed.	Seed bed.	Duration of test.	Remarks.
		Days.	
Scabiosa (Scabious.)	G	16	
Schizanthus	C	10	
Tagetes (Marigold.)	C	10	
Thunbergia	C	10	
Tropaeolum (Nasturtium.)	C	10	Use canton flannel folds.
Verbena	C	14	
Viola tricolor (Pansy.)	C	10	
Zinnia	C	10	

GERMINATING EXPERIMENTS IN PROGRESS.

Experiments are now being conducted with seeds of different grasses, trees, and other plants which ordinarily sprout with difficulty. The results of such experiments will be published from time to time, with a view of rendering assistance not only to those engaged in seed testing, but to all who may have occasion to plant such seeds in the open ground.

SOME EDIBLE AND POISONOUS FUNGI.

By Dr. W. G. Farlow,
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INTRODUCTION.

In the present paper an attempt is made to present, in as simple a manner as the subject permits, the characteristics of a few of our most common fungi, together with notes on poisonous species which might be mistaken for the edible by those who have not studied fungi. It may be called a first lesson in distinguishing edible and poisonous fungi, and is not intended as a guide to those who are to a certain extent already familiar with the subject, but merely as a primer for those who do not recognize even our commonest species, but who desire to enroll themselves among the increasing ranks of fungus eaters, or, to use a rather high-sounding word, mycophagists.

The question which everyone asks first is, How can you tell a mushroom from a toadstool? This is one of the questions which no one can answer, unless an explanation of why the question should never be asked may be considered an answer. You can not tell a mushroom from a toadstool because mushrooms are toadstools. The reason why the question is so frequently asked is because the belief is well-nigh universal in this country that the fleshy umbrella-shaped fungi are divided into two classes—mushrooms, which are edible, and toadstools, which are poisonous. This assumed difference does not in fact exist. All the fleshy umbrella-shaped fungi are toadstools, and to a small number of the best-known edible forms the name mushroom is applied popularly and in commerce; but not a small number of the other toadstools are edible, and a great many of them, probably the most of them, are not poisonous.

The question that people really wish to have answered is not how can you tell a mushroom from a toadstool, but how can you tell an edible fungus from a poisonous fungus. Our knowledge on this point is empirical. We know that certain species are edible and others are poisonous, because people have eaten the former and found them to be good, while the latter have produced unpleasant symptoms and even death. But the number of species which have been eaten or experimented with is small compared with the whole number of species of toadstools, and with regard to the species which have not been tried experimentally or accidentally we can only say that they are probably edible or poisonous, judging by their resemblance to other species known to be such. Although, in the absence of experience, analogy is the only guide, it is not a sure guide, and unpleasant surprises may arise.

HOW TOADSTOOLS (INCLUDING MUSHROOMS) GROW.

In the case of persons for whom this paper is written, it is unnecessary to consider the question of how far we are justified in judging from analogy alone, since the main point is to learn to recognize a certain number of the most common edible species and to distinguish them from poisonous species which resemble them. The toadstools and mushrooms all belong to the group of fungi known as Hymenomycetes; and before proceeding to speak of the different species which we are to consider, it will be well to state briefly some points common to the whole group.

The toadstools, including mushrooms, first appear on the surface of the ground, on the bark of trees, or on other substances in the form of small, solid balls, which gradually enlarge and at length shoot up into a stem, or stipe, bearing at its summit the umbrella top, or pileus, which is at first closed around the stalk like a closed umbrella and then expands more or less widely according to the species. When small and just beginning to open, the growths are called buttons, as in the so-called button mushrooms usually imported in cans from France. The young buttons arise from a complicated mass of fine, colorless threads in the ground, in logs, dung, or other substances. The mass of threads is known to cultivators of mushrooms as the spawn and to botanists as the mycelium, each individual thread being called a hypha.

It is often said that toadstools grow in a night, but such is not the case. After the button has fully formed it may develop into the mature toadstool very rapidly, but the development of the button from the spawn takes usually considerable time, and weeks, months, or even years may elapse before the spawn comes to the surface and forms the young button. If we compare the functions of the spawn in the ground and of the toadstool above ground with those of the roots, trunk, branches, leaves, and fruit of a plant like an apple tree, we find that in the toadstool the spawn itself performs all the functions of the root, branches, and leaves of the apple tree, and that the toadstools are really only the fruiting part of the fungus, corresponding to the apples themselves. If we imagine an apple tree to have its trunk, branches, and leaves buried in the ground, leaving only the apples themselves standing above the ground, and then to have the buried parts changed into a mass of fine threads, we shall have something similar to what is found in the case of a toadstool; in other words, all the absorption and assimilation of food, all the purely vegetative functions, are performed by the spawn, while the toadstool, like the apple, is only a reproductive body—the apple containing seeds, the toadstool spores (microscopic dust-like bodies, which correspond in function to seeds).

CHARACTERISTIC MODIFICATIONS OF FUNGI.

Without stopping to consider the various modifications of the spawn, we can pass at once to the different modifications of the stalk and of the pileus borne at its summit. In the Hymenomycetes, or toadstool family, the underside of the pileus is the part that bears the spores, which correspond to the seeds of other plants. In some cases the under surface consists of a series of gills resembling knife blades, which radiate from the top of the stalk to the circumference, like the spokes of a wheel; in others it consists of a mass of small pores or tubes packed closely together, side by side; in others, of teeth, while in still others the surface is only slightly wrinkled or undulated. The gill-bearing group are called by botanists Agaricini, which we may speak of briefly as Agarics; the tube-bearing group are called Polyporei, the teeth-bearing group Hydnei, and those with a merely wrinkled surface are called Thelephorei. In all these groups there are some species in which the stalk is wanting, and then of necessity the fructifying surface does not face downward, but upward, lying flat on the substratum. For our present purpose the stalkless forms need not be considered, as with very few exceptions they are not edible species. There is still another group, the coral-shaped fungi, belonging to the Hymenomycetes, although they do not resemble the toadstools or mushrooms in shape, which will be referred to later. By far the greater number of our edible and poisonous species belong to the two groups of gill-bearing and tube-bearing fungi, and therefore we need consider the members of the other groups only very briefly.

EDIBLE GILL-BEARING FUNGI AND RULES FOR THEIR DETERMINATION.

Let us pass at once to the principal edible fungi belonging to the gill-bearing group. This group is a very large one, and includes thousands of species, from which we must select a small number of the best known and most common. Those who wish to collect fungi for their own consumption or for the market must begin by committing to memory the distinguishing marks of a few species, and until this has been done they should not venture to trust to general rules for distinguishing good species from bad. The quickest way to accomplish the object, of course, is by having some person who is an expert give practical lessons in the field; but in most cases this is not possible, not to mention the fact that some who think they are expert are not. Dull and dry as it may be, one must memorize certain points until familiar with a few common species. There is one rule, however, which should be applied in the beginning by everyone, viz, no one unless decidedly expert should collect for eating the buttons, or small, unexpanded fungi, since in their young condition it is often impossible, even for experts, to recognize what the species is. The imported canned buttons are safe enough, because they are the young of the cultivated mushroom, and are put up by persons who know their business. Another equally general and self-evident rule is, not to collect or eat fungi which have begun to decay or are not otherwise in good condition.

THE COMMON MUSHROOM.

Assuming, then, that these two rules are never to be neglected, let us pass to a description of the fungus known as the common mushroom, the *Agaricus campestris* of botanists. This is practically the only species cultivated in this country, and is the only fresh species sold in the Northern markets in the winter months. It grows wild during the summer months, being most abundant in August and September, and inhabits grassy fields, especially those where animals have been at pasture. It is especially abundant in fields near the seashore, and is much less common in the mountains. It is almost never found in woods, and is not plentiful anywhere except in grassy pastures. Pl. XXI represents the mushroom in its normal condition. The color of the stalk and pileus varies from whitish to a shade of drab, but the color of the gills, a point which must never be overlooked, is at first pinkish and then a brownish purple. This color is due to the spores, which are borne on the gills, and if the pileus is cut off from the stalk and placed on a piece of white paper the spores fall on the paper and in a few hours leave on it a colored impression of the gills. The stalk is cylindrical and solid, and has, rather more than halfway up, a membranous collar called the ring; but there is no membrane or scales found at the base of the stalk, which appears to come directly out of the ground. Mushrooms are sometimes single, but frequently there are several, though not many, in a cluster, some mature, others younger. If we examine a specimen before it is fully expanded, we shall not be able to see the gills, since there is a thin membrane, called the veil, which extends from the stalk to the margin of the pileus. When the veil is ruptured, exposing the gills behind, a part remains attached to the stalk, forming the ring already referred to, and generally some fragments remain attached to the margin of the pileus. In older specimens the ring shrinks, but generally a mark remains, showing where it was attached.

Since nearly all persons begin their attempts at fungus hunting by going in search of the common mushroom, it is of the greatest importance that they should bear clearly in mind the characteristic marks by which that species is distinguished. The general appearance is sufficiently shown on Pl. XXI.

Summed up briefly, the first thing to be noticed is whether the gills are a purple brown, as they should be when mature. Most of the fatal errors have arisen from not noticing this point and selecting species where the gills were white. The next point is to notice whether the stem is cylindrical and solid and has a ring or traces of a ring above, and especially

COMMON FIELD MUSHROOM (AGARICUS CAMPESTRIS), EDIBLE.

FLY AGARIC (AMANITA MUSCARIA), POISONOUS.

whether it seems to come directly from the ground, or whether the base is bulbous and sheathed with a membranous bag or scales. If it has a sheath or scales it can not be the common mushroom. Furthermore, it must not be forgotten that the mushroom never grows on trees or fallen trunks, but in open, grassy pastures. If a collector finds a fungus having the points here mentioned, the chance of his being injured by eating it is next to nothing, for there is only one species at all answering the description which is to be avoided, and that is very rare indeed, and has a taste so disagreeable that no one would wish to eat it, while the taste of the mushroom is pleasant.

POISONOUS SPECIES RESEMBLING THE COMMON MUSHROOM.

Inasmuch as most cases of poisoning are due to mistaking some injurious species for the common mushroom, it will be best before passing to the other edible species related to the mushroom to refer to two of the most common poisonous forms which have been eaten by mistake for the *Agaricus campestris*, viz, *Amanita phalloides*, the deadly agaric, and *Amanita muscaria*, the fly agaric. Of the two, the former is the more dangerous and the latter the more common.

THE FLY AGARIC.

The fly agaric (*Amanita muscaria*, Pl. XXII), so called because decoctions of it are used for killing flies, is in most places, at least in the northern and eastern parts of the country, a common species—often a good deal more abundant than the common mushroom. It is found during the summer along roadsides, on the borders of fields, and especially in groves of coniferous trees. It prefers a poor soil, of gravelly or sandy character, and occurs only exceptionally in the grassy pastures preferred by the common mushroom. It grows singly and not in groups, and attains a large size, being one of the most striking toadstools. It differs from the common mushroom in having gills which are always white, never pink or purple, and in having a hollow stem which is bulbous at the base and clothed with irregular, fringy scales on all the lower part. The pileus varies in color from a brilliant yellow to orange and a deep red, the yellow and orange being more frequent than the red. The surface is polished and has scattered over it a larger or smaller number of prominent, angular, warty scales, which can be easily scraped off. The gills and stalk are white, and there is a large, membranous collar, which hangs down from the upper part of the stem. The general appearance shown on Pl. XXII, together with the color of the pileus and gills noted above, are such that it is difficult to conceive how anyone who has ever seen a common mushroom or read a description of one could mistake the fly agaric for the mushroom. Nevertheless, in the writer's experience, no fungus is so often collected by mistake on the supposition that it is the common mushroom, and it is to the fly agaric that recent cases of poisoning in Washington, D. C., were due.

When the fly agaric is young the unexpanded pileus is convex, almost globose, and densely covered with large, more or less concentric warts, which, as the pileus expands and becomes flat topped, separate from one another. When old, and especially late in the season, the pileus loses its brilliant color and is then a pale yellow or even a dirty white; but even in this case the absence of the brownish-purple gills and the different stalk make it easy to distinguish it from the common mushroom.

The fly agaric bears a much closer resemblance, and in its paler condition a decided resemblance, to one of the best of our edible fungi, *Amanita rubescens*, so called because the flesh generally has a reddish tinge; but that species is not to be recommended to the novice, since it is sometimes difficult to recognize. The writer has no desire to indulge in this really delicious fungus, unless it be collected by someone of whose expert knowledge he is quite sure. It is possible that Count de Vecchi, who recently died from eating the fly agaric, although he was believed to have some knowledge of the different kinds of fungi, may have mistaken the fly agaric, gathered late in the season, when it is generally paler than in midsummer, for *Amanita rubescens*. It is, however, possible that he mistook the fly agaric for the royal agaric (*Amanita cæsarea*), one of the most highly prized edible species, which is not common in the Northern States, but is more common in the Southern. It resembles the fly agaric in the color of the pileus, but is distinguished from it in not generally having the wart-like scales found on the fly agaric, and especially in having the gills, ring, and stalk yellow instead of white, and in having no flocculent scales around the stalk, but instead a bag-like membrane, through which the stalk protrudes. With these marked differences, there seems to be no good reason why the fly agaric should be mistaken for the royal agaric.

THE DEADLY AGARIC.

The second poisonous species, which has been mistaken for the common mushroom, and which has been more frequently the cause of death than any other, is *Amanita phalloides*, well named the deadly agaric (Pl. XXIII). It is rather common and grows singly in woods and on the borders of fields, rarely appearing in lawns, and is not pre-eminently an inhabitant of grassy pastures, like the mushroom. It prefers a damper and less sandy soil than that chosen by the fly agaric. The pileus is often a shining white, but may be of any shade, from a pale dull yellow to olive, and when wet is more slimy than the mushroom or the fly agaric. It has no distinct scales and only occasionally a few membranous patches on the pileus. The gills and stalk are white, and the latter has a large ring like the fly agaric,

DEADLY AGARIC (AMANITA PHALLOIDES), POISONOUS.

and is hollow, or, when young, is loosely filled with cottony threads, which soon disappear. The base of the stalk differs from that of the fly agaric in being more bulbous and in having the upper part of the bulb bordered by a sac-like membrane, called the volva. The volva is often of considerable size, but more frequently it is reduced to a membranous rim, as shown on Pl. XXIII. In this species the stalk is longer and slenderer in proportion to the diameter of the pileus than in either the fly agaric or the common mushroom, and is buried rather deep in the soil or dead leaves, so that it often happens that the bulb is broken off and left behind when the fungus is gathered.

DIFFERENCES BETWEEN THE COMMON MUSHROOM AND THE FLY AND DEADLY AGARICS.

The differences between the common edible mushroom and the fly agaric and deadly agaric, which the reader can easily remember, are as follows:

(1) The common mushroom has a pileus which is not covered with wart-like scales; gills which are brownish purple when mature; a nearly cylindrical stalk, which is not hollow, with a ring near the middle, and without a bulbous base sheathed by a membrane or by scales.

(2) The fly agaric has a pileus marked with prominent warts; gills always white; a stalk, with a large ring around the upper part, and hollow or cottony inside, but solid at the base, where it is bulbous and scaly.

(3) The deadly agaric has a pileus without distinct warts; gills which are always white, and a hollow stalk, with a large ring, and a prominent bulb at the base, whose upper margin is membranous or bag-like.

(4) Other minor points of difference are the different places in which these species grow, and also the colors, which, although they vary in each case, are brilliant yellow or red in the fly agaric, white varying to pale olive in the deadly agaric, and white usually tinged with a little brown in the mushroom.

(5) A word should be said as to the size and proportions of the pileus and stalk in these three species. In the mushroom the pileus averages from 3 to 4 inches in breadth, and the stalk is generally shorter than the breadth of the pileus and comparatively stout. The pileus remains convex for a long time, and does not become quite flat-topped until old. The substance is firm and solid. In the fly agaric the pileus, at first oval and convex, soon becomes flat and attains a breadth of 6 to 8 inches and sometimes more. The stalk has a length equal to or slightly exceeding the breadth of the pileus, and is comparatively slenderer than in the common mushroom, but nevertheless rather stout. The substance is less firm than in the common mushroom.

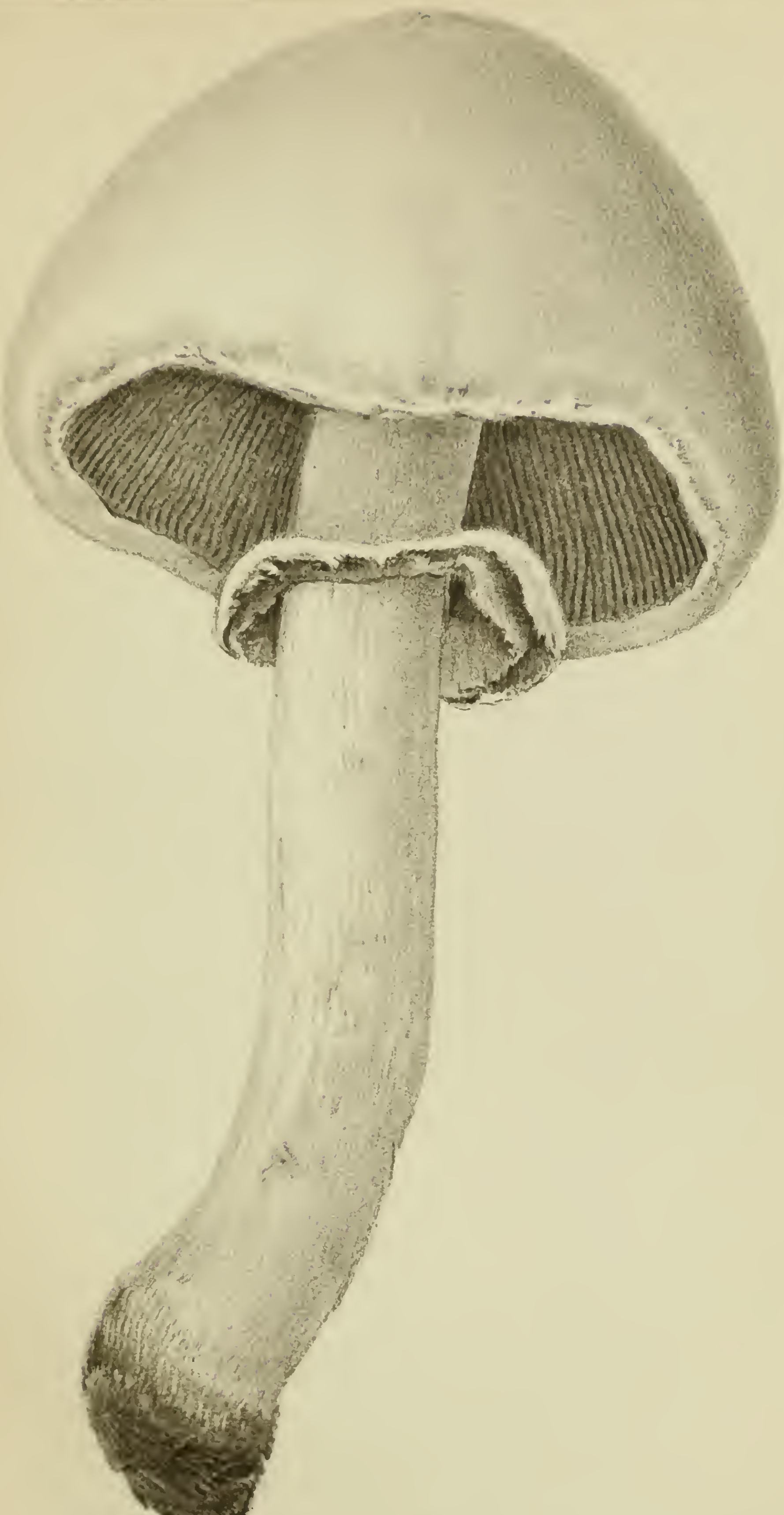
(6) The pileus of the deadly agaric is thinner than that of the common mushroom, and, from being rather bell-shaped when young, becomes gradually flat-topped with the center a little raised. In breadth it is intermediate between the two preceding species. The stalk usually is longer than the breadth of the pileus, and the habit is slenderer than in the two preceding species. All three species are pleasant to the taste, which shows that one can not infer that a species is not poisonous because the taste is agreeable. The fly agaric has scarcely any odor. The other two species have certain odors of their own, but they can not be described.

VARIETIES OF THE COMMON MUSHROOM AND CLOSELY RELATED EDIBLE SPECIES.

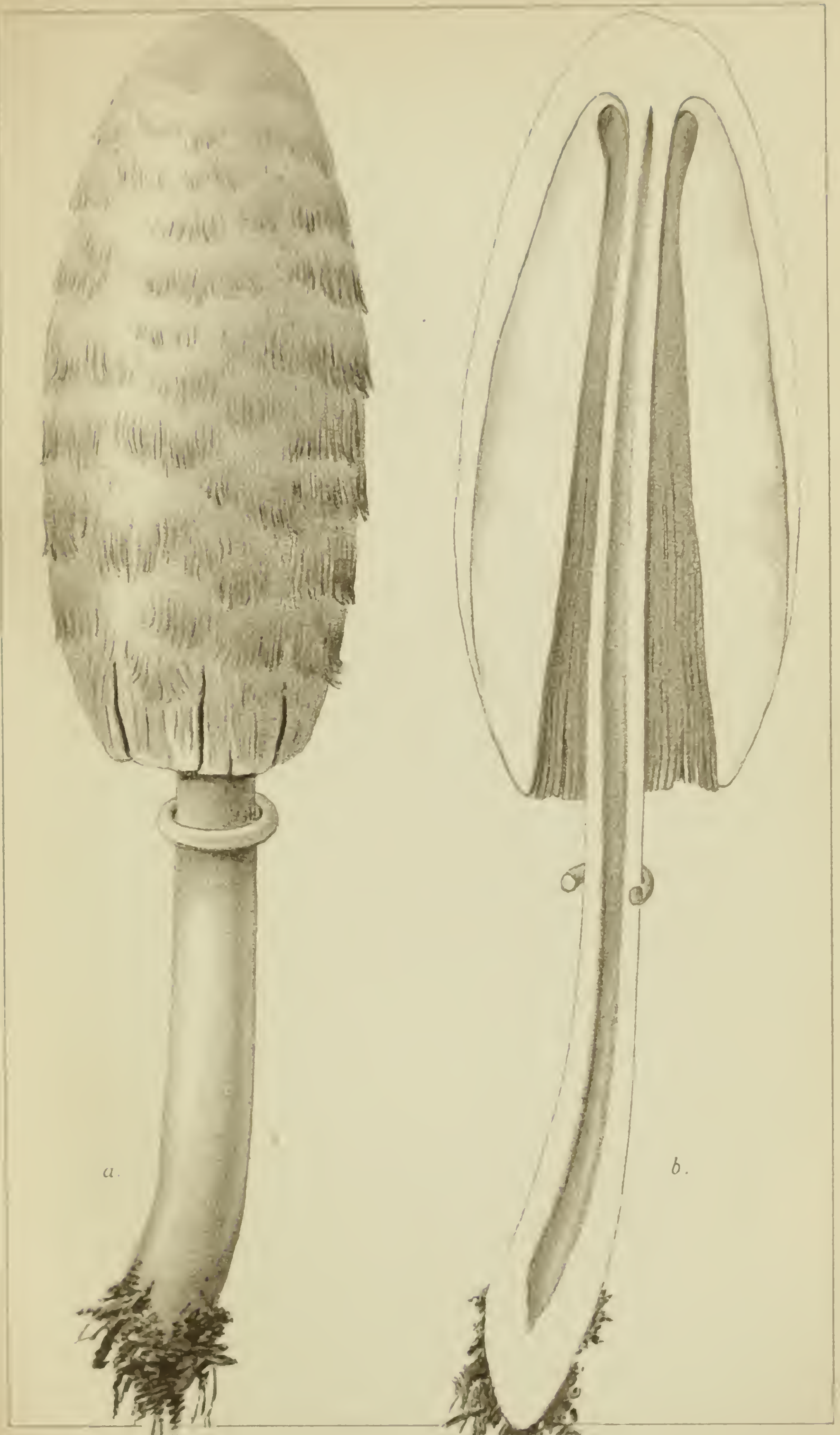
Having learned in detail the distinctions between the common mushroom and the two poisonous species most frequently mistaken for it, some of the varieties of the common mushroom and a few edible species closely related to it will now be considered. The pileus of the mushroom has been described as smooth and without scales. Varieties are not infrequently found in which the surface is more or less flocculent and with flat, tufted scales. The scales, however, are not prominent, and are not at all like the large, angular warts on the fly agaric, which can be easily scraped off the otherwise smooth surface, whereas the scales of common mushrooms are formed by the breaking up of the surface into a sort of fringe, which can not be pulled off without tearing the pileus. There is also an excellent variety of the mushroom, which may perhaps better be called a closely related species, which has an agreeable flavor of almonds. It should not be understood, however, that this is the only fungus which has a flavor of almonds, but it is the only one with this flavor that is closely related to the common mushroom.

THE HORSE MUSHROOM.

The horse mushroom (*Agaricus arvensis*) looks very much like the common mushroom, but is considerably larger, being sometimes 8 or 10 inches broad, or even broader. It frequently passes for the ordinary mushroom, and, in fact, most of the large specimens sold as the ordinary mushroom are in reality *Agaricus arvensis*. It grows frequently in hedges and in cultivated places, and differs from the mushroom in having the pileus generally a more shining white, in having the stem a little hollow as it matures, in the fact that the gills are at first white and do not change to a brownish purple until comparatively late, and especially in having a ring which is composed of two adherent layers, the inner being a smooth membrane and the outer shorter and cut up in a stellate manner. On Pl. XXIV, representing the horse mushroom, the peculiarity of the ring is shown



HORSE MUSHROOM (AGARICUS ARVENSIS), EDIBLE.



HORSE-TAIL FUNGUS (COPRINUS COMATUS), EDIBLE: *a*, ENTIRE PLANT; *b*, SECTION.

HYPHOLOMA APPENDICULATUM.

Another fungus should be mentioned in this connection, *Hypholoma appendiculatum*, since it is very common and edible, although not so good as either of the two species just described. It abounds during all the summer months in grassy places, growing on or near the remains of old stumps, and is found in dense clusters. The pileus is quite thin and conical or bell-shaped, and the edges soon split radially and roll upward. The very narrow gills are purple brown, and the stalk, which has no ring, is very slender and tubular. The color is a translucent white, often with a purple tinge, as the gills show through the thin pileus, but when young and wet it may have a tinge of yellow or brown. Although small and watery, the pileus being hardly 2 inches broad and the stalk not more than 2 or 3 inches long and not much over a quarter of an inch broad, it is often so abundant that enough for a meal can easily be collected in a short time.

THE HORSETAIL FUNGUS.

With the exception of the royal agaric and *Amanita rubescens*, noted only in passing, the edible species so far mentioned belong to that division of the Agaricini, or toadstool family, which has brownish-purple spores and gills. To another division, in which the spores are black, belongs the genus Coprinus, which includes some common and important fungi. The species grow mainly on dung, and most of them are small and perishable, but a few attain a considerable size. Pl. XXV represents the horsetail or maned agaric (*Coprinus comatus*), one of the best of our fungi, which appears in the autumn near the close of the season of fungi. It grows in dense but not very numerous clusters among grass and by roadsides, and its stalks extend a considerable distance into the ground. As shown on Pl. XXV, the pileus, instead of expanding, remains in the form of a closed umbrella, and does not roll outward until it begins to decay, when, instead of putrefying in the manner of most fungi, it quickly dissolves, forming a black, inky fluid. The pileus is white and is covered with large, fringy scales, to which it owes its name. The gills are broad, lie close to the stalk, and turn from pink to black. The stalk is not infrequently 8 or 10 inches long, hollow, at first with a fibrous string in the axis, brittle, and has a small ring, which is not attached like those previously described, but hangs loose around the stalk, so that it can be moved up and down. The horsetail is not likely to be mistaken for any poisonous species. While it does not in ordinary seasons appear until autumn, in exceptional cases it appears in small quantities early in the summer, then disappearing to return again in autumn.

Two other very common species of Coprinus are found from spring to autumn and form very large and crowded groups, not infrequently containing a hundred specimens, around the bases of trees, posts, and even of masonry. They are decidedly the commonest edible species found near houses in other than thinly settled regions. The larger of the two species, *Coprinus atramentarius*, has a closed pileus, like the horsetail, but its outline is as near conical as oval and the stalk is short and stout. The surface is not white, but an ashy black, and instead of having scales, it is furrowed with irregular longitudinal folds. The other species, *Coprinus micaceous*, is smaller and less fleshy than the two above mentioned, and the pileus is often date-colored or of a shade resembling buff. The surface is marked with regular and fine longitudinal grooves, and usually, but not always, appears to be sprinkled with fine shining particles looking like mica. It should be noticed that the spores of this species are not a pure black, but have a brown tinge, and it does not liquefy so quickly when old as the other two species. In taste these last two species are decidedly inferior to the horsetail, but they possess the advantage of being very common and growing near houses.

LESS COMMON EDIBLE FUNGI.

In the description of species so far referred to, it has been necessary to enter more or less into details, since they should be well known by anyone who attempts to collect fungi. The fungus eater who goes into the woods or fields will be sure to find in most seasons a multitude of toadstools which are quite bewildering. He ought to recognize amongst them some of the species already mentioned, but what can be said of the rest? Those that are very small, very tough, or that have a disagreeable taste may be passed by without further notice; but there still remains a large number of species, some of which are known to experts to be edible and some poisonous, while about others there is no definite knowledge. It is impossible to do more in the space of this paper than to give a hasty glance at certain typical species, with such comments as may help the beginner. So far, all the species mentioned belong to the gill-bearing group, the largest group of the Hymenomycetes, or toadstools. In this group the species may have spores which, roughly classified, are either white, pink or salmon colored, brown, purple, or black. The color of the spores can generally be inferred from the color of the mature gills, but that is not always the case, and the only sure way is to let the spores fall on paper, as already described. The color of the spores in any species is practically constant, whereas the color of the pileus may vary a great deal, as is seen in the fly agaric, which may be either bright yellow or red. The gills vary in the different species. In some they are sharp edged, in others blunt and more like ridges. In some cases the gills do not reach the top of the stalk, while in others they reach the stalk or extend down over it some distance. The stalks are sometimes solid and sometimes hollow, and in some, but not in most species, there is a ring, which may either be fixed like

PARASOL FUNGUS (LEPIOTA PROCERA). EDIBLE.

1, CHANTERELLE (CANTHARELLUS CIBARIUS), EDIBLE; 2, FAIRY-RING FUNGUS (MARASMIUS OREADES), EDIBLE.

a collar or quite free. Comparatively few of our species have a distinct volva or wrapper round the base of the stalk, but it is very important to know whether there is such a wrapper or not, since our most poisonous species have them, and unless one is an expert he should reject any toadstool having white gills and spores and a wrapper round the base of the stalk or a bulbous base clothed with scales.

PARASOL FUNGUS, CHANTERELLE, AND FAIRY-RING FUNGUS.

Among the white-spored species, which are more numerous than the others, may be mentioned the parasol fungus (*Lepiota procera*), represented on Pl. XXVI. It is large and tall and can be seen at some distance standing up in the grass where it grows. It is rather tough and does not decay quickly. Its color is sometimes whitish, but it is often brownish. The pileus is covered with coarse, flocculent scales, and the ring is free and not fastened to the stalk. The parasol fungus is not likely to be mistaken for any poisonous species. The same may be said of the chanterelle (*Cantharellus cibarius*, Pl. XXVII, 1), which is common in moist woods, whether coniferous or deciduous, in July and later. It is always of an egg yellow in all its parts and differs from all the species hitherto mentioned in having a crumpled, irregular margin, and a more or less depressed upper surface, and particularly in having shallow, blunt gills, which are prolonged down over the stalk in wavy ridges.

The fairy-ring fungus (*Marasmius oreades*) is a small species, seldom more than 2 inches broad, which grows in clusters in lawns and pastures, and the clusters form circles or segments of circles, called fairy rings, in the grass. There are, however, many other fungi which form fairy rings, and this almost seems to be the normal method of growth of species which frequent clear, level ground, but the rings are not in many species so distinct as in this case. The substance of the fairy-ring fungus is quite tough, and specimens which appear to be dry and dead revive in rainy weather. Pl. XXVII, 2, shows the fungus in its ordinary condition, and bearing in mind that the gills are comparatively few and bulge out in the middle, that the stalk is tough and tubular, and that the pileus is thin, of a pale yellow-brown or drab color, and often concave on top, with the center raised in a knob, one ought to recognize this species, although it must be admitted it is not always easy for the beginner by a description alone to distinguish it from some of the numerous small species which grow among the grass in cultivated fields. The spores of the fairy-ring fungus, however, are white, while those of the species with which it may be confused are generally brown or blackish. Some of these small species with dark-colored spores are dangerous, and several cases of poisoning, although not fatal, have been known to occur in this country, the small fungi growing in lawns having been gathered indiscriminately and eaten.

FUNGI WITH MILKY JUICE.

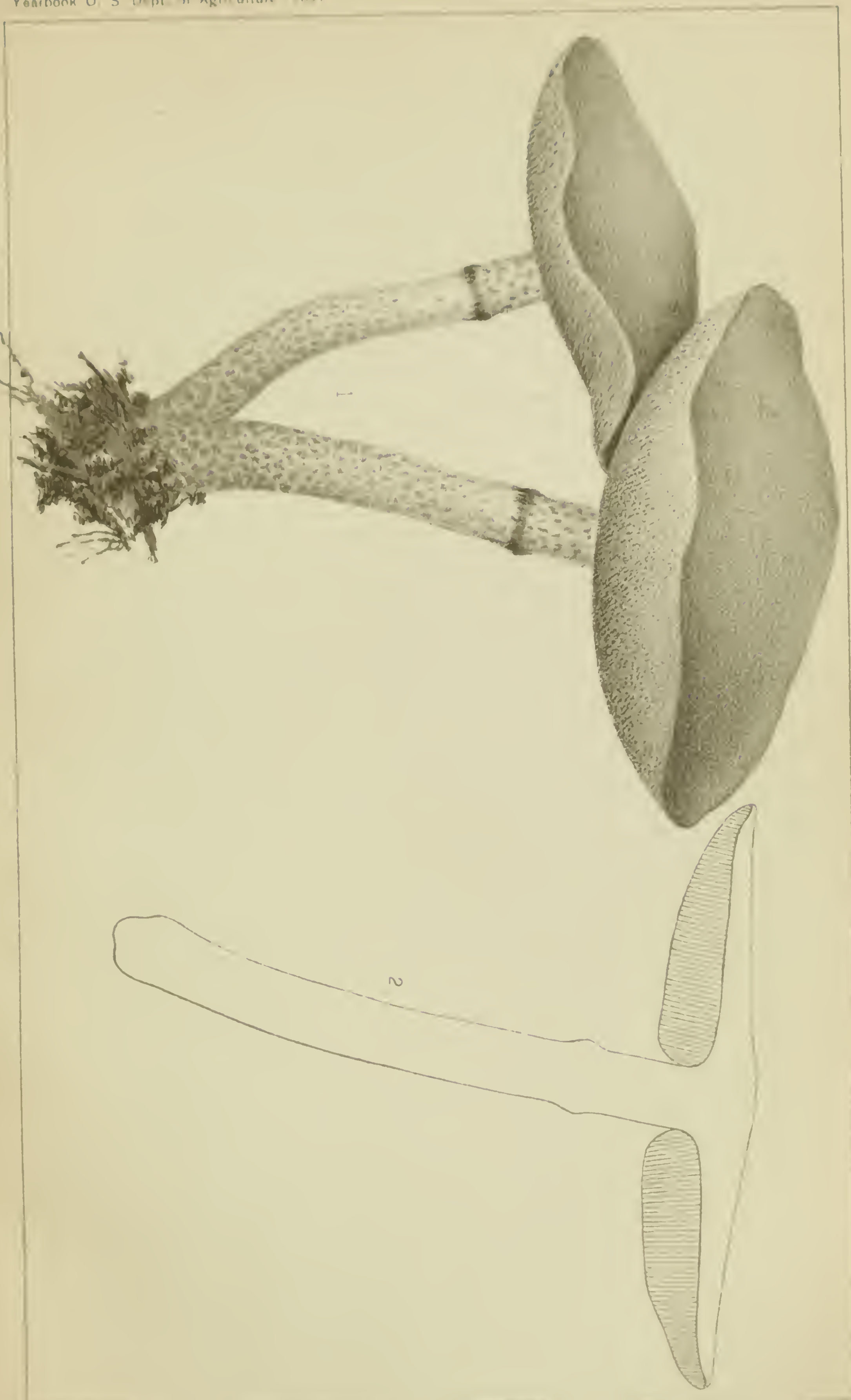
The genus Lactarius includes the gill-bearing fungi which, when broken or cut, exude a milky juice. The juice is often very copious, but in some species is scanty. Late in the season, however, the milk is less abundant than in midsummer. The milk is generally white, but it may be reddish or blue; in some cases it is a thin, fluid-like serum, and in others the milk changes color on exposure to the air. The species of Lactarius abound in midsummer and early autumn in both dry and swampy woods and also in dry pastures, and some of them are very inviting, being of good size, plump, and firm in substance, and of an agreeable white or brighter color, but unfortunately the milk of many of them is acrid and biting, and in not a few species a single taste is sufficient to satisfy anyone. The acridity is somewhat modified by cooking, but it is hardly worth the trouble for any but the most enthusiastic mycophagist to take much pains for so little good. It is generally safe to eat those species of Lactarius which do not have an acrid juice, and among them is a highly esteemed species, *Lactarius delicosus*, a beautiful fungus, rather common in damp woods in mountainous regions, but not common in the lowlands. It can not be mistaken for any dangerous species, and is at once recognized by its copious milk, which is red, with a shade of orange, and does not change color, except after long exposure, when it becomes slightly greenish. The fungus itself has nearly the same color as the milk which exudes from it, but is a little paler.

SPECIES FOR THE EXPERT ONLY.

Among the prettiest of our fungi, very attractive to the passer-by from the bright red, purple, or yellow pilei, are the species of Russula, which are often very abundant in summer in woods and swamps, and, in fact, almost anywhere, especially under or near trees. They are not generally of large size, although some are, and are to be distinguished by having very thin pilei, almost membranous except at the center, and by having the white, pale cream, or buff-colored gills arranged very regularly like the spokes of a wheel, with no shorter gills, or at least very few, inserted between them. Some of the Russulæ are acrid like the Lactarii, but others have a pleasant taste. The different species of Russula are very difficult to distinguish, even by experts, and the beginner would better postpone experiments with this genus until he has first made himself acquainted with less doubtful genera, since some of the Russulæ are poisonous.

THE OYSTER FUNGUS.

We shall conclude all that can be said on the gill-bearing fungi by a word on the oyster fungus (*Pleurotus ostreatus*). This belongs to a group which does not have a central stalk, but has the fungus attached laterally by a very short stalk, as a rule, to the trunks of



BOLETUS SUBLUTEUS, EDIBLE: 1, ENTIRE PLANT; 2, SECTION.

trees. The oyster fungus is so called, not because it tastes like an oyster, but because its habit of growth is to have a number of individuals overlap one another, bearing a somewhat remote resemblance to a heap of oyster shells. These overlapping masses often reach a large size, sometimes several square feet, and are whitish or dirty yellow, with long gills which converge toward one side of each individual pileus. The oyster fungus is generally at its best quite late in the season, being found even in November in the Northern States, and although there are other species which resemble it, they are not dangerous. Its quality is not very good, but some persons like it.

TUBE-BEARING FUNGI.

Of the species so far considered, the mushroom and its immediate allies have brownish-purple spores, the horsetail and its allies black spores, but all the others mentioned have white, or nearly white, spores. The pink-spored species of toadstools are not so numerous as the others and include but few edible forms, and some which are believed to be poisonous. The brown-spored species are decidedly more numerous, but as they include no prominent edible species they can not well be included in the present paper. We may, therefore, pass at once to the next group—fungi having tubes instead of gills.

The Polyporei, or tube-bearing fungi, include a large number of species. Only a part of these would come under the popular name of toadstools, since a great portion do not have a central stalk and pileus, but are, like the oyster fungus, either attached laterally or have no stalk at all, and lie flat on the substratum. As illustrations may be mentioned the large punk fungi, which are used by ladies for making ornamental brackets. Furthermore, the greater part of the species are tough and hard and could not be eaten. With very few exceptions the edible species of Polyporei all belong to the genus Boletus, of which the species are soft and fleshy, shaped like toadstools, and, with hardly an exception, grow on the ground in woods and pastures. They are often abundant in midsummer, but less so in autumn. To this genus belong the fungi known in France as *cèpes*, under which name they are imported into this country, but not in any great quantities. The United States has a number of edible species, some peculiar to this country and some the same as the best French species; but unfortunately there are here also a number of poisonous species, and, since the species of the genus are in many cases far from easy to distinguish from descriptions alone, the writer can only refer in general to some of the main features of the species, without going into details which are rather complicated for a first lesson in distinguishing fungi.

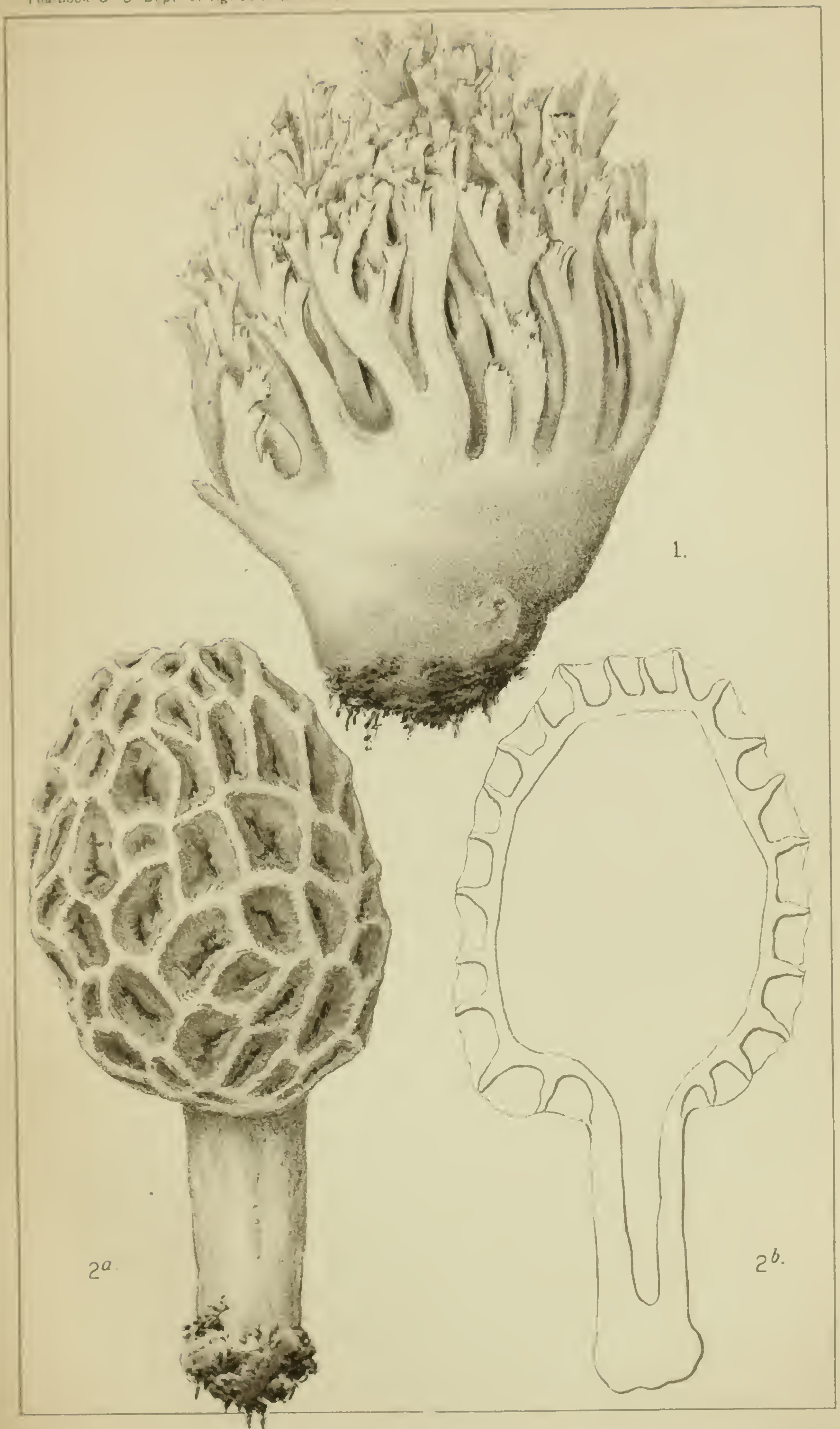
Pl. XXVIII, which represents a common species, *Boletus subluteus*, edible, but not one of the best, shows the toadstool-like habit of the genus, but with closely packed tubes on the underside instead of gills. The upper surface of the pileus is viscid when wet, and is of a dark, dingy brown, the tubes being rather lighter colored, and the solid stalk, which has a rather slimy, band-like ring, is gray or slate colored, mottled with brown spots and granulations.

The *cèpe* proper, the *Steinpilz* of the Germans, is much larger, at times nearly a foot broad, with a solid convex pileus, varying from dull white to buff color or even darker, and a stout stalk, variable in length, but usually broader at the base than at the apex and generally with a network of veins over the upper part, but without a ring. The tubes are about an inch long, but become shorter as they approach the stalk and the margin, so that, taken collectively, they form a convex disk. They are at first whitish, but become yellow, and finally a yellow green. This fungus inhabits stony soils in woody or bushy places, and is not so widespread as the species last mentioned, which is found in pastures, by shady roadsides, and on the borders of woods. The *cèpe* is not very easily distinguished from certain other species by a beginner, who should be warned against a species sometimes mistaken for it, which has, however, a bitter taste, not possessed by the *cèpe*.

For the present these two species must serve as types of the edible Boleti. Certain other species are far more striking in appearance, having brilliant blood-red or peach-colored pilei, but they belong to a dangerous group, which has caused serious and probably fatal cases of poisoning. It may be stated briefly that those Boleti in which the mouths of the tubes are red or of a different color from the rest of the tubes should be avoided. The flesh of some of the species when broken or bruised changes color, usually becoming blue, but sometimes red. Such species as show a change of color when broken should also be avoided In fact, the genus, as a whole, is a dangerous one, not because there is not a considerable number of excellent edible species in it, but because they vary more or less, and it is difficult to draw the line between the edible and the poisonous species. It may be said, however, that even the poisonous Boleti are not so poisonous as some of the Amanitæ already mentioned.

THE BEEFSTEAK FUNGUS.

In passing, only one member of the tube-bearing fungi which does not belong to the genus *Boletus* can be referred to. The beefsteak fungus (*Fistulina hepatica*) is quite unmistakable. It grows on stumps, especially of oak or chestnut, from which it projects laterally something like a tongue, whence it is called by the French *langue de bœuf;* it is not common in the North, where it is seldom more than 4 inches long. It is more common and attains a considerably larger size in the South. When young the upper side is velvety and of a beautiful peach color, but later it is somewhat slimy or mucilaginous and a deeper red. The flesh-colored tubes on the underside are very



1. CLAVARIA FLAVA, YOUNG PLANT, EDIBLE. 2. MOREL (MORCHELLA ESCULENTA), EDIBLE: *a*, ENTIRE PLANT; *b*, SECTION.

small, so that they can hardly be distinguished without the aid of a hand lens, and they do not lie in close contact with each other, as in the genus Boletus, but are slightly separated, so that seen with the naked eye the under surface looks papillated, like the surface of the tongue. The cut surface is streaked with red, like meat, and when raw there is a slight but agreeable acid taste, which disappears on cooking. Prepared for the table, the resemblance to a beefsteak is remarkable; and, although better than some beefsteaks, it certainly can not be said to be as good as the best.

TEETH-BEARING FUNGI.

The teeth-bearing fungi (Hydnei), popularly called hedgehog fungi, are found in woods, both wet and dry, where they grow either on the ground or on logs and trunks. Most of the species are too small and woody to be eaten, but there are a few species which are eaten and liked by some persons, but to others they have a bitter or slightly resinous taste.

Hydnum imbricatum is common in dry woods, especially coniferous woods, and may be recognized by its blackish-brown color, looking at times as if it had been burnt. The upper surface is cracked and split into thick, wedge-like scales and the under surface is thickly covered with ash-colored or bluish-gray teeth, or spines. *Hydnum repandum* prefers damp and wet woods, is much softer and more friable than the last-named species, and is also smaller and slenderer. The color varies from white to brownish and reddish yellow, the teeth being nearly white.

SOME OTHER EDIBLE FORMS.

Of the family of the Thelephorei, in which the spores are borne on a smooth or merely wrinkled surface, most of the species are small, and our larger species are generally tough and leathery so that the family is of little importance as food.

The coral-shaped fungi (Clavarei) include a certain number of good-sized species which frequent woods; none of them are poisonous, and several are very palatable. The coral-like habit is shown on Pl. XXIX, 1, and without stopping to describe any particular species, it may be said that it is safe for the beginner to try any of the members of this group, and he will find at least some of them worth trial.

MORELS AND TRUFFLES.

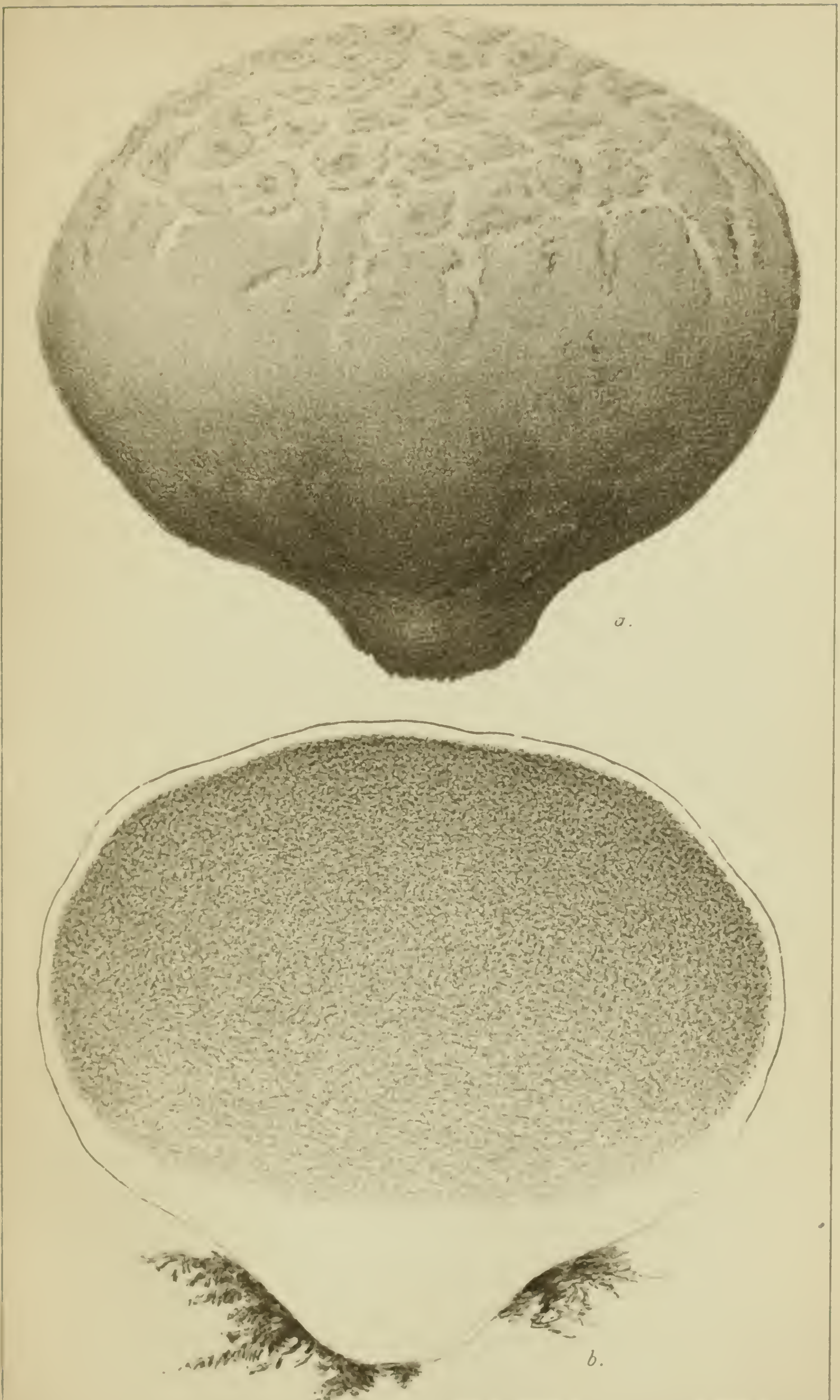
Among the best edible fungi are the morels, which are not only good when fresh, but can be dried, like the fairy-ring fungus. Pl. XXIX, 2*a*, representing a common morel (*Morchella esculenta*), shows the general habit of the genus, which would easily be recognized from the figure. Botanically considered, the morels are not closely related to the toadstool family, although they have a certain external resemblance to toadstools, but the botanical distinctions are microscopic rather than gross and need not be described here.

The morels appear toward the end of spring or early in summer in grass under or near trees, even in rather thickly settled regions, but are more abundant in places which have been burned over. They have a peculiar honeycombed upper portion, which is at first cream-colored, but becomes darker yellow. The stalk is whiter, and usually when fresh is covered with fine granulations. In the United States there are several species of morel, differing in the shape of the honeycombed part and in certain microscopic details, but from the figure the genus can be recognized, and all the species are safe. One should, however, glance at the section of a morel shown on Pl. XXIX, *2b*, and notice that the upper honeycombed part is continued directly into the stalk, and is not, like a cap, attached at the upper part, with the margins free and bending away from the stalk.

The most expensive and most highly prized of all fungi are the truffles, which grow buried in the soil and in general appearance resemble small potatoes. The best truffles are black and have a warted surface. Some species have a strong odor of garlic; others a peculiar delicate perfume which can not be described. Although in this country we have a few species related botanically to the truffles of Europe, no one has as yet discovered here the valuable species of France and Italy, which are the only truffles found in our markets; but it is not impossible that at some future day the same or equally good specimens may be found in hilly regions where oaks occur on poor calcareous soils.

PUFFBALLS.

By far the greater part of our edible and poisonous fungi belong to the Hymenomycetes, or toadstool family; but there are a few others which must be mentioned briefly. The puffballs, belonging to the family Gasteromycetes, are familiar to almost everyone, and grow usually, but not always, on the ground in lawns, cultivated places, and woods, with a preference for thin and sandy soils, but they are not limited to such localities. With few exceptions, our common native species have no stalk, but lie on the ground or partly buried in the ground, looking like slightly flattened balls. If they are cut in two, as on Pl. XXX, *b*, one sees in their younger condition a homogeneous interior substance surrounded by an external wrapper composed of two distinct layers. The outer layer often bears spines or papillæ, which add much to the beauty of the puffballs. When mature the interior portion, or a part of it, is changed into a mass of yellow-brown or purple powdery spores, with which are entangled numerous hairlike threads. Finally, the outer membrane breaks away in patches, the inner membrane is ruptured irregularly, or occasionally, a regular mouth is formed, and the spores are discharged.



PUFFBALL (LYCOPERDON CYATHIFORME), EDIBLE: *a*, ENTIRE PLANT; *b*, SECTION.

The most striking species is the giant puffball (*Lycoperdon giganteum*), which is not rarely 40 inches in circumference. It has a smooth white surface like kid, which becomes brown when old, and when a number of them are seen on the ground at a distance they look like a flock of miniature sheep. The species is not common except in certain localities, as the region of San Francisco Bay, but when a single large specimen is found it furnishes enough food for some days. The flesh is firm and white or pale yellow green when in condition for eating, but when mature the interior becomes a mass of yellowish-olive powder.

Another species, *Lycoperdon cyathiforme*, Pl. XXX, is much more common, growing in lawns and other grassy places, where it forms fairy rings, which sometimes injure the lawns in suburban districts. It is frequently 6 inches in diameter, and differs in shape from the giant puffball in not being a flattened sphere, but broader and flattened at the top and contracted toward the base. It varies from white to brown, and, except when quite young, the outer membrane of the top of the puffball is marked in a tessellated manner. The ripe spores are blackish purple when mature, unlike those of the giant puffball. There are a few other large species, but most of the puffballs so common in pastures are not more than from 1 to 3 inches in diameter.

With possibly one exception, and the records of injury done in this case are not very conclusive, none of the puffballs are poisonous if eaten before the interior becomes crumbly and powdery. The suspected species, *Scleroderma vulgare*, very common around houses and gardens and along roadsides, is 2 or 3 inches in diameter, very tough and hard, with a yellowish-brown, warty exterior, and within is purple black, marbled with white. Its solidity, coarse external warted wall, and the marbled interior, which remains hard and solid until the fungus is quite old, serve to distinguish it from the softer, thinner-walled edible species. It may perhaps be a question whether this species is really dangerous, but at all events it offers few attractions to the fungus eater.

SUMMARY.

In conclusion, it is only necessary to give a summary of the preceding pages in the form of certain rules to guide the collector. Most of the rules have exceptions, which are well known to experts, but the beginner is of course under the necessity of following the rules implicitly, for an imperfect guide is better than none at all.

It is a rule of whist that when one is in doubt he should take the trick, but in the case of fungi the reverse is true. If one has any doubt as to whether a fungus which he has collected is edible or not, he should act on the supposition that it is not edible, or at least that it is under suspicion, and should be experimented upon with great care.

The different popular tests for distinguishing edible from poisonous fungi, such as, for instance, the blackening of a silver coin or spoon when placed in a mass of poisonous fungi while they are being cooked, are all absolutely worthless. There is no test which can be applied, nor should reliance be placed, at least by the beginner, upon the fact that in some cases the poisonous substances may be removed by cooking in milk or vinegar. In such cases the danger may be only increased unless care is taken to remove all the vinegar or milk, and, in general, common sense warns us not to eat any fungus supposed to contain an active poison which requires to be removed by special treatment. The eating of such species should be left to the scientific experimenter. On the other hand, it need not be assumed that a fungus is poisonous when it is merely indigestible in consequence of the way in which it is cooked.

It is beyond the province of this paper to discuss the nature of the poison of different fungi, but it should be said in general that the poisonous effects are of two kinds: The irritant, which affect the stomach and digestive organs directly, and show their effects soon after eating; and the narcotic, much more dangerous, which act upon the nervous centers and do not produce poisonous symptoms until after a number of hours, usually eight or ten. The irritant fungi are often recognizable by their taste when raw, but the narcotic species are generally pleasant to the taste, or at least not disagreeable.

The following rules should not be neglected by the beginner:

(1) Avoid fungi when in the button or unexpanded stage; also those in which the flesh has begun to decay, even if only slightly.

(2) Avoid all fungi which have stalks with a swollen base surrounded by a sac-like or scaly envelope, especially if the gills are white.

(3) Avoid fungi having a milky juice, unless the milk is reddish.

(4) Avoid fungi in which the cap, or pileus, is thin in proportion to the gills, and in which the gills are nearly all of equal length, especially if the pileus is bright colored.

(5) Avoid all tube-bearing fungi in which the flesh changes color when cut or broken or where the mouths of the tubes are reddish, and in the case of other tube-bearing fungi experiment with caution.

(6) Fungi which have a sort of spider web or flocculent ring round the upper part of the stalk should in general be avoided.

Rules 1, 2, and 5 may for the beginner be regarded as absolute, with the exception to rule 2, *Amanita cæsarea* (p. 458), the gills of which are yellow. Rules 3, 4, and 6 have more numerous exceptions, but these rules should be followed in all cases unless the collector is content to experiment first with very small quantities and learn the practical result.

THE PRESENT STATUS OF FLAX CULTURE IN THE UNITED STATES.

By Chas. Richards Dodge,
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INTRODUCTION.

A perusal of the historical records in this country shows that flax culture was one of the earliest of colonial industries, and we may be sure that the Puritan maidens, like the Greek maids of old, were familiar with the spinning and weaving of flax, if not with the spindle and distaff of Homeric times, for until comparatively recent years the culture and manufacture of flax in America have been household industries. The American colonists brought with them the art of raising flax and of preparing and spinning it by hand, and even fifty years ago the custom prevailed among farmers of growing flax and having it retted, scutched, hackled, and spun by members of their household. In the history of Lynn, Mass., it is stated that about the year 1630 "they raised considerable quantities of flax which was retted in one of the ponds, thence called Flax Pond." As early as 1662 the State of Virginia enacted that each poll district should raise annually and manufacture 6 pounds of linen thread. All the records of New England likewise gave evidence of an earnest desire to promote the cultivation of flax and its manufacture.

About 1778, according to Mr. A. R. Turner, jr., a number of colonists arrived from Londonderry, bringing with them manufactured fabrics of linen and the implements used in their manufacture in Ireland. The matter was earnestly taken up by the Bostonians, and a vote passed to establish a spinning school on the waste land in front of Captain Southack's, about where Scollay's buildings were. About 1721, at Newport, R. I., "hemp or flax used to be received in payment of interest, the former at 8*d.* and the latter at 10*d.* per pound." Pennsylvania offered premiums for several grades of linen thread in 1753, and the Society for the Promotion of Arts, Agriculture, and Economy of New York, after adopting resolutions to arrest the importation of British goods, offered premiums for linen thread. The early records of Rhode Island develop further interesting facts concerning an association of plantation maidens about 1766. The order was known as the Daughters of Liberty. Its origin is ascribed to Dr. Brown, at whose house eighteen young ladies, belonging to prominent families in Providence, assembled by invitation, and employed the time from sunrise to evening in spinning.

It is not necessary, however, to go back a hundred years, or even fifty years, to learn the story of American household linen manufacture, for a remnant of the industry still exists in the mountains of Virginia, North Carolina, and Tennessee, and an interesting series of the fabrics made in these localities, on the farm, in recent times, has been secured by the writer for the United States National Museum.

SIXTY YEARS OF FLAX PRODUCTION.

The statistical records show that sixty-odd years ago almost three-quarters of a million pounds of flax fiber were produced in the United States, and flax was sent to market from Connecticut sixty years ago that was strong, clean, and as good as any raised in the United States at the present time. Very strong and flexible flax also came from northern New York and Vermont, but it was not clean. The poorest flax of those days came from New Jersey, though the State has been capable of growing flax equal to that of Archangel. In past times "North River" flax was regularly sent to market from New York State, it being very strong, but poorly cleaned.

The figures for flax fiber in the year 1869 show a product of over 13,000 tons; but this does not mean fine linen, but the coarser fiber, or tow, used in the manufacture of bagging. This period marks the highest point reached in fiber product before the collapse of the industry a year or two later, owing to the free introduction of jute for cotton-bagging manufacture.

At the present time flax is largely grown in the United States for seed, the straw, of inferior quality, when used at all, going to the tow mills or the paper mills, and being worth from $1 to $8 a ton, the average in different sections being not more than $2.50 to $4. In the older States the area under present cultivation is very small and steadily decreasing; in the newer States, or States where agriculture is being pushed steadily westward from year to year, the area under cultivation about holds its own one season with another. Cultivation for fiber is beginning to attract attention, however, and it is the purpose of this paper to show what the Department of Agriculture is doing to reestablish this important industry, with statements regarding its present status.

DIFFERENT KINDS OF FLAX.

It is well to consider the different kinds of flax, for representatives of the genus *Linum* are distributed over both hemispheres, though they are chiefly natives of temperate climates. While *Linum usitatissimum* is considered the cultivated fiber species, botanists recognize upward of one hundred species in this genus, De Candolle describing fifty-four in the first volume of his Prodromus. In many instances the distinctions between these species are so slight that the agriculturist or the industrialist would scarcely recognize them, and they are therefore of botanical rather than economic interest. Renouard, in "Études sur le Culture du Lin.," refers to the fact that our gardens sometimes contain three varieties which differ greatly: Two species with yellow flowers, the *Linum trigynum* (*Reinwardtia trigyna*), originating in India, and the *Linum campanulatum*, which comes from southern Europe and from Egypt, and one with red flowers, the *Linum grandiflorum*. Plants with white flowers and flesh-colored flowers are sometimes seen. There are still others known by name only, as the species is very rare; such is the *Linum catharticum*, the leaves of which have a bitter taste and are sometimes employed as a purgative. But among all these varieties the blue flowering, still designated by the name of *Linum commun*, or the *L. usitatissimum* of the naturalists, is the only industrial species and the only one readily cultivated. In the grouping of species two general divisions have been made, those having flowers yellow and those with flowers blue, flesh color, pink, or white, though a special distinction is made in regard to *L. catharticum*, "with flowers always white and leaves opposite." *L. usitatissimum* comes into the group having blue, white, pink, or flesh-colored flowers, though as far as the cultivation of these plants for commercial fiber is concerned, it is the only species that interests us. Regarding the distinctions which separate the species of Linum, Renouard says:

But these are so subtle that they evidently have no bearing upon the industrial uses of the flax and are of no value to agriculture. Often the most experienced operator and the countryman most familiar with this culture have had much trouble to classify the plants as above indicated. Moreover, all these species may be obtained from one sort of seed. What has given rise to these distinctions is that when the flax does not appear all in one growth of stem, slender at the top and without branches, bearing one flower, it may remain short and ramify its stalk to a number of branches having several flowers and considerable seed. It is under this aspect that we see the plant designated as "*tetard*" (pollard, or branched), also called *petit lin* (small, or low flax), in contrast with the ordinary flax, called *grand lin* (tall flax). Besides the above facts we may say that there have never been seen either entire fields or even parts of fields growing only the tetard, or the low flax. We therefore hold it to be inopportune to make such classification of the common flax into industrial species.

Some writers recognize *L. crepitans* as a cultivated species, this form growing less tall than *L. usitatissimum*, with much thicker stems, which have a tendency to branch, and more abundant flowers, and therefore producing more seed. In a report from Consul T. E. Heenan, at Odessa, it is stated that "*L. usitatissimum*, *L. vulgare*, and *L. crepitans* are being cultivated in Russia in several varieties of both kinds, but the difference in these varieties is so slight and they so easily blend that even those initiated in the trade of the article often fail to perceive it."

Several other forms of flax are mentioned by industrial authorities, but they are of little importance. *L. perenne*, which is known commonly as perennial flax, has been the subject of experiment, but beyond the fact that it is mentioned doubtfully as an oil plant in India it does not concern us. And it is also of slight importance from the industrial standpoint that the North American Indians use the fiber of *L. lewisii*, which has a wide range in Western North America, the plant differing from the common cultivated flax in producing usually two or three stems from its stout perennial root and in having a capsule two or three times as long as the calyx. The Indians of the Oregon plains make it into a remarkably strong twisted cord, used in the manufacture of fish nets, in the binding of grass mats and basket frames, and for other purposes.

The most ancient cultivated species of flax is thought to be *L. angustifolium*, a form found growing wild from the Canary Islands to Palestine and the Caucasus. This is the species said to have been grown by the Swiss lake dwellers and the ancient inhabitants of the north of Italy, while *L. usitatissimum* was the ancient flax of Mesopotamia, Assyria, and Egypt. In the Dictionary of the Economic Products of India it has been suggested that these two principal forms or conditions of flax exist in cultivation and have probably been wild in their modern areas for the last five thousand years at least. It is not possible to guess at their previous condition. Their transitions and varieties are so numerous that they may be considered as one species comprising two or three hereditary varieties, which are each again divided into subvarieties.

METHODS OF FLAX CULTURE IN EUROPE.

In order to come to a better understanding of the necessities of the flax industry in this country, as well as of the difficulties surrounding it, the methods of culture pursued abroad may be briefly noted. In Belgium, where the best flax is produced, it is considered essential to bring the worn-out soils to a high state of fertility through the use of commercial and other fertilizers, and this work is done with a thoroughness which would astonish many of our seed-flax farmers of the West who rely on "first breaking" from prairie sod for fertility. Among other materials the sewage from towns is utilized, sometimes mixed with oil cake, and left in closed receptacles or reservoirs until used. Stable manure, free from the seeds of weeds, is spread over the land before winter sets in. More fertilizer is used in spring about sowing time, and the ground is frequently treated with night soil in solution. Stable manure is used in connection with commercial fertilizers at the rate of 500 to 750 pounds of the latter to the acre, with the addition of the liquid night soil. Such heavy fertilizing necessarily adds to the cost of production, while another large element of cost is the land rental, which is often higher than the cost per acre of good farms in some sections of the United States. The preparation of the soil is often laborious, because few of the peasant farmers can afford the improved machinery found on almost any

American farm. What farmer in this country would think of "rolling" a 10-acre tract of land by tramping over it with a couple of broad boards strapped to his feet? And how many of our farmers have continued to use the flail as a thrashing machine? Yet much of the foreign flax-seed is still saved in this way.

There is one point, however, in the European culture, the importance of which can not be too strongly emphasized—the system pursued in preparing the seed bed. Crop rotation is considered a first essential, and while it varies widely in different sections, both as to the number of years and as to the order in which one crop follows another, the results are the same, and we are able to observe that clover is generally considered one of the best crops to precede a crop of flax. The roots are numerous and go deep into the soil, not only furnishing nutriment to the flax roots, but making it easier for them to push their way down.

Many of the smaller flax fields are prepared by the Belgian farmer by spading over the ground. But in any event the ground is thoroughly broken up either by the spade or plow, followed by the harrow, and this is done both in the fall and spring, cross plowing being common, until the seed bed has been reduced to the state of garden soil.

But with all this thoroughness the peasant farmer of Europe is slow and plodding, and therefore can not accomplish the same amount of work that an American farmer can accomplish in the same time. It will be seen, then, that the Belgian farmer or the French farmer is handicapped at the outset by an extraordinary expense account, so much so that flax culture has been abandoned in many sections on account of the losses sustained, and it is still declining.

No recent figures are available, but at the time of the writer's investigations in Europe in 1889 it was learned that the cultivator received from 300 to 1,000 francs per hectare for the raw product, or in American money about $24 to $80 per acre. The net cost of culture in France was about $48 per acre, including rental, and if the crop sold for less than this sum there was a money loss. Unfortunately, such losses were frequent, and failure to meet expenses is largely responsible for the fact that the flax culture of France at the present time is limited to one small province, and the culture here is only continued because of the advantages derived from nearness to the famed Courtrai region of Belgium and the River Lys.

The culture pursued by the peasant farmer of Ireland is wasteful and shiftless in the extreme—so much so that while the expense of cultivation is less than on the Continent, the product shows a decline in the same degree. The Russian practice in many sections is as slovenly, and the fiber when sent to market represents so many different standards, or no standards, that a most careful grading by the buyers is necessitated before it can be marketed. The lower grades are about the poorest flax that appears in the world's market.

There is profit in the better grades of Belgian flax, particularly the fiber retted in the River Lys, which brings an average of 15 to 30 cents a pound; and even higher prices are secured for a superior article from this region.

To summarize the situation in European flax countries, the crop is the object of the very highest and most systematic culture, with the attendant drawbacks of high land rentals, great expense for fertilizers, costly cultivation through plodding methods, and the lack often of high-class agricultural machinery—this latter condition compensated somewhat by low wages of labor—and finally, costly practice in harvesting and preparing the crop and making it into a marketable commodity. The results are sure, however, as far as the production of good fiber is concerned, because the elements of skill and experience are known quantities, and the work is done after very nearly the same methods that have been pursued for generations and generations. There is no doubt about the ability to produce a quantity of flax that has a standard market value, and the only thing to be considered in the agricultural operations is the expense account.

CONDITIONS IN THE UNITED STATES AND EUROPE CONTRASTED.

Now, contrast the situation in this country and Europe, first going back a few years to the time when the Office of Fiber Investigations was established. At this time the importers and foreign agents declared that it was impossible to grow flax in this country, and to prove this declaration a great deal of literature was published, and although presenting no facts to sustain such a condition, served the purpose of increasing the prejudice against flax culture. Many of the agricultural newspapers took up the cry, and some of the farmers reechoed it, with a result that the first efforts of the Department of Agriculture in the direction of reestablishing flax culture was in the nature of missionary work.

THE ADVANTAGES.

The status of the American flax industry at the present time can not better be summarized than by striking a balance sheet between the advantages and the difficulties in its establishment, for it can hardly be said as yet that we have a flax industry. The advantages are fertile lands, which in some parts of the country can be purchased, not rented, for less money per acre than an Eastern farmer spends in a year per acre for commercial fertilizers; the most improved and the best made implements and agricultural machinery in the world for use in producing the crop; intelligence and alertness in the farmer class, many of whom are well posted in all that pertains to scientific agriculture; the advantage of many localities in the country where good flax can be produced, and of some favored sections where a superior product can be grown; possession of a home market for several million dollars' worth of flax fiber—for when we can produce a home supply of fiber American linen mills will increase—and in addition to the supply for home consumption the possibility of a large foreign demand, due to the decline of flax culture in Europe; abundant literature relating to every phase of the subject, with fullest information regarding the proper practice to pursue;[1] and lastly, the present need for diversification in American agriculture.

Regarding the existence of favorable localities for the culture, a few words regarding climate may not be out of place. Much has been said by the opponents of American flax culture in the past concerning the hot, dry climate of the United States in comparison with the cool, moist climate of Ireland; but if the truth must be stated, the best flax is not grown in Ireland, nor is the best flax spun by the Belfast manufacturer produced by Irish farmers, but by the growers of Belgium. The best American flax known to the Office of Fiber Investigation was grown at Green Bay, Wis., where the average temperature for the three growing months was 54° F., and with abundant rainfall. The average temperature of Belfast, Ireland, for the same period was 52.2° F., and for Brussels, Belgium, 55.9° F. The temperature of St. Paul, Minn., near which superb flax was produced in the experiments of 1891, is only a fraction of 1° higher.

Studying the figures for humidity, we are enabled to make further interesting comparisons. For Brussels, Belgium, the average for the three growing months is 77.4 and the average annual 83. For Green Bay, Wis., average for three months 72, and for the year 77.9. For Cologne, Germany, the average for April, May, and June is but 67.1, and the annual but 74 (contrast with Green Bay), while for St. Paul, Minn., the averages are, respectively, 65.6 and 71. On the authority of an expert linen weaver, formerly of Belfast, the average humidity for that weather station is stated to be 70 to 72. The humidity of the State of Washington, as indicated by data from Spokane, Olympia, etc., is found to be almost as great as that of any foreign weather station reported; and from the fact that a fine crop of straw has been produced in "droughty Kansas," with an average of 28 bushels of seed per acre, by irrigation, we may infer that in localities liable to hot, dry spells in the growing season irrigation may be practiced with good results.

The temperature of the leading flax-growing sections of this country and Europe is practically the same, the average for four European weather stations being 54.3° F., and for four in the United States 56.3°, or a difference of but 2°. The humidity for the foreign stations given is slightly higher than that for those of this country, though stations

[1] Among the flax literature published by this Department, Farmers' Bulletin No. 27, on "Flax for seed and fiber," was especially prepared to give concise and practical information on this subject. This bulletin is sent free on application.

indicating greater humidity in the States named and near which fine flax can undoubtedly be produced could have been utilized. So much for the advantages.

THE DISADVANTAGES.

The disadvantages are: The cultivation of a million acres of flax for the seed alone by shiftless practices, which must needs be unlearned before cultivation for fiber can be attempted; too great reliance upon virgin fertility of the soil in newer sections; lack of skill and experience in the handling of a new crop; too much experience, as with some Old World flax growers who have settled among us, this being made apparent in nonadaptability to new conditions and requirements; the lack of several machines needed for economy in harvesting the crop, the most important being an improved thrasher and practical flax puller; the timidity of capital, partly through money stringency, partly through lack of confidence, but largely through lack of knowledge of what is required to start the industry, which must be the result of cooperation between grower and spinner; the inability to properly ret the straw when grown, due to carelessness, to lack of knowledge, and to the want of capital with which to secure the proper appliances for this important work, which is the most serious of all the drawbacks.

The disadvantages in detail.—Coming down to details, it is hard for the grower of seed flax to appreciate the importance of the fine points in cultivation which enter into the growth of flax for seed and fiber, or for fiber alone. To make a success of culture for seed and fiber, the land must be brought into the most thorough tilth. The old plan of turning over the sod will not answer, and if the land is not sufficiently fertile it must be made so by the application of manures. Any and all kinds of seed are sown, when the best of results can only be secured by the use of the best imported seed; and even in the purchase of imported seed there is a possibility of imposition. The old system of planting 2 pecks of seed to the acre must be abandoned and 1½ to 2 bushels used, and for the growth of fine fiber alone 2½ to 3 bushels will not be amiss. The increase in money value of fine fiber represents so much more than the total value of the best of seed for oil purposes that a farmer can well afford to sacrifice the seed when trying to produce a superior flax. More care should be given to the prevention of weeds, and to their extermination when they appear. The ill effects of drought, so disastrous to flax culture in some sections, may be avoided in a measure by irrigation; and that irrigation will be advantageous in many localities almost any season there can be little doubt.

There seems to be only one large use for the rough flax straw that is produced where the 2-peck per acre sowings are followed in growth for seed, and that is the manufacture of paper. When a single New York daily newspaper uses 90 tons of wood-pulp paper in a day, we may well wonder how long the forests can be relied upon for supply of raw material. If this rough flax straw can not be utilized in paper manufacture, it is difficult to see how it can be made of money value, for a very small part of it will supply the demand for coarse tow and very little of it has any value for flax fiber. Our farmers must not delude themselves into the belief, therefore, that they can make much of a fiber industry out of the present flax culture for seed with the practices usually followed.

The importance of keeping up the fertility of the soil should be fully appreciated. In all new countries the tendency is to underrate the necessity of returning to the soil that which is taken from it, and the growth of all fiber plants makes heavy demands upon the soil. Although the plant as a whole takes considerable from the soil, the fiber alone takes proportionately little, and it follows, then, that the entire destruction, or at least removal, of the straw, as has been the custom in this country, makes the culture an exhaustive one. To this extent, and to this only, is flax an exhaustive crop, and the remedy readily suggests itself. In water retting, when the operation is carried on in pools, it is possible to return to the soil a portion of the elements of fertility that have been taken from it by using the steep water as a form of liquid manure. In river retting, as practiced in Courtrai, in Belgium, the soluble elements of fertility are washed away and lost, though the part represented in the waste from the straw, after scutching, may be returned. But in any event, to produce a fine quality of flax fiber, the necessary elements of growth must be present in the soil or be supplied by artificial means.

EXPERIENCE IN FLAX CULTURE NECESSARY TO SUCCESS.

Regarding the difficulties that come from lack of experience in handling the crop, these can not be surmounted at once, and the growth of the crop must be in the nature of an experiment for the first two or three years. One of the nice points to be considered is the proper time to harvest, in order to save both seed and fiber in the best condition, or, if the seed is sacrificed, to produce a crop of fiber straw that at time of harvest will be evenly grown and evenly ripened, or, in other words, pulled when in the proper condition to give the largest quantity of product that will yield the best quality of fiber. Another important point is the proper drying of the straw after pulling, particularly when water retting is to be followed. This matter is of less importance when the straw is dew retted, but it is an essential point in pool retting when a light-colored fiber is to be produced, and particularly so when the growth is for fine fiber.

In regard to "too much experience," brief reference may be made to these Old World flax farmers who, bringing to this country Old World ideas, adhere to certain plodding practices of the fatherland inapplicable to our own conditions, and who never learn, or care to learn, anything new. Positive failures have been made in this country by such men, who doubtless may have been reckoned good flax farmers at home. The successful man in the American flax-fiber industry will be the man who has come to a full appreciation of the conditions which surround the industry in the United States, who has mastered the difficulties and acquired skill through experience, whether a native or alien, and not the man who clings to practices learned in his boyhood in another part of the world.

LACK OF LABOR-SAVING MACHINERY FOR FLAX CULTURE.

The lack of certain kinds of improved labor-saving machinery has proved a serious drawback. Much has been written about flax-pulling machines, but it can not be said that invention in this direction has as yet been successful. The pulling of flax is essential to the production of proper spinning fiber. It is one of the expensive operations of the industry and a kind of labor that American farmers are averse to performing. Moreover, pulling flax is one of the foreign practices which many of our adopted farmer citizens leave behind them when they come to this country, many of them being even more averse to performing such labor than is the native American. The necessity, therefore, for a machine flax puller should be fully appreciated, and the need of an improved thrasher to remove the seed without injury to the straw is almost as urgent. A practical machine scutcher is another desideratum, for the fact remains that notwithstanding the many inventions of such machines that have been brought to public notice since these investigations were begun, the Department of Agriculture can not state authoritatively from experience that there is one which may be recommended as successful. Attention has been called recently to a new foreign invention in this line, but until its merits have been fully investigated this office can make no statements concerning it.

COOPERATION AND CAPITAL ESSENTIAL TO FLAX CULTURE.

Before referring to the part that capital must play in the establishment of this industry it will be well to review the scheme of cooperation in the different branches of the industry that the Department recommends as essential to making flax culture in the United States a possibility.

As the case stands, the farmer is hardly in position to grow flax, save in an experimental way, until he is sure of a market, and the manufacturer, that is, the spinner, is not in a position to make offers of purchase or to name a price, because he is not sure that the farmer can grow flax of the proper standard or that he can afford to purchase at any price, for his particular manufacture, such flax as the farmer may produce. This simply means that what isolated farmers can not accomplish alone must be accomplished by the establishment of little local industries, that is to say, capital must establish scutch mills in localities where flax may be profitably grown, farmers of the neighborhood agreeing to produce 5, 10, or 20 acres of straw each, under the direction, if need be, of the managers of the mills, to insure the growth of a quality of straw that will give the proper standard of fiber. It means that there is a necessity for a class of skilled workers who will come between the farmer and the manufacturer in carrying on the operations of retting and scutching. It is futile to expect the farmer to ret and scutch his flax. It is not done on the farm in foreign countries, nor in Canada, save to a very limited extent, and it will not be done here. It is done largely in Russia, and low-grade fiber requiring most careful sorting by the buyers is the result. By such a cooperative arrangement the farmer is relieved from any responsibility in the matter further than to produce a proper crop of straw. The scutch mills or tow mills attend to the retting and cleaning of the fiber, which in turn is sold to the spinner. One good scutch mill will prepare the flax grown on a score or more of farms, and as the work is accomplished under one direction, the product will be far more even as to standards than would be possible were it prepared by twenty men. The scutcher has a money interest in the matter of the production of properly grown straw by the farmer and is in position to aid him by many hints and suggestions. In Canada and northern Michigan (in the neighborhood of Yale, where there are successful scutch mills) the practice is to sell the seed to the farmers at the mills at a fixed price per bushel, the farmers agreeing to sow a certain number of acres to flax, the straw of which the managers of the scutch mills agree to take at a fixed price per ton, in some cases $10 being named.

Having shown the part that capital must perform in this work, the slow advance that has been made in establishing the industry will begin to be appreciated. One of the chief reasons why beginnings have not been made in favorable localities is that the necessity for such cooperation is not understood. The employment of capital in a thoroughly systematized effort to work out a fixed idea to a practical end is one thing, but the organization of a mere "company," with no definite aim beyond a desire to make money out of something, is quite another thing. The capital invested should be home capital, used in the town where the flax is grown by establishing and running a retting and scutching enterprise to turn the farmers' straw into a salable fiber product. The moneyed men of the town may be the stockholders in this enterprise, or the farmers themselves, with a few business men of their community, may establish and conduct the business, the main essential being to secure as superintendent of the mill a practical man, that is to say, one who thoroughly understands retting and scutching flax.

Such men are not readily available, the farmers themselves do not always know just where to begin, and it is not to be wondered at that capital has been "shy," particularly in a period of money stringency such as the country has experienced in the past few years. Some one person in the community must take the initiative, but it should be said most emphatically that only failure will follow the efforts of the man without knowledge whose energy is directed toward selfish ends alone. It is unfortunate that many worthy enterprises in this country have not been able to survive the "boom" stage, for instances might be recorded where a good, healthy beginning in a new industry has been stifled—"boomed" to death—by claims that could not be substantiated, by the advertising of profits that could only appear on paper, and by the heralding of success before it had been assured. The effort to set the flax industry on its feet has not been exempt from this injurious practice, and too often harm has been done in spite of perfectly honest intentions on the part of those who were responsible for the agitation.

Unless it has already been proved by previous experimentation that the locality is favorable for flax growing, the first thing to be done is to sow an experimental plat, if it be only 5 acres. When it has been demonstrated that a good quality of straw can be produced there will be time to effect an organization for the establishment of a mill plant. In such an enterprise the capital invested need not amount to more than $20,000 to $30,000 at the outset, for the mill plant can be extended when there is a demand for greater facilities and success has been assured. In the first years of the reestablished American flax industry there will be no necessity for the formation of stock companies on a large scale, located in metropolitan centers, nor for buying up of scores of patents for machinery of doubtful utility, nor for costly experiments in impracticable "short-cut" processes for preparing the fiber. First, then, let us grow flax, then establish companies as the necessity for capital and the organization of effort in the development of the local industry demands their reformation.

PRACTICAL AND TECHNICAL KNOWLEDGE REQUIRED IN TREATMENT OF FLAX.

The next serious drawback to the success of this industry is the lack of practical knowledge regarding the standards of spinning flax by those who undertake experiments, as well as of technical knowledge in retting the straw when grown. Many superb samples of straw have been received by the Office of Fiber Investigations, which, with proper treatment, should have yielded a superior flax product, but from which only a harsh fiber, and, on this account, a fiber of inferior quality and little commercial value has been secured. The truth of this is proved by samples in our collection from the same lots of straw, but retted and scutched by different operatives under widely different conditions.

These deficient samples show nothing but lack of experience, and, in some instances, carelessness, in the one operation of retting. The best commercial flax is produced by immersion of the straw in river water, with subsequent drying, and frequently with a second immersion. It is not necessary to enter into the details of this operation here, but the skill lies chiefly in being able to control the conditions under which the work must be accomplished, and in the possession of good judgment regarding the proper time to take the straw out of the water, guided by the appearance of the straw and its action under certain manipulation in the hands. A previous knowledge regarding the temperature of the water, and of its softness or hardness, or, in other words, its chemical constituents, and of the mechanical impurities that may be suspended in it, is essential, that adverse conditions may be adjusted or avoided.

Properly prepared flax possesses marked peculiarities, which are at once made apparent to the touch, to the smell, and to the eye. Salable flax must have brilliancy or "life," with softness or oiliness, and an odor which, though difficult to describe, is easily recognizable by anyone who has handled good flax. These points are of first importance, because upon the manner in which the crop is retted its commercial value largely depends. Much has been written concerning quick-retting processes, that is to say, artificial processes, chemical or otherwise, by means of which to lessen the labor of "nature" retting (that is, dissolving out the gums by the natural operation of steeping or soaking), but considering the fact that the great bulk of the world's commercial flax is "nature" retted, it may be assumed that this form of producing the fiber gives the best results. In the present age of scientific investigation it would be unwise to say that a quick-retting system, which will give as good results as the nature method, is not a possibility, but in any event, when such a system is assured, the flax producer can study the question for himself and decide which method he will employ.

RESULTS OF PRACTICAL EXPERIENCE IN FLAX CULTURE.

Having considered in detail the difficulties attending the reestablishment of the flax industry in this country, brief reference may be made to some of the results that have been accomplished.

By experimentation in fifty or more localities in the United States, where flax cultivation was thought possible, the Department has proved the fallacy of the opinion widely prevalent less than a decade ago, that flax could not be produced commercially in the United States. By these experiments it has not only been proved that commercial flax production is possible, but that good fiber and good seed, with careful culture, can be produced in the same plant. In one of these experiments, by a skilled flax grower in Wisconsin, a profit of $229 was shown on a 6-acre tract, and $60 of this sum was received for seed, at $1 a bushel. The expenses per acre, including retting and scutching, the latter operation costing $20 per acre, amounted to a little more than $35 per acre. The flax produced was worth 11 cents per pound, while a great deal of the flax fiber imported into this country is laid down at 8 and 9 cents per pound.

Northern Michigan has successful scutch mills and an old established flax industry, the same producers also operating in Canada. In this section the practice is to sell the seed to the farmers, at the mills, at a fixed price per bushel, the farmers agreeing to sow a certain number of acres to flax, the straw of which the managers of the scutch mills agree to take at a fixed price per ton. This method has already been referred to.

The most important results have been attained on the Pacific Coast, where, as in the Puget Sound region of Washington, an ideal flax climate has been discovered through the experiments of the Office of Fiber Investigations. These cultural experiments developed the fact that for flax culture the Puget Sound region is the equal in climate of some of the best flax-producing regions of Europe. The superior quality of straw produced, which resembled the straw of the famous Courtrai region of Belgium, attracted the attention of the Barbour Company, of Lisburn, Ireland, resulting in this firm undertaking a retting experiment in Ireland with a ton of Puget Sound straw. With Mr. Frank Barbour's report was received a large series of flax, the best scutched fiber of which was valued by him at $350 per ton. Out of this lot, however, flax was hackled worth 12*d.* per pound, or about $500 a ton. There is no doubt that with experience a better quality of straw can be grown in this region than that produced in the Department's experiment. Only 1½ to 2 bushels of seed were used per acre, while in Belgium 3 bushels are oftener seeded per acre. In this experiment over 7 tons of straw were produced upon 5 acres, and also about 70 bushels of salable seed. The experiment demonstrated conclusively that it is possible to produce very fine fiber and good seed in the same plant. Mr. Barbour's report closes with the statement that "if the flax is grown and manipulated under proper conditions and by people who thoroughly understand the business, in Puget Sound, we are convinced that the cultivation of it would be of the greatest importance, and in a short time would rival the great Belgian district of Courtrai."

With such testimony as this, why should there be further hesitation? The farmers are ready in this region, but as already shown, the farmers must have the assistance of organized capital, and up to the present the moneyed interest has held aloof.

During the past season, in Oregon, under the auspices of the

Woman's Flax Fiber Association, and through the special efforts of Mrs. W. P. Lord, of that State, a great interest in the culture of flax has been developed, and already foreign manufacturers who have visited the locality have made most encouraging statements regarding the future possibilities of this region, not only in the direction of a profitable flax culture, but of a linen industry as well. Admirable samples of flax produced in this experiment have recently been received by the Department.

Even Alaska can grow flax. Being aware that superb flax is grown in northern Russia, the writer has for some time been impressed with the fact that good fiber could be produced in our most northerly possessions. Last winter such experimentation was urged, and this season a small experiment was carried on privately, the results of which were viewed by Dr. W. H. Evans, of the Department, who visited Alaska officially. The flax was grown from "drug-store" seed. It was planted in June, and by the first week in September it had blossomed and the seed capsules were forming. The straw grew 30 inches high, and was straight, slender, and fine, and not at all woody; and, without having been retted, a fine, strong filament was readily rubbed out between the hands. Specimens of the straw have not yet been received, but they will be studied with interest when they arrive.

CONDITIONS FAVORABLE TO THE REESTABLISHMENT OF THE FLAX INDUSTRY.

There is no doubt about our ability to grow commercial flax if the people will only make beginnings, and go to work in earnest with the idea in view first to establish the industry, and to make money out of it afterwards. The time is ripe for the establishment of the industry, as is proved by the profound interest that has been awakened in our experiments by foreign manufacturers. The Barbour Company, of Lisburn, Ireland, certainly did not transport a ton of the Department straw from the State of Washington to their Irish mills, and ret and scutch it at their own expense, from pure philanthropy, whatever good will may have been shown in making the experiment. During the past three years the Department has had many letters and inquiries from buyers of flax fiber in Europe, and putting all these facts together, it is evident that the wind is blowing in our direction, and that we shall be the losers by not taking advantage of the opportunity while it is in our grasp.

The flax plant is now widely distributed throughout the world. It is cultivated in portions of South America, especially in Argentina, though more for seed than for fiber. It is produced commercially to a greater or less extent in Great Britain (Ireland especially), Sweden, Denmark, Holland, Belgium, France, Russia, Germany, Austria, Spain, and Portugal. It has been introduced into Algeria and into Natal. In India large tracts are under cultivation, though more for the seed crop than for fiber. Japan has introduced its cultivation commercially, and it has been experimented with in the Australian colonies, where there is a wide range of soil and climate suited to its growth. For the present, however, our serious competition must be with Europe, and Europe has a failing supply. Is it not wisdom to begin at once, with a view to producing within our own borders the supply of raw-flax fiber needed in the home manufacture of twine, flax threads, crash, and linen? The cotton-manufacturing industry is leaving New England for the South, and linen manufacture will eventually take its place, for the movement has already begun. The establishment of a linen-manufacturing industry in New England would soon create a demand for double the quantity of raw flax now consumed, and American farmers should supply this demand.

CONCLUSION.

The Office of Fiber Investigations of the Department is always ready to answer questions, to give information regarding the industry, and to examine and report upon specimens that may be forwarded for examination and expert opinion. And, as the needs of the new industry call for further experimentation in the different branches of the work, the flax investigations will be carried on as far as the means of the Department will allow.

LEGUMINOUS FORAGE CROPS.

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INTRODUCTION.

Leguminous crops play a very important part in agriculture. Their cultivation is being deservedly extended, and the increase in acreage devoted to their growth will undoubtedly continue until their full utilization as soil renovators and as cheap producers of fodder rich in nitrogenous compounds is attained.

HISTORY OF CULTIVATION.

The oldest cultivated forage plants and the best for enriching the soil are those of the clover family. Not one of the now well-known hay or pasture grasses has been cultivated more than three hundred years, while a number of leguminous crops have been grown for forage from prehistoric times. The chick-pea, or gram, dates back full thirty centuries. It is to-day one of the leading grain crops and soil renovators of Spain, India, and central Asia.

Alfalfa, which is recognized as the best forage plant in the semiarid Western States, or wherever dependence must be placed upon irrigation, was cultivated by the Romans at least two hundred years before the commencement of the Christian era. The soy beans have been grown in China and Japan, and lentils in Hungary, from prehistoric times. The field pea, originally from northern Italy, was introduced into cultivation eight or ten centuries ago. Sainfoin was grown in France and red clover in Media during the early years of the fifteenth century, and white or Dutch clover in Holland at the beginning of the eighteenth century. Sulla, which is largely grown in southern Italy and northern Africa, and which seems to be admirably adapted to well-drained soils in Florida and the Gulf States, was first introduced into cultivation in 1766. The cowpea has been known in this country nearly as long as sulla. Alsike or Swedish clover was taken up as a forage about thirty years later, while during this century and within recent years a score or more of valuable legumes have been brought to the attention of the farmer, and hardly a year passes that new ones are not added to the list.

There are now in cultivation as forage plants upwards of seventy different kinds or species of plants of the botanical order *Leguminosæ.* This family of plants includes, among others, the clovers, vetches, lupines, beans, peas, beggar weeds, sainfoin, alfalfa, velvet bean, cowpeas, serradella, and melilotus.

FEEDING VALUE.

All green plants during the process of growth take carbonic acid gas from the air and water and soluble mineral salts from the soil and build up by the life processes the starch, sugars, fiber, oils, and other carbohydrates of the plant body. In addition they gather through their roots such compounds of nitrogen, mostly in the form of nitrates, as are available or are soluble in the water of the soil.

Leguminous crops alone of all those in cultivation have the additional power of drawing directly upon the enormous and ever-present supplies of atmospheric nitrogen. They transform it into crude protein, which is so valuable and so necessary as an animal food, and also into fertilizing compounds which, when left in the soil with the roots and stubble, may be utilized by succeeding nitrogen-feeding crops.

Nitrogen in the plant occurs in the protoplasm or life substance of every plant cell and in certain unstable compounds which approach in chemical composition gelatin or the white of an egg. The sum total of nitrogenous compounds in the plant is referred to by chemists as "crude protein," or albuminoids. The function of crude protein in plants is like that of albumen in the animal body. Without it neither animal nor vegetable existence is possible.

Following the process of digestion of food by a herbivorous animal, the carbohydrates become the sources of heat and energy, and whatever surplus remains above immediate wants is stored up in the animal carcass as fat. The crude protein is used during growth in the production of new tissues and in the repair of worn-out ones. Its nitrogen enters into the fibrin of blood, the albumen of muscle, the gelatin of bones and tendon, the casein of milk, and to a certain extent into the surplus fat. None of the animal albumens can be formed unless there is digestible crude protein in the food. Hence, the digestible crude protein in the fodder is its most important constituent.

To produce flesh and blood or any albuminous compounds within the animal body a ration containing crude protein must be fed. Determinations have been made of the exact proportion in which the different forage elements must be used to produce the greatest gain at least cost. Thus, a milch cow of 1,000 pounds live weight requires 24 pounds of dry, organic matter per day, of which about 16 pounds must be digestible. The ratio between the digestible crude protein and the digestible portion of the fats, nitrogen-free extracts, and fiber is known as the "nutritive ratio."

COMPARISON OF RATIONS.

The fats have two and one-fourth times as much heat value as starch and fiber, which is taken into account in determining this ratio. Where the percentage of digestible crude protein is large in comparison with that of the other digestible constituents, it is spoken of as a narrow ration, while a wide ration is one in which the percentage of digestible crude protein is small compared with that of the whole. The ration is "complete" if all the essential food elements are present in the right proportions.

It has been found as the result of numerous feeding experiments that a narrow ration is a much more economical one to feed than a wide one, especially in the production of milk or in promoting a rapid and continuous growth in the case of young animals. Thus, it will be seen that for the most economical, and hence the most scientific, method of feeding, it is necessary to use forage crops which contain a large percentage of digestible crude protein, rather than those which are richest in starch, sugars, gums, and oils.

Of the coarse fodders, those richest in digestible crude protein are the various legumes. The leguminous forage plants are superior in feeding value to the true grasses, because they usually contain a larger proportion of digestible protein. The most economical and most profitable method of feeding domestic stock is to feed according to the rules which have been laid down as the results of scientific experiments. In feeding two rations, a narrow one which provides for the actual needs of the animal, and a wide one, weighing as much as the first but deficient in crude protein, the former will be the most economical. The rate of gain will be greater and the relative cost of every pound of gain according to the amount of food consumed will be less. Looking at the forage question from this standpoint, it can be seen at once why the cultivation of leguminous forage plants ought to become more extended. If the necessary crude protein is bought in the form of wheat bran, cotton-seed meal and hulls, gluten meal, or any other of the so-called concentrated foods, it is necessarily expensive. But, grown upon the farm in the shape of leguminous forage, the essential crude protein may be procured at no greater outlay than is necessary in the production of forage crops of less feeding value.

USE OF FODDERS IN RATIONS.

The coarse fodders and concentrated food stuffs should be combined in the daily ration of every animal on the farm according to the laws that govern the disposition within the animal body of the digestible crude protein, fat, and carbohydrates. Knowing that the best nutritive ratio for a milch cow is about 1:5, it is absurd to feed a 1:10 ratio and expect the best results.[1] Tables giving analyses of American feeding stuffs and their digestible constituents have been published by the Department of Agriculture and by almost every State experiment

[1] A 1:5 ratio means that the forage contains five parts of digestible carbohydrates to one part of digestible crude protein.

station, so that ignorance of the reasons for feeding rations of a definite composition can no longer be advanced as a valid excuse for the wasteful use of fodder.

Leguminous forage plants are of vast importance to those farmers who would adopt scientific methods. They are the cheapest sources of crude protein. Other crops, in order to manufacture crude protein, must have the full equivalent of inorganic nitrates present in the soil. As already stated, these plants alone can draw nitrogen from the air as well as from the soil. By the use of leguminous crops the farmer may produce upon his own land fodders which approach in feeding value the various meals and oil cakes, and at the same time be growing a fertilizer crop that will supplant the expensive nitrogenous saltpeter, guano, bone, fish scrap, and animal wastes that otherwise must be purchased.

FERTILIZING VALUE.

It has been noted by competent observers that the point of decadence in the agriculture of a country is marked by the decreasing acreage devoted to the growth of forage plants. It is also true that, other things being equal, the rate of deterioration in the soil fertility is less in pastoral regions than where grain and the more specialized crops are raised. There is a constant drain or leakage of plant foods from all cultivated lands, but the annual loss is least where the farm produce is marketed in the shape of meats and animal products. The agricultural wealth per capita is higher in communities where the principal line is the growing and fattening of cattle, or the production of bacon, milk, butter, wool, and cheese.

In the cattle-growing States the rate of profit on investment may average as high as from 20 to 35 per cent per annum among those who thoroughly understand the cattle business. On the dairy farms which supply the great cities of the land the same high rate of earnings often prevails. This condition of affairs is, in a measure, due to the fact that much of the most valuable fertilizing elements of the forage plants used are returned to the land, combined in a form well adapted to the growth of succeeding crops, while only a minimum amount is lost from the holding of the producer. The land thus used becomes richer instead of poorer.

The production of forage crops and their use upon the lands where they are grown becomes, then, one of the best agricultural practices. But in growing and feeding the forage crops, as in all other branches of farm industry, it is necessary to use those plants which will give the greatest returns for the least given outlay in the shape of the fertilizing elements removed from the soil. Farmers have long recognized the necessity of leguminous crops in a feeding ration or a field rotation. Thus, a mixture of red clover and timothy was known to be a better ration than timothy hay alone long before chemists had worked out the laws which govern the proportions between crude protein and the carbohydrates in a well-balanced food. And it has been known since the days of the earliest Roman agricultural writers that the cultivation of leguminous crops upon a field tended to improve the soil.

HOW LEGUMES IMPROVE THE SOIL.

Modern agricultural chemists searching for the true answers to these problems have discovered that leguminous crops are not only consumers of available plant foods, but that they actually manufacture the most valuable and most essential nitrogenous compounds, using the free gaseous nitrogen of the air. This transformation of an inert gas takes place through the agency of minute, almost infinitesimal bacteria, which live within the tissues of the roots of plants of this order, producing knot-like swellings or galls upon them (fig. 17). Each variety of legume has its own peculiar bacterium, on whose presence it is dependent, and unless its particular species of bacterium comes in contact with and infests the roots, the plant can not get more nitrogen than could be secured by the roots of a grass or tobacco plant. It can then only take up such nitrogen as is already present in the soil in available or soluble form. If these bacteria are entirely absent from the soil, the clover or bean will not fully develop unless an abundance of soluble nitrates are present.

This wonderful dependence of plants of the clover family upon the minute bacteria which live within the root tissues offers an explanation of the failure of such crops when tried upon soils not previously devoted to their cultivation. It has been found by experiment in this country and abroad that such new leguminous crops may be successfully cultivated by inoculating the land either with artificial preparations or cultures containing these germs, or with soil from a field where this crop has been previously grown. Good results are also sometimes secured by treating the seed preliminary to sowing. By such an inoculation the yield of total dry matter has been increased sometimes from tenfold to thirtyfold. Moreover, it is found that there are no gall tubercles formed on the roots of leguminous crops when these nitrogen-bacteria are not present in a soil, and hence there can then be no utilization of gaseous atmospheric nitrogen by them.

Nitrogen is the most important plant food. It is the most expensive fertilizer when purchased in artificial manures. It is also the most necessary element of animal foods; for when it is entirely absent, or present in insufficient quantities, there can be neither growth nor the complete repair of worn-out tissue. Hence, it can readily be understood why the abundant cultivation of leguminous crops is so necessary. The legumes are the only crops which will, when plowed under, increase the total of fertilizing materials of the soil.

MECHANICAL EFFECT OF DEEP-ROOTED LEGUMES.

Leguminous crops are, furthermore, valuable soil renovators, because they are deep feeders. Their roots extend down into the stiffer and more compact subsoil, loosening and opening it to the action of the air and rendering it more permeable by water. The roots bring up from below great quantities of potash salts and phosphoric acid and leave them near the surface, where they may be utilized by potash-devouring cereals, tobacco, and root crops.

In sandy soils and reclaimed marsh lands or in soils containing large amounts of organic matter the quantity of potash is usually deficient. Here the deeper-rooted legumes, such as gorse, broom, alfalfa, lupines, sulla, and the perennial beans, may be of great value, not only taking nitrogen from the air, but potash from the subsoil, and increasing the quantity of both of these fertilizers in the surface layers of the soil. The roots and stubble largely increase the quantity of organic matter left at the disposition of surface-feeding crops. The rank-growing velvet bean, cowpea, soy bean, melilotus, and beggar weed are on this account valuable annual crops for use in the improvement of the heavier clay soils, which usually have an abundance of potash but lack humus. The humus acts as a storehouse for nitrogen, potash, and phosphoric acid, improves the physical condition of the soil, and increases its capacity for retaining water in time of drought, especially in the presence of an abundance of lime.

There is opportunity for a great saving by American farmers, and hence a greater profit, if leguminous forage crops can be extensively substituted for those of less feeding and fertilizing value. There are leguminous crops which yield as heavily as the better hay grasses and which require no greater care and attention. There is as wide a range of varieties adapted to all the varying conditions of temperature, soil, and climate. If by the use of clovers, soy beans, vetches, alfalfa, cowpeas, and velvet beans the cost of producing beef, pork, mutton, wool, milk, butter, and cheese could be lessened by ever so little, the aggregate gain to the whole farming population and the country at large would be enormous.

RED CLOVER.

Red clover grows best upon deep and well-drained calcareous loams. It is not so well adapted to the lighter sandy soils, to heavy compact clays, nor to gumbo prairie soils. Underdrainage and a plentiful supply of rainfall during the season before flowering have a marked influence on the yield. Red clover is the standard hay crop of the Northern and New England States, and is becoming every year more widely cultivated in the central prairie region. In the South and in the Pacific Coast and Rocky Mountain States other crops are more successful, and there red clover is only grown in localities where the soil conditions favor it.

The seed is usually sown with grain from March to May or, when intended for a spring soiling crop, from the middle of July to the first of August, without a nurse crop. Twenty pounds of seed are required per acre. The first crop of hay is ready to cut in June. The second crop is generally considered the best for seed, but the condition which governs seed production is the prevalence and abundance of bumblebees, upon which the clover blossoms are dependent for fertilization. The yield of seed per acre varies from 3 to 9 bushels of 60 pounds.

The best time to cut for hay is at full bloom, when not more than one-fifth of the heads have commenced to turn brown, while the leaves are ripest and the stems are still green. The content of digestible crude protein is greatest at this period. After flowering the percentages of crude ash, fat, and crude protein decrease and that of crude fiber and nitrogen-free extract increases until the seed is ripe and the plant reaches full maturity. The yield is also heaviest at the period of full bloom because of the loss of the lower leaves as the stems ripen. The nutritive ratio[1] of freshly cut clover at time of full bloom is about 1 to 5.3, while that of the hay ranges between 1 to 4.3 and 1 to 5.9. The average composition of clover hay according to a compilation from all available American analyses is, in 100 pounds, 15.3 pounds water, 6.2 pounds ash, 12.3 pounds crude protein, 24.8 pounds fiber, 3.3 pounds fat, 38.1 pounds nitrogen-free extract. Of the crude protein, 6.58 pounds are digestible. At the Massachusetts Experiment Station a ton of clover hay contained 46.8 pounds of nitrogen, 9.7 pounds of phosphoric acid, and 49.3 pounds of potash, the manurial value of which was $10.64, estimated at the same prices as were paid for these substances when purchased in commercial fertilizers.

Red clover will not grow in soils containing an excess of organic acids. It is believed that "clover sickness," which prevents the growth of clover upon the same field for an indefinite period, is due to the formation of an excess of humic acids which interfere with the growth and development of the nitrifying soil bacteria. When such a condition arises in the soil an application of lime neutralizes the acids and restores its fertility. To prevent the one-sided exhaustion of any soil which follows the continuous cultivation of this crop and to utilize its full value as a gatherer of nitrogen, red clover should only be used in rotations.

The best fertilizers for red clover are lime upon all acid soils, muriate or sulphate of potash on sandy soils, and superphosphates on the heavier clay soils. An application of well-composted manure, or liquid manure, will prove of benefit to any leguminous forage crop

[1] Computed from tables in Appendix to Yearbook of Department of Agriculture for 1896.

when there is enough lime in the soil to combine with the humic acids produced during decomposition; but large amounts upon land already rich in humus do not usually give a satisfactory increase either of the crop or its crude protein; neither do commercial nitrogenous fertilizers seem to materially increase the total quantity of crude protein in the hay.

ALFALFA.

Alfalfa (fig. 18, page 500) is probably the best known and most widely cultivated of all the leguminous forage plants, although in point of date of introduction into this country it does not compare with red clover or cowpeas. Originally of European origin, it was introduced into Mexico by the Spaniards at about the time of the Conquest; thence it spread to Chile and Peru, and was finally brought to California in the year 1854. Previous to this time it had been grown experimentally in various parts of the East, perhaps as early as one hundred years ago, but never on an extended scale. Alfalfa is well adapted to withstand extremes of temperature and summer drought; so that it at once found favor, not only in California, but throughout the Rocky Mountains and Plains regions, and the acreage devoted to this crop has increased with each succeeding year.

Alfalfa is a deep-rooted perennial, growing ordinarily from 1½ to 2 feet, or rarely 3 or 4 feet, high. Wherever the roots find loose and permeable soil they descend to great depths, ordinarily from 8 to 20 feet, though cases are recorded where the roots have been found at a depth of 50 and 60 feet below the surface on river banks in sandy soils. Its successful cultivation depends largely upon the character of the subsoil. Alfalfa will not do well on any soil, no matter how rich or well prepared, if the field is underlaid by an impermeable subsoil, or by rock or hardpan. Neither will the crop stand flooding with stagnant water. Good drainage is absolutely necessary. This crop is affected perhaps more largely than any other generally grown in this country by excess of water.

This forage plant is not so well adapted to use as a pasture plant as many others, although it is quite a general practice in the West to graze alfalfa at certain seasons of the year. It has been found by experiment that the total yield of hay or green fodder will be larger where the field is not pastured. When an alfalfa field is grazed the soil is trampled and packed too much. Moreover, when the stems are cut or grazed the stalk dies down to the very base. The new shoots come from the upper part or crown of the root. The stems of many other forage plants when cut or broken branch out above the ground, forming lateral shoots that immediately grow up and take the place of the old stems; but with alfalfa the vitality of the roots may be much impaired if the young stems are grazed as fast as they appear, because the new growth comes directly from the root itself and not from the bases of the old stems.

FIG. 1.—ALFALFA, BELLE FOURCHE, SOUTH DAKOTA, 1897.

FIG. 2.—SOY BEANS GROWN IN GRASS GARDEN, U. S. DEPARTMENT OF AGRICULTURE, WASHINGTON, D. C.

Alfalfa requires clean ground, and should never be sown on weedy or poorly prepared fields. The seedlings are very susceptible to changes of temperature, and are more tender than those of red clover; so that they are more liable to be crowded out by weeds or a nurse crop.

In Louisiana alfalfa is grown in two-year rotations upon low, alluvial valley lands, and may there be cut at intervals of from six to eight weeks throughout the season. In the Northern States three crops per annum is perhaps the average.

CUTTING AND CURING ALFALFA.

Alfalfa should be cut for hay (Pl. XXXI, fig. 1) at the time the first flowers appear. After that period the stems rapidly become woody, the amount of crude fiber increasing and the amount of fat and crude protein decreasing until the seed is fully ripe. The yield is slightly greater at the time of full blossom, but the quality of the hay is not so good as that cut a few days earlier, when fewer flowers have opened. After the period of full blossoming the lower leaves commence to fall, and as there is a much larger percentage of crude protein in the foliage than in any other part of the plant it is desirable to retain as many of the leaves as possible in the forage.

The average yield of hay is higher than with red clover, amounting to nearly 4 tons per acre. Yields of 6 to 10 tons of dry hay per acre in one year are sometimes reported. On land adapted to its cultivation, alfalfa does not attain its fullest development until after the third year, and if the land is occasionally partially broken up and fertilized with lime and fertilizers containing potash and phosphoric acid it will hold the land, yielding three annual crops, for twenty-five or fifty or even one hundred years.

Alfalfa is more difficult to cure into good hay than some of the other leguminous forage plants, because the leaves break off very easily. For this reason the hay is cured in windrows or is made up into small piles 5 or 6 feet high and as narrow as will stand, using the same precautions to prevent heating and molding as are customary with other succulent hay crops. The second crop is the one usually cut for seed. The third crop contains the largest amount of crude protein. Stacks of alfalfa, whether cut for hay or seed, will not turn rain, and a cap, or stack cover, of grass, hay, or canvas should be used. The average yield of seed ranges from 5 to 10 bushels per acre, and, as there is always a good demand for alfalfa seed, it is one of the best money crops of the Western farmer.

FEEDING AND FERTILIZING CONTENTS OF ALFALFA.

One hundred pounds of freshly cut alfalfa contain at time of flowering 28.2 pounds of dry matter,[1] and of this the amount digestible

[1] Appendix to Yearbook of the Department of Agriculture for 1896.

is 3.89 pounds of crude protein, 11.2 pounds of carbohydrates, and 0.41 pound of fat, so that the nutritive ratio is 1 to 3.1. One hundred pounds of alfalfa hay contain the following digestible constituents: 10.58 pounds of crude protein, 37.33 pounds of carbohydrates, and 1.38 pounds of fat, with a nutritive ratio of 1 to 3.8. At the Massachusetts Experiment Station 1,000 pounds of the dry substance of alfalfa hay was found to contain 81.1 pounds ash, 16.5 pounds crude fat, 760.2 pounds carbohydrates, and 142.2 pounds crude protein.

The fertilizing value[1] of 1,000 pounds of dry matter is 22.75 pounds of nitrogen, 5.61 pounds of phosphoric acid, and 16.53 pounds of potash. In Colorado 1,000 pounds of alfalfa hay were found to contain 22 pounds of nitrogen, 4.14 pounds of phosphoric acid, 25.48 pounds of potash, and 20 pounds of lime, and during one year three crops amounting to 3.8 tons per acre contained 167 pounds of nitrogen, 31 pounds of phosphoric acid, 194 pounds of potash, and 152 pounds of lime. In Kentucky the analyses of freshly cut alfalfa showed 4.22 per cent of crude protein, 0.81 per cent of crude fat, 10.9 per cent of carbohydrates, and 2.14 per cent of ash. Thus, it will be seen that the composition varies somewhat in different portions of the country. These differences in composition may result from such causes as differences in development or variation in the amount of available plant food in the soil.

To secure the best results in feeding alfalfa hay, cut when it contains the largest amount of crude protein, it should be fed with some such fodder as prairie or timothy hay, ensilage, straw, or corn stover, containing an excess of carbohydrates over crude protein. A narrow ration like green alfalfa is suitable for young pigs and is considered one of the very best crops to be fed to young animals, but for fattening mature animals or for the production of milk the ration should be a wider one. Alfalfa hay is much richer than clover hay, containing for every 100 pounds 54.5 pounds of digestible substances, of which about 11 pounds are protein. The relation of the crude protein of alfalfa hay to that of red clover is as 11 to 7.[1] Altogether, alfalfa is one of the best forage crops grown in the United States and is adapted to cultivation in a greater range of latitude than red clover. It has succeeded as far north as central New York, southern Michigan and Montana, and as far south as southern California, Louisiana, and Florida—a wider range than that of any other of our forage plants except Indian corn. Its points of superiority over other legumes are that when once well rooted it withstands drought; it may be cut oftener, thus yielding a larger amount of hay or green forage per acre in the course of a year, and the hay is richer in muscle-making crude protein than any of the clovers. Its disadvantages are that its tough, woody roots make it difficult to plow under;

[1] Appendix to Yearbook of the Department of Agriculture for 1896.

it requires better drainage than red clover; is more liable to cause bloating of sheep and cattle; is not as well adapted to pasturing, and is more tender while young, so that it is more difficult to get a stand.

COWPEAS.

Cowpeas have been in cultivation in this country for about one hundred and fifty years, having been originally introduced into South Carolina. They have spread from that source and from other importations of seed direct from China and India, until now they are in general use throughout the region south of the Ohio River and on the Pacific Coast, and as a soiling crop in the New England and Northern States. There are over one hundred named varieties of cowpeas grown in this country. These are distinguished from one another chiefly by the color and shape of the seed, the arrangement of peas in the pod, and the general habit of growth of the plant.

Thus, there are the bush peas, which grow in an upright form, having short lateral branches from a single central stem; there are trailing varieties with prostrate runners 15 or 20 feet long, and there is every possible gradation between these extremes. The peas are of every shade of white, yellow, green, pink, gray, brown, red, and purple to black, of uniform color or variously mottled, spotted, and speckled.

There is also variation in the length of the season of the different varieties, from six weeks to as many months. The usual method of cultivation of cowpeas is to sow them alone broadcast, or in drills, or between the corn rows at the last cultivation, the rate of seeding varying from 8 to 24 quarts per acre. Care must be taken not to plant the seed before the ground has become warm, as, like other beans, the cowpeas do not germinate well if the soil is wet and cold. This crop is even more susceptible to unfavorable conditions than Indian corn, but in midsummer the vegetation becomes most luxuriant.

Cowpeas are the best soil renovators for the Southern States, and will grow on land too poor to support any of the clovers, producing a large amount of herbage which may be plowed under as green manure. Cowpea vines are, because of their luxuriant growth and long, trailing stems, difficult to make into good hay, but by proper care, curing them in racks or over poles, so that the air may enter into every portion of the pile, an excellent quality of hay is produced, and if the bunch varieties are sown rather late in the season, they may be mowed without difficulty. Cowpea hay containing 89.3 per cent total dry matter averages higher (10.79 per cent) in crude protein than clover hay. It is even more difficult to make good cowpea hay than good alfalfa hay, so that the content of crude protein often falls below that figure. One thousand pounds of cowpea hay[1] contain, according to an average of all available American analyses, 19.5 pounds nitrogen, 5.2 pounds

[1] Appendix to Yearbook of the Department of Agriculture for 1896.

phosphoric acid, and 14.7 pounds potash. The nutritive ratio of cowpeas is 1 to 3.9. The crop is usually cut for hay when the first pods are ripe and the stems are commencing to turn yellow.

When growing cowpeas for fertilizer, it is best either to feed the vines and return the manure to the soil or to plow them under at once, instead of letting them stay on the ground all the winter. By the latter practice there is often a loss of two-thirds of the fertilizing value of the vines because of the leaching out of soluble fertilizers by the winter rains. The feeding value is far greater than the fertilizing value, so that it is better to use them either green or as hay than to turn the crop under.

THE SOY BEAN.

The soy bean (Plate XXXI, fig. 2) has been cultivated as human food and for green manure in China and Japan for many centuries, but has only been brought to the attention of American farmers as a forage crop within the last twenty years. In Oriental countries various preparations from the seeds are made, which take the place of meats and meat products in the dietary of the people. Here, however, the seeds are used only as cattle foods or, when parched, as a substitute for coffee. They are especially rich in fats and nitrogenous compounds. Of all legumes in cultivation the peanut alone exceeds it in the amount and digestibility of its food constituents.

The soy bean requires about the same class of soils as Indian corn, and will grow about as far north as that crop can be depended on. The best results with it have been obtained in the region between the thirty-seventh and forty-fourth parallels east of the Rocky Mountains. The region best adapted to it, then, is the "corn belt," a circumstance which argues well for its future use and value in conjunction with corn for fattening animals.

The soy bean should be planted in late spring or early summer, after the ground has become warm. In general, the early varieties should be used if a seed crop is desired, and the medium or late varieties if it is to be used as forage, it having been found that the latter much excel the former in value for that purpose. In some parts of Virginia the soy bean is planted in the corn rows in alternate hills, or between the rows at the time of the final cultivation. Usually, however, it is grown as a main crop, either broadcast, for forage, or in drills when cultivated for seed. The amount of seed required when it is sown in drills is less than when planted broadcast, varying from 2 to 3 pecks per acre, and in the latter case 3 to 4 pecks. The rate of growth is quite rapid, and unless the field is very weedy the crop does not require much cultivation.

The crop should be cut for hay from the time of flowering until the pods are half formed. Later than that the stems are coarse and woody, and the feeding value rapidly declines. One hundred pounds of soy-bean hay contain 88.7 pounds of dry matter.[1] Of the 51 pounds of digestible substances, 10.8 pounds consist of crude protein, and the nutritive ratio is about 1 to 3.9.

The crop may be converted into good silage, and for this purpose should not be cut until the seed is nearly ripe. The chief value of silage is that it provides a succulent food during the winter time when green forage is not available; but as certain changes take place in the silo, which render a large part of the protein indigestible, it is better to depend upon corn than to use any leguminous crop for this purpose.

The ripe soy beans are among the richest of concentrated foods. An average of American analyses[2] shows them to contain 34 per cent

FIG. 17.—Roots of yellow soy bean, grown at the Kansas Agricultural Experiment Station in 1896 on land inoculated with an extract containing the tubercle-forming bacteria.

of protein, 17 of fat, and 33.8 of carbohydrates. The rate of digestibility is high. Thus, there are in 100 pounds of soy-bean seed 10.8 pounds of water and 66.8 pounds of digestible food, consisting of 29.6 pounds protein, 16 pounds fat, 2.6 pounds fiber, 17.6 pounds carbohydrates, and 1 pound of ash, with a nutritive ratio of about 1 to 1.3. On a basis of 8 tons of green forage it has been estimated that about 1.1 tons of digestible substances are contained in the hay crop grown on 1 acre, of which amount one-sixth is protein and

[1] Appendix to Yearbook of the Department of Agriculture for 1896.

[2] Farmers' Bulletin No. 58, "The soy bean as a forage crop."

three-fourths fat and carbohydrates. The yield varies, according to soil and season, from 6 to 13 tons of green forage. The yield of seed varies from as low as 15 to as high as 100 bushels per acre, the average being about that of corn—from 25 to 40 bushels.

This crop is a heavy potash feeder, and requires fertilization with lime, and with potash and phosphoric acid when grown on such lighter soils as are deficient in these elements.

The soy bean is withal one of the most promising of the annual leguminous forage crops, and, as before indicated, may prove of special value in connection with Indian corn, the latter supplying the "roughness," the soy bean producing the digestible crude protein necessary to make a complete and well-balanced ration.

FIG. 18.—Alfalfa plant, three years old, showing a part of the straight taproot and the much-branched crown.

CRIMSON CLOVER.

This annual clover has not become firmly established as a valuable winter soil mulch and green-manure crop. It is of comparatively recent introduction into American agriculture, although it has been grown in southern Europe for fifty years or more. As in the case of all the new forage crops, extravagant claims have been made concerning its value. It is not adapted to the Northern States, where the winters are severe, nor does it succeed in the prairie region. Crimson clover thrives on the lighter sandy loams, requires a great deal of moisture, and will not withstand either summer droughts or severe winter cold. These conclusions have only been arrived at after wasteful expenditure of thousands of dollars by Northern farmers in the purchase of crimson-clover seed. This crop may be grown in the States south of a line through New Jersey, east Tennessee, and central Texas. Above this line crimson clover often matures fine crops, but can not be depended on. It is better adapted to the needs of the Southern farmers.

The seed is usually sown in July or August, using 12 to 15 pounds per acre. It needs to be only lightly covered, and a good plan is to sow on the fresh plowing and cover with a light harrow. A drought at any time is fatal to the stand, the plant dying quickly unless the ground continues moist. South of the latitude of Washington, D. C., it remains green all winter, and even makes some growth during occasional warm periods. In early spring the growth is very rapid, and it is in bloom, ready to cut for soiling purposes, from two to four weeks before red clover. It comes immediately after rye in the soiling series, and is ready to feed as soon as that crop commences to make its stalks and becomes unpalatable to most cattle. Or the crop may be turned under for green manure and its nitrogen-gathering qualities utilized by following with a nitrogen-requiring grain or grass crop.

Crimson clover is an excellent preparatory crop for Indian corn, sowing it in the corn rows in late summer and turning it under in time for the spring planting. It may be used in the same way for cotton or tobacco, supplying much nitrogen which has been drawn from the air and fixed in available and convenient form for the use of these crops. Its value as a winter soil mulch can not be overestimated. Moreover, it is better to have a useful clover mulch than one of weeds and annual grasses. Most Southern soils are deficient in organic matter, and their fertility can be rapidly increased by the use of leguminous crops, which may be turned under to supply this needful humus.

The digestibility of crimson clover is about equal to that of red clover, and it requires the same fertilizers—lime, potash, and phosphoric acid. The yield when cut for hay is necessarily much less than that of red clover, because it is an annual, supplying only the one cutting. It does not displace that crop in rotations, but occupies a season when the perennial clovers are dormant. Crimson clover is especially valuable to dairymen, being ready for use at a time when succulent green food is at a premium, when the pastures are comparatively bare. It is also valuable as a green manure crop in orchards, providing nitrogen in the best form and quantities, where an application of bone, nitrate, or barnyard manure would act too strongly, producing foliage at the expense of fruit.

It is very important that crimson clover should be cut for hay not later than the time of full bloom. The calyx is covered with rough, sharp-pointed hairs, which become stiff and brittle when the clover is fully ripe. It has been found that these hairs are liable to cause the formation of intestinal concretions, phyto-bezoars, or hair balls, especially when the ripe seed heads of the crimson clover are eaten by horses or cattle. Many losses are liable to occur unless care is taken in the feeding.[1]

[1] Circular 8, Division of Botany, "Crimson clover hair balls."

FLORIDA BEGGAR WEED.

This annual, which has recently come into cultivation, is a native of Florida and the West Indies. It is only adapted to the warmest parts of the Southern States, especially to Florida and the country bordering on the Gulf. Florida beggar weed is closely related to the beggar weeds, or beggar's lice, of our Eastern woodlands, but in its upright habit and unbranching stems (fig. 19) resembles the prairie beggar weeds. On rich land the growth is very rank. It thrives on the lighter sandy soils and rich clays, growing from 6 to 10 feet high, producing a great bulk of hay or of green manure. Wherever the ground has once been seeded beggar weed grows spontaneously during the month of June. In cornfields it comes up after the last cultivation. The seeds will not germinate until the ground is warm, so that this forage plant is only adapted to regions where there is a long summer season. It grows best in well-cultivated lands, making as rank a growth as the sunflowers along the creek bottoms in Kansas and Nebraska.

FIG. 19.—Florida beggar weed, grown at the Mississippi Agricultural Experiment Station—plants 7 to 8 feet high.

In from three to four months from germination the plant has ripened seed and may be plowed under, adding a large amount of organic matter to the soil and at the same time reseeding the field. Where beggar weed is not spontaneous the seed should be sown broadcast at the rate of 12 to 18 pounds per acre, and covered lightly. A thick seeding is better for hay than a thin one, as in the latter case the stems become coarse, woody, and indigestible.

According to analyses of beggar weed made at the Florida Experiment Station,[1] 100 pounds of hay consisting of the upper portion of the plant, mainly leaves and branches, contained, before maturity,

[1] Florida Experiment Station, Bulletin No. 11, 1890.

19.42 pounds of crude protein and 65 pounds of carbohydrates; and when seed was ripening, 15.75 pounds of crude protein and 69.15 pounds of carbohydrates. Analyses at the Department of Agriculture gave as high as 21 per cent of crude protein before flowering. Digestion experiments have not been made, but as the hay is readily eaten by horses, mules, and cattle, and seems to be relished by them, it is undoubtedly as digestible as red clover. This plant, like other legumes, takes a part of its supply of nitrogen from the air, and does not depend wholly on the nitrates in the soil. It produces a greater bulk of feed than the cowpea, and grows without much care on cultivated lands, but rapidly degenerates into an insignificant weed if the field is no longer cropped.

Beggar weed thus becomes one of the most valuable forage plants of subtropical regions on rich lands, excelling cowpeas both as a hay plant and soil renovator. Yields of from 4 to 6 tons of hay per acre are not unusual.

THE FIELD PEA.

There are many varieties of the field pea (fig. 20) in cultivation, showing conclusively that it is one of the oldest forage plants, and yet it has not been brought to the attention of American farmers so largely as it deserves. In Canada the acreage is about the same as that of winter wheat. Much of the success of the Canadian farmers in fattening beef and pork for export is said to be due to their extensive use of pea and oat hay and pea meal.

FIG. 20.—The Russian blue field pea, grown from Canadian seed at Washington, D. C. 1897: *a*, flowering branch; *b*, pod.

The field pea is adapted to cultivation in the northern tier of States, from New England to Washington. It is sown in early spring at the proper time for seeding grain, using from 1 to 1½ bushels of peas and an equal quantity of either oats, wheat, or barley. The crop is ready to cut for hay when the dominant variety in the mixture is nearly ripe. If there are more peas than grain, then the yellowing of the pea vines and pods marks the proper time for cutting, or if the oats exceed the peas the mixture should be cut when the grains are in the dough stage. For a seed crop, the peas are often grown alone.

The field pea is not suitable for cultivation in the Middle or Southern States, because of the ravages of a vine mildew which affects the yield of forage and seed. It requires a long, cool season, with gradually increasing heat toward the time of maturity.

According to average analyses, 100 pounds of Minnesota-grown pea hay[1] contained 12.4 pounds of crude protein and 66.2 pounds of fat and carbohydrates. Of this, 7.6 pounds of protein and 41.5 pounds of the carbohydrates were digestible, giving a nutritive ratio of 1 to 5.7. One hundred pounds of the seeds contained 90.2 pounds of dry matter, of which 80.2 pounds were digestible, having a nutritive ratio of about 1 to 3. The average of all American analyses[2] shows a nutritive ratio for the seed of 1 to 2.8 and for pea meal of 1 to 3.2. This shows the peas to be a richer food than wheat bran, but less concentrated than the gluten, linseed, cotton-seed, and soy-bean meals. The field pea is an excellent soiling crop for late spring and early summer use, furnishing a large amount of succulent forage, which is relished by cattle. It deserves wider cultivation by Northern farmers.

CROPS OF LESS IMPORTANCE.

In addition to these widely grown and well-known leguminous forage crops, there are several which have only local importance for particular soils or special purposes. There are also many native species belonging to this group of nitrogen gatherers that have not passed the experimental stage of cultivation, but which might be recommended for trial by those who wish to have a more diversified list of forage plants on which to draw.

Of the former class, perhaps the most important are alsike, or Swedish clover, for wet meadows in the northern tier of States; the broad bean, or horse bean, in New England; the white, blue, and yellow lupines for reclaiming the sand dunes along ocean coasts; the velvet bean for the Florida orange groves; serradella in Pennsylvania; Japan clover in the South; the spring and winter vetches, which serve a like purpose with crimson clover and are adapted to a wider range of climate; sainfoin and sulla taking the place of alfalfa in the South; goat's rue in the central Rocky Mountain region; the white-flowered variety of crimson clover in Virginia; white clover in every pasture, and melilotus, or sweet clover, for the reclamation of sterile lands. Each of these sorts has had its especial merit, but some have undesirable qualities. Thus, the seeds of horse bean and the lupines contain alkaloid poisons highly injurious to stock. The melilotus is offensive to cattle, and in rich ground becomes a weed; and fresh alsike clover forage is bitter and gives a rank taste to milk.

Others of less value might be cited, such as the flat pea, which is one of the most widely advertised, although with very little to recommend it.

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[1] Minnesota Agricultural Experiment Station, Bulletin No. 36.

[2] Appendix to Yearbook of the Department of Agriculture for 1896.

SOME NATIVE FORAGE PLANTS.

The eastern half of the United States is well supplied with leguminous forage crops. There are fully two dozen kinds of known value to choose from. The soils and the climatic conditions are similar to those of Europe, whence have come most of our cultivated crops, as well as our farming methods. But the West has soils and a climate of its own, necessitating longer trials before any variety of forage plant can be pronounced a success. It is not possible to transplant bodily to this region a European system of agriculture. Thus far the East has not undertaken the cultivation of a single wild legume of all the species which form its rich native flora. The needs of the West are greater, and, as might have been expected, a number of wild sorts have been tried, though none are as yet cultivated on a large scale.

THE DAKOTA VETCH.

The Dakota vetch (*Lotus americanus*) is botanically related to the birds'-foot trefoil and the square-pod pea which are useful European species. It grows throughout the northern prairie region from Kansas to Montana, and is abundant on the Pacific Coast. Ranchmen in the Upper Missouri Valley consider the Dakota vetch one of the best forage plants on the range. Where it is abundant, cattle are sure to get fat. It has been cultivated to some extent on plowed lands. It is quite a common practice to save the chaff that collects in the hay-baling machines and in the wagon beds when hauling hay to the balers. This chaff, containing often considerable quantities of seed, is scattered over the bottom lands in the valleys to further increase the amount of vetch in the hay.

Analyses of South Dakota grown hay, consisting entirely of this vetch, gave 17.6 pounds of crude protein in each hundredweight of hay.[1] The per cent digestible has not been determined, but it is undoubtedly high, as cattle become "seal fat" where Dakota vetch is abundant. The Dakota vetch seeds freely in good seasons. In times of drought or shortage, stock eat it down closely and prevent its ripening seed. Hence, the stand on the open range varies greatly, depending on the abundance or scarcity of other feed. This vetch often grows 2 to 3 feet high in good soils and seasons, or may not be more than a few inches high during dry seasons or on sterile soils, but it roots deeply and is well adapted to its native prairies. The seed may be had for the gathering, and need not cost any more than clover or alfalfa, if the trouble is taken to run the chaff through a fanning mill.

THE GROUND PLUM.

The ground plum (*Astragalus crassicarpus*) is a prairie legume found throughout the Mississippi Valley. It has straggling fleshy stems, narrow leaflets and racemes of purple flowers, and produces

[1] South Dakota Agricultural Experiment Station, Bulletin No. 40.

every year an enormous number of succulent pods, whence the plant received its name. Sheep and cattle eat both the pods and leaves. In Texas, where the razor-back hog runs at large on the ranges, the ground plum is rapidly becoming extinct, and is only found in fields and pastures protected by hog-proof fencing. The pods, or "plums," are sometimes used as a vegetable.

FIG. 21.—The fleshy root of the Metcalfe bean.

The ground plum appears very early in spring, long before the clovers are ready to use, at a period when rich, succulent food is needed for cows and young stock. If it proves to be adaptable to cultivation, it will be a valuable addition to early spring soiling crops. The pods of the ground plum attain their full size from the last of April in southern Texas to the first of June in North Dakota. They are then succulent and juicy. Later, as the seeds ripen, the pods dry out and by midsummer have become hard, tough, and inedible.

THE METCALFE BEAN.

One of the most valuable groups of American Leguminosæ is that of the wild beans, which are botanically closely allied to the common garden beans. There is one species common to the Eastern United States, from Maine to Louisiana, occurring in copses and thickets, and valued in woodland pastures. In the Southwest there is a great variety of wild beans. They are scattered through every mountain canyon, on wooded slopes, and through the little parks along the streams. Formerly they were much more abundant, but are now relegated to cliffs and canyon walls, inaccessible to sheep and cattle, or to dry valleys, far from living water. In the mountains between the Rio Grande and the Gila the wild beans formerly supplied a great amount of feed for deer and cattle. Wherever there were wild beans cattle became fat.

One of the best of these wild sorts is the Metcalfe bean (*Phaseolus retusus*). This bean and all of its near relatives are perennials. They develop enormous fleshy roots that are often 4 to 6 inches in diameter and weigh 30 pounds or more. The top of this fleshy root (fig. 21) is usually 6 or 8 inches below the surface, so that the ground may be plowed or given a shallow cultivation without destroying the beans. The vines (fig. 22) grow out in every direction from the crown much like sweet potato vines, varying from 6 to 10 or even 20 feet in length at the end of the first season. The racemes of scattered pink flowers (fig. 23) appear from July to September, and the pods and seeds (fig. 24) ripen freely in cultivation.

FIG. 22.—Leaves of the Metcalfe bean.

All perennials which grow in semiarid and desert regions have some especial adaptation for preventing the loss of water. These may include modifications of the protective surfaces of leaves and stems, such as thickening of the epidermis, the development of a dense covering of hair, or it may consist, as in this case, of an enlargement of the stems or roots, thus providing reservoirs in which water and plant food may be stored up during the season of growth for use during periods of drought or scarcity of water and food. Because of this special modification, the wild beans ought to be of great importance and value in Southwestern agriculture. As drought-resistant crops, they should be much superior to any forage plant which has not this fleshy perennial root.

FIG. 23.—Flower cluster of the Metcalfe bean.

The Metcalfe bean is one of the most promising of our native forage plants. The amount of forage which it produces is naturally large, but it also shows a tendency to improve in quality and quantity with cultivation. There is constant and growing demand for drought-resistant forage crops in the West and Southwest, and the cultivation of those leguminous forage plants that show an adaptation to natural conditions is an exceedingly promising line of work.

TEXAS PEA.

The Texas pea (*Astragalus nuttallianus*) is a perennial. It is like the ground plum in habit and general appearance, but with narrow curved, bladdery seed pods on an upright stem. It is abundant in central and northern Texas, preferring the drier ridges and stony hills, while the ground plum grows best in moister valley lands. It is much relished by cattle and is disappearing wherever the ranges have been overstocked.

It grows well on cultivated land, increasing in height and amount of seed produced, thus indicating adaptability to improved conditions. The seeds ripen about the first of May, after which the leaves and stems die down and, becoming brittle, are broken to pieces and blown away. On the ranges the Texas pea supplies a large amount of highly nitrogenous forage in early spring, when such feed is most needed in the Southwest. With plenty of rain there is always plenty of grass for summer and autumn grazing. Forage plants that will supply feed before the grass starts are of the greatest possible value to stockmen. The wild peas and vetches ought to be protected from extermination, and more extensively grown.


FIG. 24.—Ripe pods of the Metcalfe bean.

THE STOLLEY VETCH.

Another early pasture plant from central Texas is the Stolley vetch, which grows wild on the granite soils and red prairies. This vetch has the same habit and much the appearance of the hairy vetch. It branches from the base, the weak, trailing vines being 2 to 3½ feet long. As many as 50 or 60 stems and branches have been observed from a single root. This vetch has a somewhat local distribution, occurring in central and western Texas. It grows in the creek bottoms and among the underbrush along streams, and where protected from destruction by cattle, spreads to the open prairies.

The seed lies dormant in the soil through the summer. With the coming of the fall rains it germinates, grows slowly during the winter, and blossoms about April 10. By the first of May it covers the ground with a dense mat of tangled herbage. The seeds ripen uniformly about the first week in May, after which the vetch straw dries and breaks up after the fashion of other annual plants. Cattle are very fond of this vetch, and devour all that is not protected by fences, so that it is now practically extinct except in favored localities. This vetch is one of the most promising of the many native sorts. It is reported as abundant in central Texas, and is there highly esteemed by stockmen. The Stolley vetch bids fair to be one of the very best early spring forage plants, and deserves further and more extended trials.

UTILIZATION OF BY-PRODUCTS OF THE DAIRY.

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INTRODUCTION.

In making butter or cheese, a raw material (milk) is transformed into a commercial product. The process may therefore be regarded as manufacturing, even if done on a farm where the milk is produced. When milk or cream from a number of farms is brought together at one place to be made into butter or cheese, under either the cooperative or the proprietary system, the establishment is considered a factory, and the industry is properly classed among manufactures. This classification has been adopted by the United States Census, where the butter and cheese made on farms appear as farm products in one volume and the same articles made at creameries and cheese factories are included among the products of manufactures in another volume.

Regarding all butter and cheese making as a species of manufacture, the same principles should apply as to other manufactures. The cost of the work is of great importance, and should be carefully studied with a view to exercising every possible economy. The selling price of the finished product depends upon the market conditions rather than upon cost of production. Any saving which can be made in producing the raw material, or converting it into merchandise, ought primarily to benefit the milk producer, especially if the manufacturing is done under one of the advantageous forms of cooperative dairying.

Experience shows that in most lines of manufacture there are waste products, and upon the careful management of these often depends the difference between profit and loss in the business. The manufacture of butter and cheese may be included in this statement. All cow owners, therefore, who make milk into butter or cheese, as well as owners and managers of creameries and factories, are concerned in studying economy of production, and should be interested in the important subject of the proper utilization of the waste products of the dairy.

QUANTITY OF PRINCIPAL BY-PRODUCTS.

Butter and cheese making result in three well-known residues, which constitute the waste, or by-products, of dairying, namely, skim milk, buttermilk, and whey. For every pound of butter made there are 15 to 20 pounds of skim milk and about 3 pounds of buttermilk, and for every pound of cheese nearly 9 pounds of whey. The aggregate of these by-products is therefore enormous. The butter and cheese annually produced in the United States leave as residues at least 24,000,000,000 pounds of skim milk, 4,000,000,000 pounds of buttermilk, and 2,500,000,000 pounds of whey. This is about equal to 75,000,000 barrels of skim milk and buttermilk combined and 7,000,000 barrels of whey. It is easier to deal with these quantities by the barrel than by the pound, although the latter would be more accurate. Some people are able to make skim milk and buttermilk worth $1 a barrel, or more, while others find difficulty in getting from it a value of 30 cents. This difference amounts to over $50,000,000, or an average of $4 for every butter and cheese making cow per year. The item is one of consequence, and the way in which these materials can be made to yield the most value is well worthy of careful consideration.

SKIM MILK.

Skimmed milk, or skim milk, should be first considered. It is by far the greatest in quantity of the by-products of dairying, the most valuable and the most susceptible of varied and profitable uses. Skim milk is that portion of milk, or "whole milk," which remains after removal or separation of the cream. The process of removal is generally known as skimming, although changes in method have been such as to largely substitute the term "separating." The object of skimming or separating is to get all the fat out of the milk. The more completely this is done, the better the skimming. Theoretically, skim milk contains no butter fat. Practically, however, it is impossible, by any method in vogue, to remove all of the fat, and therefore skim milk always contains more or less. The quantity depends upon the method of skimming and the skill with which it is done.

METHODS OF SEPARATING THE CREAM.

There are two distinct methods of getting cream from milk, with modifications of both. The older plan is to let the milk rest undisturbed, or "set;" the fatty portion, which is lighter, naturally separates from the watery and heavier part of the fluid, "rises" and forms cream at the surface; this is known as the gravity method. The modern way is to employ mechanical devices which exert centrifugal force and throw the heavier parts of the milk outward from the center of revolution, thus separating the cream; this is the centrifugal method, commonly called the separator plan. The success of the gravity method depends upon the conditions of time and temperature. The milk may be set in vessels shallow or deep. The higher the temperature to which the milk is subjected, the shallower should be the vessels or the body of milk and the longer the time required for creaming. Deep vessels and low temperature, usually secured by setting in cold water, hasten creaming and effect more complete separation of the fat. Mechanical creaming is the most effective, and can be done in the least time; its completeness depends upon the efficiency of the machine and the skill of its operator.

PERCENTAGE OF FAT IN SKIM MILK.

There is consequently material variation in the portion, or percentage, of butter fat which skim milk contains, and this is about the only difference of consequence which is found in different lots of skim milk. Centrifugal separators are operated in ordinary practice so as to leave less than 0.1 of 1 per cent of fat in the skim milk; sometimes as little as 0.01 of 1 per cent. A number of trials with machines of eight different styles in this country gave an average result of 0.13 of 1 per cent of fat. A similar set of 171 trials in Germany, with separators of nine different patterns, gave an average of 0.243 of 1 per cent. "At the present time it is considered that where more than 0.1 of 1 per cent of fat is left in skimmed milk a centrifugal machine is not doing perfect work" (Wing). As the separator system is very rapidly extending, 0.1 of 1 per cent of fat may be adopted as the standard maximum fat content of skim milk. Skim milk from separators is the best skimmed; it is superfluous to call it "separator skim milk," because it is simply skim milk in the best sense, that is, the most completely skimmed. The deep-setting gravity method of creaming, when well managed, leaves from 0.2 to 0.4 of 1 per cent of fat in the skim milk; careless treatment may increase this to 1 per cent, but no such loss is consistent with good dairying, and half of 1 per cent should be the maximum allowed. The old-style shallow-set method of creaming usually results in a comparatively high percentage of fat in the skim milk. This method may be so skillfully managed as to leave not more than 0.3 of 1 per cent of fat, but 0.5 of 1 per cent and more is not uncommon. No dairyman can afford to lose as much as half of 1 per cent in his skim milk, and it is absurd to call any article by this name which contains 1 per cent of fat or more. Such milk is not skimmed, or is but partly skimmed. It certainly is not "skim milk."

COMPOSITION OF SKIM MILK.

A fair standard for the composition of skim milk is 90.5 per cent of water and 9.5 per cent of solids, including the fat. The State of Massachusetts prescribes a legal standard of 9.3 per cent total solids for skim milk. The solids other than fat are casein and albumen, ranging from 3 to 3.5 per cent; milk sugar, from 4.7 to 5 per cent, and ash, from 0.7 to 0.8 per cent. The solids of skim milk sometimes rise to 10 per cent, but it should always be remembered, in using this article, that in 100 pounds only 9 to 10 pounds can be relied upon as being food material; the rest is water.

THE BEST USE OF SKIM MILK.

The best use to which skim milk can be applied is as human food, in its natural, uncooked state. The value of the article as a desirable and useful portion of an everyday diet for most people is not at all appreciated. This use of skim milk ought to be very largely increased.

In the course of dietary studies made at the Maine State College during the year 1895 special attention was given to milk, for the reasons stated in the following from the report of Director W. H. Jordan:

(1) Milk has a widespread use as an article of diet, and in all civilized countries is an important item of food supply.

(2) Milk is a very valuable food. It contains a mixture of the three classes of nutrients in forms that are readily digested and assimilated.

(3) Milk is a low-cost animal food in proportion to its value as based upon chemical analysis. It is shown * * * that when milk is purchased at $2 per hundred pounds the cost of a pound of edible solids is 15.7 cents, while the cost of a pound of edible solids in beef at $10.50 per hundred pounds is 34.3 cents. This is a comparison of the retail cost of milk (fresh and not skimmed) with the cost of hind-quarter beef when purchased by the carcass. Beef bought as steak at retail prices would have a much higher comparative cost.

(4) Notwithstanding the high quality and general distribution of milk as a food, it seems by many to be regarded as a luxury in the purchase of which economy must be exercised. This attitude toward this particular food may in part be explained by the somewhat prevalent notion that a free supply of milk in the dietary is not economical, because it is supposed that as much of other foods is eaten as would be the case if the milk were not taken. This belief runs contrary to certain generally accepted facts which relate to the physiological use of foods, and it only remains for experimental data to prove or disprove its correctness. Again, milk is not given full credit by people at large for its true nutritive value. Surprise is generally occasioned by the statement that a quart of milk has approximately the food value of a pound of steak. It is important to demonstrate, for reasons of economy, whether, as is the custom with many, it is wise to purchase the least possible quantity of milk and exercise little care in buying meats.

Trials were accordingly made by which a large number of young men, students at college, were furnished milk as a part of their daily diet, the quantity being varied during successive trial periods. The milk was much relished by a large majority of the students, and at the time the quantity was greatest there was no indication of any effects injurious to health. When after a fixed, although liberal, allowance in one period, milk was supplied to be used ad libitum in the next, the quantity thus voluntarily consumed increased 55 per cent, the increase amounting to about 1 pound of milk per day to each person. It was conclusively shown that such free use of milk diminished the consumption of other foods. In the springtime the additional milk replaced other animal foods, while in the fall it replaced vegetable foods, this by a process of selection entirely natural and almost involuntary. The daily cost of food per man was 8 cents less during the period when milk was furnished in unlimited quantity than when the supply was limited. Following are the main results of these trials, as summarized in the report mentioned:

(1) The cost of the animal foods bought for the commons of the Maine State College during two hundred and nine days was 69 per cent of the total food cost, varying in the different periods from 63.7 to 73.1 per cent. This shows very clearly

the direction in which economy can most effectively be exercised in purchasing a food supply.

(2) The freer use of milk did not, as is supposed by some to be the case, increase the gross weight of food eaten. The extra amount of food consumed replaced other animal foods to a nearly corresponding extent in the first trial and caused a proportionate diminution in the consumption of vegetable foods in the second study.

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(4) In both trials the increased consumption of milk had the effect of materially narrowing the nutritive ratio of the dietary, a result which, in view of the recognized tendency of Americans to consume an undue proportion of fats and carbohydrates, appears to be generally desirable.

(5) The dietaries in which milk was more abundantly supplied were somewhat less costly than the others and at the same time were fully as acceptable.

(6) These results indicate that milk should not be regarded as a luxury, but as an economical article of diet which families of moderate income may freely purchase as a probable means of improving the character of the dietary and of cheapening the cost of their supply of animal foods.

In the Maine experiments referred to above, fresh whole milk was used, having a fat content of 3.6 per cent. It can not be doubted, however, that the same general results would have been obtained had skim milk been used instead. To some this would have been less acceptable, but while the total quantity consumed might have been less, the daily cost would also have been still further decreased, and the "balance" of the daily ration would have been still more improved. The use of skim milk instead of whole milk as food, in its natural state, is simply a matter of taste and habit. It must not be forgotten that a quart of skim milk contains more protein than a quart of whole milk, and the former is better and cheaper than the latter as a substitute for meats and other animal foods.

A report upon dietary studies made at the University of Tennessee in 1897, contains the following:

What is needed is to use foods better adapted to the needs of the body; in other words, food which contains more protein. Such are * * * and milk, which is of itself an economical and well-balanced food, and skim milk, which has all the protein and half the fuel value of whole milk, and is, in most localities, the most economical source of animal protein. * * * The nutrients in milk are equal in physiological value to those of meats, and are far less expensive.

SUGGESTIONS AS TO TRADE IN SKIM MILK.

An eminent contributor to the Journal of the British Dairy Farmers' Association lately wrote: "The question of how to dispose of more separated (skimmed) milk to the public without reducing the price of pure (whole) milk, is, to my mind, the most important dairy problem of the day." Earnest effort should be made to accomplish this object. Health and police officials having in charge the regulations for milk supply of cities and large towns should study the problem as one in which producers and consumers are alike interested. The advantages to be gained by an increased use of skim milk will repay the trouble incident to devising local methods for preventing fraud in connection with the sale of this article. One way which has proved efficient in some places, is to allow skim milk to be sold only from vehicles, stores, and cans in which no other milk or cream is kept, carried, or offered for sale, all to be plainly marked "skim milk," with, perhaps, the maximum price at which it may be sold. Such restrictions, however, seem to be unnecessary. In the factory towns of New England, skim milk from near-by creameries is sold in large quantities among the families of mill operatives at 4 cents and 3 cents a quart, and sometimes for 2 cents, to the great satisfaction of all concerned. The most common retail price for skim milk is half the price of whole milk at the same place. It furnishes a supply of cheap and wholesome food to those needing it, and has been found to interfere little, if at all, with the regular trade in whole milk. Skim milk is so bulky, compared with its value, less than one-tenth part being useful as food, that transporting it for any distance is very expensive. This difficulty has been partly overcome, in a few instances, by evaporating a portion of the water or partly condensing the milk. A product results which has decided commercial and domestic advantages. There is evidently room for more "plain condensed skim milk" or "partly condensed skim milk" to be advantageously sold in many local markets.

SKIM MILK IN COOKING.

Besides the use of skim milk as human food in its raw state, there are many ways in which it can be advantageously used in cooking. As a substitute for water in preparing various dishes, as well as for others mainly made of milk, there is no waste, but a distinct gain in food value. This is especially true in making bread. Milk adds to the weight and nutritive value of the loaf. Substituted for water, enough flour may be saved to more than pay for the milk, and yet produce a loaf of equal weight and greater food value. As an encouragement to this use of skim milk, the premium list for the annual exhibition of the British Dairy Farmers' Association at London includes prizes for four or five classes of bread made with skim milk instead of water. Two comparisons of the chemical composition of bread made in these two ways are given in the following table, taken from recent reports of the exhibitions referred to:

Comparisons of water bread and skim-milk bread.

Kind of bread.	Water.	Fat.	Protein.	Carbohydrates.	Ash.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Water bread	39.96	0.12	7.31	52.92	0.29
Water bread	37.20	.18	9.69	51.73	1.20
Skim-milk bread	38.64	.51	9.19	51.38	.28
Skim-milk bread	30.44	.80	10.24	56.32	2.20

These figures show the milk bread to be richer in fatty matter and markedly superior in the albuminoid or flesh-forming constituents, "due undoubtedly to the casein of milk becoming incorporated with the fibrin of the flour." "It is clear from these comparisons that the milk bread is more nutritious than ordinary water bread." One of the reports further states: "All these breads certainly looked appetizing, and they were most undeniably nutritious. In white bread, especially, the use of milk instead of water gives a loaf an excellent appearance and taste, and the milk not only renders it more valuable as food, but easier of digestion."

Bakers have long known the value of skim milk in bread making, and yet it is not as generally used in this way as it should be. This is partly owing to the unfortunate restrictions in some large cities, which make it difficult for bakers to get the skim milk wanted. One baker gives these reasons for using skim milk largely instead of water: "(1) It makes a loaf which is more moist and will remain moist longer; (2) it makes a closer loaf; (3) it improves the eating quality of the bread; (4) the sugar in the milk caramels in baking and browns the crust." He advises adding the milk when making the dough and not in the sponge.

The general opinion seems to be that the more thoroughly milk is skimmed the better it is suited to the needs of bakers and confectioners. The sale of skim milk to this class of consumers is capable of being very largely increased. (See note, p. 528.)

Used in this way, skim milk may be made to net the producers from 50 cents to $1.50 per hundred pounds, which is better than any other known market, except consumption in the families of the producers themselves.

SKIM MILK AS FEED FOR DOMESTIC ANIMALS.

Next to human food, the most profitable use to which skim milk can be applied is in feeding domestic animals of various kinds. Reports and bulletins of the agricultural experiment stations of Europe as well as America contain numerous results comparing skim milk with other articles for stock feeding and showing its successful use, especially with young and growing animals. In numerous cases figures are given which indicate the value which can be obtained from skim milk thus used, but it is safer to accept these values as relative rather than absolute.

The important facts which seem to be proved by these experiments are as follows: (1) Skim milk gives the best returns when fed to very young animals, constituting the greater part of their food; (2) it is next best for animals making rapid growth but which need food other than milk and mainly of a more carbonaceous character; (3) except for the very young, skim milk gives much better results when used in combination with other materials, generally grain, than when fed alone; (4) no class of live stock gives a better return for skim milk fed to it than poultry of various kinds. The nutritive ratio of skim milk ranges from 1:1.7 to 1:2; it is therefore a highly nitrogenous food and too "narrow" or concentrated to be used alone save in exceptional cases. Hence, the advice is given to feed it usually in combination with some carbonaceous material, like corn meal, to "broaden" the ratio and ration.

Skim milk for chickens.—The New York Experiment Station reports growing chickens successfully upon a diet which was mainly skim milk, although they had the run of fields. It was estimated that while allowing 25 cents per 100 pounds for the milk and some other food in proportion, the cost of producing a pound of live weight was less than 6 cents up to the time the birds weighed about 3 pounds. The milk was fed sweet in this case, but it has been found equally satisfactory to use it when loppered and quite thick, and in the latter form there seems to be less waste. Several careful feeders believe skim milk to be worth fully 50 cents per 100 pounds when judiciously fed to turkeys and poultry.

Skim milk for hogs.—The greatest number of experiments recorded are in connection with the use of skim milk in feeding swine. Director Henry, of Wisconsin, has written as follows on this subject:

> Skim milk has a higher value with stockmen than merely serving as a substitute for grain. All of the constituents of milk are digestible. and this by-product of the creamery is rich in muscle and bone building constituents. The writer conducted experiments in which milk and other foods were fed to pigs for the purpose of ascertaining the effect of these feeds on the muscle and bone of hogs. It was found by actually testing the strength of the bones that milk made the strongest bones of any food that was fed. When we consider the use of this food for bone and muscle building, also remembering its easy digestion and how, by adding variety, it makes other food articles more palatable and probably assists in their digestion, we must hold skim milk as occupying a high place in the list of feed stuffs available on most farms.

From the numerous results reported in pig feeding these items may be taken: Ten pounds of skim milk produce as much gain with young pigs as 15 pounds with maturing swine. With young pigs, 1 or 2 ounces of corn meal (or its grain equivalent) to 1 quart of milk seems enough. The proportion of the grain must be gradually increased until in finishing off pork, with animals weighing 200 pounds or more, the meal may become two-thirds the weight of the milk.

Authorities differ much as to the relative merits of having the skim milk sweet or sour, but the weight of evidence seems to favor sour milk for swine. Yet, the milk must not be too sour; the sugar of milk certainly has food value, and in very sour milk this has been largely replaced by lactic acid. Too much lactic acid is believed to be injurious. In different trials 100 pounds of skim milk has shown a feeding value equivalent to 20 to 28 pounds of corn meal; its money value may be thus easily computed, with the market price of corn meal as a base. But several experimenters, upon a basis of "4-cent pork," report returns of 20 to 30 cents per hundred pounds of skim milk. Danish experiments give 6 pounds of separated milk as the equivalent of 1 pound of barley or rye, 4 pounds of potatoes, and 8 pounds of mangel beets, when fed to swine. All agree that for economical feeding, while the skim milk may be acid, it must be sound and not putrid; skim milk from neglected, unclean, creamery tanks is often miserable stuff, hardly worth hauling away, and sometimes actually dangerous to feed. The following table of comparative values, taken from the Wisconsin Report of 1895, may be useful for reference:

Comparison of values of corn and milk.

Value of corn.		Value of 100 pounds of skim milk.		
Per ton.	Per bushel.	Maximum.	Minimum.	Average.
Dollars.	*Cents.*	*Cents.*	*Cents.*	*Cents.*
10	28	16	9	11
12	33.6	19	11	13
14	93.2	22	13	15
16	44.8	25	15	17
18	50	28	16	19
20	56	32	18	22

As the result of ten years continued experiments, the Massachusetts Experiment Station advises the following proportions for combining skim milk and corn meal in feeding pigs:

Animals 20 to 70 pounds weight: 2 ounces meal to 1 quart milk; nutritive ratio 1:2.8 to 1:3.

Animals 70 to 130 pounds weight: 4 ounces meal to 1 quart milk; nutritive ratio 1:3.6 to 1.4.

Animals 130 to 200 pounds weight: 6 ounces meal to 1 quart milk; nutritive ratio 1:4.5 to 1.5.

This station reports that it has never been able to get as much as 50 cents per hundred pounds for skim milk fed to pigs.

Skim milk for calves.—Calves appear to be next in favor as profitable consumers of skim milk, and some authorities conclude, after reviewing the records, that calves make greater gains than pigs from a given quantity of skim milk. There has been much prejudice on the part of some against using well-skimmed milk, such as comes from farm separators and separator creameries, especially for veal calves. But there is abundant evidence that good results follow proper care and judicious feeding. The use of whole milk for calves, except for a week or so, is simply wasteful. "One cent's worth of oil meal will do calves as much good as a pound of butter (or butter fat in milk). Besides this, skim milk from a separator, when run through immediately after milking and fed while new and warm and sweet, is better for calves than milk which is old and partly sour, even though the latter contains a quarter of the fat originally in it" (Goodrich).

The Ontario Experiment Station of Canada reports that after twenty years of careful work it is evident that whole-milk calves cost too much, adding: "Skimmed milk and linseed meal are a good substitute for whole milk in feeding calves. A young beast fed on a skim-milk ration, with adjuncts, may be made to weigh almost as much when one year old as one of similar breeding fed on whole milk with adjuncts of a similar character."

The Iowa Experiment Station, which has given particular attention to calf feeding, considers oil meal as too nitrogenous, making the ration too "narrow" except for very young calves. Oatmeal and corn meal are found better to "balance" the skim milk after the first four weeks. The mixture producing the greatest gain at the least cost was found to be nine parts corn meal to one part flax meal, and 1 pound of this mixture was used to 18 or 20 pounds of skim milk to each calf per day, the meal being later increased to 2 pounds a day. Grade Shorthorn calves thus fed made gain at a cost of from 1 to 2 cents a pound, the skim milk being rated at 15 cents per hundredweight. Started on such a ration, the milk was gradually withdrawn after the first one hundred days, and these calves reached an average weight of 760 pounds when one year old, a gain of 660 pounds in three hundred and sixty-five days.

The Minnesota Station, in a trial with younger calves, found that a whole-milk ration cost nearly 10 cents per day and produced no more gain than in some of the calves on skim milk. The latter made an average gain of 1¼ pounds per day, at a daily cost of 3¼ cents; the feeding period was twenty-four weeks.

At the Massachusetts Station, with veal selling at 4½ cents live weight, the skim milk on which it was raised was made to yield 37 cents per 100 pounds.

Calves for veal may be started on whole milk, gradually shifted to skim milk, and finally finished off with whole milk for a week or ten days, to give them a smooth appearance and improve their sale. In a number of careful trials reported, calves gained 1 pound in weight from 10 to 16 pounds of skim milk.

Calves for beef stock can be profitably raised on a diet largely skim milk, but should be taught to eat hay and grain as soon as possible. Heifers for dairy purposes should grow in a thrifty way, but should not get fat; for these skim milk is the best food of all until they are a year old, wheat bran and middlings being added as soon as they will eat them.

In feeding milk to calves, especially young ones, overfeeding must be guarded against, and the milk can be used to the best advantage when fresh from the separator, and warm, as already described. If skim milk from a creamery is used, great care must be exercised to prevent injury from old or tainted milk. Calves are much sooner made sick with bad milk than are pigs. If the milk is clean and pure, acidity does not hurt, but dirty and putrid milk is death to calves.

Skim milk for lambs.—There are few records of carefully conducted experiments in feeding skim milk to lambs. But one at the North Carolina Experiment Station showed the milk thus used to be absolutely lost, and even injurious to some extent, and a similar report from Germany is equally unfavorable, milk being the least satisfactory of a number of food materials compared.

Skim milk for colts.—The Iowa Experiment Station reports an experiment in feeding colts in which milk was one of the important items, and concludes: "The results of utilizing separator milk for feeding colts may be regarded as highly satisfactory." Ten pounds of skim milk were found to be the equivalent of 1 pound of grain. This accords with the results in several private trials known to the writer. In Prussia suckling colts are fed some skim milk and also buttermilk.

Skim milk for horses.—The Cooperative Dairy Association of Hamburg is reported as feeding large quantities of skim milk to its working horses with satisfactory results.

Skim milk for cows.—A seemingly unnatural use for skim milk, but one which has been reported as satisfactorily practiced in a number of places, is as food for milch cows. Some German accounts are given of mixing skim milk with water, a very little at first and gradually increased until the cows are taught to drink the milk alone. Others describe using milk and meal or bran of some kind to make a paste, and claims are made that in this form 10 pounds of skim milk replace 1 pound of wheat or rye bran, having the same food value with cows. The method of feeding skim milk back to the cows producing it, which has been most practiced and advocated in Europe, originated in Sweden. The milk is heated to 155° or 160° F. for half an hour, then cooled to 100°, and rennet is added. While the milk is thickening an equal weight of chaff or finely cut straw is mixed in, and after being well stirred it is allowed to stand two or three hours in a large tub or tank. The separated whey is then drawn off and poured over the mixture, that as much as possible may be absorbed. The whole mass is then left to ferment from forty to forty-eight hours, according to the weather, when it is regarded as prepared for feeding. Cows are given as much of this "skim-milk feed" as will equal a gallon of milk per day. It is claimed that as thus prepared a gallon of skim milk amply replaces 4 pounds of concentrated grain food. Reports from Sweden, Norway, and Denmark are favorable to this method of utilizing creamery skim milk, and some who have tried it in this country make like reports, while others give a contrary opinion.

CHEESE MADE OF SKIM MILK.

Skim milk may be made into cheese. If the latter is of the "white-oak" variety known in some parts of the United States, it is not easily sold, and the rate of value obtained for the milk is very low. Yet skim cheese has a really high food value, and may be used to advantage in cooking. In Europe both hard and soft cheeses, and several varieties of these, are made from skim milk, and so skillfully ripened or cured as to be readily sold and acceptable to consumers. The conversion of skim milk into cheese of better quality deserves more attention in America. Skim cheese should always enter the market, however, plainly marked and fully identified, as is required by law in several States.

Cottage cheese.—This product, also called pot cheese or smear-case, is a form into which skim milk is easily converted. It is nutritious and a favorite not only as made and used at home, but for sale in the markets of cities and towns. Prices vary so much locally that no reliable figures can be given, but some persons report that they have realized fully $1 per hundredweight for milk thus used, and it is certain that good returns can usually be obtained in this way, and the sale of this kind of cheese might be greatly increased.

Filled cheese.—The article now known by law in this country as "filled cheese" and in Europe as "margarine cheese" has skim milk for its chief component. To the skim milk is added some cheap form of fat, usually of animal origin, but sometimes vegetable, to replace the original fat of milk. The product resulting is, while not too old, a good counterfeit of whole-milk cheese. Laws have become necessary to prevent fraud in selling it and to check the disastrous effects upon the reputation of genuine United States cheese at home and abroad, caused by the substitution on a large scale of this cheap imitation.

FERTILIZER FROM SKIM MILK.

In the various ways described, skim milk can be used, either in its natural state or manufactured, as food for man and beast, and can thus be made to yield a value to the producer ranging from 15 or 20 cents to $1, or even more, per 100 pounds. As in all such cases, the profit will depend largely upon the skill of the feeder or the person who finds the market for the milk or its product. But if use in one or more of these ways is impossible and no sale can be made for other purposes, it must always be remembered that skim milk possesses a positive value as a fertilizer. Its composition is such that when compared with carefully saved animal manures or commercial fertilizers it is regarded as worth from $2 to $2.80 per ton, or 10 to 14 cents per 100 pounds—this, if used in a compost pile and properly managed. It remains for the experiment stations to determine whether skim milk has not a still higher value as a manure, if applied directly to growing crops.

CASEIN FROM SKIM MILK AND ITS USES.

But there are other ways of utilizing skim milk in quantities greater or less, besides its use as a food for animals or plants. The casein and the sugar in skim milk, which are its principal solid constituents, can both be separated and put into commercial form. In separating the curd or casein, whey remains, which contains the sugar and ash and such small quantity of fat as there may be, and this whey will be mentioned later. Casein, when separated and dried, forms a hard, horny, and elastic mass, which can be used in different ways. And (according to Fleischmann) when combined with the oxides and salts of the metals of the calcium group, casein forms a cement-like compound, insoluble in water.

Paper dressed with casein.—The principal use for dried casein in this country is for sizing or dressing in the manufacture of paper. For this purpose it takes the place of several kinds of glue, but, as the latter are all cheap, it follows that skim milk can not be worth much to be converted into this commercial form, although the quantity which may be thus used in connection with paper making is almost unlimited. Already there are several establishments connected with creameries or located in the creamery districts of New York and New England engaged in making large quantities of dried casein, the product being contracted for by paper makers.

Manufacture of dried casein.—For various reasons it is expedient to make casein in a place by itself and specially prepared, but the building and equipment are not necessarily expensive. The milk preferred is that from separators, containing the least possible portion of fat. It is placed in large tanks arranged for heating and raised to a temperature of 130° F.; 6,000 or 8,000 pounds may be thus handled at once. A special formula of acid is then applied, the best acid or mixture of acids to use and the quantity being secrets of the process. The milk at once coagulates and the curd is precipitated. The whey is then drawn off and the curd broken up to facilitate separation. At this stage the curd is rather stringy and tenacious. It is shoveled out to a draining table with high sides and covered with coarse cloth, where it is further drained and the whey and remaining acid are washed out by running streams of cold water over and through the curd. It is then allowed to drain and dry for two hours, or, instead, it is passed through a hand press and is pressed dry. The curd then becomes more flaky. It is then run through a cheese-curd mill, ground fine, and spread thinly on drying trays which have cloth bottoms. These trays are placed in tiers in a drying oven or flue, heated with steam pipes, and having an upward air draft much like large fruit evaporators. At a temperature of 120° F. it usually requires about twenty-four hours to dry, and the curd is stirred occasionally. It has then reached its commercial form. It is in small, yellowish-white, irregular lumps, similar to coarse gum arabic. Some skill is needed to prevent too much discoloration. If an undue portion of milk sugar remains in the curd and the heat is too great, the sugar caramelizes and makes the dried curd so dark in color as to be unsalable. When it is quite dry it is put up in 2-bushel meal sacks of 70 pounds weight each and is ready for shipment. For the skim milk to be used for this purpose manufacturers pay from 10 to 15 cents per 100 pounds in different places. From a hundredweight of milk about 3½ pounds of merchantable dried casein can be made. The selling price to the paper makers is 4 to 7 cents per pound, but of course much depends upon the distance it has to go to be used and the cost of transportation. It is evident that milk thus used does not yield to the producers its value as a feeding material for any class of growing live stock, and in some cases not even its value as a farm fertilizer.

Use of whey from casein as hog feed.—The whey, which is a waste product, is too strongly acid when drawn off for any feeding purpose. But it has been found that by treating with alkali and mixing it with more or less buttermilk it can be utilized for feeding swine.

Fertilizer from casein.—A few years ago a firm in Pennsylvania desiccated casein in a similar way and offered it as a source of nitrogen to fertilizer manufacturers, but the price obtained did not satisfy those concerned, and that method of utilizing skim milk ceased.

Casein as a substitute for celluloid.—There is at least one establishment in this country which converts the casein of skim milk into a form so hard as to be a good substitute for ivory, bone, and celluloid. Billiard balls, backs for brushes, combs, checks, and buttons are among the articles made. The material is sometimes called lactite. It is nearly white, with a yellowish shade, but may be variously colored, and when made black it is a fair imitation of hard rubber. The process of manufacture is similar to that already described for dried casein, but greater care has to be taken to prevent discoloration. The chemical treatment is more complex, and powerful pressure is required to give the final solidity and desired shapes.

SKIM MILK USED IN WHITEWASH AND IN MANUFACTURES.

For many years the use of skim milk in whitewash has been known to prevent the coating from peeling off, and at one time the Department of Agriculture gave out a simple recipe for making a skim-milk paint. It is mixed with hydraulic cement, or "water lime," so as to make a thin paint, and laid on with a broad, flat brush. One pound of cement to a gallon of milk is the usual mixture. Not more than a gallon or two should be mixed at once for one workman, and it has to be kept gently stirred and used immediately. If stirred too much, it will harden. This makes an excellent, durable, and inexpensive covering for any structure of wood or stone. If nothing but cement and milk are used, the color will be a light, yellowish brown, but other coloring matter may be added in the form of dry pigment. Another mixture for similar use is sour-milk curd, linseed oil, chalk, and water. Emulsions of olive oil and skim milk are used in wool manufacture as a dressing for the wool.

The following extract indicates other uses for skim milk:

Lactarine or casein gum is almost pure casein specially prepared, which, when dissolved in ammonia, is used for fixing and thickening colors in calico printing. Casein lime or casein cement is made out of skim-milk cheese poor in fat. It is very useful, and is much (?) used in carpentry. The cheese is cut into small morsels, quickly dried, and ground into a fine powder, which is mixed with 20 per cent of burnt chalk. If it be desired to keep it for some time, it must be put into closed vessels and mixed intimately with not more than 1 per cent of camphor. Casein lime comes in fair quantities from Switzerland. (Fleischmann.)

BUTTERMILK AND ITS USES.

Next to skim milk in importance among the waste products of the dairy is buttermilk. The two are much alike in chemical composition, their main difference being physical. Besides this, while skim milk is in most cases sweet when used, buttermilk is uniformly sour, although varying much in the degree of acidity. The total solids of buttermilk average 9.5 per cent; the casein and albumen are rather less in buttermilk than in skim milk, and the fat should be, while the sugar is a little more and the ash about the same. The percentage of fat is the most likely to vary of any of the constituents, this depending upon skill in churning. But with modern methods of well-ripened cream and exhaustive churning at low temperature there is likely to be as little fat in the buttermilk as in well-skimmed milk. The usual nutritive ratio is therefore 1 to 2 or less.

BUTTERMILK AS FOOD.

The best use for buttermilk, also, is as human food, in its natural state and in cooking. Sales are large in many places and might be much increased by proper management. A good article, the real residuum of butter making, taken from the churn and delivered while reasonably fresh, often sells at a higher price than skim milk; it sometimes retails for as much as whole milk. But a great deal of surplus milk in cities and towns, after being "much traveled" and becoming quite sour, is churned for the purpose of changing its appearance and consistency and sold for buttermilk. Such an article, although likely to contain a higher percentage of fat (the same as the milk thus manipulated), is not to be compared with the genuine buttermilk, fresh from the churn of a country dairy or creamery.

LIVE STOCK FED ON BUTTERMILK.

If fed to live stock, buttermilk seems to be best adapted to calves and pigs. For calves it must not be allowed to get too sour nor too old; the animals receiving it should not be very young, and the change from sweet milk to buttermilk should be made gradually and carefully. As food for swine, some experimenters report better results from buttermilk than skim milk, and some the contrary. At the Vermont Agricultural Experiment Station "the pigs fed buttermilk grew faster and shrunk less in dressing than the pigs fed skim milk. At 13 cents per 100 pounds, the financial returns were considerably in favor of buttermilk; rating both at 15 cents, the two gave about the same profit." In other places the opinion is expressed that buttermilk has about four-fifths the value of skim milk. This is about the relative value of the two articles in the opinion of experienced and observing feeders.

SOURCES, COMPOSITION, AND USES OF WHEY.

Whey is the by-product of dairying remaining to be considered, with its uses. When cheese is made from milk, whether the milk be skimmed or not, the only waste product is whey. And, as already stated, whey results from separating the casein from skim milk for use in the arts.

From every hundred pounds of milk converted into cheese about 90 pounds of whey is obtained, and this includes a large part of the solids of the milk—from one-third to almost one-half of them. Whey itself, a watery, semitransparent liquid in appearance, is composed of about 93 per cent of water and 7 per cent solids. The latter include the greater part of the albumen of milk, which has not been coagulated by the rennet, nearly all the sugar of milk, some of the ash, and small fractions of casein and fat. Stated in figures, average whey contains 0.35 of 1 per cent of fat, 1 per cent of albumen and casein, 5 per cent of sugar, and 0.65 of 1 per cent of ash. The fat may be increased by carelessness on the part of the cheese maker; but if the latter be expert, there will be no serious escape of fat in the whey, however rich the milk. The whey from good cheese making is therefore very uniform in composition and quality, but the solids rise and fall with those of the milk it comes from; the better the milk the better the whey. The albumen is valuable as a food, but the sugar is so largely in excess that whey is a carbonaceous material, with a broad nutritive ratio of about 1 to 6.

Under the most approved processes of cheese making the whey is sweet when drawn off from the curd, or only very slightly acid. Having such a large content of sugar and ample lactic ferment for an active "starter," whey sours very rapidly. Therefore, if the sugar is to be utilized, whether for feeding or manufacture, the whey should be used as soon as possible after coming from the cheese vat or draining sink.

VALUE OF WHEY AS FEED FOR HOGS.

Numerous recorded trials show whey to have considerable value as a food for swine, when judiciously mixed with other material. The

Wisconsin Experiment Station reports that 760 pounds of whey effected a saving of 100 pounds of corn meal and shorts, mixed in equal parts, the latter being worth $12 per ton; the whey was worth 8 cents per 100 pounds. At $15 per ton for the grain, whey was worth 10 cents per hundredweight. Whey was fed in varying quantity, from 2 to 10 pounds to 1 pound of grain. Feeding pigs on whey alone was not successful. In Danish experiments it required 1,200 pounds of whey (from skim milk) to equal 100 pounds of meal. And several trials at home and abroad indicate that whey has just about the same feeding value for hogs as half the same weight of skim milk.

A Canadian experiment is reported where sweet whey and sour whey were compared in feeding to hogs, the trials lasting from six to eight weeks. The results were practically alike, the slight difference existing being in favor of the sour whey. The latter was allowed to get into the condition usual when left in a cheese-factory tank to be hauled away by patrons. Its feeding value was computed at 8 cents per 100 pounds. This result is surprising, as it does not agree with the opinion of many practical feeders or the theory of students. "A little old, sour whey will quickly sour a large lot of new, fresh whey, especially in hot weather. It acts in the same way as the starter in cream, and when the whey sours not only is there a loss of milk sugar, but there is also a loss of albumen. Sour whey will act on bright tin or zinc and even on iron, if allowed to remain in contact with it for any length of time, and will form lactates of tin and zinc, which are poisonous compounds if taken in sufficiently large doses. The lactate of iron is not so much so." (Snyder.) The same writer further states: "A number of comparative trials have shown sweet whey to be more valuable than sour whey for feeding. When sweet, the good effects are secured of the digestive ferments of the rennet that is left in the whey."

WHEY FOR CALVES AND COWS.

Some foreign trials with calves show whey to have had about half the value of skim milk, which is rather more than the general estimate. Sweet whey has also been fed to milch cows, in foreign experiments and satisfactory results obtained where 10 to 20 pounds were given to each animal, in addition to other food.

MANUFACTURE OF SUGAR OF MILK FROM WHEY.

Sugar of milk is made from whey, and generally from the whey of cheese factories. It may be made from whey separated from the skim milk of creameries; but this industry can not accompany that of making dried casein, already mentioned, because the sugar in the whey there separated has been destroyed by the strong acid used in the process.

History and extent of milk-sugar making.—This component of milk was discovered late in the seventeenth century, and during the first half of the nineteenth century practical methods were invented for separating the sugar from the milk in a white and crystalline form. For many years Switzerland controlled the milk-sugar industry and supplied the markets of the world, although small quantities were made elsewhere. Germany just about supplied her home demand with a product quite inferior to the Swiss. The United States became in time the chief customer of Switzerland for this article, finally taking about three-fourths of the $60,000 worth annually exported from that country. Between 1880 and 1890 the manufacture of sugar of milk began in the United States, and became fairly established in two or three places before the year last named. The article was then mainly used by druggists, and the price ranged from 30 to 35 cents per pound. The tariff act of 1890 placed an import duty of 8 cents a pound on this sugar, which was reduced to 5 cents in 1894, and still stands at that rate. Increased supply has very much reduced the price, which is now 10 to 17 cents per pound for different grades. The duty is relatively higher than at first, and importations have practically ceased. European production has decreased also, because of the relative scarcity and high cost of fuel and the very great improvement in machinery and methods of manufacture in this country.

Milk-sugar making in the United States.—There are now in the States of New York, Ohio, and Illinois four or five factories of considerable size making sugar of milk. Two of these are in operation the entire year, the others only during the active cheese-making season of their localities. All use whey from neighboring cheese factories, for which they pay from 4 to 6 cents, and sometimes 7 cents per 100 pounds, usually delivered at the sugar factory.

The methods differ in these establishments from crude, open, boiling, or evaporating pans, in cheap sheds, to expensive vacuum boilers, powerful filter presses, condensers, contrifugal driers, pebble mills, and other elaborate machinery, in substantial brick buildings. In the simple method there is but one acid and chemical treatment, which, with boiling, is depended upon to remove most of the casein and fat; the purified whey is then treated much as maple sap would be to make sugar. The resulting product is, of course, of comparatively low grade.

In the finely equipped modern factory the chemical and mechanical processes are much more complete, and the sugar is so entirely free from fat, casein, and mineral matter that it will stand the test of complete combustion. These factories each consume from 10,000 to 60,000 pounds of whey per day. From this is recovered 2½ to 3 per cent of its weight in refined sugar, the higher the grade the less the product in quantity. It seems strange that milk in which the chemist finds 5 per cent or more of sugar will not yield more than half this quantity in commercial form under the highly perfected processes of manufacture, where losses and wastes seem to be almost impossible. Two or three of the factories have branches where whey is reduced to a crude sugar, which is refined at the central plant.

The finished product is prepared for market in different grades and forms. The purest of all, prepared for a special drug trade, is in large, clear crystals, formed on sticks or in "cobs," as they are called, resembling rock candy on a string. This has a wholesale price of 17 cents per pound. Granulated sugar in boxes or barrels comes next, and is worth 15 or 16 cents. Powdered sugar, pure white, and as fine as the finest flour, is the standard product. This is usually packed in barrels of 225 pounds each, and sells at 10½ to 12 cents. A less refined grade is quoted at 9 and 10 cents. Milk sugar in all forms has a very delicate, sweet taste, but is not as sweet as cane sugar or beet sugar. It is mainly used in the preparation of drugs and medicines and various special foods for infants and invalids.

The production of milk sugar a few years ago increased so rapidly in this country that home markets soon became supplied and exports began in the year 1895. There is now a growing demand for the American product in England and Germany. The lowest, or 10-cent, grade, now sent abroad, is an article superior in quality to the best which this country formerly bought in Europe at more than three times this price. One factory in Illinois has a capacity for turning out 16 to 18 barrels per day. This is not only more than is made by all other factories in the United States, but probably more than all made elsewhere in the world. German milk sugar has greatly improved in quality, but the American product now undersells all foreign competitors.

Use of waste at milk-sugar factories.—Waste products accompany the manufacture of sugar of milk. In the large factories these are found in a solid or nearly solid form in the tank precipitates or filter press cakes, and although they have a high fertilizer value, they are usually burned under the boilers. In the simple factories, the albumen, casein, and fat of the whey are largely removed from the boiling vats in the form of a white scum, which is taken off with hand skimmers; there is also more or less curdy precipitate from the vats and pans. Acids and mineral matter have been added in the purifying process. These wastes, well mixed, have been fed while warm to pigs of different ages and with marked success. The mixture seems to be a complete food for swine. The practice has been to buy weaned pigs six, eight, or ten weeks old and feed them absolutely nothing else till ready to butcher. The pigs are kept in open yards, with rough sheds attached, grouped according to ages. They not only grow but fatten, and are ready to kill at six or seven months old. The pork thus made is hard, white, and satisfactory to consumers. The pigs maintain good health. Successive lots of swine have been fed and reared as described in the same yards for four or five years without disease or any apparent sickness. This milk-sugar factory waste has not been analyzed, but it evidently contains all needed elements, and is undoubtedly highly nitrogenous, forming quite a "narrow" ration.

WHEY BUTTER AND WHEY CHEESE.

If the whey from a cheese factory appears to have enough fat in it to justify the labor, the fat is collected or separated and made into a low grade of butter, used for "dressing" cheese while in the curing room. This is whey butter or cheese grease. A whey cheese is also made, known as Mysost, in the northern European countries and in Scandinavian settlements in America. It consists chiefly of milk sugar, but contains also the albumen, fat, and ash of whey. It is molded in brick form, has the color of chocolate, is about as hard as ordinary cheese, slightly granular, and has a peculiar, sweetish taste. Ziger cheese is another European product from the whey of rennet cheese making, well known in Switzerland and Germany. Mysost is dry, less than 25 per cent water, strong in sugar and fat, and low in protein; Ziger, on the contrary, is very soft, being two-thirds water, and is strong in protein, while low in sugar and fat.

WHEY FOR INVALIDS.

Finally, ordinary whey has been considerably used for invalids and convalescents, especially in cases of lung and chlorotic diseases, mainly as an aid to digestion. An article known as "wheyn" has been patented, which is a purified and sterilized whey, free from albumen and fat, and constitutes a nourishing and mildly stimulating beverage.

NOTE.—Since the foregoing matter was put in type a new skim-milk product has taken commercial form, under the name of "faracurd." Skim milk is so separated that the whey carries practically all the sugar and ash, while the albumen, coagulated, and the casein are preserved together, and with these is mixed a very small quantity of fine wheat flour. The only purpose of the latter is to act as a divisor and keep the casein from hardening in mass. Faracurd is preferably in the form of a thick paste, but may be dried and powdered. It is used by bakers and confectioners, being found an excellent substitute for eggs in many bakery products. Provided this article meets present expectation, it will give a new outlet for large quantities of skim milk; and since the product can be sold for less than half the price of its practical equivalent in eggs, it will thus yield at the rate of more than 50 cents per hundredweight for the milk consumed.

DANGER OF IMPORTING INSECT PESTS.

By L. O. Howard, Ph. D.,
Entomologist.

INTRODUCTION.

It is only within very recent years that the agriculturists and horticulturists of this country have begun to realize thoroughly the fact that their crop interests are quite as seriously threatened by foreign insect pests as by native ones. The extensive work of extermination which the State of Massachusetts has been forced to undertake in an effort to repress or exterminate the gipsy moth has thoroughly opened the eyes of the New Englander; the advent of the Mexican cotton-boll weevil into Texas cotton fields has been a serious lesson to the planters of that part of the country, while horticulturists all through the principal fruit-growing portions of the country have learned the same disagreeable truth from the spread of the San Jose scale and the great damage which it has already done.

It is now some years since the writer began to look into this important subject, and he has already published several articles dealing with the general principles involved. In 1894 he started an investigation of the injurious insects of Mexico which are liable to be imported into the United States, and since that time has been collecting in one way or another information concerning the principal crop enemies in the countries having most intimate commercial relations with the United States, as well as specimens, in all stages, of the various insects themselves.

In the spring of the present year (1897) a convention was held in Washington, D. C., which was attended by representatives of horticultural and agricultural societies of many of the different States. This convention was called to consider the desirability of State and national legislation with a view to preventing the introduction and spread of injurious insects and fungus diseases; and while the bulk of its time was occupied by the question of interstate commerce in infested nursery stock and that of appropriate State legislation, much consideration was given to a proposed plan of national quarantine against pests coming from abroad. This fact is mentioned as indicating that at last the persons most interested understand the situation and are seeking for the remedy.

We need only look at the already long list of prominent injurious insects to become at once aware of the fact that had a national quarantine been established long ago its saving to the country would have been enormous. For example, at the World's Columbian Exposition a somewhat elaborate collection of the injurious insects of the United States was exhibited by the Department of Agriculture. This exhibit was included under 602 numbers. Of these 602 numbers, 111 refer to imported species.

Again, the writer has drawn with great care a list of what may be termed the injurious insects of first-class importance. This list was prepared upon the most rigid lines, and every species not of prime importance was excluded. Seventy-three species remained, and these are insects whose names and depredations are familiar to almost every farmer and fruit grower. In fact, each of them almost annually causes a loss of hundreds of thousands of dollars. Of these 73 species, 30 are native to the United States, 37 species have undoubtedly been introduced from foreign countries, while 6 are of doubtful origin. Among the imported species it may be interesting to mention especially the codling moth, the Hessian fly, the asparagus beetles, the "buffalo moth," the hop plant-louse, the horn fly, the common cabbage worm, the sugar-cane borer, the wheat plant-louse, the pear midge, the oyster-shell bark-louse, the pea weevil, the croton bug, and the fly weevil or Angoumois grain moth, in addition to the three important species already mentioned. In many instances the original home of some of our worst insect pests which have been introduced from abroad can not be traced. They have become almost universally distributed, more or less independently of climatic changes, and may have reached our country from east, west, or south. To this class belong many of the most dangerous scale insects; in fact, we may say all of the most dangerous scale insects now occurring in this country. In 1889 the writer stated that the worst 23 scale insects then occurring in the United States were of foreign origin, and that number has unquestionably been considerably increased since that time. Most of the granary pests, most of the household pests, and most of the greenhouse pests also belong to this class.

EUROPE AS A SOURCE OF DANGER.

In glancing over the list of the principal introductions of this kind, it seems certain that the great majority of them have come to us from Europe or via Europe. This is natural enough, since the European climate is similar to our own and since trade connections with that part of the world are of very long standing and very frequent and the journey has of late years come to be of astonishingly short duration. A study of the animals and plants common to the two continents shows a great similarity between them, owing to a similarity in the natural conditions which exist and which govern the development and distribution of life. There is a greater similarity between the animals and plants of Europe and North America, or rather of North America and the more northern portion of the combined continents of

Europe and Asia, than between the forms of life existing in either area and any other of the principal life zones of the world or between any two others of these principal life zones; so that, entirely independent of the matter of trade connections, it would be safe to premise that injurious insects from Europe would be more likely to flourish in the United States and British North America than in other portions of the world, and that insects coming from other regions would be less likely to flourish in North America than would European forms.

Theoretically, and upon these considerations only, it would seem equally certain that injurious insects carried from the United States to Europe would flourish equally well, but this, curiously enough, is not the case, and the reason is difficult to find. Were we considering

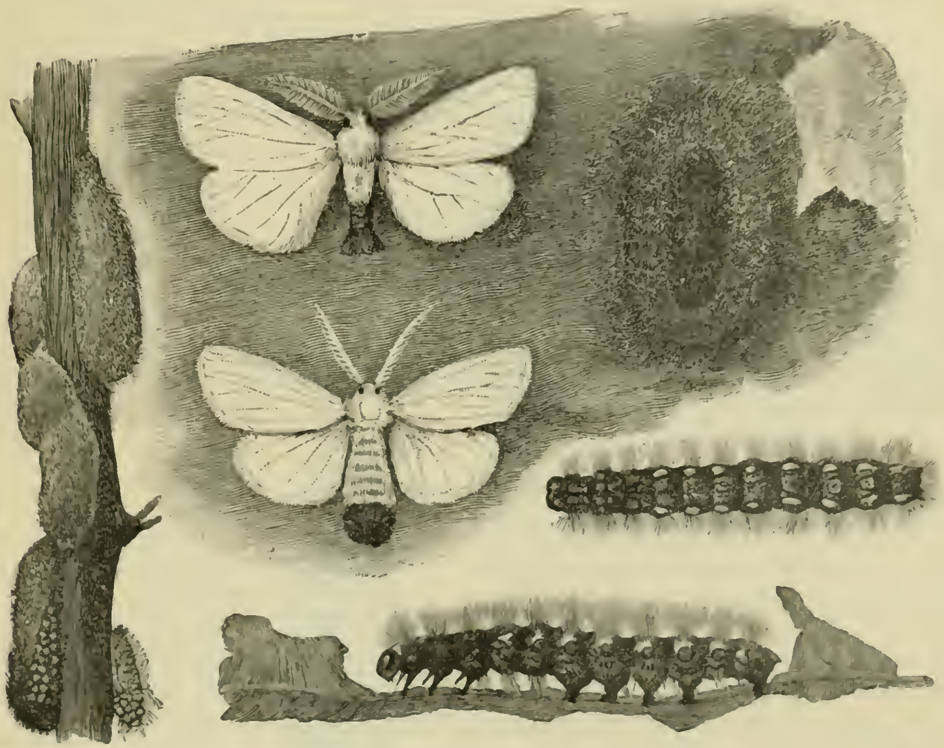

FIG. 25.—*Euproctis chrysorrhœa:* male moth above, female below, eggs at left, cocoon at right, larvae below at right—natural size (original).

injurious insects only, this unexpected condition might be explained largely from the widely differing crop conditions in Europe and America. The small size of the holdings, the closer methods of cultivation, the more frequent rotation of crops, in Europe, exercise a repressive influence upon injurious insects. Brought to this country, however, they are liberated from this repressive system, and being brought over also usually without their natural enemies, they are free to multiply and spread.

Our own species in turn introduced into Europe are likely to be destroyed by agricultural methods alone. This applies with especial force to the insect enemies of field crops. In lesser degree, but still to some extent, does it apply to the insects of the orchard. By no means, however, can this state of nonreciprocity in pests be accounted for on these grounds alone. There are undoubtedly deeper influences at work, and upon this subject there has been much theorizing but no conclusions. It is a fact which must be generally accepted that the general trend of insect migration as well as of weed migration, as shown by Mr. L. H. Dewey in his important article published in the Yearbook of the Department for 1896, is and has always been from the East toward the West, and that the return migration is so insignificant as to be practically unworthy of consideration. It is true that coming from the East toward the West we move in the direction of the newer civilization, and this fact in itself has a greater significance than has generally been assigned to it.

FIG. 26.—*Trypeta ludens:* female—enlarged (redrawn from Insect Life).

By far the greater number of our principal injurious insects, therefore, have come to us from Europe. Of the species incidentally mentioned in a previous paragraph as prominent examples of introduced pests, all have come to us direct from Europe with the exception of three, viz, the sugar-cane borer, the cotton-boll weevil, and the San Jose scale. Of the European forms, it is likely that some of them originally entered Europe from Asia. We know, for example, that the codling moth exists in Siberia to-day, while the gipsy moth spreads across the temperate portions of Asia to Japan. The oyster-shell bark-louse has a similar distribution.

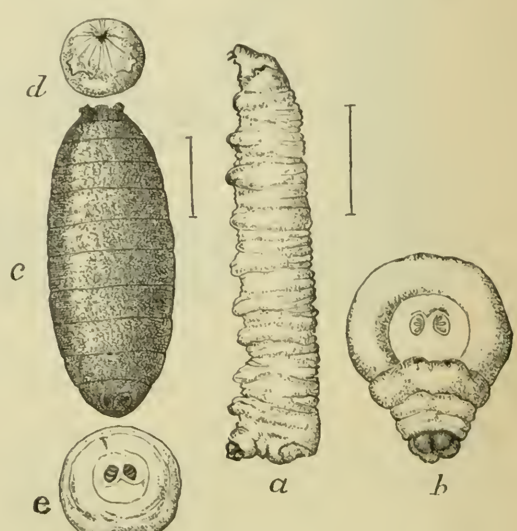

FIG. 27.—*Trypeta ludens:* *a*, larva; *b*, anal segment of same; *c*, puparium; *d*, head of same; *e*, anal segment of same—*a* and *c* enlarged; *b*, *d*, *e* still more enlarged (reengraved from Insect Life).

INJURIOUS INSECTS FROM THE TROPICS.

There are two or three points in the United States which have a distinctively tropical climate, and therefore contain tropical vegetation and tropical animals. These points are the coast of the tip of

Florida, the extreme southern tip of Texas along the Gulf of Mexico and the Rio Grande River, and the valley of the Colorado River in Arizona and southeastern California. Certain tropical insects show a tendency to spread into the life zone immediately north of the Tropics in low-lying regions, and, moreover, the central portion of Mexico between the eastern and western ranges of the Sierra Madre Mountains is in the main an elevated plateau, the climatic conditions of which resemble those of certain portions of our Western States; so that we have had injurious insects reach our Territories from the south, as well as from the east, and our increasing commercial relations, particularly with Mexico by reason of the new progressiveness of that country and the consequent activity in railroad building, will certainly, sooner or later, bring us other dangerous pests from that direction. Thus, the West Indian peach scale (*Diaspis lanatus* = *amygdali*) has been introduced into Georgia and other Southern States; the "red bug" or "cotton stainer" (*Dysdercus suturellus*), an insect which formerly did great damage to cotton in Florida and Georgia, probably came from the West Indies; the sweet-potato root-borer (*Cylas formicarius*) has thoroughly established itself within our boundaries, having been brought either from the northern countries of South America or from the West Indies; and the advent of the cotton-boll weevil into Texas, already referred to, is so recent and so serious an event as to indicate what Mexico may yet have in store for us.

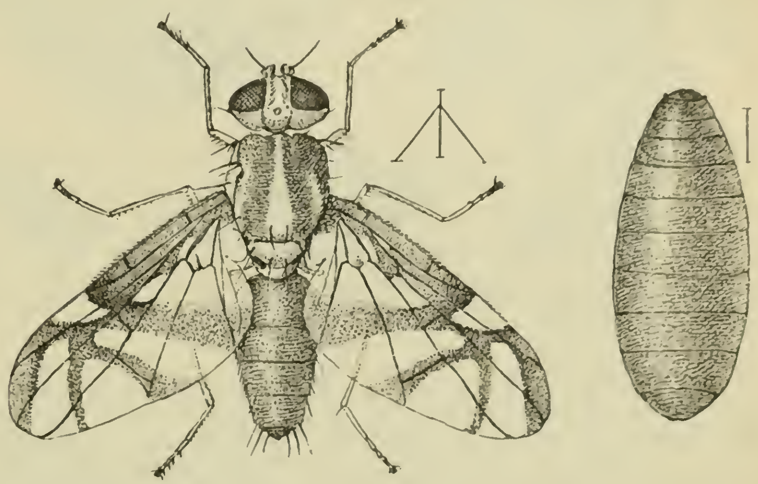

FIG. 28.—*Trypeta acidusa:* puparium at right, adult at left—greatly enlarged (original).

INSECTS FROM PACIFIC REGIONS.

Although there is little similarity in general between the animals and plants of the so-called Oriental and Australian regions and those of our own country, we have already seen that certain species from these two regions, and particularly from the Australian, will successfully propagate in portions of the United States. It is true that the majority of these species have been scale insects, and we are beginning to find that the scale insects as a group are capable of almost universal spread. At all events, they are by no means as restricted in their possible distribution as are insects of other classes. The white scale of California, an extremely destructive insect, which spread with astonishing rapidity over California during fifteen years, was Australian in its origin. The San Jose scale is probably of oriental origin. Even

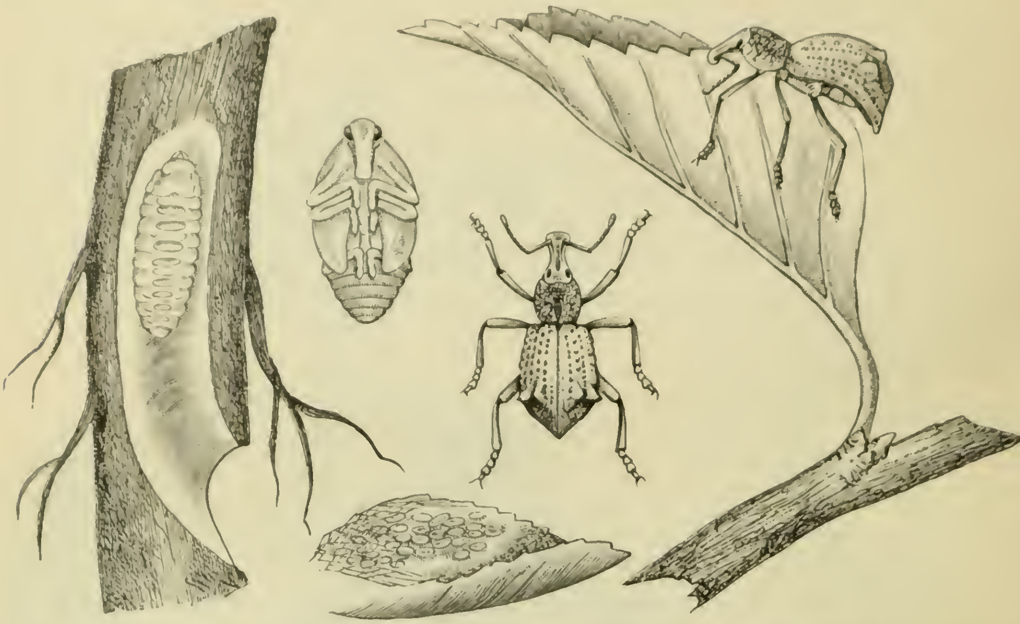

FIG. 29.—*Leptops hopei:* different stages and method of work—natural size (redrawn from French and Kirby).

outside of scale insects we do not lack for examples of the possibility of acclimatization of injurious insects. The potato tuber moth (*Lita solanella*) unquestionably came to California from New Zealand or Australia, and it has spread as far east as Colorado. Other species,

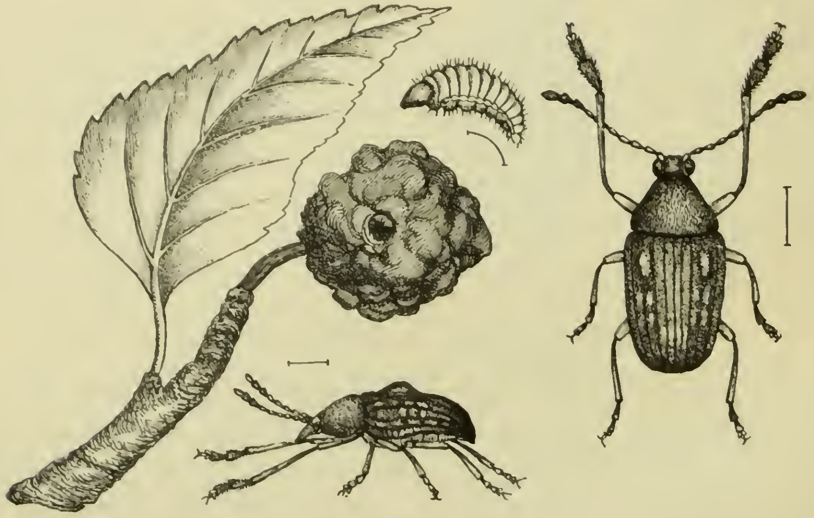

FIG. 30.—*Doticus pestilens:* larva and adult and effect of work—insects enlarged (redrawn from French and Kirby).

with little doubt, would have followed its example had it not been for the admirable quarantine work carried on in California under the State board of horticulture. It is worthy of remark that our rapidly increasing trade relations with western nations will continue to render this quarantine more important and more arduous.

Japan has evidently a number of injurious insects which have not yet reached us and against which we must be on our guard. In the recent impetus to scientific research, which Japan seems to have fostered, economic entomology has not been overlooked. As early as 1890 Professor Sasaki, of the Imperial University at Tokyo, studied with some care the habits of a peach-fruit worm allied to Grapholitha, and within the last two or three years Prof. M. Matsumura, of the agricultural college at Sapporo, has taken up the study of injurious insects with energy, and has corresponded with the writer about Japanese forms. A list of species already under observation by Professor Matsumura has been published (see Bulletin 4, technical series, Division of Entomology, "Some Mexican and Japanese injurious insects liable to be introduced into the United States," pp. 6 and 7). In a later paragraph is given some account of two prominent Japanese fruit worms.

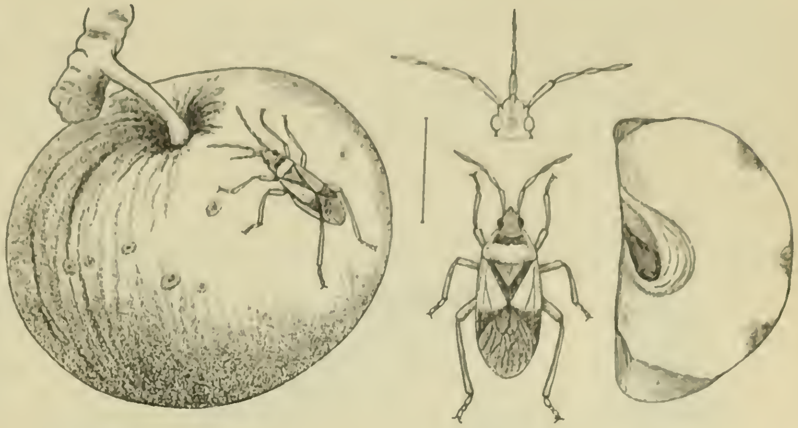

FIG. 31.—*Dindymus versicolor* and its work—natural size indicated by hair line (redrawn from French).

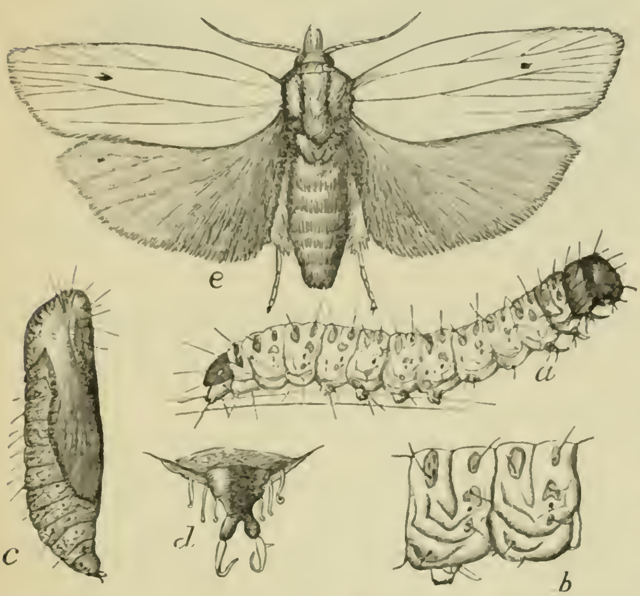

FIG. 32.—*Maroga gigantella*: *a*, larva; *b*, segment of same; *c*, pupa; *d*, anal end of same; *e*, moth—all natural size except *b* and *c*, which are enlarged (redrawn from Insect Life).

INSECTS FROM OTHER PARTS OF THE WORLD.

From the far south it may be said, in general terms, that we have comparatively little to fear. In spite of the fact that there have been some successful establishments of injurious species, these are not likely to be many, particularly in our more northern States, and this is due to the diametrically opposed seasons. An insect starting from Chile or Peru, for example, in the height of summer, would reach the United States in the dead of winter, under conditions, therefore, least likely to encourage its establishment and spread.

From the north there is little to fear, from the fact that we have already within our territory practically every species of injurious insect which occurs in British America. Should this Government, however, establish a general quarantine against foreign countries, and should Canada establish no such quarantine, there will always be

FIG. 33.—Different stages and method of work of *Rhinaria perdix*—slightly enlarged (redrawn from French).

the possibility of certain more northern forms reaching us via Canada and British Columbia.

METHODS OF IMPORTATION OF INSECTS.

Having shown what the probabilities are as to the countries from which new insect pests are still likely to come, the next point to consider is the principal means by which they reach our shores. As the writer has shown in a recent paper presented before the American Association for the Advancement of Science, these insect immigrants come mainly in three ways: First, they are unnoticed or ignored passengers on or in their natural food, such as nursery stock, plants, fresh or dried fruit, dried fruit stuffs, clothes, lumber, or domestic animals; second, their food may be the packing substances used to surround merchandise, or the wood from which cases are made; third, they may have been perfectly accidental passengers, having entered a vessel being loaded during the summer season and hidden themselves away in some crevice.

NURSERY STOCK MOST DANGEROUS.

With insects brought over on plants or nursery stock the conditions could not well be much more favorable. Their supply of food is looked after with care, the host plant is soon put in the ground in the best of surroundings, and the greatest care is taken of this choice importation. Upon or in importations of this kind are carried scale insects in all stages of growth (and often, fortunately, their inclosed parasites), the eggs of plant lice, the larvæ of wood-boring beetles, the eggs of many other insects, the cocoons of small Lepidoptera, and probably even in rare cases the larvæ of Lepidoptera, since it now seems likely that the brown-tail moth (fig. 25) was imported into Massachusetts on nursery stock in its larval wintering nests. The scale insects, how-

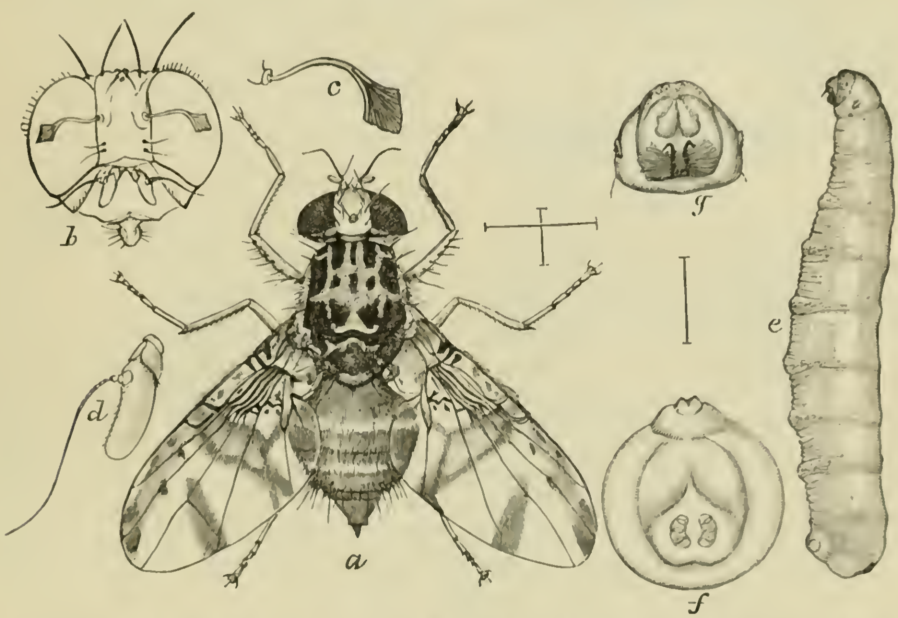

FIG. 34.—*Ceratitis capitata*: *a*, adult fly; *b*, head of same from front; *c*, spatula-like hair from face of male; *d*, antenna; *e*, larva; *f*, anal segment of same; *g*, head of same—*a* and *e* enlarged; *b*, *g*, and *f* greatly enlarged; *c* and *d* still more greatly enlarged (redrawn from Insect Life).

ever, are most abundantly carried in this way. Under natural conditions these insects have usually a rather restricted distribution, but by means of this commercial distribution many of them have become of almost world-wide range, and the end will certainly not be reached until every country possesses every species of scale insect which can possibly live in its climate.

Only second to the scale insects in the facility in which they are transported in this way are the plant lice. These insects, however, are fragile, soft-bodied, and unprotected. They are readily carried, nevertheless, in the winter egg condition, and many species are rapidly becoming cosmopolitan. For example, it was probably in this way that the hop plant-louse was originally brought from Europe to America and, within recent years, from the East to the far Northwest. Other still smaller and less studied insects are undoubtedly carried by this method of transportation. Many of the thrips, for example, of North America have recently been discovered to be identical with those of Sweden and Russia. The small plant-feeding mites of the family Phytopidæ are also particularly subject to this form of commercial distribution. Nearly all of the wood-boring beetles, common to Europe and the United States, have probably been brought over in nursery stock, and even the large wood-boring leopard moth, *Zeuzera pyrina*, probably came over in living plants. This commerce in nursery stock and living plants, is, moreover, rapidly increasing. The imports into the United States during the fiscal year ending June 30, 1896, reached the value of nearly $1,000,000, while the previous year they exceeded $600,000. This class of importations is, therefore, by far the most dangerous and affords the strongest argument for a system of inspection.

FIG. 35.—*Tephritis onoperdinis:* adult (enlarged) larvæ and method of work—natural size (redrawn from Curtis).

Upon imported fruits, fresh and dried, other dried food stuffs, cloths, lumber, and domestic animals many insects are brought in, but the opportunities for the establishment of such insects are by no means as great as are those of insects coming with nursery stock. As a matter of fact, moreover, the dried-fruit insects and those affecting domestic animals are in the main already cosmopolitan.

INSECTS IN PACKING FOR MERCHANDISE.

As to the second means of importation which we have mentioned, it is an undoubted fact that insects may be and doubtless are frequently transported in material used in packing merchandise. The well-known Hessian fly is supposed to have been brought over in straw bedding by the troop ships during the war of the Revolution and to have recently been carried from Europe to New Zealand in the straw packing of merchandise. Laws recently proposed in New Zealand, Australia, and Cape Colony provide that such straw or hay packing shall be burned immediately the case is opened. Other straw or grass inhabiting species have also been brought to this country in this way.

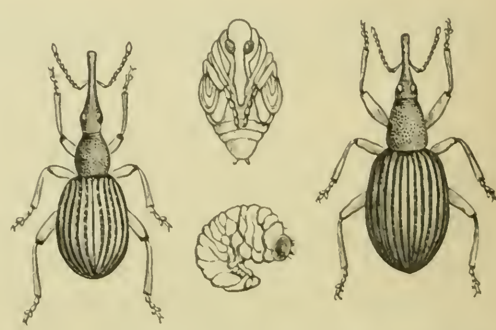

FIG. 36.—*Apion apricans:* male and female beetles, larva and pupa—all greatly enlarged (redrawn from Ormerod).

The well-known wheat-stem sawfly borer of Europe (*Cephus pygmæus*), which has been found in restricted numbers in portions of New York State, is an example, while all of the grass-stem maggots common to Europe and North America have also probably reached us by this method. Grains and grasses, in fact, all over the world, are subject to the attacks of a host of insects of all kinds, many of which pass the winter upon or within the stems,-so that the proposed restrictions of the English colonies just mentioned are by no means unwise.

ACCIDENTAL IMPORTATIONS.

While the opportunity for the establishment of species brought over in the more accidental way mentioned in our third category are much less frequent than are the chances of species coming over attached to

FIG. 37.—*Oscinis vastator* (redrawn from Curtis).

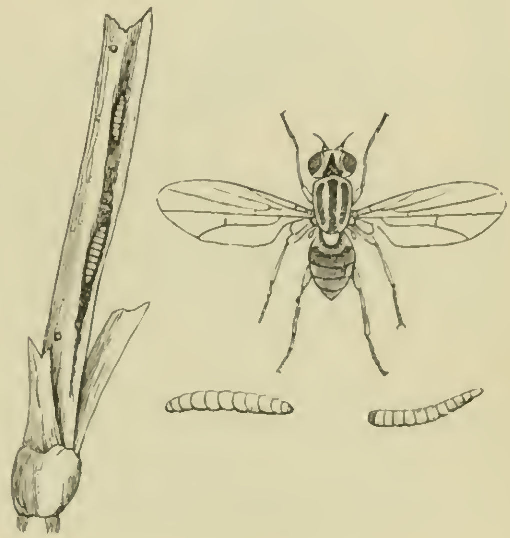

FIG. 38.—*Chlorops tæniopus*: larvæ and adult, and method of work—enlarged (redrawn from Curtis).

or contained in their normal food, still very many species which have flown into a vessel loading at a foreign port in the summer time are carried to us alive and are liberated with the unloading of the vessel on our wharves; and occasionally one of these is able through accidental conditions to establish itself and spread. Against such strictly accidental importations it will be practically impossible to defend ourselves, and it is fortunate that the opportunities for the establishment of such forms are so slight. It is very likely, however, that many of the two-winged flies common to Europe and North America have been brought over in this way and that certain other insects which in the summer are seeking places of hibernation, such as the clover-leaf weevil and the imported elm leaf-beetle, have been brought from Europe in this way.

INSECTS LIABLE TO BE IMPORTED.

It would seem at first glance that it would be a simple and extremely desirable thing for the economic entomologist in this country to thoroughly familiarize himself with the prominent injurious insects of the countries having most frequent commercial relations with the United States, and especially with those species which from their habits would seem most likely to be brought into this country. Such knowledge having become general among consulting entomologists, the advent of any foreign insect would be at once recognized, and in the event of the establishment of an inspection system the labors of the inspectors would be rendered much more efficient.

FIG. 39.—*Cephus pygmæus: a*, larva; *b*, same enlarged; *c*, same in wheat stalk; *d*, frass; *e*, adult female; *f*, its European parasite (*Pachyonerus calcitrator*)—sizes indicated by hair lines (reengraved from Insect Life).

All this is true up to a certain point, but experience has taught us two facts which modify this conclusion. The first is that many prominent injurious insects of foreign countries, living in such a manner as apparently to favor their easy commercial distribution and establishment are never carried abroad, or, if so carried, never succeed in establishing themselves; and the second is that many species unknown as crop enemies in their native homes, when once transported into a new country

FIG. 40.—*Abraxas grossulariata:* larva and adult, natural size (redrawn from Ormerod).

flourish to an astonishing degree and become pests of the first magnitude. So it is impossible to make a list of the injurious insects of foreign countries for the purpose indicated which shall have any great value.

Moreover, aside from the injurious insects of Europe, those of other countries have not been fully studied. There is at present considerable activity in the study of such species in the Australian colonies, in British India, and in Cape Colony, and within the last year or two in Japan, while of New Zealand the same may be said; but this interest is of very recent development, and useful knowledge is as yet slight. In other portions of the world almost nothing has been done. China, Mexico, South America, the settled portions of Africa, and other regions which might be also mentioned are practically unknown to the economic entomologist.

FIG. 41.—*Hyponomeuta padellus:* adult, larva, and web, the latter containing cocoons, natural size (redrawn from Ormerod).

In spite of the difficulties pointed out, this paper would fail of its intent were not special mention made of some of the principal foreign insects which have not as yet succeeded in establishing themselves within our territory. An extended catalogue of such species would be impossible for the reasons mentioned, and for a popular paper we may mention with some little detail as to habit only a very few of the more injurious and striking forms. The illustrations which are scattered through this paper show some prominent insects of this kind.

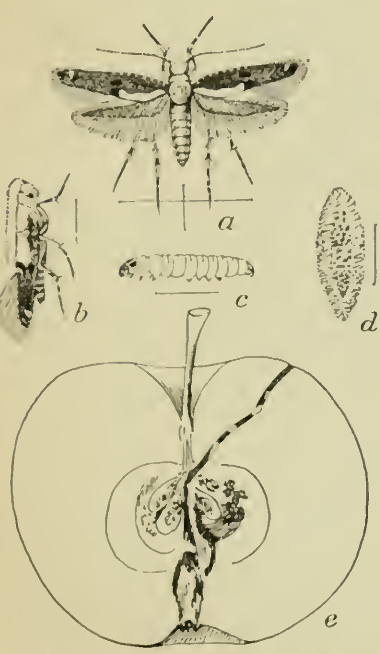

FIG. 42.—*Laverna herellera:* a, adult; b, same, side view; c, larva; d, cocoon; e, injured apple—all slightly enlarged except e, which is reduced (redrawn from Matsumura).

At the convention of horticulturists held in Washington, D. C., in March, 1897, already mentioned, the delegates from California insisted upon the necessity of quarantine against foreign countries. While the State of California has long been alive to this question herself, supporting a quarantine system which has been very effective as against insects occurring upon importations consigned to persons living within the State of California, she has not been able to protect the country at large, except measurably, even from insects entering at the port of San Francisco; but in supporting the idea of national legislation against foreign pests, these delegates had particularly in mind the danger of the introduction of the Morelos orange fruit worm from Mexico, and the imminence of the danger of such introduction was the immediate cause of their attendance at the convention.

THE MORELOS ORANGE FRUIT WORM.

For a number of years it has been known that Mexican oranges sold in the New Orleans market occasionally contained maggots. The writer ascertained this when visiting New Orleans as long ago as 1881, but was unable to secure specimens. In 1887 Prof. Lawrence Bruner, then an agent of the Division of Entomology, while visiting Mexico, secured infested fruit, took it home with him to West Point, Nebr., and succeeded in rearing the adult insect, which proved to be a two-winged fly, described in 1873 from Mexico by Loew, the Austrian naturalist, as *Trypeta ludens* (figs. 26 and 27). According to Bruner's report, this insect was most abundant in the oranges raised in the State of Morelos, 100 miles south of the City of Mexico, and the statement was made to him while in the City of Mexico that oranges from Morelos were very liable to be thus infested. An article upon the insect was published by Riley in the first volume of Insect Life (July, 1888), but no further information as to the natural distribution of the species was gained for a number of years. In late December, 1894, and again in February, 1895, the orange groves of Florida suffered, as will be remembered, to a very serious extent from severe cold. Hundreds of thousands of trees were killed and the orange crop for that year was practically annihilated. It resulted that during January, February, and March, 1895, and again during December, 1895, and January, 1896, orange buyers spread out into the West India Islands, and many of them went to Mexico. The shipments of Mexican oranges into the United States took an enormous jump, and the markets of our Northern and Eastern States were largely supplied with this fruit. Many persons saw the Morelos orange fruit worm in oranges upon their tables for the first time during these winters, and many newspapers contained accounts of the supposedly new insect.

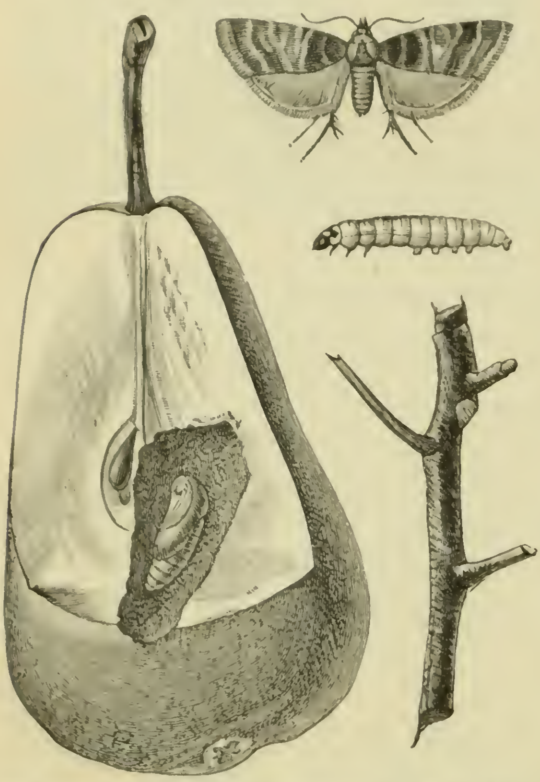

FIG. 43.—*Nephopteryx rubrizonella:* adult above, larva just beneath, egg mass on twig at right; damaged pear with pupa at left—all natural size (redrawn from Matsumura).

In only one case, however, so far as we know, was an effort made to trace the exact source of the infested fruit. Prof. W. G. Johnson, now of the Maryland Agricultural Experiment Station, but then assisting Prof. S. A. Forbes, at Champaign, Ill., found the worms in his own breakfast oranges, traced the stock to a particular dealer in Chicago, and from him learned that the consignment of which these oranges were a part came from just south of the City of Mexico—presumably the State of Morelos.

For some years past the Mexican oranges have reached the California market in the early fall, before the California fruit has ripened. Shipments have been begun as early as October and have continued up to December, when the California fruit is fit for consumption. The occurrence of these Morelos maggots in some of this fruit was pointed out in certain of the California papers during the fall of 1896, with the result which has already been indicated.

The shipment of this Mexican fruit through to the Northern United States can do no possible harm, since this species, so far as known, breeds only in citrus fruits. Even did it attack other fruits, such as peaches, pears, and apples, as some of its close allies are known to do, the fact that the oranges are shipped in winter would bar its introduction. During the seasons following the Florida freezes this fruit was even carried into Florida and was found upon the tables at the principal winter resorts in that State. So little native fruit was left in the State, however, that even this could not be considered as very dangerous. The carriage of infested fruit into the State of California, however, is quite another matter. It arrives there just before the California fruit begins to ripen. A Mexican orange containing these maggots thrown away even at some distance from an orange orchard might result, as can readily be seen, in the establishment of this destructive species in California. There is little wonder, then, at the interest felt in the matter by fruit growers in that State.

In 1894, as we have already stated, an agent of the Division of Entomology was sent to Mexico for the purpose of investigating the insects injurious to agriculture. This agent, Prof. C. H. T. Townsend, reported incidentally upon this insect, although his trip was made before the "scare," if we may call it so, had developed. He showed that oranges were shipped from Guaymas and Hermosillo, in Sonora. Sonora oranges were sent to Chicago and other eastern points, some going, however, to California to the San Francisco market. The Morelos oranges, according to the information which he was able to gain, were shipped only as far as the City of Mexico. This, however, we have already shown was a mistake. From the Guadalajara region oranges were shipped by the car load through to northern points, mainly to Kansas City. The same was the case with the oranges of Tamaulipas. He could find no evidence that *Trypeta ludens* infested any oranges except those from the State of Morelos.

During the winter of 1895-96, however, it was learned from American orange buyers that the Morelos fruit worm existed also in the State of Puebla.

During his travels in the summer and fall of 1897 in Mexico, Mr. Albert Koebele was good enough to further investigate this question of the distribution of this insect. He was informed by the agent of the Wells, Fargo Company, at the City of Mexico, in October, 1897, that but few oranges are now shipped by this company. A few years since, however, large quantities from the State of Morelos were delivered to their office by the Interoceanic Railroad, to be shipped to the United States via El Paso, their ultimate destination being unknown to the agent. The freight agent of the National Railroad informed him that but few oranges were shipped from the State of Morelos; many, however, were shipped from the States further north, principally for New Orleans and Central States.

The agent of the Interoceanic Railroad informed him that some of the fruit was shipped by his railroad, chiefly from Jalapa, and thence to Vera Cruz, and no doubt from that place by steamer to New Orleans and other points. It was by this road that, in Mr. Koebele's opinion, the largest quantity of the Morelos oranges were exported, since their line runs through the States of Morelos and Puebla. This agent stated that about 100 car loads are shipped annually from Jalisco. He was informed by the agent of the Mexican Central Railroad that but few oranges were shipped from the City of Mexico, though a great many were shipped from further north, and especially from the Guadalajara branch, chiefly to St. Louis and Chicago. An experienced fruit merchant informed him that he had found the larva in Morelos oranges and also in considerable number in those from Michoacan, Puebla, and Jalisco. The same merchant also informed him that the National Railroad buys large lots of oranges in the City of Mexico for shipment.

This represents our actual knowledge of the distribution of the species in Mexico down to the autumn of 1897. Appreciating the desirability from every point of view of exact information on this important question, Professor Townsend was commissioned to visit in November and December, 1897, every orange-growing district of Mexico, with the exception of Sonora, and to examine into conditions with relation to this one insect. He carried out his mission with success, and found, as anticipated by the writer, that the orange fruit worm occurs practically wherever oranges are grown to any extent in Mexico. Good evidence was gathered of the existence of the species in the following localities: Morelos, Cordova, Yantepec, Coatepec, Teoselo, Amacusac, Puente de Ixtla, Toliman, Jalapa, San Luis Potosi, Pueblo Nuevo, Cuernavaca, Monterey, Linares, Montemorelos, Chihuahua, Guadalajara, Escalon, San Cristobal, Ameca, La Barca, Victoria, Tuxpan, Jalisco, Manzanillo, Acapulco, and Guerrero. The fruit flies have actually been reared in Washington, D. C., from oranges received from Professor Townsend from the City of Mexico, from Cordova, from Jalapa, and from Tampico. There is, however, no certainty as to where the Tampico oranges were grown.

Mexican orange growers have become much interested in the subject of the California opposition to their fruit, and are naturally, though not justifiably, indignant at the California call for quarantine or prohibition of their fruit. One of the leading industrial papers of Mexico, El Progreso, contained a leading article last spring insisting that the true cause of the California movement was "the desire which these horticulturists have of freeing themselves from the competition which grows more threatening for them day by day, and not that of escaping from the problematic infestation."

The knowledge of the exact details of the life history of *Trypeta ludens* may prove of value in this apparent emergency. Unfortunately, the insect has not been carefully studied in its native home by a competent entomologist. Bruner brought back with him in the early winter specimens of oranges containing larvæ, and from these bred the adult fly the following February. All of the oranges showed a more or less well-defined outward sign of the depredations of some insect enemy. In one a freshly made hole coming to the surface was found, and one of the maggots was observed protruding. December 30 several of the larvæ had pupated, having left the fruit December 22. The fruit itself had rotted and molded, and about one-half of the pulp had been devoured. The first adult appeared February 9. The adults of both sexes were confined with ripe fruit to see if they would oviposit in the orange, if not on the tree. Experiments failed, however, and none of the flies laid eggs, all dying after several days. Johnson experimented with two infested oranges. In both instances the fruit was perfect, so far as outward appearances were concerned. There were no visible ruptures or punctures in the skin, and the flavor of the fruit was sweet and luscious. The maggots when first noticed, on January 10, were about one-third of an inch long, of a dirty whitish color, and worked their way freely through the pulp. The fruit was placed in a dish with some larvæ, and after three or four days became very moldy; but the larvæ continued feeding until January 18, when two of them, having reached the length of 11 mm., left the oranges and burrowed into the ground, one pupating on the 21st and the other on the 24th. The first adult, a male, issued February 28, or just thirty-eight days after pupation. Four days later the second fly emerged.

The observations of both Messrs. Johnson and Bruner show that the fly is hardy and will stand considerable neglect. Mr. Johnson kept a male and female for several days in close confinement in a glass-covered dish and they were seemingly as active as ever when removed. Mr. Bruner showed that the flies can stand a considerable variation in temperature, since on several occasions during his experiments the mercury fell below the freezing point in the room where his breeding cage stood.

The oranges received at Washington from Professor Townsend from the City of Mexico, Cordova, Jalapa, and Tampico all arrived between November 26 and December 21, 1897. The first flies were reared January 12, 1898, and between that date and February 3 twenty-five active specimens emerged, of which fifteen were females.

The different stages of the insect, with the exception of the egg, are well indicated by fig. 27. The larva is dirty white, the puparium is light brown, and the adult fly is straw yellow in its general color. The bristles upon its body are black and the stripes upon the body are silver yellow. The markings upon the wings, as shown by the figure, are brownish yellow with brown edges.

OTHER FRUIT INSECTS IN MEXICO.

There are other insects which attack the fruit of citrus plants in Mexico of which we know much less than we do about the Morelos orange worm. A broad, stout maggot, which may belong to the same family as this worm, is found in oranges in the States of Michoacan and Jalisco, and in the same States a little caterpillar of the family Tortricidæ works in the skin of the fruit. Insects of the same genus as *Trypeta ludens* are also found in Mexico, and the larva of one of these has the injurious habit of working in peaches in much the same way as *T. ludens* does in oranges and as the so-called "railroad worm," or apple maggot (*Trypeta pomonella*), works in apples in the northeastern United States. This species has been reared by Mr. Koebele from peaches at Orizaba and is *Trypeta acidusa* Walk. It is shown by fig. 28.

INJURIOUS AUSTRALIAN INSECTS.

From a study of the recent Australian reports and from correspondence with certain of the newly appointed colonial entomologists, it appears that there are several very destructive insects in Australia which are entirely unlike anything occurring in the United States, and which may at the same time be imported, and if imported might prove disastrous to certain fruit-growing industries. These are the apple root-borer (*Leptops hopei*), the apple fruit beetle (*Doticus pestilens*), the harlequin fruit bug (*Dindymus versicolor*), and the cherry borer (*Maroga gigantella*).

The apple root-borer (fig. 29) belongs to a genus which is indigenous to Australia, forty-four species having been found in the various colonies. For the past thirty years the species in question has been known in Victoria to attack fruit trees, especially apples and pears, but it has only recently become a serious scourge. In one case 13 acres of fine trees, most of which had been in full bearing, were rooted up and destroyed, owing to the damage done by this insect. The affected trees died from the top branches downward, and upon examination the larger roots, mainly 8 inches or more below the surface, were found to have been tunneled by the larvæ of Leptops, as shown by fig. 29. The figure of the larva and its work has been adapted from Mr. Charles French's "Handbook of destructive insects of Victoria," and that of the beetle from Kirby.

The apple beetle attacks the fruit of the apple and bids fair in portions of Australia to rival the codling moth in its damage. Its capacity for damage is, in a way, greater than that of the codling moth, since the latter insect, while frequently spoiling fruit for table purposes, does not damage it for cider. Indeed, as Walsh once said, it is problematical whether the presence of thousands of codling-moth larvæ in cider apples does not improve the quality of the cider. The work of the Doticus, however, results in the complete shriveling of the apple, rendering it unfit for any purpose whatever, as indicated by fig. 30. The beetle is a minute species, brown in color, perhaps one-sixth of an inch in length, and of the general appearance shown by fig. 30. Mr. French considers that this insect was probably imported from West Australia into Victoria, either from Queensland or some of the Polynesian group of islands. The exact period at which the eggs of the insect were deposited is not known, and little is known, in fact, about the other points in the natural history of the species. Apples containing the grub wither and dry up, and the shriveled fruit frequently hangs upon the tree for a whole year. The fact that the fruit does not at once begin to wither allows an opportunity for the exportation of the insect within apples, and renders the spread of the species possible. The Australian apples received at the port of San Francisco have frequently been found by Mr. Craw, of the California board of horticulture, to contain shriveled fruit, resembling that in which the Doticus has been working; but up to the present time no evidence has been found of the incoming of the living insect.

The harlequin fruit bug (*Dindymus versicolor*) is a small red and black bug, illustrated by fig. 31, which is found only in the Australian colonies. The eggs are laid during the late summer months, among rubbish, under logs, stones, decayed wood, and stubble. The young insects, which have an odor, by the way, like bedbugs, and crawl actively around, sucking the juices of growing plants, upon attaining wings fly into the trees, and have been the cause of much damage to the apple crop. They insert their beaks into the side of the ripening apples, extracting the juice and causing the apples to become spotty.

The cherry borer (*Maroga gigantella*) is the larva of the moth shown by fig. 32. These larvæ, which are pinkish white in color, destroy cherry trees, plums, apricots, nectarines, and even quinces, by boring at first under the bark and then into the heart of the tree. The sawdust-like excretion on the trees is a sufficient indication of the presence of this larva. As early as 1860, this insect was reported by the late Henry Edwards to have destroyed nearly all of the cherry trees in a large garden at Richmond, Victoria. This insect, according to Mr. Edwards, was originally a borer in the black wattle (*Acacia decurrens*), and has evidently transferred its attentions from this tree to fruit trees. Curiously enough, although boring in wood like the larva of the moth family Cossidæ, this insect is a Tortricid, the majority of the species of which are leaf rollers.

The strawberry beetle (*Rhinaria perdix*), shown at fig. 33, is another of the Australian species. It is reported to be a very serious enemy of the strawberry grower, and in some cases of the grower of raspberries, in Victoria. They destroy both the flower and leaf stalks by tunneling, and the larvæ eat large holes in the crown of the plant, killing it outright. The beetles are most plentiful in December, and are found until the early part of February.

THE BERMUDA PEACH MAGGOT.

Before referring to European pests of importance which have not yet reached us, attention must once more be called to the occurrence in neighboring West India islands of a fruit insect of great importance. We refer to the peach maggot of Bermuda (*Ceratitis capitata*). This insect (fig. 34) has already a very wide distribution, and this not only in peaches, but also in oranges and other fruit. It occurs in the East Indies, in South Africa, in Mediterranean countries, as well as in Bermuda, and it is a wonder that it has not already established itself in this country. In Bermuda, some years ago, the peach crop was almost annually completely destroyed by this insect, and this has practically been the case since 1866. Many peach trees have been cut down owing to its damage.

A FEW EUROPEAN DESTRUCTIVE INSECTS.

It would be interesting to mention the habits of a number of liable importations from Europe, but there is space for only a few.

One of the insects most abundantly treated in European works on destructive insects is the celery, or parsnip, fly (*Tephritis onoperdinis*). The celery crop suffers more severely from the attacks of this insect than does the parsnip. The eggs are laid on or in the leaf, and from these hatch maggots which feed between the upper and the under surface of the leaf, causing large blister-like patches. Where the insect is abundant, the leaves are destroyed and the plants are consequently greatly damaged. When full-grown, the maggots generally leave the leaf and transform beneath the surface of the ground. There are several broods, and development is rapid. This species is shown at fig. 35.

There are already two important clover enemies in the shape of beetles imported from Europe, viz, the clover root-borer (*Hylesinus trifolii*) and the clover-leaf weevil (*Phytonomus punctatus*). There are several other European beetles, however, which in their native home are even more destructive than these species, and which, it is rather surprising, have not yet been reported. Prominent among these is one of the pear-shaped weevils, known as *Apion apricans* (fig. 36). They are common upon red and purple clover, laying their eggs in the blossom heads. The larvæ feed on the still unripe seeds and seriously injure the production of clover seed. The heads wither rapidly, and when the larvæ are full grown they turn to pupæ at the bottom of the flower, the weevils issuing in about a fortnight. There are several broods each year. The harvested clover retains the insects, and swarms of weevils issue from it.

In Europe no insect is more prominent as an enemy to small grains than *Oscinis frit*, the "frit fly," as it is called in England. Already the Hessian fly and the wheat midge from Europe have established themselves in this country, and it is astonishing that not only *Oscinis frit*, but several other allied species, such as the gout fly or ribbon-footed corn fly (*Chlorops tæniopus*), have not also been brought over in hay or straw packing. The frit fly is especially abundant and injurious in northern Europe. Its maggot works in the stems and leaves of the young growing plant, and has also been recorded as feeding in its second generation on the soft grains in the ears of barley, thereby causing the light, worthless development of the grain known in Swedish as "frits"—hence the name of the fly. A nearly related European species, *Oscinis vastator*, is illustrated by fig. 37. The ribbon-footed corn fly (fig. 38) affects wheat, rye, and barley, but is most prevalent on barley. The work of its larvæ produces a swollen state of the heads of the grain, the ear being unable to burst its sheaths. The eggs are laid in the forming ear while still wrapped in the sheathing leaves, and the larva forms a tunnel down one side of the stem to the uppermost knot, where it changes to a puparium.

A well-known wheat enemy in Europe, known in England as the corn sawfly, *Cephus pygmæus* (fig. 39), has already reached this country, although, contrary to what might be expected, it has attracted no attention by its injuries. It has been found at Ithaca and Buffalo, N. Y., and near Ottawa, Canada, as well as in Manitoba. It was first captured in this country near Ithaca, certainly as early as 1882. The female lays her eggs one at a time in the wheat stem, just below one of the knots. The larva feeds on the soft inner substance of the stalk, and about harvest time, or a little before, reaches the base of the stem, where it gnaws a ring so nearly through that the straw readily falls with its own weight or from a slight wind. From the drain on the vitality of the stalk, the ear seldom produces the usual number of seed or full seed, and frequently appears white when the remainder of the field is green. This is an insect which is constantly liable to be reintroduced should previous introductions die out from one cause or another.

The commonest of our currant worms, the larva of a sawfly, *Nematus ventricosus*, is an importation from Europe, but the commonest of the European currant worms has not yet reached us. It is the larva of the so-called magpie moth, *Abraxas grossulariata* (fig. 40), and is a variable species, one of the common forms of which we have illustrated. The caterpillar feeds on both gooseberry and currant, is widely distributed in Europe, and is one of the commonest of the English species. The caterpillar is one of the loopers, and makes its appearance in August or September. It passes the winter in the caterpillar stage, among the leaves and rubbish at the surface of the ground, coming out again in the early spring and feeding upon the new foliage, doing its principal damage at this time.

One of the most serious enemies of apple trees in parts of Europe is the small ermine, *Hyponomeuta padellus* (fig. 41). This insect, which is mentioned in almost every work upon European economic entomology, is a small white moth, with black spots on its forewings, which lays its eggs in roundish bunches on small twigs, covering them with a gummy substance, yellow at first, but gradually changing to a dark brown, so as not to be easily distinguished from the brown twigs. The eggs hatch about the end of October in England, but the caterpillars remain sheltered by the gum until spring, when the leaves begin to unfold. They burrow into the young leaves and at first feed upon the parenchyma, afterwards destroying the whole leaf, feeding in companies and spinning webs, as shown in the figure. The moths appear about the end of June.

SOME DANGEROUS JAPANESE INSECTS.

Of Japanese insects we need mention at this time only two species. These are the apple fruit borer (*Laverna herellera* Dup.) and the pear fruit borer (*Nephopteryx rubrizonella* Rag.). Accounts of each have been sent us by Prof. M. Matsumura, of the agricultural college at Sapporo. The figures which we introduce of these two insects are redrawn from Professor Matsumura's sketches.

The apple fruit borer (fig. 42) is said to be the most troublesome insect with which the fruit growers of Japan have to contend. It is thought to have been introduced into the country, and is now met with there wherever apples are grown. The larvæ live only in the core of the apple, injuring the seeds. They mature in about a month, make a passage through the flesh of the fruit, crawl or drop to the ground or emerge from the fallen fruit, making white cocoons in the earth and hibernating in the pupa stage. It produces only one brood each season.

On the day that these words were written, November 11, 1897, parts of two apples were received from Mr. Craw, at San Francisco, which a passenger on the steamer from Japan had given him, and which showed evidence of the work of what is very probably this insect. No specimens of the insect itself were found, but the apples contained the larval burrows leading to the core, and two of the seeds had been eaten out. It is not likely that the passenger would have bought damaged apples in Japan, and, therefore, it is probable that the larvæ issued from the fruit on the journey; so that it appears to us that this insect is one which is particularly liable to be introduced. It has since been learned that this insect has already probably gained a foothold in British Columbia.

The pear fruit borer (fig. 43) is the larger of two species of similar habits found in Japan. Professor Matsumura states that pear growers lose every year from 30 to 50 per cent of their crops from this insect, which is more troublesome than the apple fruit borer. The eggs are laid under a small twig, in clusters of twenty, protected by a white silken web. They hatch early in June, at the time when the fruit has reached the size of a cherry. The young larvæ spin a considerable amount of silken thread on the twigs and make their way to different fruits near by, which they puncture to the core, always leaving a blackish opening at their entrance. Their presence is readily detected by these holes. The larval stage lasts three weeks or more, and the pupal change is undergone within thin silken cocoons inside the fruit. The insect hibernates in the egg stage.

NATIONAL QUARANTINE AND INSPECTION.

It would be a comparatively simple matter to go on indefinitely with these brief accounts of foreign insects, but for reasons already pointed out this is not considered necessary. It has been shown that the majority of our most injurious insects have been imported. It has also been shown that not only are there many other injurious insects in foreign countries which are noted enemies of cultivated crops, and which are constantly liable to be brought over under our present lack of inspection, but also that species of foreign countries not known as especially injurious are liable to multiply excessively and to become serious pests when brought into this country.

The remedy for this condition of affairs is obvious. Laws must be passed establishing a system of inspection of dangerous classes of merchandise, just as has already been done in the case of live stock, and just as has already been done in a partial way by the State of California.

The experience in California is an interesting one and its results should be appreciated. By the operations of a State law and by the cooperation of the common carriers of the State, an inspection system has been carried on for a number of years, which, without doubt, has prevented the establishment of many species of injurious insects within the State boundaries. Every vessel containing suspected articles entering at the port of San Francisco is examined by the State officer, who has power to condemn or to order treated all plants, trees, nursery stock, or fruit consigned to persons living in California, which, in his judgment, may need such condemnation or treatment.

This system of inspection at the port of San Francisco, however, does not protect the country as a whole, except indirectly, since articles consigned to persons living outside of the State are beyond the jurisdiction of the State officials. The protection of a national law is, therefore, needed, even at San Francisco. The passage of some such national measure as that recommended by the convention of horticulturists and agriculturists held in Washington, D. C., March 5 would seem, from a consideration of the facts here presented, to be abundantly justified by the constant danger which threatens our agricultural and horticultural interests.

THE AGRICULTURAL OUTLOOK OF THE COAST REGION OF ALASKA.

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INTRODUCTION.

During the summer of 1897 the writer visited that part of the coast region of Alaska which extends from Dixon Entrance to Unalaska to investigate the agricultural and horticultural possibilities of that country. Including numerous side and return trips, a distance considerably exceeding 4,000 miles was traveled by boat, there being no other means of travel. The time covered was from June 8 to September 11, and there is scarcely a village along the entire route that was not visited, or concerning which reliable information was not secured.

GENERAL TOPOGRAPHY.

The region visited consists of numerous islands and peninsulas, the shore line everywhere being irregular and indented by innumerable bays and inlets. (See Pl. XXXII, fig. 1.) Hills and mountains abound, with valleys of greater or less extent, but occasionally considerable areas of apparently level land are met with along the shore line or along the larger streams. Much of the land is boggy, the marshes often extending to a considerable distance up the rather steep hillsides. On the Kenai Peninsula and on the western side of Cook Inlet, in the vicinity of West Foreland and Tyoonock, are extensive plateaus, but elsewhere the surface is more or less broken. Two large rivers, the Stikine and the Copper, are found in this region. They cut through the coast ranges and extend some distance into the interior. At the head of Cook Inlet are two other rivers of considerable size, the Sushitna and the Knik. The other streams of the coast region are mostly small in size and comparatively short. Fresh-water lakes of greater or less extent are numerous throughout the region, their margins being more or less marshy, depending on the contour of their surroundings. Tide flats of considerable extent exist at the delta of the Copper River and at the mouth of the Stikine River.

Much of the land, even on the rather steep hillsides, is boggy, the drainage usually being poor. The formation of the soil and the blanket of moss, almost universally present, greatly extends the marshy area. This mossy blanket, much of which is composed of sphagnum, occurs nearly all along the coast region, in some places the layer of dead and living moss covering the ground to a depth of several feet. The power possessed by the moss of absorbing and retaining large amounts of water and its character as a nonconductor of heat will, to some extent, account for the cold, wet condition of the underlying soil. The presence of this dense mossy layer makes traveling very difficult, since crevices, rocks, fallen limbs, and trees are so covered that numerous pitfalls are hidden from sight. Limited experiments have shown that beneficial results follow the removal of the moss so that the soil may be warmed and thawed earlier in the season.

Considered from an agricultural standpoint, the coast region is divided by a wide stretch of mountains, embracing the St. Elias and Fairweather ranges, into two rather characteristic regions, a timbered and a treeless region. The southeast or wooded region extends from Dixon Entrance to Cross Sound or a little beyond, a distance of about 4 degrees of latitude. The greater portion of this region is embraced in the great Alexandrian Archipelago, which consists of more than 1,000 islands, and the mainland as far as Juneau. The larger islands of this region are Prince of Wales, Kupreanof, Baranof, Admiralty, and Chichagof. The smallest of these islands is about 50 miles long, while Prince of Wales Island is about 120 miles long and about 40 miles wide. The second or southwestern region, much of which is barren of trees, extends from Cook Inlet along the Alaskan Peninsula westward, including the Aleutian Archipelago, Kadiak, and the neighboring islands, the Shumagin group, and numerous other smaller islands. The northern and northeastern part of this region contains some timber, but in general the region is characterized by its remarkable wealth of grasses. Toward the western portion of this area the arborescent flora disappears entirely or is represented by a few small, stunted shrubs, mostly willows.

METEOROLOGY.

In general, the coast region of Alaska is characterized by great rainfall and a rather constant temperature, due to the Japan current, which sweeps the whole coast. The popular idea of extremes of temperature throughout this region is erroneous. In many places zero temperature is seldom experienced, and the lowest recorded temperature (Fahrenheit) during a period of about ten years, as given by the United States Weather Bureau, at Juneau was —4°; at Killisnoo, —2°; at Sitka, —3°; at Kadiak, —2°. On the other hand, the maximum temperatures observed at the same stations were: Sitka, 80°; Juneau, 88°; Killisnoo, 84°; and Kadiak, 79°. The average daily range of the thermometer during the summer months is very small. On several occasions during cloudy weather a variation of but 2° was noticed at

FIG. 1.—GOVERNMENT BUILDING AND HARBOR, SITKA.

FIG. 2.—ALASKAN RED TOP, SITKA.

Kadiak; and at Killisnoo, observations were reported in June in which there was no diurnal variation. The following tables show the average monthly temperatures and rainfall of eight stations in Alaska, and for comparison the same data for several places in northern Europe and this country are added. The data for the meteorology of Alaska were supplied by the United States Weather Bureau, and, while somewhat fragmentary, covers at each station the following number of years: Wrangel, four years; Sitka, twelve years; Juneau, eight years; Killisnoo, fourteen years; Kadiak, twelve years; Unalaska, six years; St. Michaels, twelve years, and Pyramid Harbor, five years.

Compilation of average temperatures.

Station.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Average.	Total temperature, May 1 to Sept. 30.	Sum of effective temperatures, May 1 to Sept. 30.
	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
Wrangell[1]	26.2	30.8	31.6	42.7	49.3	55.3	58.2	57.5	52.3	45.9	33.5	32.9	43.0	8,343.0	1,764.0
Sitka[1]	32.9	33.6	37.1	42.1	47.6	51.9	55.1	56.4	52.3	46.2	38.9	35.8	44.2	8,058.1	1,479.1
Juneau[1]	27.5	24.7	33.5	40.1	47.6	53.6	56.6	55.0	49.9	41.9	31.2	29.3	40.9	8,040.2	1,461.2
Killisnoo[1]	27.7	26.8	33.1	36.9	45.6	51.6	55.2	54.4	47.8	41.1	33.4	30.1	40.3	7,793.2	1,214.2
Kadiak[1]	30.0	28.2	32.6	36.3	43.2	49.5	54.7	55.2	50.0	42.2	34.7	30.6	40.6	7,731.1	1,152.1
Unalaska[1]	33.5	30.5	32.6	35.2	40.4	45.6	49.8	50.3	46.0	40.4	34.6	32.8	39.3	7,103.5	624.5
St. Michaels[1]	7.4	—2.3	8.9	19.9	33.1	46.3	53.6	51.9	43.9	30.5	15.6	4.8	26.1	7,002.6	423.6
Pyramid Harbor[1]	25.0	23.0	35.0	43.0	48.7	55.4	56.3	56.1	50.0	40.9	28.2	25.3	40.6	8,156.1	1,577.1
Trondhjem, Norway[2]	27.4	26.8	28.6	37.9	45.8	53.6	57.2	56.3	50.0	41.1	32.7	27.5	40.6	8,046.3	1,465.3
Bergen[2]	34.1	32.2	35.4	43.7	48.9	55.0	57.9	57.5	52.7	45.1	38.5	34.7	44.6	8,324.3	1,745.3
Christiania[2]	24.1	23.9	29.5	39.9	50.9	59.9	62.6	60.6	52.7	41.9	32.1	25.6	41.9	8,775.1	2,196.1
Helsingfors, Finland[3]	20.9	18.8	26.2	34.8	44.1	56.9	61.9	58.3	50.5	43.9	33.7	21.7	39.2	8,315.3	1,736.3
Stockholm, Sweden[4]	33.5	29.5	33.8	39.5	52.5	57.0	59.1	59.3	53.6	40.6	35.6	27.3	43.4	8,615.9	2,074.9
Orkney Islands[5]	38.5	38.2	40.3	43.3	47.8	52.8	55.1	55.0	52.5	47.5	42.6	40.9	46.2	8,053.9	1,474.9
Scotland[6]	37.1	38.4	39.4	44.1	49.0	54.8	57.1	56.6	52.8	46.4	40.6	37.8	46.1	8,271.7	1,692.7
Winnipeg, Manitoba[7]	—11.0	—5.0	10.5	33.5	53.6	61.5	64.0	61.5	49.0	36.5	18.0	3.0	29.6	8,867.1	2,288.1
Qu'Appelle, Assiniboia[7]	— 8.0	—2.5	15.0	35.5	50.0	61.0	63.0	60.5	48.5	36.5	19.5	3.0	29.8	8,663.5	2,084.5
Port Angeles, Wash[7]	34.7	36.7	41.7	45.6	50.6	54.0	56.6	56.8	52.7	47.7	42.4	38.2	46.1	8,285.0	1,671.0

[1] Compilation U. S. Department of Agriculture, Weather Bureau.

[2] Landrugsdirekt. Beretning, 1893.

[3] Ofver. Finska Veteuskaps. Soc. Fordhandlingar. Average 1869-1878.

[4] Meteor. Iaktag. Sverige k. Svensk. Vetensk. Akad., 1890.

[5] Trans. Highland and Agricultural Society, Scotland, 1874.

[6] Idem, 1895.

[7] Monthly Weather Review, U. S. Department of Agriculture, Weather Bureau, 1893.

Average precipitation.

Station.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.	Precipitation. May 1 to Sept. 30.
	In.	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*
Wrangell[1]	......	5.70	2.58	3.87	3.06	3.56	3.98	2.62	9.58	8.16	11.03	9.44	.....	22.80
Sitka[1]	7.95	8.02	7.78	5.03	3.89	3.87	4.14	6.67	10.94	12.96	10.77	8.52	90.54	29.51
Juneau[1]	10.59	4.80	6.49	5.25	7.36	4.99	5.25	7.35	10.04	8.49	8.78	7.38	86.77	34.99
Killisnoo[1]	5.26	5.03	4.39	2.56	2.80	2.00	3.53	4.80	6.39	6.92	6.43	5.84	55.92	19.52
Kadiak[1]	6.56	3.70	4.86	4.01	5.92	4.91	3.38	4.97	7.26	8.09	6.56	7.94	68.16	26.44
Unalaska[1]	13.81	7.68	6.48	7.51	4.49	4.26	2.78	3.40	8.64	11.98	9.30	11.81	92.14	23.57
St. Michaels[1]	0.86	0.18	0.46	0.49	0.99	1.40	1.76	2.61	2.90	1.34	0.79	0.67	14.44	9.66
Pyramid Harbor[1]	2.96	6.06	2.81	1.19	1.15	1.31	1.18	1.45	3.38	4.03	5.01	4.50	35.03	8.47
Trondhjem, Norway[2]	3.36	2.28	2.52	2.20	2.32	2.48	2.56	2.59	3.27	4.29	3.50	4.25	35.60	13.22
Bergen, Norway[2]	6.93	5.55	4.33	3.78	4.09	4.37	6.06	6.85	8.26	8.78	6.73	7.44	69.13	29.63
Christiania, Norway[2]	1.22	0.94	1.06	1.10	1.77	2.04	3.34	2.87	2.99	2.56	1.89	1.26	22.56	12.92
Helsingfors, Finland[3]	1.47	1.20	1.16	1.39	1.67	1.72	2.09	2.71	2.20	2.57	2.42	1.61	22.25	10.39
Stockholm, Sweden[4]	0.88	0.44	1.34	2.85	3.12	1.58	2.62	4.57	1.26	3.28	2.65	0.69	25.22	13.16
Orkney Islands[5]	4.29	3.11	2.71	1.86	1.55	2.17	2.62	2.84	2.72	4.85	3.89	4.33	36.95	11.94
Scotland[6]	3.95	3.00	2.78	2.15	2.29	2.50	3.11	3.55	3.67	4.05	3.82	3.97	38.83	15.12
Winnipeg, Manitoba[7]	0.66	1.27	1.20	1.35	2.72	3.84	3.22	3.46	2.00	1.73	1.00	1.39	23.93	15.24
Qu'Appelle, Assiniboia[7]	0.38	0.67	0.64	1.06	1.52	3.35	2.35	1.37	1.14	1.02	0.67	0.64	16.35	9.73
Port Angeles, Wash[7]	4.90	3.33	2.53	1.90	1.05	1.50	0.27	0.85	2.10	2.91	3.52	5.35	29.35	5.77

[1] Compilation U. S. Department of Agriculture, Weather Bureau.
[2] Landrugsdirekt. Beretning, 1893.
[3] Ofver. Finska Vetenskaps. Soc. Fordhandlingar. Average 1869–1878.
[4] Meteor. Iaktag. Sverige k. Svensk. Vetensk. Akad., 1890.
[5] Trans. Highland and Agricultural Society, Scotland, 1874.
[6] Idem, 1895.
[7] Monthly Weather Review, U. S. Department of Agriculture, Weather Bureau, 1893.

In the foregoing tables, in addition to the usual data, there is added the total sum of temperatures for the five months in which most plant growth is made, that is, May 1 to September 30, the sum of the effective temperatures for the same time, and the rainfall for the same period. It appears from the tables that several of the north European stations have lower annual temperatures than some of the Alaskan places, while the total temperatures for the period indicated at Wrangell, Juneau, and Sitka are almost the same as those for the same period at Trondhjem and Bergen, in Norway, Helsingfors, Finland, the whole of Scotland, Orkney Islands, and at Port Angeles, Wash. The sum of effective temperatures for the Alaskan towns, although somewhat lower than the same factors for the European stations in several instances, however, surpass the effective temperatures of several localities of known agricultural capabilities.

The annual rainfall for the southern coast of Alaska, as shown in the table of average precipitation, is rather heavy when compared with other regions, ranging, as it does, from 35.03 inches at Pyramid Harbor to 92.4 inches at Unalaska. The only European region given in the table where a nearly equal rainfall is shown is that at Bergen, with 73.18 inches. If we consider the rainfall of Alaska for the five growing months, May 1 to September 30, it is seen that with the exception of Juneau only one-third or less of the annual precipitation falls during the summer months. The total amount of summer rainfall, while large, is not excessive, especially when it is shown that Raleigh, N. C., has an annual precipitation of 55.67 inches, 30.82 of which falls during the period indicated. Washington, D. C., with an annual precipitation of 43.59, and Indianapolis, Ind., with 43.09, have, respectively, 21.29 and 20.54 inches during the same period. The summer rainfall of each of these places exceeds that of Wrangell, Pyramid Harbor, and Killisnoo, and that of Raleigh is exceeded by Juneau alone. Official data relative to the proportion of sunshine and cloudy days, or days on which there was some rainfall, are extremely meager. From private records it was found that at Juneau, in 1894, during the five summer months, there were fifty-nine clear and sixty-three rainy days; in 1895, fifty-six clear and sixty-seven rainy days; and in 1896, sixty-two clear and sixty-seven rainy days. This enumeration includes under clear days those recorded as fair, but no account is taken of cloudy days on which there was no rainfall. At Klawock, in 1894, during the summer, there were sixty-three clear and fifty-five rainy days; at Sitka, according to Dr. Dall, in Report of the U. S. Department of Agriculture, 1868, there were during the year ending October 31, 1868, one hundred and six fair and one hundred and thirty-four rainy days; at Metlakahtla during the summer months of 1893 there were fifty-seven clear and eighty-two rainy days. Comparing the proportion of sunshine and rainfall in some of the European stations it appears that in Sterlingshire, Scotland, as an average of fourteen years' observations, there were two hundred and five days on which some rain fell. In Sutherland, Scotland, with an annual rainfall of 31.71 inches, there were, in 1875, one hundred and fifty-seven days with 0.1 inch or more rainfall; in 1876 there were two hundred and nine.

In general, along the coast region, the winter's snow has disappeared at sea level by the middle of April, although snow flurries are common for some time after that date. Killing frosts are seldom experienced between May and October. At Metlakahtla, on Annette Island, in the southern part of Alaska, during 1893, the last killing frost occurred April 6, and the first in autumn was October 30. Comparing the temperature, rainfall, proportion of clear and cloudy days of Sitka, Wrangell, and Killisnoo with the data of various agricultural regions of the higher latitudes of Europe, it is seen that the comparison is not wholly unfavorable to the Alaskan stations.

SOILS.

The soils of Alaska to a great extent are of vegetable origin and to a considerable degree resemble what are called the rice lands of the South or the peat formations of Europe and elsewhere. In some places in southeastern Alaska there are deep deposits of this rich-looking soil overlying slate or conglomerate bed rock, with often a deposit of gravel intervening. Sometimes there is an impervious stratum of clay underlying the black soil. Where the soil lies directly on bed rock or is underlain with clay, the drainage is usually poor and the land more or less marshy.

Samples of what appeared to be average soils were collected at various places and transmitted to the Division of Soils of the Department. The chief of that division, Prof. Milton Whitney, has reported on a number of these, and to him the writer is indebted for the data relating to their analysis. The water capacity of these soils and the tenacity with which they retain it is shown by the water content of the air-dry samples, ranging from 1 to 47 per cent. The amount of organic matter ranges from 3.01 per cent in a subsoil to 61.19 per cent in a soil from a small meadow at Sitka. In some of the garden soils there is a high percentage of coarse material (gravel and slate), which is undoubtedly due to attempts having been made to warm and lighten the soil by the addition of these substances. The presence of large amounts of very coarse material in the soil taken from the spruce bog at Wrangell and of a sample taken from a ditch running through a bog in Juneau find a possible explanation in the action of land slides which have been of not infrequent occurrence in that country. The following table shows the relative percentages of coarse material, fine earth, etc., of the specimens analyzed:

Percentage of coarse material and fine earth in Alaskan soils and subsoils.

Locality.	Description of sample.	Depth.	Coarse material (larger than 2 mm. in diameter).	Fine earth.
		Inches.	*Per cent.*	*Per cent.*
Sitka	Garden soil	0–6	63	37
Wrangell	Beach soil		62	38
Juneau	Spruce soil	12–24	60	40
Kadiak	Meadow soil	1–6	46	54
Do	Garden soil	12–18	38	62
Do	do	1–6	36	64
Wrangell	do	72	35	65
Sitka	Virgin soil	12–36	30	70

Percentage of coarse material and fine earth in Alaskan soils and subsoils—Continued.

Locality.	Description of sample.	Depth.	Coarse material (larger than 2 mm. in diameter).	Fine earth.
		Inches.	*Per cent.*	*Per cent.*
Juneau	Garden soil	2-12	29	71
Do	Ditch soil	36-48	27	73
Wrangell	Spruce land	24-36	26	74
Juneau	Garden soil	12	23	77
Wrangell	Spruce bog	24-72	18	82
Juneau	Garden soil	12-24	12	88
Wrangell	Spruce land	36-72	10	90
Do	Virgin soil	3-12	7	93
Kadiak	Garden soil	6-12	5	95
Sitka	Meadow soil	3-12	3	97
Wrangell	Spruce land	18	2	98
Sitka	Virgin soil	36-72	0	100
Do	do	24	0	100
Kadiak	do	6-12	0	100
Juneau	Spruce bog	0-24	0	100
Sitka	Virgin soil	0-12	0	100

The mechanical analyses of the samples are shown in the following table. Owing to the unusually large and varying amounts of organic matter in the soils their analyses were based upon the organic free basis:

Mechanical analyses of Alaskan soils and subsoils.

Locality and description of sample.	Depth of sample.	In original sample.		Calculated on dry and organic free material.							
		Moisture in air-dry sample.	Organic matter.	Gravel, 2-.1 mm.	Coarse sand, 1-.5 mm.	Medium sand, .5-.25 mm.	Fine sand, .25-.1 mm.	Very fine sand, .1-.05 mm.	Silt, .05-.01 mm.	Fine silt, .01-.005 mm.	Clay, .005-.001 mm.
Wrangell:	*Inches.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Beach	....	2.50	10.50	24.94	38.11	20.53	5.85	5.65	3.25	0.85	0.82
Spruce land	24-36	4.88	4.64	21.67	24.79	17.72	12.98	12.85	7.76	0.97	1.28
Garden soil	72	17.27	26.33	15.79	20.49	11.33	11.92	18.56	15.45	2.50	3.96
Spruce land	18	1.09	3.57	4.70	17.26	13.30	9.07	21.60	26.18	3.39	4.48
Spruce bog	24-72	4.28	10.42	13.79	12.78	19.15	9.80	17.54	19.33	2.66	4.93
Spruce land	36-72	7.12	16.03	10.82	17.21	11.79	8.17	18.61	24.17	2.89	6.34
Virgin soil	3-12	14.22	15.28	11.31	18.26	13.29	9.31	20.01	16.32	3.56	7.94
Juneau:											
Garden soil	2-12	14.07	16.20	18.28	10.76	5.46	7.80	29.97	19.55	3.59	4.57
Do	12	12.95	7.54	11.49	12.80	13.01	11.83	28.24	13.29	1.69	4.63
Spruce land	12-24	1.25	4.45	6.37	7.13	5.05	10.48	36.21	27.04	2.74	5.02
Do	12-24	7.79	7.83	28.91	16.14	5.50	7.25	17.81	15.53	2.36	6.50
Ditch	36-48	17.34	6.65	18.92	13.02	4.82	5.87	22.17	19.43	3.66	12.09
Spruce bog	0-24	19.00	57.68	3.11	5.48	7.78	11.04	18.98	34.93	5.56	13.10

Mechanical analyses of Alaskan soils and subsoils—Continued.

Locality and description of sample.	Depth of sample.	In original sample.		Calculated on dry and organic free material.							
		Moisture in air-dry sample.	Organic matter.	Gravel, 2-.1 mm.	Coarse sand, 1-.5 mm.	Medium sand, .5-.25 mm.	Fine sand, .25-.1 mm.	Very fine sand, .1-.05 mm.	Silt, .05-.01 mm.	Fine silt, .01-.005 mm.	Clay, .005-.001 mm.
Sitka:	*Inches.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Meadow soil	3-12	22.31	61.19	6.57	4.67	5.28	18.56	38.73	22.61	3.25	0.34
Virgin soil	36-72	5.05	2.40	16.29	29.00	18.86	14.29	9.71	5.25	1.91	4.69
Do	0-12	15.34	32.96	0.51	2.77	10.59	21.47	28.58	25.37	5.34	5.36
Do	24	8.93	4.95	13.20	23.92	19.86	9.77	10.26	12.20	3.19	7.60
Do	12-36	8.04	3.01	32.42	20.18	4.92	2.47	2.89	20.57	4.80	11.77
Garden soil	0-6	47.02	13.06	18.06	8.14	6.45	10.26	12.86	22.06	7.13	15.06
Kadiak:											
Virgin soil	6-12	11.20	22.15	1.61	1.29	2.06	15.74	42.17	27.26	4.06	5.80
Garden soil	6-12	12.51	23.17	1.05	1.00	1.09	13.11	42.19	29.51	6.05	5.98
Do	1-6	8.62	7.76	20.77	22.98	16.03	9.21	9.15	9.45	3.53	8.89
Do	12-18	12.73	17.04	7.02	5.17	4.87	8.10	21.80	30.38	7.24	15.45
Virgin soil	1-6	8.94	10.90	11.75	8.97	6.68	9.08	15.77	21.98	7.78	17.98

In commenting upon the character of the soil samples analyzed, Professor Whitney says:

The organic content of many of these soils is very much higher than in any of the agricultural lands of the States. They correspond very nearly with the rice lands and peat formations. The black soils of the plains and the famous Red River Valley soils of the Northwest contain from 8 to 10 per cent of organic matter, but seldom more. If these soils are so situated as to be well drained, they should be capable of producing enormous crops, and with an abundant and well-distributed rainfall they would be adapted to almost any kind of crop suited to the general climatic conditions of that portion of the country.

In several places complaints were heard of a decided acidity or the soil, but no definite information could be secured relating to it. In one place the addition of a large amount of lime to a small plat had corrected the evil complained of.

In the valley immediately back of Sitka, where a ditch had been dug, the soil was very peaty in appearance and when dry it was said to burn readily. The extent of similar formations throughout the southeastern portion of Alaska is very considerable. In southwestern Alaska a gravelly subsoil is more abundant and the presence of considerable amounts of volcanic material in some places renders the soil very rich and requires less drainage. In some places in the Cook Inlet region the drainage is very good, the soil overlying deep gravel deposits. Another characteristic soil formation is that which is so conspicuously illustrated by the tide flats of the Copper and Stikine rivers. These places are more or less marshy and are subject to overflow at high tides. Where protected from the encroachment of the sea and sufficiently drained they are generally considered as very productive soils.

FIG. 1.—TIMBERED REGION, SOUTHEASTERN ALASKA.

FIG. 2.—SPRUCE STUMPS AND SECOND-GROWTH TREE.

FORESTS.

In the southeastern portion of Alaska the Sitkan spruce (*Picea sitchensis*) and the hemlock (*Tsuga mertensiana*) abound, now one and then the other predominating. They grow from tide water to timber line, an elevation varying from 2,000 to 4,000 feet, and in some places the trees attain considerable size. (See Pl. XXXIII.) Specimens of the Sitkan spruce were seen that were at least 8 feet in diameter and probably more than 200 feet high. Logs of this species were seen at the Wrangell sawmill that approximated 100 feet in length, with an average diameter of more than 4 feet. At different places in the southeastern region the so-called red and yellow cedar (*Thuja gigantea* and *Chamæcyparis nootkatensis*) abound, usually at some little elevation from the sea, although trees of considerable size were seen almost at sea level. In no place do these trees occur in such abundance as to wholly exclude other species. Another spruce (*Tsuga pattoni*) was observed, but not in great abundance. But a single species of pine (*Pinus contorta*) was seen, and that was almost invariably found on the flats or on the edge of bogs. Two species of alder (*Alnus oregona* and *A. viridis*) were common along the streams and on the mountain sides where snow slides have swept away the dense growth of moss and conifers. Willows are common, but seldom were they seen to attain the dignity of trees.

This great forest area is almost without the mark of the woodsman. There are at present but few sawmills, the exportation of lumber being unlawful. Local demands for lumber and fuel are the principal uses to which the timber is put, and, with almost entire exemption from forest fires, the supply, if properly regulated, will be sufficient for all needs of Alaskans for a long time to come. In addition to furnishing him with fuel for his fires and lumber for his houses, the native employs the trees of the forest in many ways. The red and yellow cedar furnish trunks of huge proportions adapted to boat building, and dugout canoes capable of carrying thirty men were seen, in whose construction considerable first-class workmanship was apparent. The trunks of these trees also furnish the logs whence are carved the grotesque totem poles which stand before the houses of the native and over his grave, telling to those capable of reading the symbols the genealogy of the individual over whom they stand guard. The Hydah and other southern tribes excel in the excellence of their carvings in wood, and only their near neighbors to the north follow the custom of the erection of totem poles. The bark of the cedar tree furnishes roofs for houses, temporary summer dwellings, boat covers, etc., while the finer and softer inner bark is twisted into ropes or braided into mats. The tough roots of the spruce serve many purposes, not the least of which is for basket material. Many baskets are still being woven for sale and domestic use, although for the latter purpose an empty kerosene can holding about 5 gallons is beginning to take the place of baskets as less expensive and equally well adapted to the purpose.

In the north and northeastern section of what has been designated the southwestern part of the coast region some spruce (*Picea sitchensis*) and cottonwood (*Populus balsamea*) occur, the trees frequently attaining a considerable size. Considerable birch (*Betula papyrifera*) and perhaps another species occur in the upper part of the Cook Inlet region, but elsewhere the forests of the southwestern coast are very insignificant.

GRASSES.

Next to the timber, perhaps the grasses of Alaska are among the most valuable of the plant products. In all parts of the country they flourish to an extraordinary degree. In southeastern Alaska, wherever the timber is cut away and the undergrowth of the shrubs kept down, a dense growth of grass soon takes place, to the exclusion of all other plants. (Pl. XXXIV, fig. 1.) Of the common grasses, timothy (*Phleum pratense*), Alaska red top (*Deschampsia cæspitosa* and *D. bottnica*), blue grass (*Poa pratensis*), orchard grass (*Dactylis glomerata*), wild barley (*Hordeum boreale*), *Calamagrostis aleutica*, and wild rye (*Elymus mollis* and other species) are the most widely distributed, and are probably the most valuable for pasture and hay. Timothy, orchard grass, and blue grass have become thoroughly established and grow to great size. One of the most common native grasses is the Alaskan red top. It is a prominent factor in nearly all grass mixtures and frequently exceeds a man in height. Specimens at Sitka, July 5, which are shown on Pl. XXXII, fig. 2, were a little more than 4 feet in height and just heading. Orchard grass more than 3 feet high was seen as early as June 20. In the western part of Alaska, valley and hillside as far as 1,000 feet or more elevation were green with grass during the time spent in that region.

The most common hay grasses at Kadiak are *Poa pratensis*, *Deschampsia cæspitosa*, and *Hordeum boreale*, with some wild timothy (*Phleum alpinum*). *Calamagrostis langsdorfii* was the most abundant hay grass observed in Cook Inlet. At Unalaska the common pasture and hay grasses appear to be *Trisetum subspicatum* and *Calamagrostis aleutica*.

White clover was seen in many of the small meadows and dooryards, from which places it seems to be rapidly spreading. Some red clover was also seen, but its adaptability to Alaskan conditions can neither be affirmed nor denied since apparently no thorough attempt has been made to introduce it. In a few places alfalfa was also seen that was beginning to seed in August.

On the tide flats dense growths of sedges are common, and in some places a very common vetch (*Vicia gigantea*) occurs, and if utilized

FIG. 1.—MEADOW AT WRANGELL, MOSTLY NATIVE GRASSES.

FIG. 2.—CURRANTS AND RASPBERRIES, WRANGELL.

it would add considerable to the feeding value of the marsh hay. Specimens of some of the more common Alaskan grasses were secured through Mr. H. J. Minthorn, of Metlakahtla, and referred to the chief of the Division of Chemistry of the Department for analysis. The results of the fodder analyses are as follows:

Analyses of Alaskan grasses (air-dried material).

Species.	Water.	Protein.	Fat.	Nitrogen-free extract.	Crude fiber.	Ash.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Phleum pratense (just heading)	8.59	8.94	2.14	45.69	30.06	4.58
Poa pratensis (beginning to flower)	8.11	8.94	2.04	41.46	34.24	5.22
Bromus sp. (just heading)	7.72	8.85	2.28	38.41	34.59	8.15
Anthoxanthum odoratum (in flower)	8.56	10.88	1.74	40.86	33.58	4.28
Deschampsia bottnica (in flower)	8.75	7.44	2.07	47.05	31.54	4.15
Calamagrostis aleutica (in flower)	8.33	10.00	1.37	37.89	38.89	4.52

For comparative purposes the following table is given from Jenkins and Winton's Compilation of American Feeding Stuffs.[1] The species in some cases are not the same, but are closely related ones.

Comparative analyses of American grasses (air-dried material).

Species.	Water.	Protein.	Fat.	Nitrogen free extract.	Crude fiber.	Ash.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Phleum pratense (in flower)	15.01	6.01	3.01	41.90	29.59	4.48
Poa pratensis	17.44	10.80	3.45	46.10	22.09	7.35
Bromus secalinus	14.30	6.61	3.07	44.97	20.39	6.10
Anthoxanthum odoratum	14.30	9.85	2.52	46.46	21.85	5.00
Deschampsia cæspitosa [1]	14.30	9.04	1.06	37.20	29.03	9.37
Calamagrostis canadensis	6.87	11.19	3.45	35.82	37.18	5.49

[1] Deitrich and König.

The nutritious value of Alaskan grass is not only plainly seen by comparing the figures in both tables, but it was evidently shown in the sleek and fat cattle observed during the summer season, although they had come through the winter in very poor condition.

In Alaska the principal use of grasses is for pasturage, although in some places—notably Kadiak, Unalaska, Cook Inlet—hay is made nearly every year. Haymaking is usually secondary to other affairs, and the best results are not secured. During the past summer about 20 tons of hay of a very fair quality was made at Kadiak, and smaller quantities elsewhere. Often the complaint was heard that it costs too much to make hay in Alaska. With the crude methods in vogue it probably does cost considerable when small patches here and there are mowed and the hay carried in a small boat to the shed

[1] U. S. Department of Agriculture, Office Experiment Stations, Bulletin No. 11.

or barn. About the only place a mowing machine was used was at Kadiak, scythes being used elsewhere. One place was visited where it was claimed that hay could be brought from San Francisco or Seattle as cheaply as it could be cut and cured at home. A few days' work in leveling off the irregular hummocks would have produced a meadow sufficiently smooth to cut grass with a mower and rake it by horse power, and then the cost would not have exceeded a few dollars per ton. It is claimed that in the Cook Inlet region hay can be made for less than $5 per ton.

Some years ago, at the mouth of the Stikine River, considerable marsh hay was made, but the place is now abandoned, due largely to the inaccessibility of the place several months in the year on account of the shallow water and ice which exist during the winter season.

Some crude attempts have been made at various places with silos, noticeably at Yakutat, Unalaska, and the Stikine River farm. The silos were filled with grass just as it was mowed, and complaints were heard of its molding to such an extent that stock refused to eat it. Perhaps with more care in the construction and filling of silos this difficulty might be obviated.

At Kadiak and elsewhere a tall-growing wild rye is used to a considerable extent for thatching buildings. The sweet-scented grasses (*Hierochloa odorata* and *Anthoxanthum odoratum*) are used to some extent as ornamental grasses, while some species of grasses are used to a limited degree in basket work.

BERRIES.

The abundance of berries in Alaska has been a subject of remark by everyone who has written concerning this country. So far as could be learned but little attention has been given to their cultivation, but the few attempts that have been made seem to promise favorably. Hardly any berries are cultivated except a few strawberries, currants, and raspberries (see Plate XXXIV, fig. 2), and of these both wild and cultivated forms were seen growing, and the adaptability of the wild plants to domestication was very evident. The wild strawberry was seen under cultivation at Wrangell, and specimens of *Rubus stellatus*, known as dewberry, "Morong" and "Knesheneka," were seen growing in a garden at Sitka, and it seems probable that more could be done in this line.

The flavor of most Alaskan berries was found to be excellent, and some of them might be worthy of introduction into the States.

Of the berries which have widest distribution may be mentioned the salmonberry (*Rubus spectabilis*), two kinds of cranberries, the highbush (*Viburnum pauciflorum*) and the little cranberry (*Vaccinium vitis-idæa*), the red and black currant (*Ribes rubrum* and *R. laxiflorum*), crowberries (*Empetrum nigrum*), huckleberries (*Vaccinium uliginosum* and its variety *mucronatum*), raspberries (*Rubus strigosus*), elderberries (*Sambucus racemosa*), bunchberries (*Cornus canadensis* and *C. suecica*), and the "Molka" berry (*Rubus chamæmorus*). Of less general distribution are strawberries (*Fragaria chiloensis*), dewberries (*Rubus stellatus*), thimbleberries (*R. parviflorus*), salalberries (*Gaultheria shallon*), bog cranberries (*Vaccinium oxycoccus*), wine, or bear, berries (*Arctostaphylos alpina*), etc. These berries are used in many ways by the native and white population, and in addition to the consumption of fresh berries many are stored up in various ways for winter use. The white population preserve, can, and make jelly of the different kinds; among the natives the principal method of preserving them is in seal oil, a vessel filled with berries preserved in this way forming a gift that is usually highly prized.

MISCELLANEOUS FOOD AND OTHER PLANTS.

In some parts of the country the leaves of *Ledum grœnlandicum* and *L. palustre*, under the names of Labrador tea, or Hudson Bay, tea, are used to a considerable extent, and are said to afford a no mean substitute when tea is not to be had. It is highly probable that in the past other indigenous plants have entered into the food of the natives; but, with the advent of the whites, bringing with them flour, sugar, etc., to supplement the native diet of fish, seal oil, and meat, the use of native plants as sources of food has diminished considerably.

One of the native plants used to a considerable extent is the so-called wild rice, or, as it is called by the Thlinket Indians, "Koo" (*Fritillaria kamchatkensis*). The small underground bulbs of this plant are collected, dried, powdered, and made into a sort of cake. The bulbs while green have a decidedly bitter taste; whether they lose this in drying and cooking can not be definitely stated.

In many portions of the country, especially Cook Inlet and adjoining regions, there is a beach pea (*Lathyrus maritimus aleuticus*), the young fruit of which is used to some extent in the same way we use the ordinary garden pea, and some of those who have tried it are quite enthusiastic in their praise of this vegetable. The plants yield abundantly, and the pods are well filled with small, juicy peas about the size of the French peas of the market. The question of this plant having injurious properties, as have other species of the same genus which produce lathyrism, has been raised, but no intimation was at any place heard concerning any injurious effects following the use of this vegetable.

There are quite a number of indigenous plants in Alaska used as pot herbs. Common among them are *Claytonia sibirica*, *Nasturtium* sp., *Rumex* spp., skunk cabbage (*Lysichiton camschatcensis*), as well as introduced plants, of which shepherd's purse, horse-radish, dandelion, and turnip tops are the most common.

The leafstalks of *Heracleum lanatum* are quite extensively eaten, but not as a regular article of diet. They are peeled and chewed at irregular intervals, taking the place of peanuts, fruits, etc., which with us are eaten more for pleasure than as foods. In eating the petioles of this plant care must be taken that they are well peeled, or the mouth will be made very sore by the hairs which almost cover the plant.

Quite a number of mushrooms were observed growing in Alaska, and specimens of a few of the more common were collected. The natives are said to collect and use them both fresh and dried.

A rather common marine alga, which has been determined as *Porphyra laciniata*, forms an article of considerable value from a dietary standpoint in southeastern Alaska. This plant is called "thlakusk" by the Thlinket Indians. It grows on kelp, and after storms or very high tides large quantities are washed ashore and the natives collect and preserve it for future use. The method of preparation consists of cleaning it from foreign material as much as possible, drying a little, and then packing in boxes about a foot square. After a sufficient quantity is placed in the box a weight is placed upon it, and the pile soon reduced to a compact purplish-black mass about an inch thick. When thoroughly dried it will keep indefinitely. When used a small portion is shredded in tepid water, allowed to come to a boil, and to cook for about twenty minutes, after which it is eaten as it is, or it may be sweetened. This article of diet is highly esteemed, both by whites and natives, as very nutritious and valuable in cases of stomach and bowel disorders, it being claimed to be a specific for dysentery. The same or a similar plant is collected and used in the north of Ireland under the name of "sloke," "slocan," or "laver."

In addition to the use of thlakusk as medicine, the root stalks of the Alaskan skunk cabbage has quite a reputation and use in domestic medicine, its peppery and aromatic roots being highly esteemed. The buck bean (*Menyanthes trifoliata*) is also recognized as having medicinal virtue. But little information could be gained from the natives relative to plants used by them for medicinal purposes. It seems probable, however, that the medicinal value of quite a number of plants is well known to and appreciated by them, and that this knowledge is by no means monopolized by the medicine men, a representative of whom may still be found in many of the villages.

GARDEN PRODUCTS.

Cultivated areas in Alaska are, with the exception of one or two notable instances, confined to kitchen gardens, in which are grown many of the hardier vegetables of our own gardens, such as lettuce, radishes, carrots, parsnips, potatoes, onions, peas, snap beans, celery, turnips, cauliflower, cabbage, rhubarb, horse-radish, etc., in most places the local supply of radishes, lettuce, turnips, and carrots being about equal to the demand.

It is a subject of dispute whether or not potatoes mature in Alaska. Under the methods of culture adopted in Alaska it is very probable that a dry, starchy potato is not secured, as potato tops seen late in the fall were still quite green. In Cook Inlet and on Kadiak Island, as well as elsewhere, the natives grow a small round potato, the original stock of which is said to have come from Russia or Siberia, and so far as could be learned, it is the same now as it was fifty or one hundred years ago. No trouble was reported in securing sufficiently mature tubers so that the seed could be kept over from one season to another. Among some specimens of vegetables sent the Department by Mr. Frederick Sargent, of Kadiak, were some potatoes, specimens of which weighed a pound each. No doubt these were larger than the average, but it certainly disposes of the idea "that potatoes will not grow larger than walnuts in Alaska."

Complaints were heard in some places that cabbage and cauliflower would not head. There occasionally appears to be some ground for this, but 16-pound cabbages from Killisnoo and 24-pound cauliflowers from Wrangell would rather indicate that in some places these plants do well. Local conditions may cause failures of these crops just as seems to be the case with several others. Localities were visited where it was said that onions would not grow; others where beets could not be raised; but both of these vegetables were seen in flourishing conditions elsewhere. In a few places where attempts have been made to grow peas and snap beans the efforts have been apparently quite successful. When the peas are gathered at frequent intervals, the vines are said to bear for an extra long period. Specimens of a so-called dwarf pea were seen at Wrangell that had grown to a height of 3 feet. Whether this was due to a mistake in the variety or to the climate and soil can not be determined. During the past summer cucumbers are reported to have been grown at Tyoonock, but none were seen when that place was visited.

Samples were very frequently seen of the abnormal behavior of some of the common biennial plants, such as beets, turnips, and occasionally cabbage and cauliflower. These plants frequently attempt to complete their life cycle in one season. In the case of the root crops no enlarged root is formed, and in the cabbage and cauliflower there is no indication of a heading. The loss occasioned by this unusual behavior is frequently very great, if one considers the total area devoted to the crop. A large bed of beets was seen about June 18 in which there was not a single plant that showed any indication of producing an edible root, while many of the plants were already in bloom. Turnip beds frequently occurred where fully one-fourth of the plants were running to seed. In the case of turnips it is known that some varieties are less subject to this undesirable trait than others, and it is probable that the causes and means for its prevention would not be far to seek.

At Kadiak, potato plants were seen that had produced numerous small tubers in the axils of the lower leaves. In some cases these aerial tubers were quite small, but several were seen that were more than an inch in diameter. It was claimed, and perhaps very justly, that there was an intimate connection between the formation of these aerial tubers and those grown beneath ground, the more of the one the less of the other. Crowding can hardly explain this behavior, as one of the best examples was seen in an almost isolated hill.

Aside from these troubles there are several parasitic diseases of garden crops. The most conspicuous, perhaps, are the "club root of cabbage," due to *Plasmodiophora brassicæ*, observed at Sitka, and potato scab, caused by the fungus *Oospora scabies*, seen at Kadiak. At the same place what appeared to be eel worms, or nematodes, were observed in potato stalks, causing the foliage to turn yellow and the stem to split and break just about even with the ground.

White rust (*Cystopus candidus*) of cruciferous plants, rusts of grasses, a disease resembling apple scab of the wild crab, and a very destructive disease of the red currant were quite conspicuous at different places.

CEREALS.

But little appears to have been done in attempting to grow cereals throughout the whole country. It is reported that during the Russian régime spasmodic attempts were made to do something in the line of promoting agriculture, but it appears that nothing of a permanent nature was accomplished. At Yakutat, on the site of the old town, an agricultural colony was established, and at various places in Cook Inlet the same was attempted. It is claimed that during Russian occupation oats, rye, barley, and buckwheat were grown to a considerable extent, but if this is true there are now no traces of the fields where the grain was formerly cultivated.

The few cereals seen growing were for the most part self-seeded from hay, feed, etc. At Wood Island and Kadiak mature oats were seen August 22 that had evidently grown from seed scattered from feed or packing. A few specimens of barley were seen at one of the places that were about 15 inches high, headed but not ripe. Their origin was probably due to the same causes as that of the oats.

At Tyoonock a limited experiment was made during the last summer with spring-sown wheat, rye, and barley, and on the last day of July the barley and rye were about 15 to 18 inches high and fully headed out. The wheat had made a fine growth, but showed no tendency to head. At Sitka, in 1896, a small plat of wheat was ripened in fairly good condition, and this year at the same place a plat of flax was sown, and on September 4 the plants averaged about 30 inches in height and were in full bloom, the earlier capsules containing almost mature seed.

There are only two places concerning which any accurate information could be secured where farming on anything like an extensive plan has been attempted. These two places are near Wrangell and Killisnoo. The farm near Wrangell is several miles from that village, at the mouth of the Stikine River, where there is quite an area of land capable of cultivation. Some years ago this land was taken possession of, farm buildings constructed, and a very good equipment of implements and stock secured. One of the principal objects of the venture was stock raising, although some attempts were made at general agriculture. Silos were built and filled with marsh hay from the tide flats, and in addition to the silage some hay of a rather poor quality was made. After a few years' trial, during one winter of which nearly all the stock perished on account of an insufficient forage supply, the venture was abandoned. The buildings and implements, however, remain just as they were left. As has been stated in another place, the inaccessibility of the farm was largely responsible for the failure. Access to it is gained by boat and ordinarily only at high tide on account of the extensive flats filled with débris from the Stikine River. During the winter season ice forms to such an extent that it becomes almost impossible to effect a landing anywhere near the place. A serious shortage of forage without any possibility of relief could hardly produce any other result than that described above. An unusual prolongation of the winter season could not have been foretold, but with as large an investment as was represented in the plant it would certainly appear that more than barely sufficient fodder would have been secured to carry the stock through until the next grazing period.

The Killisnoo farm, as it is called, is on Hoods Bay, a few miles from the village of Killisnoo, which is the nearest steamer landing. It consists of about 40 acres under cultivation, and has been under cultivation for about three years. The equipment of stock consists of a team of horses, six head of cattle, and about thirty hogs. Part of the land was tide land, and dikes have been built to keep out the sea. Turnips, peas, cabbage, potatoes, Swedish turnips, beets, etc., are now grown extensively. The crop for this year consisted of about 7 tons of potatoes, 20 tons of Swedish turnips, several tons each of beets, carrots, parsnips, and a large quantity of peas. Two silos are maintained at this place, and the owner is able to carry his stock through the winter in very good condition. He supplies some milk and meat as well as vegetables to the village of Killisnoo, where there is a fish oil and guano factory, and also to the steamers touching there during the season.

METHODS OF CULTIVATION.

For the most part the same methods of cultivation are pursued throughout nearly the entire country. The generally neglected appearance of gardens is everywhere apparent. It is not confined to the garden of the native, but too often that of the white man is as poorly cared for. Often a vast amount of labor is expended in planting the crop, but once planted it is allowed to care for itself. The result is a large and luxuriant crop of weeds, the most common being groundsel (*Senecio vulgaris*), chickweed (*Cerastium vulgatum*), sorrels (*Rumex acetosa* and *R. acetosella*), spurry (*Spergula arvensis*), *Matricaria discoidea*, and yarrow (*Alchemilla millefolium*), the last occurring mostly in meadows.

Kelp and seaweed are extensively used in Alaska in many places, large quantities being employed on the potato crop. A layer of this is placed over the potatoes when planted and the whole covered several inches deep with soil. The effect of this large amount of kelp on the crop can only be conjectured. It probably warms the soil by its fermentation and forces the crop to some extent. It may also have a manurial value in adding some necessary constituent to the soil, but in nearly every place where it was employed the percentage of organic matter in garden soil was very high, so that it could hardly be needed for that purpose.

Bedding up the soil is practiced nearly everywhere. On the lighter and better drained soils it is not as necessary as on the heavy, poorly drained ones. Usually the beds are formed about 3 or 4 feet wide and raised as high above the general level as can be economically done. Where the ground is sufficiently level to permit it, the beds are so arranged as to secure the greatest amount of light to the growing plants. When upon a hillside the beds extend up and down. While this latter arrangement may secure the best drainage and most light, it is certainly liable to result in a great washing away of the soil.

After the construction of the soil beds, planting naturally follows. Most crops are planted in rows across the beds, the distance separating the individual plants varying according to the crop. Close planting seems to be the rule with nearly every crop. The attempt seems to be to secure the largest possible harvest from a limited area by planting a large amount of seed. Potatoes are not infrequently planted 6 inches apart in rows separated not more than a foot. The result of such planting is a thick growth of vines that covers the ground to such an extent that the sun's rays never reach the ground. Such methods can hardly fail to produce a yield of very inferior tubers.

Examples were common where rational methods of cultivation had been disregarded in every possible way, and it is very probable that the wholesale condemnation of the agricultural and horticultural possibilities of the country is based upon data gathered from such inconclusive tests. An example was seen in southeastern Alaska where, for want of better information, a native had dug a ditch through his little garden, but neglected to provide an outlet for the water.

Consequently, in June the ditch was nearly full. Another case was that of a man, not a native, who complained of his inability to drain his garden successfully. In this case the water from a hillside bog was allowed to percolate through the garden instead of being diverted.

STOCK RAISING.

Prior to the occupancy of Alaska by the Americans, some attempts were made by the Russians to introduce live stock into the country. Cattle were successfully introduced in a number of places and, according to Dr. Dall, one of the islands of the Chernabura group was well stocked with pigs. During a tidal wave following a volcanic eruption on Unimak Island these pigs are said to have been drowned. The small cattle which are referred to as Russian or Siberian, still seen at various places on the Kenai Peninsula and elsewhere, are descended from those brought by the Russians in the early part of the century.

At present stock raising is carried on to a very limited extent, milch cows being the most common farm animal seen. At nearly every village there were seen some cows, pigs, and poultry, while horses are kept at a few of the larger places. The team at the Killisnoo farm is probably the only team in Alaska employed in agriculture, the other horses being used for teaming around the towns and packing around mining camps. At several places dairies are maintained, supplies of milk and a small quantity of butter being furnished most of the year. At Kadiak some years ago an attempt was made to introduce sheep. Quite a number were placed on a small island, but, as they had come from a much warmer and a drier region, many died in consequence of being poorly fed and not provided with shelter. The flock was greatly reduced in size, and at the present time is neither increasing nor diminishing, some of the animals being slaughtered each year. Except that they are sheared in July or August, these sheep receive but little attention. During the winter, should a long storm prevail, they are given a little hay, and their only shelter is provided by a not very vigorous growth of spruce trees.

In a few places beef cattle were seen in excellent condition by the middle of summer. At Feeney's Ranch, near Kadiak, about twenty head of beef cattle were seen, and at Belkofsky a 3-year-old dressed beef, weighing 990 pounds, was seen. This animal was said to have received no feed or shelter except what it found upon the range. The meat was fine in appearance—fat, tender, and juicy.

Pigs are reported to thrive exceedingly well in most parts of Alaska, but when allowed to run at large their flesh is liable to acquire a fishy flavor. The same objection is raised against the flesh of fowls, since their diet in winter consists almost entirely of fish refuse.

In most cases animals are housed in fairly comfortable quarters, protection from winter rains being very essential. The great drawback to stock raising is a lack of forage for the long feeding period.

The winter range is of little value, as the grasses contain apparently little nutrition after being soaked by the winter rains.

The prevailing conception of Alaska as a region wholly given up to glaciers and mountains is strikingly at variance with the facts. In 1894, the Director of the Geological Survey estimated the tillable land in southeastern and southwestern Alaska as embracing between 4,000 and 5,000 square miles, or from 2,500,000 to 3,200,000 acres, an area about equal to that of the State of Connecticut. If the grazing lands be added to the above estimate, the acreage would be greatly extended. There is little doubt that the local demand for many agricultural and horticultural products could be supplied from the soil of the coast region of southern Alaska.

AGRICULTURAL DIFFICULTIES AND POSSIBILITIES.

The agriculturist of Alaska will have some serious problems to consider. The more important are the clearing and draining of the land, lack of markets, and transportation facilities.

In southeastern Alaska, with the exception of the tide flats, land must first be cleared of the dense forest growth, and in some places the deep moss will also have to be removed. The spruce stumps must be dug out, as they are very slow in rotting, and not infrequently produce large second-growth timber. In addition to clearing, the land must be thoroughly drained and protected against seepage from above. This ditching and removal of stumps is very laborious, and estimates of $200 per acre were given as a probable cost of preparing the soil for cultivation. This cost seems well nigh prohibitive for agricultural purposes. However, the same process had to be followed elsewhere. A report issued by the experiment station at Pullman, Wash., states the cost of clearing muck lands of cedar and alder stumps at the Puyallup substation to be $122.80 per acre. No definite information has been obtainable as to the cost of clearing farm land elsewhere, but wherever practiced the process is expensive. In the southwestern portion of the country the expense of clearing away the stumps will not be required, nor is draining necessary to the same extent as in the other region.

Lack of markets and transportation facilities seriously retard the agricultural development of the country. The local demand for agricultural products where produce could be supplied is not very great, and freight rates between Alaskan points have not been favorable to production in that region. The lack of land laws for Alaska has also contributed not a little to retard the development of the country. So long as surveys could not be made nor titles given to agricultural lands, very few persons care to spend their money and labor in improving land, the only claim to which they could acquire being that of squatter sovereignty.

When writing of the agricultural possibilities of Alaska, there is danger on the one hand of magnifying failures and on the other of not doing justice to the capabilities of the country. Numerous articles have been written on this subject, many of which appear to have been based upon such information as would be gathered on an excursion trip from Seattle to Sitka and return. Others have written of Alaska as a whole when their knowledge is based upon a limited experience in a restricted locality; while still others have written of the country as possessing almost unlimited agricultural possibilities. A mean between these extreme reports would probably about represent the actual conditions.

The agricultural possibilities of Alaska can be estimated only from the rather meager evidence of limited experiments and by comparing what has been accomplished in regions having somewhat similar conditions. Agriculture as it exists in Alaska has been described in the previous pages. It is not expected that this country will ever rival the Mississippi Valley in its productiveness, but it does seem probable that agriculture and horticulture could be extended so as to supply local demands for many products. When the climatic conditions, topography, soils, etc., of Norway, Iceland, the Orkney Islands, as well as Scotland, Sweden, and Finland, are compared with those of Alaska, it seems probable that what has been accomplished in European stations could also be done in that country, if properly undertaken. It is well established that many agricultural products flourish in parts of northern Europe having approximately the same temperature during the growing season as we find to exist in portions of Alaska, and if temperature is the controlling factor in plant distribution there would seem no reason why the same varieties of plants would not succeed in both countries if properly introduced and cultivated. Rye, oats, and barley are grown in sufficient abundance in the north of Europe, not only to supply local demands, but also to some extent for export. Cattle, sheep, and swine are extensively raised, sheep doing well in Iceland, which appears less auspicious from an agricultural standpoint than Alaska. In 1891 there were exported from Iceland 1,300,000 pounds of wool, 24,000 live sheep, 700,000 pounds of mutton, and 2,500 ponies.

In the table of average temperatures (p. 555), there are given, in addition to other data, the total temperatures and the sums of effective temperatures from May 1 to September 30, inclusive. The effective temperatures are the sums of daily mean temperatures above 43° F., which is recognized by Hoffman, Merriam, and others as being the physiological constant for plant growth. A greater proportional difference is seen to exist in comparing the sums of effective temperatures than is shown in those of the total temperatures, the effective temperatures ranging from 2,288° F. at Winnipeg to 423.6° F. at St. Michaels.

Phenologists are not in accord as to the exact data for determining the physiological constant, and it is by no means certain that this method gives the only or the most exact constant expressing the relation of temperature to the growth of cultivated plants. Brendel claims the constant for plant growth is the sum of the temperatures in excess of freezing from January 1 to date of flowering or whatever events are compared. Linsser claims that the physiological constant is the ratio between the sum temperature at flowering, maturity, etc., and the sum temperature for the year. Objection may be raised to the selection of an arbitrary period of five months, but if the table be consulted it will be seen that at very few of the stations are the averages for April and October above 43° F., and in the reports on which the table is based there were few days in either month when the average temperature was above that point. In the higher latitudes the preparation of the soil and planting of crops is not begun before May 1, and most of them have matured and are partly, if not entirely, harvested by September 30; so that one hundred and fifty-three days between May 1 and September 30 expresses the full period of plant growth. In the northern part of Russia, in the governments of Archangel and Vologda, agriculture is said[1] to be the chief occupation of the inhabitants, which number more than 50 to the square mile. In these two governments the maximum temperature is given as 60.8° F. for Archangel and 62.6° F. for Vologda. There is an average of one hundred and eighty-five and two hundred days, respectively, when the temperature rises above 32° F. and one hundred and twenty-five and one hundred and fifty days when it exceeds 43° F. More than half the rainfall of both of these places falls during the five summer months. In Archangel the average date of harvesting winter rye is August 22, and at Vologda the same. In the latter government spring wheat and oats are harvested about August 27, the crops having a growing period of one hundred and one hundred and three days, respectively. In addition to rye, barley, oats, and spring wheat, flax and potatoes are grown. Dairying and animal husbandry supplement the agricultural industries of these regions. It seems probable that if the hardier cereals, vegetables, and fruits are grown and live stock successfully raised in the north of Europe with sums of effective temperature ranging from 2,196° F. to 1,465.3° F., that the same could be done in southeastern Alaska, where the sums of temperature range from 1,461.2° F. at Sitka to 1,577.1° F. at Pyramid Harbor and 1,764° F. at Wrangell.

Comparing Alaskan data, secured from agricultural experiments that have not always been conducted in the best manner, with the results secured from other regions having a somewhat comparable climate, it seems safe to say that the coast region of Alaska possesses agricultural possibilities of no little importance, and for their

[1] Industries of Russia, Agriculture and Forestry, vol. 3, p. xxxi.

FIG. 1.—BARRABARA, OR SOD HOUSE, KADIAK.

FIG. 2.—NATIVE DWELLINGS AND TOTEM POLES, HOWKAN.

development the most that is required is a hardy race of permanent residents and the proper direction of their efforts along lines that seem most promising.

POPULATION.

The native population of Alaska is estimated by Hon. J. G. Brady, governor of the Territory, at about 30,000, and is practically at a standstill, or the number may be slowly decreasing. The white population prior to 1898 was supposed to number about 10,000, with prospects for a rapid increase in the near future. Much of this increase will be transient; but in the opinion of well-informed individuals this influx is expected to result in the development of the extensive mineral resources of the country and the establishment of a more permanent population. The white inhabitants of Alaska are chiefly concerned in trading, fishing, or mining, and aside from the lines indicated concern themselves but little about the permanent improvement of the country.

The native population, deprived to a great extent of their former resources, are in some places living a very precarious existence. Especially is this true of those living along the Alaskan Peninsula and on the Aleutian Islands. These natives have always depended upon fur-bearing animals for their income. Now that killing the fur seal is denied to them and the sea otter is rapidly becoming extinct, the lot of these natives is a hard one. The annual catch of sea otters has become so small as to be unprofitable to the hunter as well as to the trading companies, which formerly maintained stations all along this coast. One of the largest companies has already abandoned ten of its stations, and the agent has recently given it as his opinion that Government aid will soon be needed for the support of these natives. The extensive salmon-canning establishments employ a few natives, but only a very few, the work in the canneries being done very largely by contract Chinese laborers. No other employment seems open to the native unless it should be agriculture, and that will have to be taught him. The natives from Sitka southward do not have quite such a dark outlook. They are becoming skilled in other pursuits, and more opportunity is given for manual labor of an unskilled kind.

That the natives are susceptible to civilization and elevation by contact with superior races is shown in their dwellings and clothing. But few of the native barrabaras, or sod houses (see Pl. XXXV, fig. 1), remain, their places being taken by frame or log houses of greater or less pretensions. In many cases their houses still consist of a single room, no difference what the size; but their comfort seems greatly increased. Many individuals possess a considerable amount of skill, as is shown in the way their canoes are constructed and in the manner in which they take to carpentering, shoemaking, etc., in the training schools. That some possess considerable talent of a certain sort is shown in their carvings on totem poles, in stone, and on metal. (Pl. XXXV, fig. 2.) Their basket work and blankets are often marvels of fine workmanship, when their crude implements are considered. Some of the accompanying illustrations show the advancement in the character of their dwellings as well as some of their totem poles. In some places the natives retain many of their early superstitions and practices; but, as a rule, they are considered peaceful, honest, and fairly truthful. From reports of the reindeer stations it appears that the Esquimos have been taught how to keep the reindeer, and it would seem that the other natives could probably be taught the elements of agriculture so as to become self-supporting. Whether they would take advantage of opportunities offered in this line can not be foretold.

With an enlightened native population and a permanent white one it seems possible that the demand for many of the agricultural products could be supplied.

AGRICULTURAL PRODUCTION AND PRICES.

By George K. Holmes,
Assistant Statistician.

MAGNITUDE AND DEVELOPMENT.

Foremost among countries in agricultural resources, equipment, and production, the United States affords an interesting and important subject for statistical examination with respect to agriculture. Here is a country covering the breadth of the North American continent and extending almost to antarctic regions on the north and fully to semitropical regions on the south, with an area of 2,939,000 square miles[1] of land surface, of which 623,218,619 acres were in farms in 1890 and 357,616,755 acres were under cultivation, and within this great area the variations in soil, altitude, heat, moisture, rainfall, and other agricultural conditions are so numerous and so considerable in degree, that the products of agriculture are of many kinds and bountiful, so that the world market is largely affected by many of them.

GROWTH OF FARMS.

Great and rapid development has characterized the agriculture of this country. The number of farms increased 215 per cent from 1850 to 1890, or from 1,449,073 to 4,564,641; their total acreage increased 112.3 per cent, or from 293,560,614 acres to 623,218,619; their improved acreage, 216.2 per cent, or from 113,032,614 to 357,616,755 acres, and their unimproved acreage, 47.1 per cent, or from 180,528,000 acres to 265,601,864. The largest percentage of increase of improved land within a decade since 1850 was 50.7—from 1870 to 1880; next to this was an increase of 44.3 per cent—from 1850 to 1860; third in order was the decade 1880 to 1890, with an increase of 25.6 per cent, while the lowest percentage of increase was in the decade in which the civil war occurred, and was 15.8.

Upon examining the figures for the different geographical divisions,[2] the rate of growth of improved land is found to be much greater in the regions where there were public and railroad lands that could be

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[1] Not including Alaska and Indian Territory.

[2] The geographical divisions of the Eleventh Census are adopted, as follows: North Atlantic—Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania. South Atlantic—Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida. North Central—Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas. South Central—Kentucky, Tennessee, Alabama, Mississippi, Louisiana, Texas, Oklahoma, Arkansas. Western—Montana, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada, Idaho, Washington, Oregon, California.

acquired for agriculture than in the older States. In the North Atlantic division the acreage of improved land increased 24.7 per cent from 1850 to 1890; in the South Atlantic division, 38.9 per cent; in the North Central division, 590.7 per cent; in the South Central division, 200.8 per cent, and largest of all, 6,518 per cent in the Western division.

The following table exhibits a more detailed statement of increases, not only of improved land but also of unimproved land and of farms, and shows that they have been rapid outside of the Atlantic States. The table also shows a marked slackening in the increase during the last decade, when public land suitable for agriculture had approached more nearly the point of exhaustion of supply.

Percentage of increase (+) or decrease (—) of number and acreage of farms, by geographical divisions and by census decades.

Geographical division and decade.	Number of farms.	Acreage.		
		Total.	Improved.	Unimproved.
North Atlantic:				
1850 to 1860	+ 15.4	+ 10.7	+ 14.8	+ 4.2
1860 to 1870	+ 6.5	+ 2.7	+ 5.5	— 2.1
1870 to 1880	+ 15.7	+ 8.4	+ 12.8	— 0.1
1880 to 1890	— 5.4	— 7.7	— 8.7	— 5.5
1850 to 1890	+ 34.5	+ 13.7	+ 24.7	— 3.8
South Atlantic:				
1850 to 1860	+ 21.6	+ 14.0	+ 16.3	+ 13.0
1860 to 1870	+ 23.9	— 15.3	+ 13.5	— 16.2
1870 to 1880	+ 72.3	+ 12.4	+ 19.8	+ 8.7
1880 to 1890	+ 16.3	— 1.2	+ 15.2	— 10.4
1850 to 1890	+ 202.0	+ 7.2	+ 38.9	— 7.7
North Central:				
1850 to 1860	+ 76.5	+ 72.1	+ 96.1	+ 54.4
1860 to 1870	+ 45.7	+ 29.0	+ 49.9	+ 9.4
1870 to 1880	+ 50.9	+ 48.7	+ 74.5	+ 15.4
1880 to 1890	+ 13.3	+ 24.0	+ 34.7	+ 3.1
1850 to 1890	+ 339.6	+309.3	+ 590.7	+100.8
South Central:				
1850 to 1860	+ 38.8	+ 53.2	+ 50.8	+ 54.2
1860 to 1870	+ 38.0	— 16.5	— 6.4	— 20.4
1870 to 1880	+ 73.5	+ 34.4	+ 60.2	+ 22.6
1880 to 1890	+ 22.6	+ 17.2	+ 33.1	+ 7.7
1850 to 1890	+ 307.3	+101.5	+ 200.8	+ 62.1
Western:				
1850 to 1860	+ 416.4	+172.7	+ 959.9	+ 10.9
1860 to 1870	+ 39.1	+ 27.5	+ 119.8	— 10.1
1870 to 1880	+ 73.7	+ 61.5	+ 92.1	+ 31.0
1880 to 1890	+ 74.2	+ 80.5	+ 47.9	+123.3
1850 to 1890	+2,073.4	+913.7	+6,518.0	+462.1
The United States:				
1850 to 1860	+ 41.1	+ 38.7	+ 44.3	+ 35.2
1860 to 1870	+ 30.1	+ 0.1	+ 15.8	— 10.4
1870 to 1880	+ 50.7	+ 31.5	+ 50.7	+ 14.8
1880 to 1890	+ 13.9	+ 16.2	+ 25.6	+ 5.7
1850 to 1890	+ 215.0	+112.3	+ 216.4	+ 47.1

CHEAP PUBLIC LAND.

Conspicuous among the causes of the rapid and enormous development of agriculture in the United States is the large area of public land that has been available to immigrants as well as to natives at small prices and waiting for the exploitation of fertility to begin. Previous to July 1, 1897, final homestead entries to the number of 529,051 had been made for 70,396,856 acres belonging to the National Government and disposed of under the homestead act of May 20, 1862, while the number of entries made, both final and pending, cover 102,280,228 acres.

During the twenty-two years preceding July 1, 1897, the public and Indian lands disposed of for cash and under the homestead laws, under the timber-culture laws, located with agricultural college and other kinds of scrip, located with military bounty land warrants, and selected by States and railroads embraced 299,961,357 acres.

In addition to this, some of the States and many railroad companies have been selling land, mostly for farms, amounting in the aggregate to a vast area. The number of sales on credit of tracts of land large enough to be measured by acres has been ascertained for the ten years 1880 to 1889, and these are: By States, 60,431 sales for $30,533,142; by railroads, 140,190 sales for $81,591,299.

EXTENSION OF RAILROADS.

Railroad companies have facilitated the acquisition of public land by farmers by constructing their lines through that portion of our domain extensively enough to enable them to carry away the crops that have been raised, and in many instances railroad projection has antedated settlement, so as to make settlement possible. The increase and magnitude of the railroad mileage in the various geographical divisions should be noted in connection with this.

From 1870 to 1896 this mileage was increased from 14,203 to 27,538 miles in the North Atlantic division, or 93.9 per cent; in the South Atlantic division, from 7,349 to 21,924 miles, or 198.3 per cent; in the North Central division, from 22,747 to 80,820 miles, or 255.3 per cent; in the South Central division, from 6,073 to 28,297 miles, or 366 per cent, and in the Western division, from 2,550 to 24,198 miles, or 848.9 per cent; while in the United States the increase during the twenty-six years was from 52,922 to 182,777 miles, or 245.4 per cent. Thus, it appears that the growth of railroad lines corresponds geographically with the multiplication of farms and farm acreage.

FARM CAPITAL AND PRODUCTS.

In magnitude of value farm capital and products reach stupendous figures, as the table following shows. A prominent feature of the table is the fact that about one-half of the capital and products is found in the North Central States, the great wheat and corn producing region. The farm capital of the United States, as reported by the census of 1890, was valued at $15,982,267,689 as the aggregate of these items: Land, fences, and buildings, $13,279,252,649; implements and machines, $494,247,467; live stock on hand, $2,208,767,573. The product of farms in the year previous to June, 1890, was valued at $2,460,107,454.

Value of farm property and products in 1890, by geographical divisions.

Geographical division.	Total farm capital.	Land, fences, and buildings.	Implements and machines.	Live stock on hand.	Farm products.
North Atlantic	$2,969,971,293	$2,539,200,537	$116,868,252	$313,902,504	$418,309,066
South Atlantic	1,333,395,489	1,135,319,670	36,444,018	161,631,801	292,847,809
North Central	8,517,238,731	7,069,767,154	252,225,315	1,195,246,262	1,112,949,820
South Central	1,849,395,198	1,440,022,598	58,343,772	351,028,828	480,337,764
Western	1,312,266,978	1,094,942,690	30,366,110	186,958,178	155,662,995
The United States	15,982,267,689	13,279,252,649	494,247,467	2,208,767,573	2,460,107,454

INCREASE OF CAPITAL AND PRODUCTS.

The table following has been computed to discover the percentage of increase or decrease of the value of farm capital and products every ten years from 1850 to 1890, and for the whole period of forty years. During the full period the value of land, fences, and buildings increased 305.9 per cent; implements and machines, 226 per cent; live stock, 305.9 per cent; the aggregate of these three classes of capital, 302.8 per cent, and the value of the annual products, 1870 to 1890, 15.5 per cent.

The decade exhibiting the highest degree of increase of capital is from 1850 to 1860, for which the percentage is 101.2; next is the decade 1880 to 1890, the percentage being 28.8; the intermediate decades have nearly the same percentage, the smaller one being 21.2 for 1870 to 1880.

From 1870 to 1880 the value of farm products increased 3.9 per cent; from 1880 to 1890, 11.2 per cent. It is a conspicuous fact that the value of capital increased in a much greater degree than the value of products.

Percentage of increase (+) or decrease (—) of the value of farm property and products, by geographical divisions and by census decades.

[Values for 1870 are in gold.]

Geographical division and decade.	Total farm capital.	Land, fences, and buildings.	Implements and machines.	Live stock on hand.	Farm products.[1]
North Atlantic:					
1850 to 1860	+ 45.7	+ 45.8	+ 36.3	+ 47.1	----------
1860 to 1870	+ 30.7	+ 29.6	+ 32.2	+ 39.2	----------
1870 to 1880	— 3.2	+ 2.0	+ 9.8	— 20.5	— 20.2
1880 to 1890	— 6.8	— 9.4	+ 9.1	+ 9.7	— 5.1
1850 to 1890	+ 76.3	+ 74.5	+ 115.7	+ [2] 78.7	— 24.2
South Atlantic:					
1850 to 1860	+ 71.0	+ 74.9	+ 38.1	+ 56.9	----------
1860 to 1870	— 33.2	— 34.2	— 36.0	— 27.1	----------
1870 to 1880	+ 22.9	+ 34.3	+ 41.4	+ 7.4	— 0.0
1880 to 1890	+ 23.2	+ 27.3	+ 18.3	+ 25.3	+ 9.2
1850 to 1890	+ 88.8	+ 96.9	+ 47.8	+ [2] 54.0	+ 9.2
North Central:					
1850 to 1860	+ 175.9	+ 183.4	+ 104.8	+ 151.7	----------
1860 to 1870	+ 77.1	+ 76.3	+ 84.6	+ 81.0	----------
1870 to 1880	+ 33.6	+ 36.6	+ 53.4	+ 31.4	+ 18.6
1880 to 1890	+ 35.5	+ 37.8	+ 22.3	+ 56.7	+ 10.1
1850 to 1890	+ 831.2	+ 840.5	+ 609.2	+ [2] 838.3	+ 30.6
South Central:					
1850 to 1860	+ 159.1	+ 174.0	+ 66.8	+ 130.2	----------
1860 to 1870	— 41.0	— 43.8	— 47.0	— 27.1	----------
1870 to 1880	+ 20.0	+ 33.0	+ 43.5	+ 8.4	+ 0.3
1880 to 1890	+ 40.3	+ 46.7	+ 25.2	+ 49.7	+ 20.6
1850 to 1890	+ 186.6	+ 200.3	+ 58.8	+ [2] 172.2	+ 20.9
Western:					
1850 to 1860	+ 652.5	+ 711.2	+ 823.5	+ 571.7	----------
1860 to 1870	+ 72.7	+ 120.3	+ 67.2	+ 4.6	----------
1870 to 1880	+ 115.3	+ 151.8	+ 127.8	+ 72.6	+ 56.5
1880 to 1890	+ 148.9	+ 180.1	+ 92.2	+ 112.1	+ 64.2
1850 to 1890	+7,893.2	+12,501.6	+ 6,660.7	+[2]2,472.0	+ 157.0
The United States:					
1850 to 1860	+ 101.2	+ 103.1	+ 62.4	+ 100.2	----------
1860 to 1870	+ 21.3	+ 21.3	+ 19.1	+ 21.9	----------
1870 to 1880	+ 21.2	+ 26.5	+ 38.6	+ 13.0	+ 3.9
1880 to 1890	+ 28.8	+ 30.2	+ 21.6	+ 47.2	+ 11.2
1850 to 1890	+ 302.8	+ 305.9	+ 226.0	+ [2] 305.9	+ 15.5

[1] Includes betterments and additions to stock in 1870.
[2] 1870 to 1890.

CROP INCREASE AND DECREASE.

The magnitude and growth of farm area and property having been shown, the tendency of the principal crops may now be noted. The following table discloses the percentage of increase or decrease of area devoted to each crop from 1880 to 1890, as shown by the census. Corn acreage increased 15.6 per cent; rye, 17.9 per cent; oats, 75.4 per cent; barley, 61.2 per cent; cotton, 39.3 per cent; sugar cane, 20.7 per cent; hay, 72.9 per cent, and tobacco, 8.8 per cent; while wheat acreage decreased 5.2 per cent; buckwheat, 1.3 per cent, and rice, 7.4 per cent.

Percentage of increase (+) or decrease (—) of acreage of farm crops, 1880 to 1890, by geographical divisions.

Geographical division.	Corn.	Wheat.	Rye.	Oats.	Barley.	Buckwheat.	Cotton.	Hay.	Tobacco.
North Atlantic	—20.7	—20.5	—16.1	+ 8.1	— 2.0	—13.1	....	+ 9.8	— 1.7
South Atlantic	— .9	—17.7	— 5.3	— 1.2	+ 8.6	—54.2	+30.6	+ 70.7	— 2.7
North Central	+25.7	— 5.6	+74.6	+124.6	+112.6	+75.5	+80.6	+108.0	+11.2
South Central	+ 7.8	—28.7	—39.0	+ 40.2	— 56.5	—58.9	+44.0	+202.1	+20.1
Western	+60.1	+57.6	+85.6	+ 65.4	+ 39.1	—21.5	....	+172.5	—51.0
The United States	+15.6	— 5.2	+17.9	+ 75.4	+ 61.2	— 1.3	+39.3	+ 72.9	+ 8.8

A census of agricultural production was first taken in 1840, and the increase or decrease to 1890 is contained in the table following for principal crops. The product of corn increased 462.2 per cent during the fifty years, or to 2,122,327,547 bushels; wheat, 452.2 per cent, or to 468,373,968 bushels; rye, 52.4 per cent, or to 28,421,398 bushels; oats, 557.6 per cent, or to 809,250,666 bushels; barley, 1,782.3 per cent, or to 78,332,976 bushels; buckwheat, 66.1 per cent, or to 12,110,349 bushels; cotton, 372.7 per cent, or to 7,472,511 bales (9,476,435 in 1894–95); hay, 552.1 per cent, or to 66,831,480 tons; rice, 59.1 per cent, or to 128,590,934 pounds; tobacco, 122.8 per cent, or to 488,256,646 pounds, and Irish potatoes, from 1850 to 1890, 230.6 per cent, or to 217,546,362 bushels.

The decade 1870 to 1880 is a prominent one during the fifty years with respect to the rate of increase of corn, wheat, cotton, sugar cane, and tobacco; and the decade 1880 to 1890 for rye, oats, and hay. In each of the two decades since 1870 the production of most of the crops increased faster than the population.

Percentage of increase (+) or decrease (—) of production of farm crops, by geographical divisions and by time periods.

Geographical division and period of time.	Corn.	Wheat.	Rye.	Oats.	Barley.
North Atlantic:					
1840 to 1890	+ 97.4	+ 13.2	— 39.0	+ 67.3	+ 170.8
South Atlantic:					
1840 to 1890	+ 24.8	+ 48.2	— 50.5	+ 2.0	— 27.9
North Central:					
1840 to 1890	+1,410.4	+ 1,067.7	+ 1,473.8	+ 2,026.7	+ 9,910.2
South Central:					
1840 to 1890	+ 142.6	+ 133.3	— 59.5	+ 128.6	+ 771.9
Western:					
1850 to 1890	+1,208.5	+11,729.0	+135,634.8	+21,580.5	+183,306.6
The United States:					
1840 to 1850	+ 56.8	+ 18.5	— 23.9	+ 19.1	+ 24.2
1850 to 1860	+ 41.7	+ 72.3	+ 48.7	+ 17.8	+ 206.3
1860 to 1870	— 9.3	+ 66.2	— 19.8	+ 63.4	+ 88.0
1870 to 1880	+ 130.6	+ 59.7	+ 17.2	+ 44.6	+ 47.8
1880 to 1890	+ 21.0	+ 1.9	+ 43.3	+ 98.4	+ 78.0
1840 to 1890	+ 462.2	+ 452.2	+ 52.4	+ 557.6	+ 1,782.3

Geographical division and period of time.	Buck-wheat.	Cotton.	Hay.	Tobacco.	Potatoes (Irish).
North Atlantic:					
1840 to 1890	+ 45.0	....	+ 106.6	+5,693.5	[1] + 24.8
South Atlantic:					
1840 to 1890	— 19.4	+ 299.6	+ 229.2	— 14.0	[1] + 154.8
North Central:					
1840 to 1890	+ 243.5	+2,393.1	+ 2,473.2	+ 345.9	[1] + 810.6
South Central:					
1840 to 1890	— 12.7	+ 414.3	+ 1,293.3	+ 210.5	[1] + 201.6
Western:					
1850 to 1890	+3,904.6	....	+73,145.7	+ 151.8	+6,826.4
The United States:					
1840 to 1850	+ 22.8	+ 56.2	+ 35.0	— 8.9	....
1850 to 1860	+ 96.2	+ 118.2	+ 37.9	+ 117.4	+ 68.9
1860 to 1870	— 44.1	— 44.1	+ 43.1	— 39.5	+ 29.0
1870 to 1880	+ 20.3	+ 91.1	+ 28.7	+ 79.9	+ 18.2
1880 to 1890	+ 2.5	+ 29.8	+ 90.1	+ 3.3	+ 28.4
1840 to 1890	+ 66.1	+ 372.7	+ 552.1	+ 122.8	[1] + 230.6

[1] From 1850 to 1890.

Farm animals are commensurate in number with the magnitude of farming operations. At the census of 1890 there were 14,969,467 horses on farms, 2,295,532 mules and asses, 1,117,494 working oxen, 16,511,950 milch cows, 33,734,128 other cattle, 57,409,583 swine, and 35,935,364 sheep, not including spring lambs, and in the census year the wool clip amounted to 165,449,239 pounds, not including pulled wool and wool clipped on ranges, which were sufficient, according to the estimates of the Department, to make the entire wool clip for the census year 276,000,000 pounds.

In forty years, from the census of 1850 to that of 1890, the number of horses on farms increased 245.2 per cent; mules and asses, 310.4 per cent; milch cows, 158.6 per cent; other cattle, 248 per cent; swine, 89.1 per cent; sheep, not including spring lambs, 65.4 per cent, and the farm wool clip increased 215 per cent; but working oxen decreased 34.3 per cent. The following table shows further details:

Percentage of increase (+) or decrease (—) of farm animals in the United States, by census decades.

Decade.	Horses.	Mules and asses.	Neat cattle.			Swine.	Sheep, not including spring lambs.	Wool.[1]
			Working oxen.	Milch cows.	Other cattle.			
1840 to 1850	----------	----------	----------	----------	----------	+15.5	+12.5	+ 46.7
1850 to 1860	+ 44.1	+105.8	+32.6	+ 34.5	+ 52.5	+10.4	+ 3.4	+ 14.8
1860 to 1870	+ 14.3	— 2.2	—41.5	+ 4.1	— 8.2	—25.0	+26.7	+ 66.1
1870 to 1880	+ 45.0	+ 61.1	—24.7	+ 39.3	+ 65.8	+89.7	+23.6	+ 55.5
1880 to 1890	+ 44.5	+ 26.6	+12.4	+ 32.7	+ 50.0	+20.4	+ 2.1	+ 6.3
1850 to 1890	+245.2	+310.4	—34.3	+158.6	+248.0	+89.1	+65.4	+215.0

[1] Not including pulled wool nor wool clipped on ranges.

The increase of population compares with the preceding increases of farm property and products as follows: Increase, 1840 to 1850, 35.9 per cent; 1850 to 1860, 35.6 per cent; 1860 to 1870, 22.6 per cent; 1870 to 1880, 30.1 per cent; 1880 to 1890, 24.9 per cent; 1840 to 1890, 266.9 per cent; 1850 to 1890, 170 per cent.

ECONOMIC CONDITIONS.

AGRICULTURAL OCCUPATIONS.

By far the largest portion of the people are engaged in agriculture in comparison with the other great groups of occupations, known as mining, fishing, manufacturing, domestic and personal service, professional service, and trade and transportation. The number of persons reported in 1890 to be engaged in agriculture for gain was 8,395,634, of whom 678,142 were women, and the entire number is 36.9 per cent of all persons having gainful occupations. This percentage may be regarded as substantially representing the agricultural portion of the population if the farm family is of about the same size as that of the rest of the population. The table following exhibits the number of persons in agricultural pursuits:

Number of persons in the United States ten years of age and over engaged in agriculture, by specified occupations, 1890.

Occupation.	Males.	Females.	Total.
Agricultural laborers [1]	2,556,957	447,104	3,004,061
Apiarists	1,728	45	1,773
Dairymen and dairywomen	16,161	1,734	17,895
Farmers, planters, and overseers	5,055,130	226,427	5,281,557
Gardeners, florists, nurserymen, and vine growers	70,186	2,415	72,601
Other agricultural pursuits	17,330	417	17,747
Total	7,717,492	678,142	8,395,634

[1] In agricultural districts "agricultural laborers" are often reported by census enumerators simply as "laborers."

FARM TENANCY.

What effect upon agricultural production the drift toward farm tenancy has it is impossible to establish, but the common supposition is that in this country farm tenancy is detrimental to production, because the tenant's interest in maintaining the productivity of the farm is not as great as that of the owner.

The following table shows that from 1880 to 1890 farm tenancy increased from 25.6 to 28.4 per cent, the increase being 2.8 farms in 100, and being about the same in all the geographical divisions, except the Western, where tenancy decreased:

Percentage of farms cultivated by owners and tenants, 1880 and 1890, by geographical divisions.

Geographical division.	Percentage cultivated by—			
	Owners.		Tenants.	
	1880.	1890.	1880.	1890.
North Atlantic	84.0	81.6	16.0	18.4
South Atlantic	63.9	61.5	36.1	38.5
North Central	79.5	76.6	20.5	23.4
South Central	63.8	61.6	36.2	38.4
Western	86.0	87.9	14.0	12.1
The United States	74.4	71.6	25.6	28.4

On account of the increase of farm tenancy and because of the diminishing demand for labor relative to quantity of products, due to the increasing use of machinery, the number of agricultural laborers who work for hire, who were 48.9 per cent of all agricultural workers in 1870, became 43.6 per cent in 1880, and fell to 35.8 per cent in 1890.

WAGES OF FARM LABOR

The productivity of farm labor as measured in wages is represented by a low figure, as is the case with unskilled labor in general. Wage rates for this labor have been ascertained by the Department for a long series of years, beginning with 1866, when the monthly pay of an agricultural laborer without board was $19.07. It rose to $19.49 in 1869 and fell to $16.42 in 1879. In 1882 the rate was $18.94, and in 1885, $17.97, after which there was a rise to $19.10 in 1893, followed by a fall to $17.69 in 1895, during the financial depression. Details for geographical divisions will be found in the table following. The divisions are unlike those mentioned elsewhere throughout this paper, and are the ones established long ago for the tabulation of farm-wage statistics in the Department, and are sufficiently indicated by their names:

Wages of farm labor per month without board, by geographical divisions and by years.

[In gold for all years.]

Geographical division.	1895.	1894.	1893.	1892.	1890.	1888.	1885.	1882.	1879.	1875.	1869.	1866.
Eastern States	$29.00	$27.02	$29.07	$26.46	$26.64	$26.03	$25.30	$26.55	$21.36	$25.24	$24.08	$23.64
Middle States	23.80	23.64	24.82	23.83	23.62	23.11	23.19	23.21	20.24	23.49	21.95	21.17
Southern States	12.71	13.04	14.07	14.86	14.77	14.54	14.27	14.67	12.65	13.30	12.40	11.80
Western States	21.82	21.50	23.12	22.61	22.01	22.23	22.27	23.26	19.81	20.23	19.84	19.76
Mountain States	30.04	29.95	33.97	32.16	31.94	33.37	30.24	36.50	------	------	------	19.33
Pacific States	31.68	34.15	36.95	36.15	34.87	36.73	37.78	37.22	40.11	43.50	46.38	44.60
The United States	17.69	17.74	19.10	18.60	18.33	18.24	17.97	18.94	16.42	17.29	19.49	19.07

SIZE OF FARMS.

In this age of agricultural machines the area of a farm has some relationship to agricultural production. A farm may be so small that its owner can not afford to own expensive machines, and, although this difficulty is obviated in many parts of the country in the cases of some crops, as in the ginning of cotton and in the thrashing of wheat by men who do this work for a neighborhood of farmers at a rate per pound or bushel, yet, generally speaking, a farmer with a small farm does feel his limitations in the purchase and use of machines.

While it might be too much to claim that the average area of farms is economically the best one, it may be more reasonable to suggest that it is adjusted to the financial ability of the owners. At any rate, whatever may be the cause or causes of changes in average farm areas, the fact is that they uninterruptedly diminished from 1850 to 1880, and, outside of comparatively small regions where new land has been taken in large farms for wheat raising, mostly between the Missouri River and the arid region and on the Pacific Coast, there was a diminished average farm area from 1880 to 1890. This may be verified by reference to the "Abstract of the Eleventh Census," from which the table following has been computed.

It is better, however, to take the average farm areas of improved land as more truly responding to economic conditions, if there is such a response. In 1850 the average farm had 78 acres of improved land; in 1860, 80 acres; in 1870 and 1880, 71 acres, and in 1890, 78 acres, or the same number as at the beginning of the forty-year period under consideration. So it appears that the number of acres under cultivation on each farm on the average has remained substantially the same in the days of the use of machines and improved tools and of convenient railroads as it was in the days of hand labor, the ox team, and restricted markets.

Average acreage of farms, by geographical divisions and by census years.

Geographical division and year.	Average number of acres.		Geographical division and year.	Average number of acres.	
	Improved.	Entire farm.		Improved.	Entire farm.
North Atlantic:			South Central:		
1850	69	113	1850	83	291
1860	69	108	1860	90	321
1870	68	104	1870	61	194
1880	67	98	1880	56	151
1890	64	95	1890	61	144
South Atlantic:			Western:		
1850	121	376	1850	52	695
1860	116	353	1860	106	367
1870	81	241	1870	168	336
1880	56	157	1880	186	313
1890	56	134	1890	158	324
North Central:			The United States:		
1850	61	143	1850	78	203
1860	68	140	1860	80	199
1870	70	124	1870	71	153
1880	81	122	1880	71	134
1890	96	133	1890	78	137

As having further bearing on this subject, it may be said that 29.3 per cent of the farms of 1880 and 28.9 per cent of those of 1890 had less than 50 acres each; the farms of 50 and less than 100 acres were 25.8 per cent of the total in 1880 and 24.6 per cent in 1890; the farms of 100 and less than 500 acres were 42.3 per cent in 1880 and 44 per cent in 1890; those of 500 and less than 1,000 were 1.9 per cent in 1880 and 1.8 per cent in 1890; while those of 1,000 acres and over were 0.71 of 1 per cent in 1880 and 0.69 of 1 per cent in 1890.

PROPORTIONS OF CLASSES OF CAPITAL.

As a contribution to information regarding the economic conditions attending agriculture the table on page 588 has been computed. In this it appears that the value of farm real estate in 1890 was 83.1 per cent of the value of the farm capital reported by the census and the portion was very nearly the same in 1880 and 1870.

The value of implements and machines was 3.1 per cent of the value of capital in 1890, 3.4 per cent in 1880, and 3 per cent in 1870, so that they can hardly be said to have gained in relative importance in value as an element of capital during the twenty years; and the same remark applies to the value of live stock on hand, which was 13.8 per cent of the value of capital in 1890, 12.4 per cent in 1880, and 13.7 per cent in 1870.

RATIO OF PRODUCT TO CAPITAL.

While the three specified elements of the capital of the farm have maintained about the same relationship to one another during the twenty years, a decided change in the ratio of the value of product to that of capital has taken place. This ratio is expressed by 22 per cent for 1870, by 18.3 per cent for 1880, and by 15.4 per cent for 1890, and, since there has been no decrease in crop production per acre, the inference is that a fall in crop prices is responsible for the diminishing ratio.

Percentage that the value of farm property and products is of the total farm capital, by geographical divisions and by census years.

Geographical division and year.	Land, fences, and buildings.	Implements and machines.	Live stock on hand.	Farm products.[1]
North Atlantic:				
1870	85.7	3.1	11.2	17.2
1880	87.7	3.4	8.9	13.8
1890	85.5	3.9	10.6	14.1
South Atlantic:				
1870	82.4	2.7	14.9	33.3
1880	84.8	2.9	12.3	25.5
1890	85.2	2.7	12.1	22.0
North Central:				
1870	84.0	3.0	13.0	19.1
1880	84.1	3.4	12.5	16.6
1890	83.0	3.0	14.0	13.1
South Central:				
1870	74.8	3.3	21.9	40.3
1880	77.7	3.7	18.6	31.6
1890	77.9	3.1	19.0	26.0
Western:				
1870	72.8	3.2	24.0	28.4
1880	79.0	3.2	17.8	19.2
1890	83.4	2.3	14.3	11.9
The United States:				
1870	83.3	3.0	13.7	22.0
1880	84.2	3.4	12.4	18.3
1890	83.1	3.1	13.8	15.4

[1] Includes betterments and additions to stock in 1870.

CAPITAL AND PRODUCT AVERAGES.

Quite similar results are shown in another way by means of averages in the table following. The average value of land, buildings, and fences per farm in 1870 was $3,030, in 1890, $2,909; of implements and machines in 1870, $111, in 1890, $108; of live stock on hand in 1870, $499, in 1890, $484; of farm products in 1870, $801, in 1890, $539. During this time the increase in the number of acres of improved land per farm was 7, or from 71 to 78; but notwithstanding this the average amount of each of the three classes of farm capital slightly decreased, while the average value of products very considerably decreased.

Average value of capital and products per farm, by geographical divisions and by census years.

[Values for 1870 are in gold.]

Geographical division and year.	Land, fences, and buildings.	Implements and machines.	Live stock on hand.	Farm products.	Geographical division and year.	Land, fences, and buildings.	Implements and machines.	Live stock on hand.	Farm products.
North Atlantic:					South Central:				
1870	$4,570	$162	$598	$917	1870	$1,444	$64	$423	$777
1880	4,027	154	411	633	1880	1,107	53	265	449
1890	3,856	177	477	635	1890	1,325	54	323	442
South Atlantic:					Western:				
1870	1,775	58	321	716	1870	3,220	144	1,059	1,257
1880	1,384	48	200	416	1880	4,669	189	1,053	1,133
1890	1,515	49	216	391	1890	7,506	208	1,282	1,067
North Central:					The United States:				
1870	3,338	119	516	757	1870	3,030	111	499	801
1880	3,021	121	449	595	1880	2,544	101	374	552
1890	3,675	131	621	579	1890	2,909	108	484	539

Upon turning to the geographical divisions it will be noticed that the average value of farm real estate increased during the twenty years in the North Central and Western divisions; that the average value of implements and machines increased in the North Atlantic, North Central, and Western divisions; that the average value of live stock increased in the North Central and Western divisions, all of these being exceptions to the general tendency for the United States, but there are no exceptions among the geographical divisions to the conclusion that for the United States the average value of products per farm has materially diminished during the period under consideration.

RELATION OF IMPLEMENTS TO PRODUCTS.

The value of farm implements and machines increased from 1870 to 1890 relative to the value of farm products, being 13.8 per cent of the products in 1870, 18.4 per cent in 1880, and 20.1 per cent in 1890. Every geographical division shows an increasing percentage. The highest percentage for 1890 for any geographical division is 27.9 for the North Atlantic; next, 22.7 per cent for the North Central; third, 19.5 per cent for the Western; fourth, 12.4 per cent for the South Atlantic; and, fifth, 12.2 per cent for the South Central.

RELATION OF IMPLEMENTS TO CAPITAL.

The ratio of the value of farm implements and machines to farm real estate was higher in 1850 than in any subsequent census year, but has not materially changed since 1860. The ratio was 4.6 per cent in 1850, 3.7 per cent in 1860, 3.6 per cent in 1870, 4 per cent in 1880, and 3.7 per cent in 1890. Since 1860, therefore, changes in the value of farm real estate have been commensurate with the changes in the value of equipment of machines and implements.

In the present consideration of values it should be borne in mind that farm machines and tools are more varied, better, and cheaper than in the earlier year of comparison, and that the cost of producing most, if not all, of the farm crops may be less than before.

EARNINGS OF FARM LABORERS IN 1890.

It is possible to compute the wages paid to farm laborers (those working for hire) in 1890, the wage rates for the States and Territories, the number of laborers, and the time employed being known. The result of this computation is that the agricultural laborers of the United States were paid $645,460,352 in 1890, or 26.2 per cent of the value of the farm product. Board is not included, nor is there included any compensation to farmers (working on farms owned or hired by them), nor to their wives, children, and others working without wages or merely for board and keeping.

PRODUCTS MEASURED BY RAILROAD TRAINS.

So large in quantities are the crops produced in the United States that numbers of pounds, tons, and bushels fail to convey anything more than a vague conception of their amounts. To put the matter in form for better intellectual grasp, computations have been made to ascertain the number of railroad freight cars, each of 15 tons capacity, required to haul the crops of 1897, and what their length would be.

To haul the hay crop 4,017,933 cars would be needed, and the length of the train would be 25,112 miles, or more than long enough to encircle the earth at the equator; for the corn crop there must be 3,540,257 cars, making a train 22,127 miles long; the wheat crop would take 1,060,000 cars, with a total length of 6,625 miles, or farther than from New York to Cape Horn; a train of 772,098 cars, extending 4,826 miles, or from New York to the Congo River, would be required for the oat crop; a train of 327,354 cars, and 2,046 miles long, to move the potato crop, and this train would extend from New York to Utah; a train to haul the cotton crop would be as long as from New York to Chicago, and one to haul the barley crop would reach from Washington, D. C., to Atlanta, Ga.

EXPORTS.

Raising, as this country does, a larger amount of agricultural products than its people can consume, the exports constitute a considerable portion of some of the crops, as the table following shows. The average portion of the corn crop exported annually from 1894 to 1896 was 5.4 per cent; of wheat, 16 per cent; of rye, 12.2 per cent; of oats, 2.2 per cent; of barley, 13 per cent; of tobacco, 67.4 per cent; of cotton, 73.6 per cent.

Percentage of crops exported.

Crop.	Annual average.			
	1868–1872.	1878–1882.	1888–1892.	1894–1896.
Corn	1.84	4.82	3.49	5.39
Wheat	12.83	27.84	17.68	15.96
Rye	1.78	10.30	....	12.21
Oats	.13	.37	.80	2.22
Barley	.93	1.55	....	12.96
Potatoes	....	.37	....	.30
Tobacco	71.12	55.84	....	67.42
Cotton	72.81	72.80	66.79	73.60
Hay	....	.03	....	.10

It is to be remembered that large portions of some of the crops are exported in the form of animals and animal products. In 1895 the exports of beef products were 344,598,139 pounds; of hog products, 1,092,024,847 pounds; of mutton, 591,449 pounds, and of oleomargarine 88,199,775 pounds.

SURPLUS ACREAGE.

In recent years predictions have been made of the near approach of the time when our domestic consumption will overtake domestic production of various crops, especially of wheat, but the predictions seem hardly nearer realization as time passes, and the potential expansion of acreage, as demand and price become strong and high, promises a surplus for export for many years to come.

For domestic requirements 28.6 bushels of corn are needed per capita, 5.5 bushels of wheat, and 10.7 bushels of oats, the computations being made in the usual way upon the figures of exports, imports, production, and population, and the annual average for 1888–1892 being adopted.

Therefore, it follows that 1.15 acres in corn are required per capita for domestic consumption, 0.43 of 1 acre in wheat, and 0.43 of 1 acre in oats. This gave us a surplus area in corn in 1890 of 2,648,404 acres above domestic requirements, of 11,264,478 acres in wheat, and 238,162 acres in oats.

VALUES AND PRICES.

AVERAGE VALUE OF PRODUCTS PER ACRE.

There is space for only a brief reference to crop production and value per acre and to prices, and the tables presented need little comment. The first table following shows that the average value of farm products per improved acre decreased from $11.28 in 1870 to $7.77 in 1880, and then to $6.88 in 1890. The geographical divisions show the same tendency, with the exception that the average value increased from 1880 to 1890 in the North Atlantic division and in the Western.

Average value of farm products per improved acre, by geographical divisions and by census years.

Geographical division.	1870.[1]	1880.	1890.
North Atlantic	$13.42	$9.50	$9.88
South Atlantic	8.88	7.41	7.03
North Central	10.87	7.38	6.04
South Central	12.78	8.00	7.25
Western	7.48	6.09	6.75
The United States	11.28	7.77	6.88

[1] Farm products include betterments and additions to stock; values are in gold.

Average value and yield of cereal crops in the United States, by geographical divisions and by periods of years.

[Values are in gold.]

Geographical division and period.	Corn.			Wheat.			Oats.		
	Average farm price per bushel.	Average yield per acre.	Average value per acre.	Average farm price per bushel.	Average yield per acre.	Average value per acre.	Average farm price per bushel.	Average yield per acre.	Average value per acre.
North Atlantic:		*Bush.*			*Bush.*			*Bush.*	
1870 to 1879	$0.66	34.8	$23.09	$1.33	14.2	$18.94	$0.43	31.6	$13.56
1880 to 1889	.59	30.7	18.11	1.02	13.3	13.61	.39	28.4	11.06
1890 to 1896	.53	32.0	16.81	.81	14.9	11.99	.35	27.3	9.68
South Atlantic:									
1870 to 1879	.66	15.0	9.89	1.31	9.0	11.81	.51	15.6	7.90
1880 to 1889	.57	13.7	7.80	1.02	8.3	8.49	.48	11.3	5.46
1890 to 1896	.50	14.4	7.29	.80	9.4	7.47	.44	13.1	5.71
North Central:									
1870 to 1879	.33	32.3	10.56	.96	13.0	12.50	.28	30.8	8.67
1880 to 1889	.32	28.9	9.41	.79	12.6	9.94	.26	31.0	8.14
1890 to 1896	.30	28.4	8.46	.62	13.3	8.28	.25	27.2	6.87
South Central:									
1870 to 1879	.58	21.2	12.21	1.11	9.0	9.98	.48	20.5	9.82
1880 to 1889	.50	18.5	9.19	.91	8.1	7.34	.44	15.8	6.91
1890 to 1896	.44	18.8	8.37	.73	9.8	7.15	.39	17.7	6.93
Western:									
1870 to 1879	.88	31.0	27.26	1.10	13.9	15.18	.62	32.5	20.01
1880 to 1889	.72	26.3	18.84	.80	14.1	11.31	.46	29.5	13.54
1890 to 1896	.57	23.4	13.30	.68	14.7	9.95	.39	30.7	11.96
The United States:									
1870 to 1879	.426	27.1	11.54	1.049	12.4	13.00	.353	28.4	10.03
1880 to 1889	.393	24.1	9.48	.827	12.1	9.98	.309	26.6	8.22
1890 to 1896	.355	24.1	8.55	.658	13.0	8.54	.286	25.2	7.21

Average value and yield of cereal crops in the United States, by geographical divisions and by periods of years—Continued.

[Values are in gold.]

Geographical division and period.	Barley.			Rye.			Buckwheat.		
	Average farm price per bushel.	Average yield per acre.	Average value per acre.	Average farm price per bushel.	Average yield per acre.	Average value per acre.	Average farm price per bushel.	Average yield per acre.	Average value per acre.
North Atlantic:		*Bush.*			*Bush.*			*Bush.*	
1870 to 1879	$0.86	21.8	$18.76	$0.83	13.8	$11.47	$0.72	18.4	$13.16
1880 to 1889	.75	22.5	16.79	.72	11.3	8.09	.63	13.5	8.50
1890 to 1896	.58	21.8	12.68	.53	15.2	8.10	.48	18.5	8.89
South Atlantic:									
1870 to 1879	.89	15.0	13.38	.81	9.9	8.03	.71	16.5	11.77
1880 to 1889	.86	15.5	13.35	.79	6.9	5.43	.66	10.7	7.05
1890 to 1896	......	......	......	.62	9.3	5.70	.56	16.9	9.40
North Central:									
1870 to 1879	.62	23.5	14.50	.55	16.4	9.10	.70	15.7	11.04
1880 to 1889	.51	21.9	11.13	.52	14.0	7.34	.69	11.2	7.74
1890 to 1896	.31	23.7	7.44	.39	13.5	5.22	.52	13.8	7.12
South Central:									
1870 to 1879	.89	22.7	20.26	.79	11.3	8.92	.81	12.9	10.51
1880 to 1889	.68	18.7	12.71	.75	8.1	6.08	.67	8.6	5.82
1890 to 1896	.49	19.0	9.39	.60	10.7	6.46	.58	14.8	8.55
Western:									
1870 to 1879	.80	20.9	16.68	.98	17.5	17.14	1.25	24.9	31.13
1880 to 1889	.63	21.1	13.31	.77	11.5	8.89	.74	17.9	13.28
1890 to 1896	.44	21.4	9.31	.58	14.6	8.51	.64	20.0	12.75
The United States:									
1870 to 1879	.738	22.1	16.34	.701	14.1	9.92	.715	17.7	12.65
1880 to 1889	.589	21.7	12.79	.622	11.9	7.39	.642	12.8	8.24
1890 to 1896	.374	22.8	8.52	.467	13.6	6.35	.490	17.4	8.51

FARM PRICES OF CROPS.

As exhibited in the above table, corn had the average farm price of 42.6 cents per bushel in the ten years 1870 to 1879, 39.3 cents in 1880 to 1889, and 35.5 cents in 1890 to 1896. The farm price of wheat declined in a more marked degree, the prices for the three periods being 104.9, 82.7, and 65.8 cents, respectively. The farm prices of the other cereals also declined during the twenty-seven years.

In farm value of product per acre, corn averaged $11.54 in 1870 to 1879, $9.48 in 1880 to 1889, and $8.55 in 1890 to 1896; while wheat averaged $13 in 1870 to 1879, $9.98 in 1880 to 1889, and $8.54 in 1890 to 1896. A decline will be noted for the other cereals.

PRODUCTION PER ACRE.

Nothing conclusive with regard to increasing or decreasing fertility of soil is revealed in crop statistics of acreage and production. The extension or contraction of crop area may have the effect of raising or lowering the average yield per acre in the whole country. The average bushels of corn produced per acre were 27.1 in 1870 to 1879 and 24.1 in each of the periods 1880 to 1889 and 1890 to 1896; of wheat, 12.4 in 1870 to 1879, 12.1 in 1880 to 1889, and 13 in 1890 to 1896. Oats declined from 28.4 to 25.2 bushels from the first to the last period, while barley, rye, and buckwheat did not change materially from first to last, except that the production of rye and buckwheat per acre was small in the middle period.

PRICES OF COTTON AND WHEAT.

The tables following exhibit the average prices of cotton and wheat for a long series of years. Fluctuations appear in the prices, due to scarcity, to plenty, to wars, and to other causes, but the general fact of decreasing price during the present century is conspicuous. A brief reference to wool may be added. The average price of medium washed clothing Ohio fleece wool in the Eastern markets was 43 cents per pound from 1852 to 1859,[1] 43 cents from 1860 to 1869,[1] 45 cents from 1870 to 1879, 40 cents from 1880 to 1889, and 28 cents from 1890 to 1896. In 1890 the price was 37 cents per pound, and the decline was unbroken to 20 cents in 1896.

Average prices of cotton per pound in New York and Liverpool, 1791 to 1896, by periods of years.

[In gold for all years.]

Period of years.	In New York.	In Liverpool.	Year.	In New York.	In Liverpool.
	Cents.	*Cents.*		*Cents.*	*Cents.*
1791 to 1799	34.4	48.9	1890	11.5	12.2
1800 to 1809	23.2	36.0	1891	9.0	9.9
1810 to 1819	20.4	38.5	1892	7.6	8.5
1820 to 1829	13.2	15.4	1893	8.2	9.3
1830 to 1839	12.4	14.5	1894	7.7	8.5
1840 to 1849	8.1	9.7	1895	6.3	6.7
1850 to 1859	11.4	12.5	1896	8.0	8.3
1860 to 1869	29.4	30.5			
1870 to 1879	14.4	16.3			
1880 to 1889	10.8	12.1			
1890 to 1896	8.3	9.1			

Average prices of wheat in England, 1041 to 1896, by periods of years.

Period of years.	Number of years represented.	Price per bushel.	Period of years.	Number of years represented.	Price per bushel.
1041 to 1100	7	$0.351	1800 to 1809	10	$2.493
1114 to 1197	10	.511	1810 to 1819	10	2.693
1202 to 1294	27	1.828	1820 to 1829	10	1.764
1301 to 1391	29	1.032	1830 to 1839	10	1.651
1401 to 1500	39	.494	1840 to 1849	10	1.619
1504 to 1600	41	.737	1850 to 1859	10	1.575
1601 to 1700	96	1.108	1860 to 1869	10	1.518
1701 to 1800	85	1.096	1870 to 1879	10	1.514
1801 to 1896	96	1.690	1880 to 1889	10	1.091
			1890 to 1896	7	.833

[1] In gold.

Farm prices of wheat and freight rates from Chicago to New York, by years.

[Prices and rates in gold.]

Year.	Farm prices per bushel.	Average freight rate per bushel.	Number of bushels which could be carried for farm price of 1 bushel.	Year.	Farm prices per bushel.	Average freight rate per bushel.	Number of bushels which could be carried for farm price of 1 bushel.
		Cents.				*Cents.*	
1867	$1.436	32.38	4.44	1892	$0.624	13.80	4.52
1872	1.104	31.13	3.55	1893	.538	14.63	3.68
1877	1.034	19.56	5.29	1894	.491	13.20	3.72
1882	.882	14.47	6.10	1895	.509	11.89	4.28
1887	.681	15.75	4.32	1896	.726	12.00	6.05

PRICES BECOMING MORE STEADY.

The prices of agricultural products, especially those that have a world market, have tended toward a narrower range of fluctuations in a marked degree. Cotton prices may be cited as an illustration. The range in the prices of middling upland cotton per pound in New York has been ascertained for each year from 1821 to 1895, and the ranges have been averaged for groups of years. For the ten years 1821 to 1830 the average range of prices was 7.35 cents; 1831 to 1840, 7.60 cents; 1841 to 1850, 4.12 cents; 1851 to 1860, 3.46 cents; 1861 to 1870, 43.95 cents; 1871 to 1880, 4.16 cents; 1881 to 1890, 1.77 cents; 1891 to 1895, 2.21 cents. Here may be seen the steadying of prices due to the telegraph, the publication of trade and market news, to crop reporting and estimating, and to the anticipation of higher or lower prices in the future by raising or lowering present prices.

INFLUENCES THAT DEPRESS PRICES.

TRANSPORTATION.

That the wholesale market price of wheat and many other farm products should be less now than in earlier years is partly accounted for by the diminished cost of transportation. The tables following disclose this. The freight rate on 100 pounds of wheat from Chicago to New York in 1870 was 42 cents; in 1896 it was 20 cents. The rate per mile per ton of freight on thirteen large railroads was 1.37 cents in 1870; it was .71 of 1 cent in 1896. On all of the railroads of the United States this rate declined from 1.29 cents in 1880 to .81 of 1 cent in 1896. So greatly have the freight rates declined that the farm value of 1 bushel of wheat in 1896 paid for the transportation of 6.05 bushels from Chicago to New York, as against 4.44 bushels in 1867.

Freight rates, by years.

Year.	Rates in cents per 100 pounds.				Coal, per ton.	Rates in cents per mile.			
	Wheat.		Flour.	Packed meats.		Freight, per ton.	Freight, per ton.	Per passenger.	Anthracite coal, per ton.
	Chicago to New York.	St. Louis to New York.	St. Louis to New York.	Cincinnati to New York.	Clearfield region to Jersey City.	Thirteen railways.	All railways of United States.	All railways of United States.	Lehigh Valley Railroad.
1870 [1]	42	----------	----------	38	----------	1.37	----------	----------	----------
1875 [1]	30	----------	----------	23	$3.20	1.03	----------	----------	1.61
1880	33⅙	42	42	33⅖	4.17	1.01	1.29	2.51	1.43
1885	23⅓	22 1/7	22 1/7	21 1/10	2.72	.83	1.04	2.20	1.22
1890	23⅝	27⅗	27⅗	23 9/10	2.25	.77	.94	2.17	.84
1894	21⅓	24¾	24¾	26	2.10	.76	.87	1.98	.74
1895	20⅓	[2] 23½	[2] 23½	26	2.10	.72	.84	2.04	.65
1896	20	23	23	26	1.95	.71	.81	2.02	.68

[1] The rates are in gold.

[2] Actual rates probably lower.

COST OF MARKETING COTTON.

For the purpose of discovering in detail how much the cost of marketing cotton has declined since 1840, one of the special agents of the Department, living in Mobile, Ala., was requested to duplicate for 1897 the itemized statement of cost for 1840, published in Hunt's Merchant's Magazine[1] fifty-seven years ago. It cost $18.15 to market a bale of upland middling cotton weighing 420 pounds in 1840, or 4.32 cents a pound, and the cost fell to $7.89 in 1897, on account of the elimination of some charges and the reduction of others. This makes the present cost of marketing 1.58 cents per pound, a saving of 2.74 cents per pound from the beginning to the end of the fifty-seven years.

Charges for marketing a bale of cotton, 1840 and 1897.

[The charges exhibited in this table were incurred at Mobile, Ala., exclusive of insurance, calculated on a bale of 420 pounds of middling upland cotton at 10 cents in 1840, with ocean freight at ¾*d.*; and on a bale of 500 pounds of middling upland cotton at 5¼ cents in 1897, ocean freight at 15/64*d.*]

Charge.	In 1840.	In 1897.	Charge.	In 1840.	In 1897.
Wharfage (if by river)	$0.10	[1] $0.08	Commission on purchase	$0.80	[3] $0.00
Weighing	.12½	.10	Freight and primage	6.64½	2.46½
Draying to press	.12½	.10	Chargeable to purchaser	8.00	3.75½
Storage	.20	.25	Compressing	.80	[4] .00
Factor's commissions	.80	.05	Lighterage to lower bay	.25	.00
Add for freight to city (by river)	1.50	.75	Stowing	.25	.35
Chargeable to planter	2.85	1.93	Chargeable to vessel	1.30	.35
Brokerage	.25	.50	Total charges on a bale	12.15	6.03
Storage until compressed	.12½	[2] .00	Add port charges at Liverpool	6.00	1.86
Drayage to vessel or lighter	.08	.00	Total, on both sides, per bale	18.15	7.89
Wharfage	.10	.04			
Compressing	.00	.75			

[1] If by railroad, no wharfage charge.

[2] No charge if shipped in ten days.

[3] Included in charges for brokerage.

[4] Purchaser pays charge for compressing.

[1] Vol. II, p. 267 (March, 1840).

EFFECT OF INVENTIONS.

Perhaps it has not occurred to the reader that the chief causes of our nearly ten-million-bale cotton crop were ideas that were in the minds of inventors many years ago. This great crop is absolutely dependent upon the invention of the machines of the cotton mills and upon the cotton gin, which have made the cost of production of cotton fabrics very cheap, and thus made markets for enormous quantities of them. This is brought out forcibly in the table following, which mentions various inventions and the consequent extraordinary increase in the imports of cotton into Great Britain.

The extraordinary importance of some of these machines may be understood from the statement that before Whitney's invention of the cotton gin one person could pick the seed from only about 1½ pounds of cotton lint in ten hours, while at the present time one machine will gin from 1,500 to 7,500 pounds of lint in the same time, the quantity varying according to the size and power of the gin.

Inventions and cotton production.[1]

Invention.	Year of advent of invention.	Cotton imported to Great Britain.	Year of importation.
		Pounds.	
Hargreave's spinning jenny (patented 1770) for weft only	1764	3,870,392	1764
Calico printing introduced into Lancashire	1764		
Arkwright perfects Wyatt's spinning frame (patented 1769), liberating cotton from dependence on linen warp	1768		
Arkwright's mill built at Crawford	1771	4,764,589	1771 to 1775
Arkwright takes patents for carding, drawing, roving, spinning	1775		
Crompton's mule completed (combining jenny and water frame, producing finer and more even yarn)	1779	5,198,775	1781
Cartwright's power loom; Watt and Boulton's first engine for cotton mills	1785	18,400,384	1785
Whitney's saw gin	1792	34,907,497	1792
Horrock's dressing machine	1813	51,000,000	1813
The "Throstle" (almost exclusively used in England for spinning warp)	1830	261,200,000	1830
Roberts's self-acting mule perfected	1832	287,800,000	1832
Bullough's improved power loom; ring spinning (largely used in United States of America, recently introduced into Lancashire)	1841	489,900,000	1841

[1] The Evolution of Modern Capitalism (Hobson), p. 60.

RESULTS OF USE OF FERTILIZERS.

Intensive agriculture, as affecting the economics of farming, has supplied few statistics beyond those collected by the Department for 1896 in North Carolina, South Carolina, Georgia, Florida, and Alabama with regard to the use of commercial fertilizers in cotton raising. It is a practical question to the farmer whether by the use of fertilizers his profit per bale is more or less than it has been without fertilizers;

and if the fact is established that it is profitable to use them, it is important to know when the point of diminishing returns is reached.

From returns made by 1,495 cotton planters in the States named, the table on page 599 has been prepared. The crop planted in 1896 is the one represented, and the crop brought a profit to 1,268 planters and a loss to 227. All of them used commercial fertilizers, and they are classified according to the value of the fertilizers used; those making a profit being in one group, and those suffering a loss in another.

It appears that twenty-one planters spent 74 cents apiece, on the average, for fertilizers for 1 acre, and that they each derived a profit of $4.62, on the average, above all costs of raising the crop. The planters who spent from $1 to $1.99 for fertilizers, made a profit of $5.09; from $2 to $2.99, a profit of $5.34; from $3 to $3.99, a profit of $5.91; from $4 to $4.99, a profit of $7.96; from $5 to $5.99, a profit of $8.76; and those whose fertilizers cost them $6 and more, made a profit of $12.51.

So it is evident that, so far as the table shows, the point of diminishing returns was not reached, when the crop was profitable, at any degree of fertilization. The returns from the planters who suffered a loss, while at first seeming to indicate a conclusion contrary to the above, in reality do not, because their crops were subject to abnormal conditions and were partial failures, the cause generally having been a drought, in which the fertilizer is likely to "burn" the plants. It will be observed that in the cases of the planters who lost on their crops the loss is greater as the cost of fertilizers is greater, and had climatic conditions been favorable the loss would have been a profit.

The word "profit" as here used should mean the excess of returns over expenses, including the theoretical one of rent, and for the most part has such a significance; some small charges against the crop may have been omitted from the schedules, such as the acre's share of the general farm expenses of insurance, repairs, and renewals.

Percentages of increase of profit and loss by each class over the preceding class have been computed to discover whether there is much, if any, uniformity in the increase, as there is in the classification of cost of fertilizers, but the uniformity does not appear.

Relationship between the average cost of fertilizers and the profit in raising 1 acre of cotton in 1896 in North Carolina, South Carolina, Georgia, Florida, and Alabama.

Classification of cost of fertilizers per acre.	For plantations having a Profit. Number of farms reporting.	Average cost of fertilizers.	Average profit.	Percentage of increase of profit over preceding class.	Loss. Number of farms reporting.	Average cost of fertilizers.	Average loss.	Percentage of increase of loss over preceding class.
Under $1	21	$0.74	$4.62		3	$0.74	$1.48	
$1 and under $2	291	1.40	5.09	10.2	60	1.40	1.50	1.4
$2 and under $3	656	2.20	5.34	4.9	126	2.20	1.89	26.0
$3 and under $4	118	3.13	5.91	10.7	16	3.13	2.75	45.5
$4 and under $5	82	4.11	7.96	34.7	9	4.11	3.69	34.2
$5 and under $6	49	5.14	8.76	10.1	7	5.14	3.89	5.4
$6 and over	51	9.11	12.51	42.8	6	9.11	3.95	1.5
Total	1,268	2.52	5.71		227	2.52	1.91	

Statistics of agriculture are mainly concerned with quantities, areas, values, and prices, and comparatively little statistical work with an economic bearing has been done. It was not the design of this paper to bring together the old matter of this sort, but rather to use the new matter at hand and to present some of the old in a new light.[1]

HAND AND MACHINE LABOR.

A very remarkable economic investigation into the old and new processes employed in manufacture, agriculture, and transportation was recently made by the United States Department of Labor, the results of which will be shown in a forthcoming report of that Department. The endeavor was to ascertain the time and labor cost by the latest processes of production and to compare them with the processes that obtained twenty to fifty years ago.

Certain facts relating to agriculture have been taken from thirty-three pairs of schedules, and these are presented in the table following.

Each pair of schedules has one relating to hand labor and one relating to machine labor, and the two are to be compared with each other, since they represent the same area of ground—an acre in the case of every schedule included in the table—and the same quantity of product. Each pair of schedules also covers the same extent of operations, although by different means. The information was obtained by special agents, and has been very carefully scrutinized by them and by other experts. It seems desirable to give this assurance, since the table is such an extraordinary one.

[1] For valuable discussions of economic conditions with respect to agriculture, see Wells's Recent Economic Changes.

Hand and machine labor in

[The words "hand" and "machine" within

No.	Crop and predominating labor.	Units of production on 1 acre.	Year of operation.	Time worked. By employees. Hrs.	Time worked. By employees. Min.	Time worked. By animals. Hrs.	Time worked. By animals. Min.	Cost of labor. For employees.	Cost of labor. For animals.	Cost of labor. Total.
1	Corn—hand . . bushels	40	1858	34	38.5	34	23.5	$3.2642	$1.2898	$4.5540
2	machine ...do...	40	1894	16	30.3	38	41.2	1.6505	1.9344	3.5849
3	Corn—hand ....do....	40	1855	38	45.0	37	30.0	3.6250	1.4064	5.0314
4	machine ...do....	40	1894	15	7.8	35	56.2	1.5130	1.7969	3.3099
5	Corn—hand ....do....	40	1855	182	40.8	54	9.0	14.3082	2.0308	16.3390
6	machine ...do....	40	1894	27	30.3	47	46.8	4.2269	2.3891	6.6160
7	Corn—hand........do....	40	1858	169	27.0	49	2.5	16.9451	1.8392	18.7843
8	machine...do....	40	1894	27	17.0	47	30.2	4.1502	2.3753	6.5255
9	Wheat—hand ......do....	20	1830	64	15.0	23	0.0	3.7125	.2875	4.0000
10	machine .do....	20	1896	2	58.2	8	3.6	.7180	.4030	1.1210
11	Wheat—hand......do	20	1830	61	5.0	22	20.0	3.5542	.2792	3.8334
12	machine .do	20	1896	3	19.2	27	18.6	.6605	1.3655	2.0260
13	Oats—hand ....do	40	1830	60	25.0	9	0.0	3.4375	.1125	3.5500
14	machine ...do	40	1893	7	10.8	10	51.2	1.0836	.5427	1.6263
15	Oats—hand ....do	40	1830	66	15.0	9	40.0	3.7292	.1208	3.8500
16	machine ...do	40	1893	7	5.8	10	31.2	1.0732	.5260	1.5992
17	Rye—hand.........do	25	1848	62	58.9	36	40.0	[1] 4.1061	1.1459	5.2520
18	machine....do	25	1895	25	10.0	25	50.0	[1] 2.6542	1.6459	4.3001
19	Rye—hand.........do	25	1848	66	3.8	38	0.0	[1] 3.3031	1.4250	4.7281
20	machine....do	25	1895	25	10.0	26	20.0	[1] 2.6542	1.3167	3.9709
21	Barley—hand......do	30	1830	63	35.0	23	0.0	3.5958	.2875	3.8833
22	machine.do	30	1896	2	42.8	9	12.6	.6020	.4605	1.0625
23	Barley—hand......do	30	1830	58	5.0	22	20.0	3.3208	.2792	3.6000
24	machine.do	30	1896	3	24.4	26	18.0	.7136	1.3150	2.0286
25	Potatoes (Irish)—hand, bushels.	220	1866	108	55.0	45	50.0	10.8916	2.2916	13.1832
26	Potatoes (Irish)—machine, bushels.	220	1895	38	0.0	43	28.0	3.8000	2.1733	5.9733
27	Potatoes (Irish)—hand, bushels.	220	1870	108	55.0	45	50.0	10.8916	2.2916	13.1832
28	Potatoes (Irish)—machine, bushels.	220	1895	38	21.0	44	10.0	3.8350	2.2083	6.0433
29	Potatoes (sweet)—hand, bushels.	105	1868	317	20.0	97	4.0	28.2334	6.0666	34.3000
30	Potatoes (sweet)—machine, bushels.	105	1895	122	7.0	55	14.0	7.5292	2.7618	10.2910
31	Potatoes (sweet)—hand, bushels.	105	1868	317	20.0	97	4.0	28.2334	6.0666	34.3000
32	Potatoes (sweet)—machine, bushels.	105	1895	122	7.0	55	14.0	7.5292	2.7618	10.2910
33	Tobacco—hand, pounds.	1,500	1853	311	23.0	66	40.0	[1] 23.3538	2.5002	25.8540
34	Tobacco—machine, pounds.	1,500	1895	252	54.6	57	30.6	[1] 25.1160	2.8755	27.9915
35	Cotton (seed)—hand, pounds.	1,000	1866	115	58.0	25	18.0	8.7921	1.9461	10.7382
36	Cotton (seed)—machine, pounds.	1,000	1895	111	58.0	23	18.0	6.6133	1.3441	7.9574
37	Sugar cane—hand, tons.	20	1855	351	21.0	184	18.0	37.9409	2.3773	40.3182
38	Sugar cane—machine, tons.	20	1895	191	33.0	111	6.0	11.3189	5.0500	16.3689

[1] With board.

agriculture in the United States.

each brace cover the same extent of operations.]

Average total labor per bushel, etc.	Average human labor per bushel, etc.	Human labor required per bushel, etc.	Extent of operation and means employed.	No.
		Minutes.		
$0.1138	$0.0816	52.0	Stalks not cut from ground and corn not shelled; shovel plow, hoe, husking peg.	1
.0896	.0413	24.8	Gang plow, disk and four-section harrows, corn planter, and cultivator.	2
.1258	.0906	58.1	Stalks not cut from ground and corn not shelled; shovel plow, hoe, husking peg.	3
.0827	.0378	22.7	Gang plow, disk and four-section harrows, corn planter, and cultivator.	4
.4085	.3577	274.0	Stalks cut from ground and made into fodder and corn shelled; corn knife, horses.	5
.1654	.1057	41.3	Machine for cutting and binding stalks, and for husking and cutting into fodder; gang plow, corn planter, steam corn-sheller.	6
.4696	.4236	254.2	Stalks not cut from ground and corn not shelled; shovel plow, hoe, husking peg.	7
.1631	.1038	40.9	Gang plow, disk and four-section harrows, corn planter, and cultivator.	8
.2000	.1856	192.8	Oxen, brush harrow, sickle, flail and hand winnowing	9
.0560	.0359	8.9	Steam gang plow, seeder and harrow, steam reaper and thrasher.	10
.1917	.1777	183.2	Oxen, brush harrow, sickle, flail and hand winnowing	11
.1013	.0330	10.0	No steam power, disk plow, seeder and harrow, reaper and thrasher.	12
.0888	.0859	90.6	Oxen, brush harrow, sickle, flail and hand winnowing	13
.0407	.0271	10.8	Self-binding reaper, steam thrasher, spading harrow	14
.0962	.0932	99.4	Oxen, brush harrow, sickle, flail and hand winnowing	15
.0400	.0268	10.6	Self-binding reaper, steam thrasher, spading harrow	16
.2101	.1642	151.2	Oxen, sickle, flail, hand winnowing	17
.1720	.1062	60.4	Self-binding reaper, steam thrasher	18
.1891	.1321	158.6	Oxen, sickle, flail, hand winnowing	19
.1588	.1062	60.4	Self-binding reaper, steam thrasher	20
.1294	.1199	127.2	Oxen, brush harrow, sickle, flail and hand winnowing	21
.0354	.0201	5.4	Steam gang plow, seeder and harrow, steam reaper and thrasher.	22
.1200	.1107	116.2	Oxen, brush harrow, sickle, flail and hand winnowing	23
.0676	.0238	6.8	No steam power, disk plow	24
.0599	.0495	29.7	Shovel plow, hoe; potatoes cut by hand	25
.0272	.0173	10.4	Potato cutter, planter, digger	26
.0599	.0495	29.7	Shovel plow, hoe; potatoes cut by hand	27
.0275	.0174	10.5	Potato cutter, planter, digger	28
.3267	.2689	181.3	Plants set out by hand; hoe, spade for digging	29
.0980	.0717	69.8	Ridger, transplanter, digger	30
.3267	.2689	181.3	Plants set out by hand; hoe, spade for digging	31
.0980	.0717	69.8	Ridger, transplanter, digger	32
.0172	.0156	12.5	Plants set out by hand	33
.0187	.0167	10.1	Transplanter	34
.0107	.0088	7.0	Fertilizer distributed and seed planted by hand	35
.0080	.0066	6.7	Fertilizer distributor, planter	36
2.0159	1.8970	1,054.0	Hoe; hand planting	37
.8184	.5659	574.6	Cane planter, disk cultivator to cover cane, cultivator	38

Hand and machine labor in agriculture

[The words "hand" and "machine" within

No.	Crop and predominating labor.	Units of production on 1 acre.	Year of operation.	Time worked.				Cost of labor.		
				By employees.		By animals.		For employees.	For animals.	Total.
				Hrs.	*Min.*	*Hrs.*	*Min.*			
39	Carrots—hand, tons.	30	1855	418	30.0	68	30.0	$27.1875	$3.4250	$30.6125
40	Carrots—machine, tons.	30	1895	257	20.0	60	40.0	26.1667	3.7917	29.9584
41	Carrots—hand tons.	30	1850	480	30.0	81	30.0	34.6375	4.0750	38.7125
42	Carrots—machine, tons.	30	1895	238	3.0	73	3.0	23.5550	3.6525	27.2075
43	Turnips—hand, bushels.	350	1850	456	0.0	39	30.0	31.1375	1.9750	33.1125
44	Turnips—machine, bushels.	350	1895	217	18.5	34	48.5	19.5433	1.7404	21.2837
45	Turnips—hand, bushels.	350	1855	399	0.0	35	30.0	23.8525	1.7750	25.6275
46	Turnips—machine, bushels.	350	1895	240	50.0	30	40.0	21.4292	1.9167	23.3459
47	Tomatoes—hand, bushels.	150	1870	324	20.0	128	40.0	30.1833	6.4333	36.6163
48	Tomatoes—machine, bushels.	150	1895	134	52.5	69	45.0	12.3894	3.4875	15.8769
49	Tomatoes—hand, bushels.	150	1870	322	20.0	124	40.0	29.9833	6.2333	36.2166
50	Tomatoes—machine, bushels.	150	1895	134	12.5	68	25.0	12.3327	3.4208	15.7535
51	Beets—hand...bushels..	300	1850	441	0.0	37	0.0	30.4500	1.8500	32.3000
52	machine...do....	300	1895	202	35.0	32	35.0	18.3833	1.6292	20.0125
53	Beets—hand ......do....	300	1855	383	20.0	33	20.0	23.1500	1.6667	24.8167
54	machine...do....	300	1895	225	20.0	28	40.0	20.1667	1.7917	21.9584
55	Strawberries—hand, quarts.	4,000	1872	1,728	20.0	84	40.0	226.2084	4.2333	230.4417
56	Strawberries—machine, quarts.	4,000	1895	676	40.0	93	40.0	93.5667	4.6833	98.2500
57	Strawberries—hand, quarts.	4,000	1872	1,732	20.0	92	40.0	226.6417	4.6333	231.2750
58	Strawberries—machine, quarts.	4,000	1895	675	21.2	89	43.6	93.4353	4.4863	97.9216
59	Peas—hand....bushels..	20	1856	77	0.0	49	20.0	[1] 4.8126	1.8500	6.6626
60	machine ...do....	20	1895	45	38.0	40	13.0	[1] 4.7534	2.0109	6.7643
61	Peas—hand. ......do....	20	1855	82	0.0	49	20.0	5.1251	2.4668	7.5919
62	machine ...do....	20	1895	45	38.0	40	13.0	4.7534	2.5136	7.2670
63	Onions—hand......do....	250	1850	433	55.0	35	20.0	30.7938	1.7667	32.5605
64	machine .do....	250	1895	223	22.6	31	11.6	22.3277	1.5597	23.8874
65	Onions—hand .....do....	250	1855	501	30.0	32	0.0	28.5125	1.6000	30.1125
66	machine .do....	250	1895	343	44.0	27	28.0	29.9667	1.7167	31.6834

[1] With board.

in the United States—Continued.

each brace cover the same extent of operations.]

Average total labor per bushel, etc.	Average human labor per bushel, etc.	Human labor required per bushel, etc.	Extent of operation and means employed.	No.
		Minutes.		
$1.0204	$0.9062	837.0	Hoe; seed planted by hand	39
.9986	.8722	514.7	Drill, cultivator	40
1.2904	1.1546	961.0	Hoe; seed planted by hand	41
.9069	.7852	476.1	Drill, cultivator, weeding hoe	42
.0946	.0890	78.2	Hoe; bottle with hole in cork to drill seed	43
.0698	.0558	37.3	Drill, cultivator, weeding hoe	44
.0732	.0682	68.4	Hoe; bottle with hole in cork to drill seed	45
.0667	.0612	41.3	Drill, cultivator, weeding hoe	46
.2441	.2012	129.7	Plants set out by hand; hoe	47
.1058	.0826	54.0	Transplanter, cultivator, fertilizer drill	48
.2414	.1999	128.9	Plants set out by hand; hoe	49
.1050	.0822	53.7	Transplanter, cultivator, fertilizer drill	50
.1077	.1015	88.2	Hoe; seed planted by hand	51
.0667	.0613	40.5	Drill, cultivator, weeding hoe	52
.0827	.0772	76.7	Hoe; seed planted by hand	53
.0732	.0672	45.1	Drill, cultivator, weeding hoe	54
.0576	.0566	25.9	Plant set out by hand; hoe	55
.0246	.0234	10.2	Transplanter, cultivator, weeder	56
.0578	.0567	26.0	Plant set out by hand; hoe	57
.0245	.0234	10.1	Transplanter, cultivator, weeder	58
.3331	.2406	231.0	Seed sown by hand, covered by harrow; scythe, flail	59
.3332	.2377	136.9	Drill, mower, thrasher	60
.3796	.2563	246.0	Seed sown by hand, covered by harrow; scythe, flail	61
.3634	.2377	136.9	Drill, mower, thrasher	62
.1302	.1232	104.1	Hoe; seed planted by hand	63
.0955	.0893	53.6	Drill, cultivator, weeding hoe	64
.1295	.1140	120.4	Hoe; seed planted by hand	65
.1267	.1198	82.5	Drill, cultivator, weeding hoe	66

REMARKABLE EFFECTS OF MACHINES.

Examination of a pair of schedules will show how the table on pages 600–603 is to be understood. Schedule 5 represents the raising of corn on 1 average acre in 1855, with the implements and in the manner of that day, the shovel plow being used for marking the rows and for cultivating, the hoe for planting, and a peg in husking by hand. The stalks were cut with knives, and cut for fodder with an old-fashioned cutter turned by hand, and the corn was shelled by hand.

From the plowing of the ground to the depositing of the corn in the granary the human labor required per acre was equal to that of one man for 182 hours and 40.8 minutes, and labor of horses was required equal to that of one horse for 54 hours and 9 minutes. The cost of the human labor was $14.3082; animal, $2.0308; total labor per acre, $16.3390, or 40.85 cents per bushel. The human labor per bushel was 274 minutes, and cost 35.770 cents.

On the other hand, schedule 6 is for the raising of the same quantity of corn (40 bushels) on the same area (1 acre) in 1894 with the use of the best implements, machines, and methods. The plowing was done with a gang plow and corn planter; machine for cutting and binding stalks, a combined husking and fodder-cutting machine, and a steam cornsheller were used.

The human labor required was equal to that of one man for 27 hours and 30.3 minutes; the animal labor, 47 hours and 46.8 minutes. The cost of the human labor was $4.2269; animal, $2.3891; total, $6.6160.

The increased effectiveness of labor when aided by machines is clearly brought out in the table under consideration. Machines and improved implements in raising corn reduced the human labor cost per bushel from 35.770 to 10.57 cents, or 25.20 cents, or 70.5 per cent, and reduced the time of human labor from 274 to 41.3 minutes, or 84.9 per cent. A very remarkable reduction in human labor not appearing in the table is in the shelling of the corn, which is from 100 minutes per bushel when the work was done by hand to 1 minute when the steam sheller is used, or 99 per cent.

REDUCTION OF COST OF LABOR.

A comparison of schedules discovers the following reductions in the cost of human and animal labor per bushel caused by the use of machines and implements: Corn, from 12.58 to 8.27 cents; wheat, 19.17 to 10.13 cents; wheat (another pair of schedules), 20 to 5.60 cents; oats, 8.88 to 4.07 cents; rye, 21.01 to 17.20 cents; barley, 12.94 to 3.54 cents; Irish potatoes, 5.99 to 2.72 cents.

The reduction of human labor per bushel is as follows for selected pairs of schedules: Corn, from 58.1 to 22.7 minutes; wheat, 183.2 to 10 minutes; oats, 90.6 to 10.8 minutes; rye, 151.2 to 60.4 minutes; barley, 116.2 to 6.8 minutes; Irish potatoes, 29.7 to 10.4 minutes.

SAVING OF TIME.

Every pair of schedules in the table shows a saving of human labor in time, and all but six pairs show a saving in animal labor in time. This should be remembered in any consideration of the number of farm horses, mules, and oxen, with comparison of dates, and also in similarly considering the number of persons engaged in agriculture.

The cost of the human labor required to produce the unit of product is shown to have been reduced with the substitution of machine for hand labor by all but two pairs of schedules, and the exceptions are due to higher wage rates at the later or machine time. With respect to the cost of animal labor, the reverse is more generally true, although thirteen out of the thirty-three pairs of schedules show a decreased cost. The increase is due to the greater rate of cost of animal labor in the later years.

CONCLUSION.

It is not the purpose of this paper to predict the future of agriculture in this country. For some years past magazine and newspaper writers have been prophesying that upon complete or nearly complete disposal of the better public land the production of corn and wheat, at least, would be arrested, and, while domestic consumption is absolutely increasing, the exported fraction of these crops would be diminished; but the prophets have not taken into account the possible redistribution of cultivated land among the various crops, nor the conversion of unimproved into cultivated land, nor have they recognized the expanding consumption of commercial fertilizers, especially in the cotton States, and the dissemination of information with regard to technical and scientific agriculture through the efforts of the Department, the boards of agriculture of the various States, and the many experiment stations, all of which agencies are in more or less close touch with millions of the farmers of the country, and whose services can be made available to everyone at the cost of a letter.

The changes that agricultural production, especially the preparation of agricultural products for the market, have undergone within the last half century, and still more within the last quarter century, are remarkable and important. There is a great difference in results between the time when, as ascertained by the United States Department of Labor, 20 minutes of human labor were required to husk a bushel of corn by hand, with the use of a husking peg, and 102 minutes to haul the stalks required to produce a bushel of corn to a barn and cut them into fodder, and the time, as at present, when 17½ minutes are sufficient to haul the same stalks to a husker and, by the use of a machine operated by steam, to husk the corn and at the same time cut the stalks into fodder; and there was a transition from one agricultural age to another when a man ceased to expend 100 minutes of labor in shelling corn by hand, and employed a steam sheller by which a bushel of corn is shelled in a minute and a half. When farmers reaped their wheat with sickles and bound the straw by hand, hauled the sheaves to the barn and thrashed the grain with flails, these operations, applied to 1 bushel of wheat, required the labor of one man for 160 minutes, whereas this work is now done, by the use of a combined reaper and thrasher operated by steam, with 4 minutes of human labor.

Present conditions indicate that a subject of growing importance in agriculture will be the use of fertilizers, both homemade and commercial. There was a time when it was the practice of the cotton planters to crop the soil until it became so unfertile that it was abandoned, whereupon new land was cleared of its forest and the exploitation of soil fertility repeated. But such a practice as this, in the case of nearly all agricultural land, must end in the poorest sort of agriculture, if not in the abandonment of agriculture, and so farmers have resorted, and now are still more resorting, to the use of fertilizers. The use of these, as discovered in a recent investigation by the Division of Statistics, in the cultivation of cotton, presents economic advantages to farmers, and teaches them rather to cultivate well the land that they cultivate at all than to cultivate poorly a larger area.

The foregoing consideration has been sufficient to account on economic grounds for some of the reduction in prices of farm products—production increasing faster than population, necessitating the meeting of cheaper foreign agricultural labor in the world market; cheaper transportation; cheaper cost of production due to machines and improved implements; reduced expenses of marketing; the dissemination of information and the multiplying of the means and facilities of transportation, preventing scarcity with respect both to time and place, and thus steadying prices.

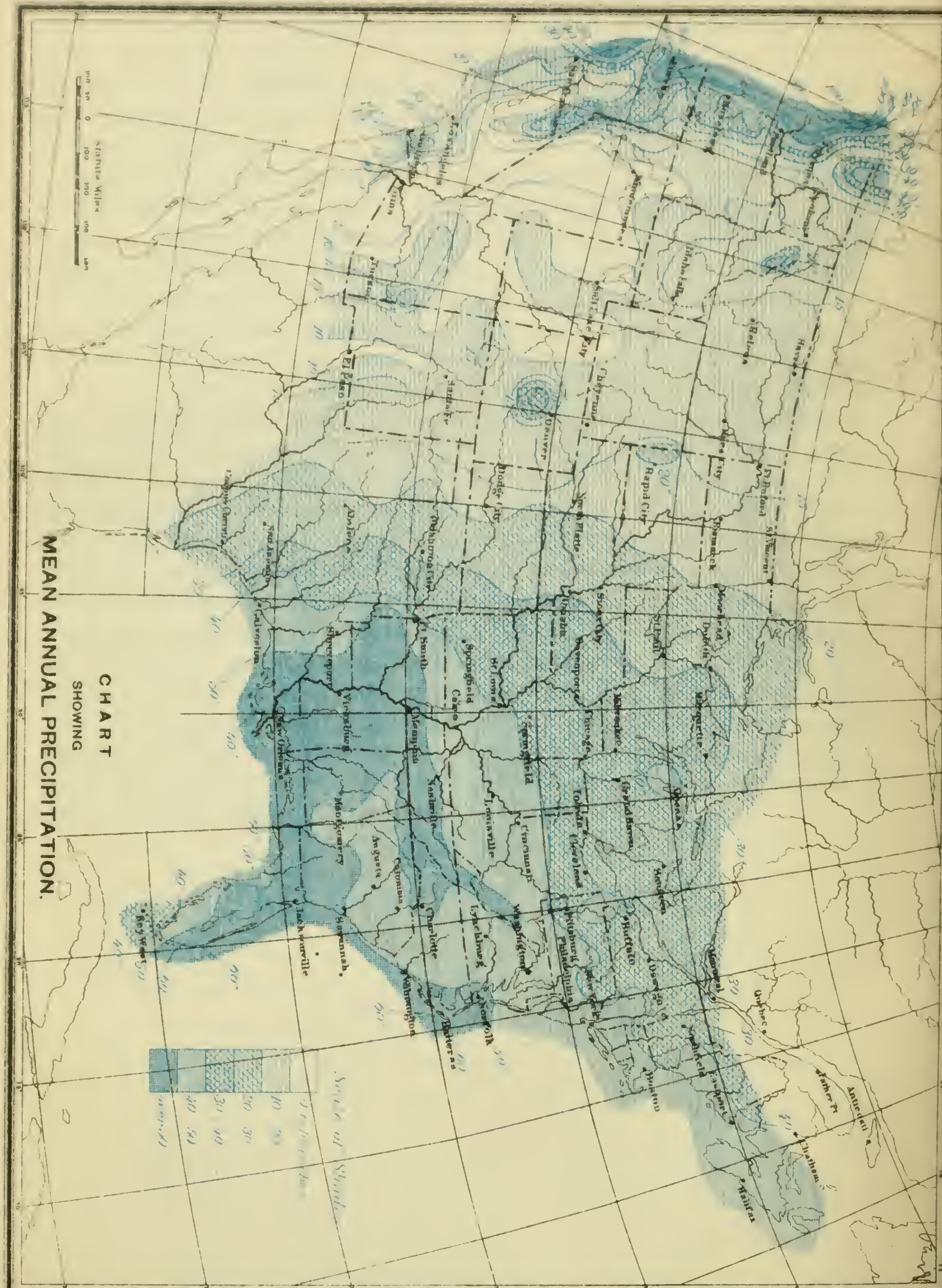

PHOTO-LITH. BY A. HOEN & CO. BALTO.

RAINFALL OF THE CROP SEASON.

By A. J. Henry,
Chief of Division, Weather Bureau.

PACIFIC COAST COMPARED WITH THE EAST.

The rainfall conditions of the Pacific Coast are quite different from those of the East. Grain sown in the fall begins to sprout with the first rain and thenceforth grows more or less slowly throughout the winter. It is ready for the reaper from the first of June to the first of July, according to latitude, and with the harvest comes the end of the rains. Fall-sown grain in the East makes little if any growth during the winter, but with the advent of warm weather in the spring the plant grows rapidly under favorable conditions of heat and moisture. April to August may, therefore, be called the critical months for the staple crops in the eastern two-thirds of the United States, and it is with the rainfall of these months that the agriculturist is chiefly concerned. Pl. XXXVI shows the mean annual precipitation, and the table below shows the normal rainfall of each month of the growing season, including September, the total for the season, and the greatest and least seasonal fall during the period of observation.

Monthly and seasonal averages of rainfall, April to September.

Station.	Latitude.	Longitude.	Elevation.	Number of years.	April.	May.	June.	July.	August.	September.	Total.	Maximum.	Minimum.	Year of minimum rainfall.	Percentage of annual rainfall.
MAINE.	° ′	° ′	*Feet.*		*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*		
Brunswick	43 54	69 57	64	20	4.2	4.7	3.8	3.8	4.9	3.2	24.6	37.6	14.7	1846	49
Cornish	43 44	70 51	784	40	3.3	3.6	3.5	4.2	4.3	3.4	22.3	34.8	14.9	1880	48
Eastport	44 54	66 59	30	23	3.0	3.7	3.5	3.9	3.5	3.2	20.8	30.6	11.2	1894	46
Gardiner	44 14	69 43	23	53	3.4	3.8	3.2	3.2	3.6	3.2	20.4	31 4	12.3	1844	47
Orono	44 56	68 44	71	24	2.8	3.4	3.4	3.3	3.6	3.4	19.9	29.2	13.4	1895	45
Portland	43 39	70 15	12	25	3.0	3.6	3.4	3.6	3.8	3.1	20.5	25.4	15.2	1883	48
NEW HAMPSHIRE.															
Concord	43 12	71 32	252	42	2.8	3.3	3.1	3.7	3.9	3.4	20.2	27.6	12.7	1869	50
Hanover	43 42	72 49	545	48	2.3	3.2	3.5	3.4	3.7	3.0	19.1	28.9	12.8	1880	53
Lakeport[1]	43 32	71 28	......	23	2.7	3.3	3.5	4.0	3.8	3.6	20.9	26.9	16.3	1894	49
Stratford	44 40	71 39	1,000	24	2.4	3.4	3.4	4.0	4.0	3.5	20.7	31.0	14.1	1870	53
VERMONT.															
Burlington	44 28	73 12	268	53	1.9	3.1	3.2	4.0	3.6	3.5	19.3	34.4	11.8	1894	59
Lunenburg	44 28	71 41	850	44	2.6	3.6	3.5	3.9	3.8	3.4	20.8	40.8	12.5	1854	53
Strafford	43 52	72 24	500	24	2.5	3.3	3.5	4.1	3.7	3.4	20.5	29.4	14.4	1896	52

[1] Formerly Lake Village.

Monthly and seasonal averages of rainfall, April to September—Continued.

Station.	Latitude.	Longitude.	Elevation.	Number of years.	April.	May.	June.	July.	August.	September.	Total.	Maximum.	Minimum.	Year of minimum rainfall.	Percentage of annual rainfall.
MASSACHUSETTS.	° ′	° ′	*Feet.*		*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*		
Amherst	42 22	72 32	235	61	3.1	3.9	3.7	4.5	4.4	3.4	23.0	35.0	14.0	1894	52
Boston	42 21	71 04	12	79	3.8	3.7	3.2	3.6	4.3	3.4	22.0	41.7	11.8	1836	48
Fall River	41 42	71 09	259	22	3.9	4.0	3.1	3.5	4.4	3.3	22.2	30.4	16.4	1886	44
Fitchburg	42 36	71 50	433	32	2.9	3.8	3.3	3.7	4.3	3.2	21.2	32.2	13.5	1883	51
Lowell	42 39	71 17	104	42	3.6	3.7	3.3	3.8	4.4	3.3	22.1	34.3	14.5	1883	49
New Bedford	41 39	70 56	100	83	3.6	3.8	3.0	3.1	3.9	3.3	20.7	34.8	11.6	1849	48
Springfield	42 05	72 35	70	47	3.2	4.2	3.8	4.5	4.5	3.4	23.6	33.2	12.3	1864	52
Taunton	41 54	71 05	30	22	3.6	3.3	2.5	3.5	4.2	2.8	19.9	33.1	9.6	1883	44
Worcester	42 16	71 49	473	43	3.7	4.1	3.1	3.8	4.5	3.5	22.7	36.0	13.9	1883	49
RHODE ISLAND.															
Providence	41 50	71 25	11	65	3.7	3.8	3.3	3.3	4.2	3.2	21.5	34.6	11.3	1836	47
CONNECTICUT.															
Hartford	41 45	72 40	38	27	3.0	3.6	3.0	4.1	4.6	3.2	21.5	32.9	13.3	1870	47
New Haven	41 18	72 56	10	45	3.3	3.9	3.1	4.5	4.6	3.8	23.2	38.2	16.0	1894	51
New London	41 21	72 05	8	26	3.7	3.6	3.2	4.0	4.7	3.4	22.6	42.2	12.6	1894	47
Middletown	41 33	72 39	37	33	3.4	3.8	3.5	4.3	4.8	3.6	23.4	37.2	14.2	1894	48
Southington	41 35	72 51	152	26	3.1	3.2	2.8	3.9	4.6	2.9	20.5	31.4	12.6	1883	47
Wallingford	41 27	72 49	73	35	3.6	4.2	3.6	4.2	5.0	3.6	24.2	37.1	15.0	1881	49
NEW YORK.															
Albany	42 40	73 45	32	69	2.8	3.6	4.1	4.2	4.0	3.5	22.2	36.8	14 2	1896	56
Buffalo	42 53	78 53	587	27	2.5	3.4	3.5	3.2	3.2	3.3	19.1	32.8	11.4	1881	50
Cooperstown	42 42	74 57	1,300	43	2.6	3.6	4.1	4.3	4.1	3.4	22.1	33.4	12.8	1881	57
Gouverneur	44 25	75 35	423	21	2.1	2.7	2.7	2.8	2.3	3.1	15.7	30.1	5.4	1842	50
New York	40 43	73 58	52	61	3.4	4.0	3.8	4.0	4.7	3.4	23.3	42.6	12.5	1849	52
North Salem	41 20	73 34	361	23	3.4	4.4	3.5	4.0	4.1	3.1	22.5	35.2	15.6	1841	55
Rochester	43 08	77 42	494	27	2.5	3.3	3.3	3.0	3.0	2.4	17.5	21.7	9.6	1887	50
Ithaca	42 27	76 30	375	36	2.2	3.4	3.7	3.5	3.0	3.0	18.8	27.5	11.3	1879	57
NEW JERSEY.															
Atlantic City	39 22	74 25	13	23	3.3	3.1	3.0	3.5	4.3	3.2	20.4	33.4	13.8	1895	50
Trenton	40 14	74 45	33	24	3.7	4.1	3.9	5.5	5.3	4.0	26.5	39.4	17.4	1895	53
Lambertville	40 23	74 57	75	25	3.3	4.4	3.8	4.4	4.9	4.3	25.1	42.3	14.9	1848	54
Newark	40 45	74 10	13	52	3.5	4.0	3.5	4.4	5.0	3.8	24.2	40.1	12.1	1881	52
New Brunswick	40 30	74 27	48	43	3.7	3.9	3.9	4.7	4.9	3.8	24.9	37.2	11.7	1881	53
South Orange	40 45	74 15	141	26	3.3	3.2	3.6	4.9	5.2	4.0	24.2	49.9	12.5	1881	51
Vineland	39 29	75 01	97	25	3.3	3.9	3.3	4.3	4.9	4.0	23.7	33.0	14.2	1884	50
PENNSYLVANIA.															
Blooming Grove	41 23	75 09	......	25	3.2	4.0	4.1	5.0	4.9	3.1	24.3	42.8	12.8	1881	55
Dyberry	41 38	75 18	1,100	25	2.5	3.4	3.1	4.6	3.8	2.8	20.2	27.5	14.2	1875	53
Erie	42 07	80 05	686	23	2.5	3.8	3.9	2.8	3.3	4.0	20.3	27.3	11.5	1891	49
Gettysburg	39 49	77 15	624	24	3.5	4.0	3.5	3.4	3.6	3.0	21.0	32.1	11.6	1845	54
Harrisburg	40 16	76 53	320	25	3.0	4.6	4.4	4.2	3.9	3.6	23.7	37.4	11.5	1849	59
Pittsburg[1]	40 22	79 59	745	54	3.0	3.5	3.6	4.0	3.4	2.9	20.4	33.5	12.8	1854	56
Philadelphia	39 53	75 10	32	72	3.4	3.8	3.8	4.0	4.3	3.5	22.8	41.1	10.3	1881	54
DISTRICT OF COLUMBIA AND MARYLAND.															
Washington	38 54	77 03	110	41	3.4	4.1	3.9	4.5	4.0	3.5	23.4	39.9	14.3	1894	55
Baltimore	39 17	76 37	68	26	3.4	3.8	4.0	4.7	4.0	3.9	23.8	38.7	15.0	1893	54
Cumberland	39 39	78 45	639	24	2.5	3.4	3.8	3.4	3.2	2.8	19.1	29.4	11.0	1885	57
Emmitsburg	39 43	77 20	498	12	3.5	4.6	3.9	3.4	3.3	3.8	22.5	33 8	13.5	1885	52
Fallston	39 30	76 24	300	25	3.5	4.3	4.1	4.4	4.7	4.5	25.5	42.9	15.1	1881	53
Frederick	39 24	77 24	415	15	3.7	4.4	4.6	3.5	2.7	3.7	22.6	31.2	15.0	1854	56
Fort McHenry	39 16	76 35	36	45	3.0	3.4	3.4	3.5	4.0	3.4	20.7	42.9	11.5	1855	53
Woodstock College	39 19	76 51	820	21	3.2	4.0	3.7	3.7	4.0	4.0	22.6	30.7	11.6	1884	51
VIRGINIA.															
Lynchburg	37 22	79 12	523	26	3.3	4.0	3.5	4.1	3.9	3.9	22.7	39.4	12.3	1881	53
Norfolk	36 51	76 17	12	26	4.3	4.2	4.4	5.8	6.3	4.7	29.7	43.3	19.9	1884	57
Powhatan Hill	38 13	77 12	317	20	2.4	3.4	3.4	3.6	4.5	2.8	20.1	28.0	12.2	1872	61
Prospect Hill Farm	37 25	75 52	573	27	3.7	4.0	3.2	4.7	4.6	3.7	23.9	39.3	9.2	1884	51
Wytheville	36 55	81 00	2,230	26	3.4	3.7	4.0	4.0	4.0	3.7	22.8	30.7	17.3	1885	55

[1] Combined with Allegheny Arsenal.

Monthly and seasonal averages of rainfall, April to September—Continued.

Station.	Latitude.	Longitude.	Elevation.	Number of years.	April.	May.	June.	July.	August.	September.	Total.	Maximum.	Minimum.	Year of minimum rainfall.	Percentage of annual rainfall.
NORTH CAROLINA.	° ′	° ′	*Feet.*		*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*		
Hatteras	35 15	75 40	20	22	4.7	4.6	4.6	6.4	6.4	6.4	33.1	52.0	23.7	1887	50
Kittyhawk	36 00	75 42	22	18	4.4	3.7	4.6	5.8	6.8	4.6	29.9	47.3	16.0	1893	53
Lenoir	35 58	81 30	1,186	25	3.5	4.8	4.1	5.1	5.7	4.6	27.8	39.7	14.8	1881	55
Southport	33 55	78 01	34	20	2.8	3.4	3.9	6.8	5.7	5.6	28.2	38.3	20.2	1882	56
Wilmington	34 14	77 57	52	26	2.9	4.2	5.7	7.1	7.3	6.3	33.5	56.5	27.0	1882	62
Weldon	36 24	77 32	80	24	3.4	4.6	4.0	5.1	5.3	4.0	26.4	39.3	16.5	1881	56
SOUTH CAROLINA.															
Aiken	33 32	81 34	520	23	3.4	3.7	4.6	4.9	5.9	3.5	26.0	35.6	16.6	1861	54
Kirkwood	34 17	80 33	232	32	3.1	3.6	3.9	5.2	5.3	3.9	25.0	37.6	12.8	1869	57
Charleston	32 47	79 56	15	89	2.4	3.6	4.8	6.6	7.2	5.7	30.3	52.0	11.3	1850	62
GEORGIA.															
Atlanta	33 45	84 23	1,050	27	4.2	3.6	4.1	3.9	4.5	3.7	24.0	36.3	16.0	1878	48
Augusta	33 28	81 54	134	27	3.4	3.4	4.6	5.4	5.0	3.7	25.5	37.4	17.4	1870	53
Forsyth (near)	33 00	83 55	735	23	3.8	3.3	4.7	4.9	5.7	3.3	25.7	38.5	16.1	1878	48
Quitman (near)	30 45	83 39	170	15	4.0	3.0	6.6	6.2	5.6	4.1	29.5	38.0	19.8	1886	55
Savannah	32 05	81 05	32	48	2.7	3.8	5.8	6.6	7.8	5.2	31.9	53.9	19.0	1881	63
FLORIDA.															
Fort Barrancas	30 21	87 18	20	23	4.9	4.6	5.8	8.4	9.9	5.9	39.5	77.4	18.7	1851	56
Fort Brook	28 00	82 28	20	24	1.9	2.9	7.6	9.8	9.5	6.2	37.9	73.1	22.7	1857	71
Key West	24 33	81 49	27	49	1.2	2.9	4.5	3.8	5.0	6.6	24.0	46.1	12.8	1893	63
Jacksonville	30 20	81 39	24	27	2.7	3.8	6.1	6.2	6.7	8.2	33.7	52.3	23.7	1896	62
ALABAMA.															
Greensboro	32 41	87 36	220	23	4.0	3.5	3.7	3.6	5.2	3.1	23.1	32.1	13.9	1858	46
Greene Springs	32 47	87 43	500	23	6.0	3.8	4.4	4.5	4.6	2.8	26.1	36.3	17.5	1870	48
Mobile	30 41	88 02	4	26	4.6	4.3	5.9	6.7	6.8	5.0	33.3	49.6	20.0	1894	53
Montgomery	32 23	86 18	162	24	4.8	4.0	4.7	4.6	4.0	2.9	25.0	36.7	18.3	1875	48
Mount Vernon Arsenal	31 12	88 02	200	30	4.6	3.9	6.1	6.2	5.9	3.7	30.4	46.6	18.9	1891	49
Union Springs	32 12	85 39	485	26	4.4	3.2	3.9	3.8	3.9	2.5	21.7	33.0	10.1	1870	47
MISSISSIPPI.															
Columbus	33 31	88 28	208	34	5.8	3.6	4.1	4.7	4.2	3.4	25.8	40.3	14.2	1860	47
Natchez	31 34	91 27	206	23	5.2	4.1	4.0	5.1	4.5	3.7	26.6	38.5	16.8	1862	49
Vicksburg	33 22	90 53	190	42	5.3	4.4	3.9	4.5	3.4	3.3	24.8	42.6	7.8	1851	47
LOUISIANA.															
Baton Rouge	30 26	91 11	19	24	4.7	4.5	5.0	6.3	5.9	4.2	30.6	81.9	17.1	1844	51
New Orleans	29 58	90 04	6	26	5.2	4.8	6.7	6.4	6.0	4.6	33.7	49.7	15.2	1891	56
Shreveport	32 30	93 40	183	25	5.2	4.2	3.7	3.4	2.1	3.7	22.3	38.1	13.7	1883	46
ARKANSAS.															
Helena	34 36	90 36	197	21	6.7	4.5	4.7	4.5	3.5	3.9	27.8	53.2	15.0	1881	48
Washington	33 34	93 41	660	28	6.0	5.2	3.9	4.7	3.9	3.1	26.8	40.8	14.6	1851	49
Fort Smith	35 22	94 24	418	33	4.8	4.7	4.2	3.9	3.4	3.1	24.1	37.4	10.4	1856	58
TEXAS.															
Austin	30 16	97 42	480	30	3.0	4.2	2.7	1.8	2.7	4.2	18.6	32.0	9.3	1856	56
El Paso	31 45	106 30	3,697	33	0.1	0.3	0.5	1.6	1.9	1.6	6.0	14.8	1.1	1860	68
Fort Brown	25 52	97 28	165	28	0.7	2.1	1.9	2.1	2.9	5.6	15.3	38.9	3.7	1850	59
Fort Clark	29 14	100 51	1,000	27	1.5	3.2	2.5	1.6	2.5	3.6	14.9	30.0	4.1	1893	66
Fort Duncan[1]	28 38	100 15	800	26	1.1	2.5	2.9	2.1	2.9	3.7	15.2	25.1	4.6	1893	70
Fort McIntosh	27 31	99 32	460	30	1.3	2.3	2.3	1.8	2.8	2.6	13.1	19.2	5.0	1856	64
Galveston	29 17	94 49	3	26	2.8	3.7	4.9	3.1	5.3	6.0	25.8	43.7	9.1	1896	58
San Antonio	29 24	98 29	686	26	2.5	3.0	3.1	2.0	3.6	3.6	17.8	27.2	4.9	1858	59
WEST VIRGINIA.															
Morgantown	39 36	79 59	963	19	3.5	3.6	4.7	5.2	4.6	3.7	25.3	37.2	17.5	1894	54
Wheeling	40 03	80 43	637	12	2.8	4.1	3.7	3.7	4.1	2.8	21.2	36.5	12.9	1894	55

[1] Camp Eagle Pass.

Monthly and seasonal averages of rainfall, April to September—Continued.

Station.	Latitude.	Longitude.	Elevation.	Number of years.	April.	May.	June.	July.	August.	September.	Total.	Maximum.	Minimum.	Year of minimum rainfall.	Percentage of annual rainfall.
OHIO.	° ′	° ′	*Feet.*		*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*		
Cincinnati	39 06	84 30	490	62	3.3	4.0	4.4	3.9	3.8	3.0	22.4	33.3	11.9	1870	53
Cleveland	41 30	81 42	582	41	2.7	3.5	3.9	3.4	3.1	3.6	20.2	31.4	12.5	1895	55
Marietta	39 30	81 26	611	69	3.3	3.9	4.1	4.4	3.9	3.1	22.7	38.3	14.5	1894	54
North Lewisburg	40 11	83 35	1,030	25	3.1	3.9	4.0	4.4	3.3	3.2	21.9	33.5	10.2	1895	54
Portsmouth	38 48	83 03	528	64	3.2	3.5	4.0	3.9	3.4	2.8	20.8	33.1	9.7	1834	51
Steubenville	40 25	80 41	663	39	3.4	3.9	4.0	4.0	3.9	3.5	22.7	33.7	13.5	1854	55
Toledo	41 40	83 34	579	26	2.2	3.4	3.4	3.1	2.7	2.4	17.2	26.5	10.2	1893	55
Wauseon	41 36	84 07	767	23	3.0	4.2	4.1	3.4	2.7	2.6	20.0	35.2	10.2	1895	54
KENTUCKY.															
Louisville [1]	38 15	85 45	432	54	4.2	4.1	4.7	4.1	3.8	3.0	23.9	37.0	14.6	1881	51
Newport Barracks	39 06	84 29	515	24	3.3	4.1	4.2	4.3	3.5	3.4	22.8	40.2	10.5	1870	57
TENNESSEE.															
Austin	36 12	87 10	568	17	4.8	3.4	5.1	4.0	3.7	3.8	24.8	34.2	13.3	1887	48
Glenwood Cottage [2]	36 28	87 20	394	30	4.9	3.8	4.1	3.7	3.5	2.9	22.9	33.6	16.3	1860	48
Knoxville	35 56	83 58	900	26	4.9	4.0	4.2	4.4	4.0	2.7	24.2	38.2	15.6	1894	48
Memphis	35 09	90 03	245	26	5.4	4.4	4.6	3.4	3.5	3.1	24.4	49.2	12.8	1887	46
Nashville	36 10	86 47	435	32	4.7	3.9	4.3	4.3	3.6	4.1	24.9	29.8	15.4	1871	50
Chattanooga	35 04	85 15	783	18	4.5	4.1	4.7	4.1	4.1	3.7	25.2	37.3	13.6	1894	47
INDIANA.															
Evansville	38 02	87 29	386	18	4.5	4.4	4.5	3.6	3.8	3.3	24.1	33.8	15.1	1887	51
Indianapolis	39 46	86 10	722	27	3.6	4.0	4.5	4.2	3.3	3.1	22.7	36.7	10.9	1870	54
Laconia	38 05	86 07	530	23	3.8	3.8	4.3	3.3	3.2	2.9	21.3	31.5	13.6	1874	49
Logansport	40 45	86 22	586	19	3.5	5.0	4.2	2.9	2.9	3.1	21.6	33.8	11.0	1895	55
New Harmony	38 10	87 54	350	25	3.4	3.7	3.9	3.8	3.4	3.2	21.4	30.8	10.4	1871	54
Richmond	39 51	84 53	968	22	3.6	4.3	3.9	3.5	3.9	4.1	23.3	38.0	10.4	1856	55
Spiceland	39 48	85 18	1,063	28	2.9	3.8	4.4	4.1	3.3	3.1	21.6	38.2	11.1	1871	54
Vevay	38 46	84 59	525	31	3.7	4.0	4.9	3.8	3.2	3.2	22.8	33.1	12.4	1895	53
ILLINOIS.															
Augusta	40 12	90 57	674	19	4.0	4.1	4.1	4.8	3.6	4.1	24.7	36.7	14.8	1857	63
Aurora	41 47	88 08	648	22	3.2	4.0	3.8	3.3	3.4	3.2	20.9	35.5	14.8	1887	56
Cairo	37 00	89 10	313	25	3.8	4.1	4.4	3.4	2.8	2.6	21.1	29.6	10.0	1887	49
Chicago	41 52	87 38	589	30	3.0	3.7	3.7	3.4	2.9	3.0	19.7	29.1	11.9	1887	58
Golconda	37 23	88 30	......	18	3.8	4.3	4.4	3.4	3.2	3.2	22.3	39.1	14.2	1869	50
Marengo	42 15	88 37	819	45	2.8	3.9	4.3	3.7	3.7	3.8	22.2	43.1	12.0	1863	63
Mattoon	39 29	88 24	737	15	4.2	5.0	4.8	3.9	3.4	2.9	24.2	36.8	15.1	1881	57
Ottawa	41 22	88 48	688	25	2.9	4.0	3.6	3.6	2.9	2.9	19.9	37.3	9.7	1887	59
Peoria	40 42	89 36	452	41	3.2	3.8	3.7	4.0	3.0	3.5	21.2	34.9	10.4	1870	61
Rockford	42 15	89 05	730	22	3.3	4.0	4.8	3.6	3.2	2.4	21.3	41.2	13.8	1874	59
Sandwich	41 31	88 32	656	17	3.7	4.6	4.3	4.5	4.5	3.5	25.1	36.5	10.6	1877	59
Winnebago	42 17	89 12	861	18	3.2	4.0	4.1	3.5	3.2	3.6	21.6	33.8	14.4	1859	63
IOWA.															
Amana	41 47	91 55	......	21	2.6	4.1	4.8	3.9	3.5	3.4	22.3	32.3	9.7	1886	67
Ames	42 09	93 38	926	21	2.9	4.1	4.4	4.7	3.4	3.6	23.1	38.7	13.0	1886	74
Brookville	41 04	92 05	......	17	3.1	4.0	4.6	3.9	3.5	3.1	22.2	41.3	9.7	1863	68
Clinton	41 50	90 10	593	22	3.1	4.7	4.7	3.9	3.3	3.3	23.0	34.6	13.9	1886	63
Cresco	43 32	92 10	1,300	25	2.6	3.8	5.0	3.9	2.8	3.6	21.7	30.1	12.0	1877	70
Davenport	41 30	90 39	595	26	2.8	4.2	4.2	3.6	3.6	3.2	21.6	32.8	10.9	1894	65
Dubuque	42 30	90 40	611	27	2.6	3.7	4.6	4.2	3.2	4.1	22.4	39.1	10.6	1894	65
Fort Madison	40 37	91 28	522	43	3.2	4.3	4.4	3.8	3.7	3.7	23.1	37.6	13.7	1857	63
Independence	42 29	91 57	915	27	2.2	4.1	4.9	4.4	3.3	4.3	23.2	42.3	11.0	1894	72
Iowa City	41 37	91 30	667	33	3.0	4.3	4.7	4.4	4.4	4.0	24.8	41.3	10.5	1886	65
Keokuk	40 25	91 21	505	25	3.2	4.1	4.5	4.1	2.8	3.5	22.2	37.9	13.0	1887	64
Logan	41 00	95 00	......	27	2.7	4.4	5.6	5.0	3.9	3.2	24.8	40.7	10.7	1894	73
Monticello	42 15	91 15	880	42	2.6	3.9	4.5	4.2	3.7	3.8	22.7	39.3	10.2	1871	63
Mount Pleasant	40 59	91 37	729	16	2.5	4.5	5.8	3.1	3.2	2.8	21.9	33.5	11.1	1890	67
Muscatine	41 26	91 05	562	48	3.5	4.4	4.8	3.8	4.2	3.7	24.4	[3] 56.6	11.1	1863	63
Oskaloosa	41 18	92 36	843	13	2.6	3.6	4.4	3.4	2.8	3.3	20.1	30.6	9.8	1890	69

[1] Combined with Springdale. [2] Clarksville. [3] Probably an overmeasurement.

Monthly and seasonal averages of rainfall, April to September—Continued.

Station.	Latitude.	Longitude.	Elevation.	Number of years.	April.	May.	June.	July.	August.	September.	Total.	Maximum.	Minimum.	Year of minimum rainfall.	Percentage of annual rainfall.
MISSOURI.	° ′	° ′	*Feet.*		*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*		
Hermann	38 41	91 27	480	21	3.4	4.6	5.1	3.7	2.9	3.7	23.4	31.6	11.0	1883	60
Miami	39 18	93 15	640	49	3.0	4.2	5.0	4.2	3.6	3.4	23.4	42.4	8.1	1860	65
Oregon	39 59	95 09	1,100	41	3.3	4.7	4.7	4.3	4.3	3.1	24.4	36.8	12.7	1894	68
St. Louis	38 38	90 12	431	60	3.7	4.7	5.0	3.8	3.5	3.1	23.8	31.2	10.7	1871	58
INDIAN TERRITORY AND OKLAHOMA.															
Fort Gibson	35 50	95 20	510	29	4.1	4.5	3.9	2.7	2.8	2.7	20.7	34.7	9.7	1838	58
Fort Sill	34 40	98 23	1,190	24	2.7	4.4	3.7	2.9	3.2	2.8	19.7	31.3	8.0	1896	66
MICHIGAN.															
Alpena	45 05	83 30	609	24	2.2	3.5	3.7	2.9	3.5	3.8	19.6	30.3	12.6	1895	56
Detroit	42 20	83 03	580	46	2.6	3.1	3.8	3.6	2.6	3.0	18.7	31.0	10.9	1895	58
Grand Haven	43 05	86 18	593	25	2.6	3.4	3.8	2.8	2.7	3.6	18.9	30.5	10.6	1891	55
Grand Rapids	42 57	85 40	604	14	2.8	3.6	4.2	2.4	2.4	3.4	18.8	28.3	11.3	1895	55
Kalamazoo	42 20	85 38	770	20	2.6	4.4	4.5	3.2	2.6	3.2	20.5	28.6	15.0	1895	57
Lansing	42 44	84 32	836	33	2.4	3.4	4.0	3.1	2.7	2.9	18.5	32.8	12.9	1887	59
Port Huron	43 00	82 26	584	22	2.1	3.4	3.5	2.4	2.6	2.6	16.6	25.1	8.8	1889	53
MINNESOTA.															
Fort Ripley	46 10	94 24	1,169	27	1.8	3.2	4.3	4.0	3.3	3.1	19.7	28.3	8.6	1864	73
Fort Snelling	44 53	93 10	722	44	2.3	3.2	3.9	3.4	3.1	3.3	19.2	35.3	11.6	1852	74
Minneapolis	44 58	93 15	810	29	2.5	3.5	4.1	3.2	3.7	3.4	20.4	33.4	10.8	1894	69
St. Paul	44 58	93 03	703	39	2.5	3.5	4.1	3.3	3.8	3.2	20.4	28.1	12.2	1882	72
WISCONSIN.															
Beloit	42 30	89 11	741	30	2.9	3.2	4.0	3.5	3.6	3.4	20.6	35.2	10.9	1870	62
Embarrass	44 25	88 38	796	29	2.6	3.7	5.3	4.5	4.9	4.1	25.1	39.0	15.7	1867	62
La Crosse	43 49	91 15	657	24	2.4	3.3	4.5	4.0	3.2	4.2	21.6	32.1	11.8	1887	70
Madison	43 05	89 24	857	28	2.6	3.5	4.5	4.0	3.1	3.1	20.8	35.5	7.9	1895	63
Manitowoc	44 07	87 46	593	33	2.4	2.6	3.6	3.5	3.2	3.0	18.3	29.6	11.5	1891	59
Milwaukee	43 02	87 54	591	53	2.8	3.4	3.8	3.2	2.7	3.0	18.9	29.7	12.6	1847	61
NORTH DAKOTA.															
Bismarck	46 47	100 38	1,670	22	2.3	2.5	3.5	2.3	2.0	1.2	13.8	23.4	7.7	1889	75
Fort Buford [1]	48 01	103 58	1,855	29	1.2	2.4	2.8	1.7	1.2	0.8	10.1	17.8	4.4	1871	73
St. Vincent [2]	48 56	97 10	789	24	1.5	2.5	3.9	2.6	2.6	1.7	14.8	23.4	8.5	1889	76
Fort Totten	47 59	98 57	1,565	21	1.4	2.3	3.7	2.4	2.5	1.0	13.3	17.7	8.3	1883	75
SOUTH DAKOTA.															
Fort Meade	44 26	103 28	3,624	16	2.8	3.5	3.3	1.9	1.7	0.6	13.8	20.3	8.9	1893	74
Fort Randall	43 04	98 42	1,236	32	1.9	3.4	3.3	2.7	2.6	1.9	15.8	34.3	5.3	1863	75
Fort Sully	44 39	100 39	1,688	25	2.1	2.6	3.3	2.7	1.9	0.9	13.5	21.4	7.5	1884	78
Fort Wadsworth	45 43	97 40	2,000	18	2.0	3.0	3.7	3.4	2.7	1.3	16.1	25.1	7.8	1871	77
Yankton	42 56	98 23	1,206	20	3.3	4.0	4.1	3.5	3.0	2.6	20.5	32.3	11.3	1894	79
NEBRASKA.															
Desoto	41 28	96 03	1,100	24	2.6	4.5	4.6	4.3	3.3	3.3	22.6	39.5	13.0	1886	68
Genoa	41 26	97 43	1,585	21	2.9	4.1	4.5	3.9	2.5	2.8	20.7	30.1	11.1	1894	77
North Platte	41 08	100 45	2,809	29	2.1	3.0	3.5	2.5	2.3	1.5	14.9	21.7	8.0	1869	82
Omaha	41 16	95 56	1,040	27	3.1	4.5	5.3	4.6	3.3	3.0	23.8	39.9	11.1	1894	76
KANSAS.															
Dodge City	37 45	100 01	2,477	22	1.8	3.1	3.3	3.2	2.8	1.3	15.5	27.6	9.0	1893	78
Independence	37 13	95 41	798	25	3.7	4.6	4.9	4.2	3.0	3.7	24.1	36.4	16.9	1890	66
Lawrence	38 58	95 14	829	31	3.2	4.6	5.0	4.7	3.9	3.5	24.9	38.6	15.7	1886	69
Leavenworth	39 19	94 57	770	57	2.9	4.4	5.4	4.0	4.1	3.6	24.4	42.6	9.3	1864	70
Manhattan	39 12	96 37	1,014	35	2.6	4.1	4.5	4.7	3.6	3.0	22.5	36.4	10.2	1860	75
Fort Riley	39 02	96 45	1,074	40	2.0	3.4	3.9	3.7	3.7	2.8	19.5	31.0	9.7	1860	76
Topeka	39 03	95 39	886	18	2.9	4.8	5.2	4.7	4.0	3.1	24.7	36.7	14.8	1886	72
Wallace	38 54	101 35	3,303	18	1.6	2.8	2.3	3.4	1.7	1.3	13.1	31.8	6.4	1873	83

[1] Combined with Williston.

[2] Combined with Pembina.

Monthly and seasonal averages of rainfall, April to September—Continued.

Station.	Latitude.	Longitude.	Elevation.	Number of years.	April.	May.	June.	July.	August.	September.	Total.	Maximum.	Minimum.	Year of minimum rainfall.	Percentage of annual rainfall.
MONTANA.	° ′	° ′	*Feet.*		*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*		
Fort Assinniboine[1]	48 36	109 45	2,576	16	1.0	1.7	3.1	2.1	1.4	1.2	10.5	22.9	5.2	1883	74
Helena	43 33	112 04	3,932	15	1.1	1.6	2.3	1.1	0.6	1.2	7.9	13.0	3.8	1889	60
Fort Keogh	46 22	105 56	2,367	19	1.1	2.2	2.8	1.2	0.9	0.8	9.0	18.3	5.6	1894	71
WYOMING.															
Cheyenne	41 08	104 48	6,064	27	1.5	2.3	1.5	1.9	1.6	1.0	9.8	17.3	3.9	1876	77
Laramie	42 14	104 25	7,159	21	1.3	2.6	1.4	1.5	1.2	0.9	8.9	29.0	1.3	1863	72
Fort Bridger	41 28	110 30	6,753	17	0.9	1.0	0.5	0.5	0.9	0.5	4.3	7.2	1.8	1871	46
IDAHO.															
Boise City	43 37	116 00	2,768	27	1.3	1.6	0.8	0.2	0.2	0.4	4.5	9.1	2.0	1881	32
Fort Lapwai	46 18	116 54	2,000	12	1.3	1.8	1.5	0.4	0.6	0.8	6.4	10.6	2.4	1872	39
UTAH.															
Corinne	41 30	112 18	4,232	23	1.1	1.1	0.6	0.4	0.3	0.6	4.1	8.7	2.0	1877	35
Camp Douglas	40 46	111 50	5,024	23	2.0	2.4	0.7	0.8	0.7	0.7	7.3	14.4	3.2	1865	43
Ogden	41 12	111 57	4,307	23	1.5	1.5	0.6	0.2	0.4	0.7	4.9	9.9	0.5	1881	35
Promontory	41 35	112 35	4,905	27	0.8	0.8	0.5	0.2	0.4	0.7	3.4	9.0	0.3	1890	41
Salt Lake City	40 46	111 54	4,262	29	2.0	2.0	1.1	0.9	1.3	1.0	8.3	23.3	2.2	1890	44
Terrace	41 30	113 30	4,544	22	0.4	0.6	0.2	0.1	0.1	0.3	1.7	4.8	0.0	1882	40
NEW MEXICO.															
Santa Fe	35 42	106 01	6,939	37	0.7	0.9	1.1	2.7	2.7	1.6	9.7	18.4	4.6	1889	66
Fort Stanton	33 29	105 31	6,151	19	0.6	1.0	1.7	3.2	3.8	2.1	12.4	22.8	5.4	1892	69
Fort Wingate	35 28	108 32	7,038	30	0.9	0.5	0.6	2.4	2.3	1.3	8.0	14.2	1.7	1892	55
COLORADO.															
Colorado Springs	38 51	104 46	5,978	12	1.4	2.4	1.9	3.2	2.2	1.1	12.2	16.7	7.1	1888	84
Denver	39 45	105 00	5,182	27	2.0	2.7	1.3	1.7	1.4	0.9	10.0	14.7	5.6	1871	70
Fort Garland	37 25	105 23	7,921	20	1.1	1.0	1.2	2.4	2.0	1.1	8.8	33.6	1.4	1863	70
Fort Lyon	38 06	103 30	3,910	17	1.0	1.8	1.4	2.2	1.8	0.9	9.1	15.8	4.3	1871	77

[1] Combined with Havre.

AREAS EAST OF ROCKY MOUNTAINS ADAPTED TO AGRICULTURE WITHOUT IRRIGATION.

The averages for the crop-growing season and the amount of rain that fell in the season of least rainfall are graphically shown on Pls. XXXVII and XXXVIII, respectively. The particular significance of the figures and charts lies in the fact that they broadly outline the areas in the United States east of the Rocky Mountains that are adapted to agricultural operations without irrigation. The exact amount of rainfall required for the successful cultivation of crops has not been fixed nor can be in terms of rainfall alone. On the Pacific Coast and over comparatively small areas in the arid regions wheat and other cereals are grown with a seasonal rainfall considerably less than 15 inches; but it should be remembered that the climatic conditions, as regards temperature and humidity, are quite different from those which obtain in the wheat region of the Northwest. The character of the soil, especially as regards its ability to retain moisture,

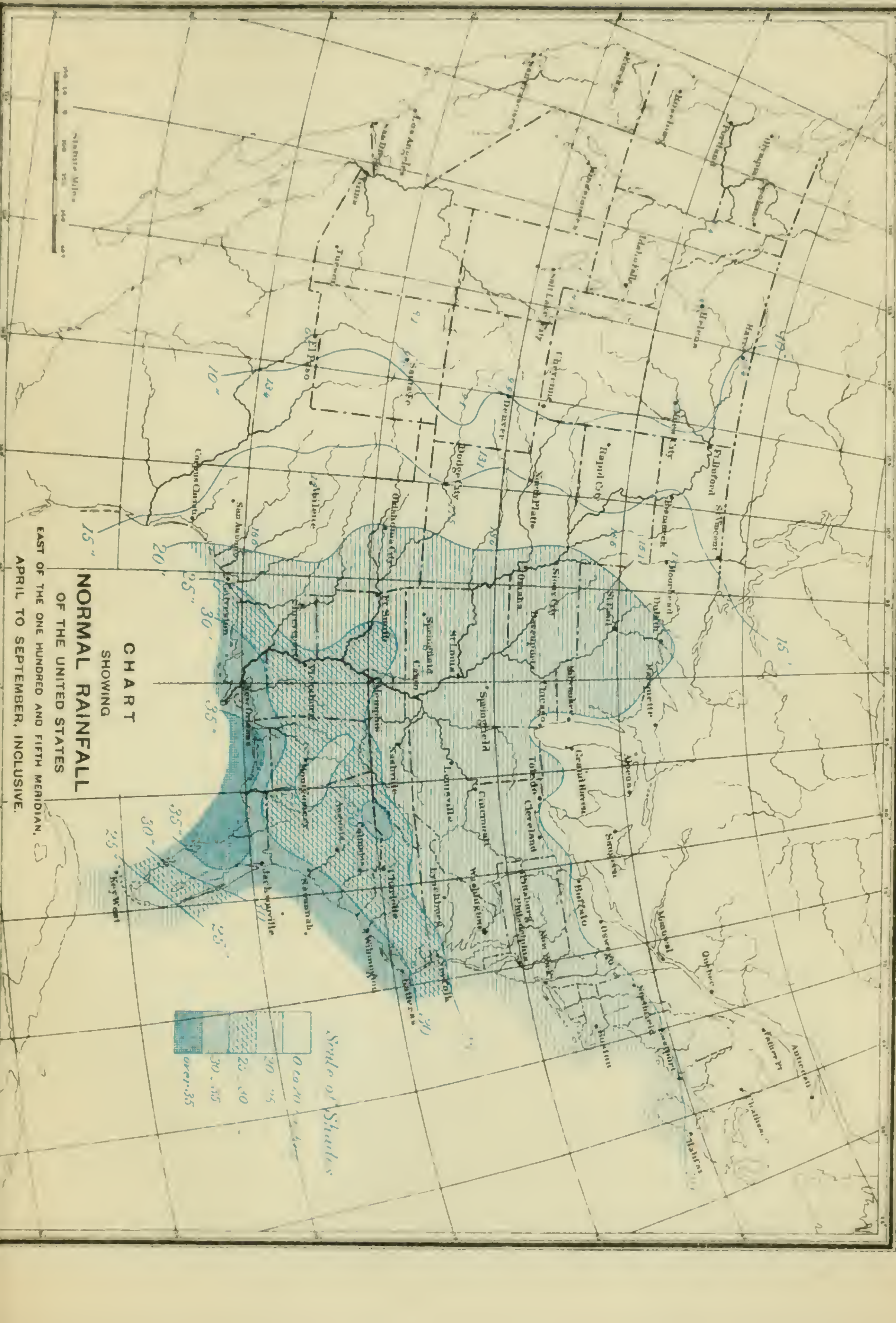
CHART
SHOWING
NORMAL RAINFALL
OF THE UNITED STATES
EAST OF THE ONE HUNDRED AND FIFTH MERIDIAN,
APRIL TO SEPTEMBER, INCLUSIVE.
Scale of Shades
0 to 20
20 - 25
25 - 30
30 - 35
over 35
Statute Miles

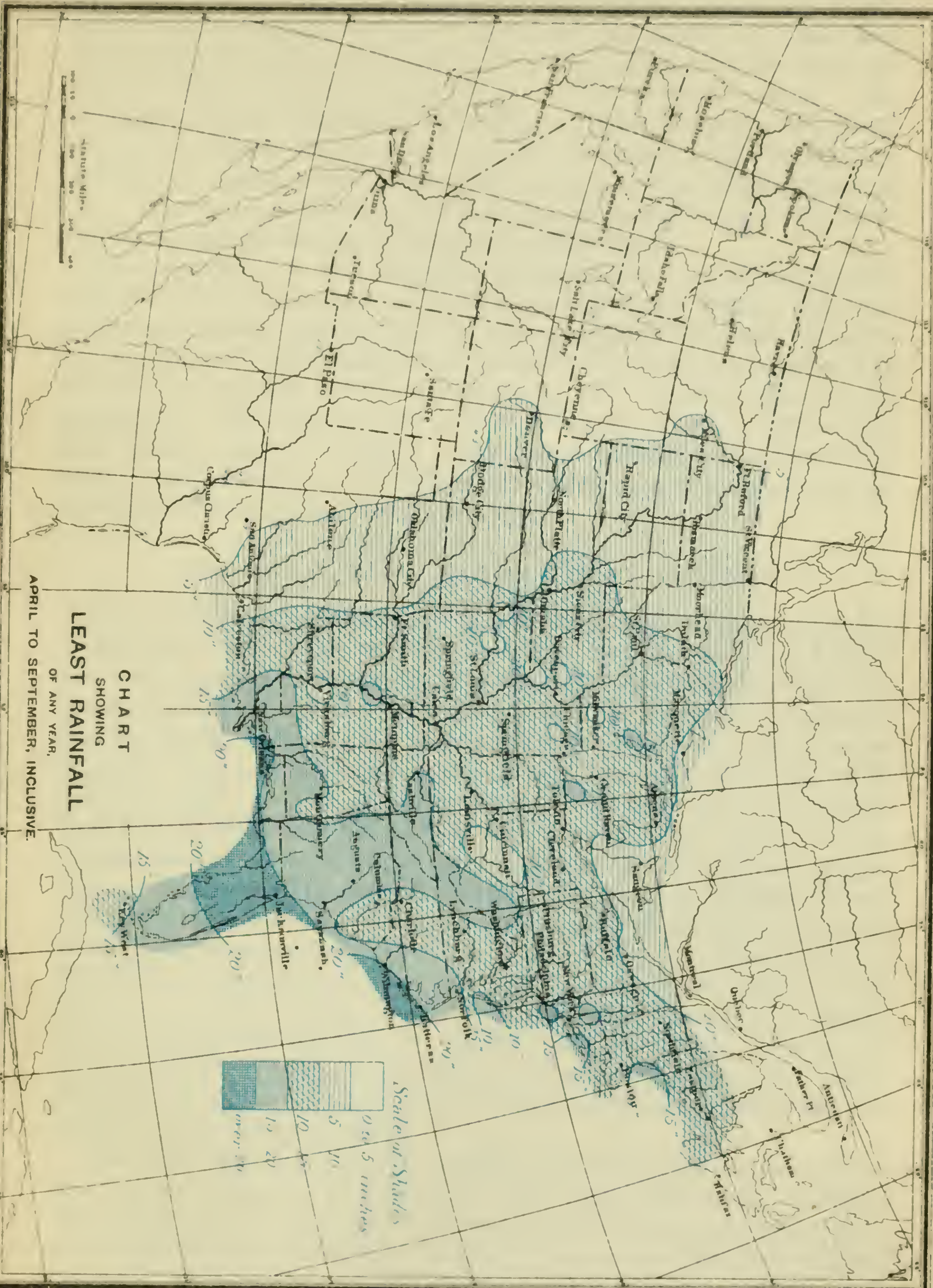
CHART
SHOWING
LEAST RAINFALL
OF ANY YEAR,
APRIL TO SEPTEMBER, INCLUSIVE.
Scale of Shades

is a very important consideration. It is said, in explanation of the fact that wheat is grown in eastern Washington, where the yearly fall of rain is generally under 18 inches, that the rainfall of winter and early spring is conserved in the soil and is supplied to the plant by capillary action during the early part of the growing season. The average rainfall of Spokane, in the wheat region of eastern Washington, during April, May, and June is but 4.5 inches, or about as much as falls in a single month in the wheat regions of the Mississippi Valley. It is obvious that the growth of the plant is not due to the rainfall of the spring and early summer months alone.

A comparison of the seasonal precipitation, as shown by Pl. XXXVII, with the returns of the Eleventh Census, confirms the view above expressed, namely, that the area adapted to the cultivation of cereals can be broadly defined by the line of 15 inches, or nearly that amount, of rain per season, although no hard and fast rule can be laid down. The valley of the Red River of the North, in Minnesota and North Dakota, is widely known as a famous wheat-producing region, yet the seasonal rainfall is but a trifle over 15 inches, whereas southern Minnesota has almost 20 inches.

SMALLEST SEASONAL RAINFALL TO BE EXPECTED.

The chart of least rainfall (Pl. XXXVIII) is intended to show the smallest amount of rain that has ever been recorded between April 1 and September 30. Since some of the rainfall records upon which this chart is based extend over half a century, it is reasonable to assume that the chart expresses the least seasonal rainfall that may ever be expected. The smallest amount that may be expected in the great corn and wheat regions of the central valleys does not vary greatly from 9 or 10 inches, as will be seen by reference to the chart. In the South Atlantic and Gulf States the fall in the year of least rain ranges from a maximum of 20 inches in central and northern Florida to less than 15 inches in the Mississippi Valley and a considerable fringe of country to the westward. It will be noticed that the amount of rain that falls in the year of severe drought in the greater part of the Southeastern States is sufficient for the growth and maturity of staple crops, if properly distributed. Success in agricultural pursuits, so far as conditioned upon the rainfall, should therefore be more easily achieved in the Southeastern States than elsewhere, particularly in regions of precarious rainfall.

There appears to be a fairly constant ratio between the least rainfall and the mean fall of any place; thus, points east of the Alleghenies having an average fall for the season of 20 inches generally have not less than 11 or 12 inches, or about 60 per cent, in the year of least rainfall. West of the Alleghenies the ratio is a little less, the fall of the driest year being about 55 per cent of the seasonal average.

The ratio of the rainfall of the crop season to the total of the year varies still more widely. (The total for the year is shown by Pl. XXXVI.) On the plains 70 per cent and upward of the yearly fall comes in the growing months of the year; elsewhere the ratio is less, being a little over 50 per cent east of the Mississippi River.

It must not be supposed that the chart of least rainfall in the crop season represents the actual rainfall of any single year. Fortunately severe drought has never prevailed over so great an area in the same year.

The years of minimum rainfall or drought from 1871 to 1896 fall in groups separated by irregular intervals. The first group centers about 1871; the second, 1881; the third, 1887, and the last, 1894–95. The drought of 1887 was severe in some months, but not consistently so throughout the entire season. The droughts of 1881 and 1894 were widespread and severe. The former was confined principally to States east of the Alleghenies, while the former was felt from Nebraska eastward to Massachusetts and southward to Alabama. Prior to 1870 the few records available indicate a severe drought in 1860 in Kansas and western Missouri, more severe than has since been experienced. Widespread drought in the central valleys and the Lake region also occurred in 1863. The periods of extensive drought in chronological order are, therefore, 1860, 1863, 1870–71, 1881, 1887, and 1894–95. There have been, of course, several local droughts in various portions of the United States during the intervening years, as there must always be in a territory of such vast extent.

Since observations on the rainfall of the United States were not generally made prior to 1870, it may well be asked, Is it not possible that years to come may yield less rain than any of which we have authentic record? In order, therefore, to determine how closely the least seasonal rainfall of the period 1871–1896 approaches the lowest ever recorded in that or previous periods, an examination was made of the group of forty-nine stations whose registers extend over earlier years as well as the epoch 1871–1896.

The table below shows the least rainfall of the two periods at sixteen stations where the rainfall has been measured for forty years or more:

Least rainfall at sixteen stations from April to September, inclusive.

Station.	Least rainfall during 1871–1896.	Least rainfall during previous years.	Remarks.
	Inches.	*Inches.*	
New Bedford, Mass	13.2 in 1891	11.6 in 1849	Continuous record from 1814.
Boston, Mass	13.9 in 1887	11.8 in 1836	Continuous record from 1818.
Providence, R. I	16.3 in 1894	11.3 in 1836	Continuous record from 1832.
Amherst, Mass	13.9 in 1887	11.8 in 1836	Continuous record from 1836.
New York City, N. Y	12.7 in 1881	12.5 in 1849	Do.

Least rainfall at sixteen stations from April to September, inclusive—Continued.

Station.	Least rainfall during 1871-1896.	Least rainfall during previous years.	Remarks.
	Inches.	*Inches.*	
Newark, N. J.	12.1 in 1881	16.4 in 1845	Continuous record from 1844.
Philadelphia, Pa.	10.3 in 1881	14.5 in 1825	Continuous record from 1825.
Washington, D. C.	14.3 in 1894	16.7 in 1869	Continuous record from 1856.
Savannah, Ga.	19.0 in 1881	20.8 in 1857	Continuous record from 1837.[1]
Portsmouth, Ohio	12.8 in 1878	9.7 in 1834	Continuous record from 1830.[2]
Cincinnati Ohio	12.6 in 1895	11.9 in 1870	Continuous record from 1835.
Louisville, Ky.	14.6 in 1881	15.4 in 1856	Continuous record from 1842.[3]
St. Louis, Mo.	10.7 in 1871	15.8 in 1870	Continuous record from 1837.
Miami, Mo	13.3 in 1871	8.1 in 1860	Continuous record from 1847.
Monticello, Iowa	10.2 in 1871	12.4 in 1863	Continuous record from 1855.
Fort Riley, Kans.	11.1 in 1875	9.7 in 1860	Continuous record from 1854.
Average	13.2	13.2	

[1] 1839, 1859-1868, inclusive, and 1870 missing. [2] 1856, 1857, and 1858 missing. [3] 1860 missing.

As will be seen by the above, the year of least rainfall occurred prior to 1871 in nine cases, and either with or subsequent to 1871 in the remaining seven cases. The two principles illustrated by these facts are that intense droughts are not general in extent of territory covered, and that for all practical purposes the least rainfall may be expected to occur within a twenty-five-year period.

VARIATION IN AMOUNT OF RAIN.

The question of secular variation or change in the amount of rain that falls from one year to another is not only intensely interesting in its physical aspects, but also of very great economic importance. Consequently it is not surprising that it should have been the subject of extended investigation at the hands of rainfall students in many parts of the world. The literature of the subject is very extensive, and much ingenuity has been displayed in the search for cycles or recurring periods of "fat" and "lean" rainfall. While it is true that suggestions of a faint periodicity have been found in some regions of the globe, yet it is still the general belief that the vicissitudes of rainfall, if not wholly fortuitous, are so intermingled with the variations of air pressure, temperature, etc., that no satisfactory solution of the problem will be reached until the greater problem of the general circulation of the atmosphere has been solved.

The local distribution of rainfall is exceedingly erratic. Thus, the catch of two gauges having practically the same exposure and but a few miles apart may differ as much as 10 or 15 inches in the total of the year, due solely to the occurrence of a few more thunderstorms at one station than the other. Individual registers, therefore, often afford doubtful and conflicting information respecting the yearly fall of one and the same region. But if we group the rainfall registers of an entire district, the combined result will generally show whether the fall of the year is abnormal or unusual, and to what extent.

Using for convenience the geographic districts of the Monthly Weather Review and tabulating the monthly abnormality—the difference between the amount of rain that actually fell and the normal amount—of each district, the following table has been formed:

Departures from the normal precipitation, by geographic districts (1887–1896).

District.	Number of station.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	Years. Above.	Years. Below.
		Ins.	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*		
New England	9	+2.4	+10.1	+ 5.2	+5.8	+0.3	−4.3	− 0.8	− 7.5	− 2.8	− 5	5	5
Middle Atlantic States	11	−1	+ 4.7	+12	+5.4	+4.5	−2.3	+ 2.9	− 2.5	− 7.6	− 7.2	5	5
South Atlantic States	11	−1.5	+ .2	+ 2	−5	−1.7	−7.4	+ 1.5	− 2	− 1.5	−10.7	3	7
East Gulf States	5	−6	+ 7.2	− 6.7	−5	− .2	−7	− 1.2	− 6.9	− 6.4	− 9	1	9
West Gulf States	8	−6.1	− 8.3	− 2.2	+2.1	−9	−3.8	− 9.3	− 4.6	− 3.6	−12.5	2	8
Ohio Valley and Tennessee	11	−4.2	+ 1.9	− 4.3	+9.2	+ .3	−1.9	− 2.6	− 8.9	−11.6	− 4.6	3	7
Lower Lake region	8	−3.9	− 4.8	− 2.4	+5.2	−3.6	+3.8	− .3	− 3.8	− 5.5	+ .1	3	7
Upper Lake region	10	−3.1	− 5	− 3.6	− .1	−2.4	− .8	+ .7	− 2.8	− 5.4	− 4.6	1	9
Extreme Northwest	4	−1	− 2.9	− 6.3	− .4	+3.9	−1	− .9	− .4	− 1.1	+ 2.9	2	8
Upper Mississippi Valley	13	−4.9	− .6	− 6.1	+ .1	−5.1	+4.7	− 3.4	− 8.7	− 9.2	+ .5	3	7
Missouri Valley	10	−2.2	− 2.3	− 4.1	−4.1	+ .9	+2	− 2.1	− 8	− .6	+ .2	3	7
Northern Slope	6	+1.1	0	− 2.4	−2.7	+4.5	+1.8	− 1.8	− 1.2	− 1	+ .9	4	5
Middle Slope	7	−4.2	− 4.5	− .3	−4.2	+6	+1.8	− 5.4	− 5.1	+ .6	− 1.8	3	7
Southern Slope	4	+1.3	+ 3.7	− 2.4	+1.8	− .8	+2.2	− 5.2	− 3.4	+ 4	+ 1	6	4
Southern Plateau	9	+ .9	+ .2	− 1.4	+1	−2.1	−4.7	− 1.7	− 2.7	+ .2	+ 1.1	5	5
Middle Plateau	5	−3.9	− 1.7	+ 1.9	− .4	+2	− .6	+ .4	+ .7	− 2.8	+ 2.4	5	5
Northern Plateau	4	−2.1	− 4.5	− 4.1	−4.1	− .8	0	+ 6.2	+ 3.2	− 3	+ 1.1	3	6
North Pacific Coast	8	−6.2	− 6.6	−10.6	−9	+8.4	−3	+13.3	+11.8	+ 5.8	+10.1	5	5
California	12	−5.6	− 1.8	+11.4	+1.9	−3.4	+4.4	+ 1	+ .6	− 1.1	+ 1	6	4
Above the mean	4	4	8	5	9	9	7	7	4	4	11	....	....
Below the mean	15	15	10	14	10	10	11	12	15	15	8	....	....

The first entry opposite New England in the table is +2.4, and the year at the head of the column is 1887. The figures +2.4 mean that the average rainfall at nine points in New England for the whole year was two and four-tenths inches (+2.4) *above* the normal. Farther along on the same line, the figures −4.3, −0.8, −7.5, −2.8, −5 appear under the years 1892, 1893, 1894, 1895, and 1896, respectively. These figures show that during the years named the average rainfall of New England was *below* the normal by the amounts given.

The table is worthy of careful examination, since it shows that the rainfall may be considerably above the normal in one district and as much or more below in another; yet there is no law apparent whereby a shortage in the rainfall of one district is balanced by an excess in another.

There is another very interesting fact to be gleaned from the table, namely, that there has been a shortage of rainfall generally in the United States during the last ten years. The South Atlantic and Gulf States, in particular, show a marked deficit throughout almost the entire period. This fact naturally suggests an inquiry into the rainfall of the preceding ten years.

AVERAGE PRECIPITATION AT PRINCIPAL WEATHER BUREAU STATIONS.

The following table shows the average precipitation at the principal Weather Bureau stations in the South Atlantic and Gulf States for twenty consecutive years in periods of ten years each:

Average annual precipitation in periods of ten consecutive years, 1877–1886 and 1887–1896.

Station.	1877–1886.	1887–1896.	Difference.
Lenoir, N. C	51.40	48.88	− 2.62
Hatteras, N. C	73.41	57.76	−15.65
Wilmington, N. C	58.83	47.30	−11.53
Charleston, S. C	56.82	52.37	− 4.45
Augusta, Ga	46.53	47.44	+ .91
Savannah, Ga	50.91	48.75	− 2.16
Jacksonville, Fla	57.69	49.12	− 8.57
Mobile, Ala	66.61	58.73	− 7.88
Montgomery, Ala	52.04	49.90	− 2.14
Vicksburg, Miss	62.04	46.69	−15.35
Memphis, Tenn	56.76	48.78	− 7.98
New Orleans, La	61.34	54.28	− 7.06
Shreveport, La	54.26	40.42	−13.84
Galveston, Tex	52 40	39.96	−12.44

The facts presented above may be viewed from either of two aspects: (1) The rainfall of the first period was abnormally high, and the apparent decrease noted in the second period is merely a return to normal conditions; or, (2) there has been a permanent decrease in the rainfall. The first proposition seems to be the more rational one. The heavy rainfall on the Texas coast, where there is a marked deficiency, is largely due to the advent of cyclonic storms from the Gulf, which often have a very slow movement and give torrential rainfall for several days in succession. Thus, 8.7 inches fell on September 16 and 17, 1877; 8.4 inches on October 24, 1877; 8.24 inches on September 3 and 4, 1885; 16.53 inches on September 15 to 20, 1885. In the last-named case, the rainfall at points less than 100 miles inland was not a fifth of the fall at Galveston on the coast.

The seaward margin of the South Atlantic States is in the region of West India hurricanes, and naturally receives a greater amount of rainfall in years when these storms are prevalent. While these facts may partly explain the marked variation in the rainfall of individual years, they by no means fully account for the phenomenon in all of its phases.

APPEARANCE OF FIRST AND LAST KILLING FROST.

The average date of first and last killing frost, respectively, east of the Rocky Mountains is shown by Pls. XXXIX and XL. It is not deemed advisable to attempt to draw lines of equal frost dates over the mountain and plateau region westward of the one hundred and third meridian, but the average dates for Weather Bureau stations in that region have been entered upon the charts.

Killing frosts generally appear first in northern Minnesota and Dakota, in the region of greatest cold in winter. The advance of the frost line southward is irregular, there being a considerable area in the central valleys, shown on the chart by the interval between October 15 and November 1, over which the average date falls in the latter part of October. Southward of Tennessee and Arkansas the average date of killing frost is deferred until November, although in some years killing frost may occur in the latter part of October. Killing frosts in Tennessee rarely occur as early as October 1.

Killing frost may occur in northern Minnesota and Dakota as early as August 25, and light frost at an earlier date. Light frost during the latter part of August is not an unusual occurrence over Michigan, Wisconsin, Minnesota, the Dakotas, and Montana.

The time that generally elapses between the date of killing frost on the average of all years ana the date of the earliest killing frost in any individual year varies greatly with locality. In some regions, as in Nebraska and Iowa, it is about thirty days. Farther north it is less, probably fifteen days; and it is also less in the South, probably twenty days.

The occurrence of frost is largely governed by local topographical features, and should be studied more from a local than a general standpoint. There are undoubtedly limited areas in all States where frost does not occur with the same frequency or severity as in other localities.

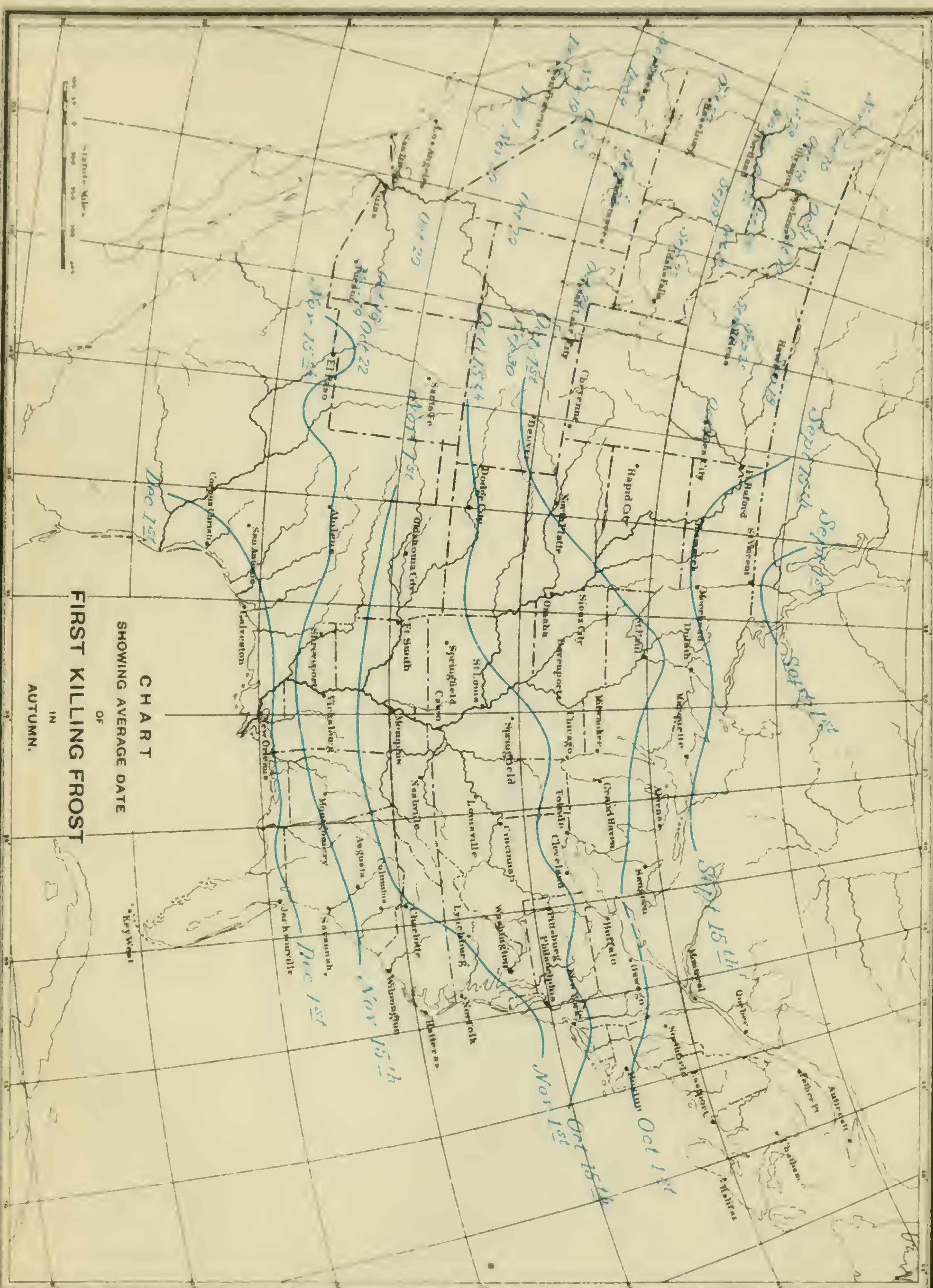
CHART
SHOWING AVERAGE DATE
OF
FIRST KILLING FROST
IN
AUTUMN.

CHART
SHOWING AVERAGE DATE
OF
LAST KILLING FROST
IN
SPRING.

APPENDIX.[1]

ORGANIZATION OF THE DEPARTMENT OF AGRICULTURE, DECEMBER 31, 1897.

SECRETARY OF AGRICULTURE, James Wilson.

The Secretary of Agriculture is charged with the supervision of all public business relating to the agricultural industry. He appoints all the officers and employees of the Department, with the exception of the Assistant Secretary and the Chief of the Weather Bureau, who are appointed by the President, and directs the management of all the divisions, offices, and bureaus embraced in the Department. He exercises advisory supervision over the agricultural experiment stations deriving support from the National Treasury, and has control of the quarantine stations for imported cattle and of interstate quarantine rendered necessary by contagious cattle diseases.

ASSISTANT SECRETARY OF AGRICULTURE, Joseph H. Brigham.

The Assistant Secretary performs such duties as may be required by law or prescribed by the Secretary.

CHIEF CLERK, Andrew Geddes.

The Chief Clerk has the general supervision of the clerks and employees; of the order of business, records, and correspondence of the Secretary's office; of all expenditures from appropriations for contingent expenses, stationery, etc.; of the enforcement of the general regulations of the Department; and of the buildings occupied by the Department of Agriculture.

BUREAUS, DIVISIONS, AND OFFICES.

WEATHER BUREAU (corner Twenty-fourth and M streets NW.).—*Chief*, Willis L. Moore; *assigned as Assistant Chief*, Lieut. Col. H. H. C. Dunwoody, U. S. A.; *Chief Clerk*, James R. Cook; *Professors of Meteorology*, Cleveland Abbe, F. H. Bigelow, Henry A. Hazen, Charles F. Marvin, Edward B. Garriott.

The Weather Bureau has charge of the forecasting of weather; the issue of storm warnings; the display of weather and flood signals for the benefit of agriculture, commerce, and navigation; the gauging and reporting of rivers; the maintenance and operation of seacoast telegraph lines, and the collection and transmission of marine intelligence for the benefit of commerce and navigation; the reporting of temperature and rainfall conditions for the cotton, rice, sugar, and other interests; the display of frost and cold-wave signals; the distribution of meteorological information in the interests of agriculture and commerce, and the taking of such meteorological observations as may be necessary to establish and record the climatic conditions of the United States, or as are essential for the proper execution of the foregoing duties.

BUREAU OF ANIMAL INDUSTRY.—*Chief*, D. E. Salmon; *Assistant Chief*, G. M. Brumbaugh; *Chief Clerk*, S. R. Burch; *Chief of Inspection Division*, A. D. Melvin; *Chief of Miscellaneous Division*, A. M. Farrington; *Chief of Pathological Division*, Victor A. Nörgaard; *Chief of Biochemic Division*, E. A. de Schweinitz; *Chief of Dairy Division*, Henry E. Alvord; *Zoologist*, Ch. Wardell Stiles; *In charge of Experiment Station*, E. C. Schroeder.

The Bureau of Animal Industry makes investigations as to the existence of contagious pleuro-pneumonia and other dangerous communicable diseases of live stock, superintends the measures for their extirpation, makes original investigations as to the nature and prevention of such diseases, and reports on the condition

[1] For subject-matter of Appendix, see under Contents, page 5.

and means of improving the animal industries of the country. It also has charge of the inspection of import and export animals, of the inspection of vessels for the transportation of export cattle, and of the quarantine stations for imported neat cattle; supervises the interstate movement of cattle, and inspects live stock and their products slaughtered for food consumption.

Division of Statistics.—*Statistician*, John Hyde; *Assistant Statistician*, George K. Holmes.

The Division of Statistics collects information as to the condition, prospects, and harvests of the principal crops, and of the numbers and status of farm animals, through a corps of county correspondents and the aid of a supplementary organization under the direction of State agents, and obtains similar information from European countries monthly through the deputy consul-general at London, assisted by consular, agricultural, and commercial authorities. It records, tabulates, and coordinates statistics of agricultural productions, distribution, and consumption, the authorized data of Governments, institutes, societies, boards of trade, and individual experts, and issues a monthly crop report and occasional bulletins for the information of producers and consumers, and for their protection against combination and extortion in the handling of the products of agriculture.

Section of Foreign Markets.—*Chief*, Frank H. Hitchcock.

The Section of Foreign Markets makes investigations and disseminates information "concerning the feasibility of extending the demands of foreign markets for the agricultural products of the United States."

Office of Experiment Stations.—*Director*, A. C. True; *Assistant Director*, E. W. Allen.

The Office of Experiment Stations represents the Department in its relations to the experiment stations which are now in operation in all the States and Territories. It seeks to promote the interests of agricultural education and investigation throughout the United States. It collects and disseminates general information regarding the colleges and stations, and publishes accounts of agricultural investigations at home and abroad. It also indicates lines of inquiry of the stations, aids in the conduct of cooperative experiments, reports upon their expenditures and work, and in general furnishes them with such advice and assistance as will best promote the purposes for which they were established. It is also charged with investigations on the nutritive value and economy of human foods.

Division of Chemistry.—*Chemist*, Harvey W. Wiley; *First Assistant Chemist*, Ervin E. Ewell.

The Division of Chemistry makes investigations of the methods proposed for the analyses of soils, fertilizers, and agricultural products, and such analyses as pertain in general to the interests of agriculture. It can not undertake the analyses of samples of the above articles of a miscellaneous nature, but application for such analyses should be made to the directors of the agricultural experiment stations of the different States. The division does not make assays of ores nor analyses of minerals except when related to general agricultural interests, nor analyses of water.

Division of Entomology.—*Entomologist*, L. O. Howard; *First Assistant Entomologist*, C. L. Marlatt.

The Division of Entomology obtains and disseminates information regarding insects injurious to vegetation; investigates insects sent to the division in order to give appropriate remedies; conducts investigations of this character in different parts of the country; and mounts and arranges specimens for illustrative and museum purposes.

Division of Biological Survey.—*Chief*, C. Hart Merriam; *Assistant Chief*, T. S. Palmer.

The Division of Biological Survey studies the geographic distribution of animals and plants, and maps the natural life zones of the country; it also investigates the economic relations of birds and mammals, and recommends measures for the preservation of beneficial and the destruction of injurious species.

Division of Forestry.—*Chief*, B. E. Fernow; *Assistant Chief*, Charles A. Keffer.

The Division of Forestry is occupied with experiments, investigations, and reports dealing with the subject of forestry, and with the dissemination of information upon forestry matters.

Division of Botany.—*Botanist*, Frederick V. Coville; *First Assistant Botanist*, G. H. Hicks.

The Division of Botany investigates botanical agricultural problems, including the purity and value of agricultural seeds; methods of controlling the spread of weeds or preventing their introduction into this country; the dangers, effects, and antidotes for poisonous plants; the native plant resources of the country, and other subjects of economic botany.

Division of Vegetable Physiology and Pathology.—*Chief*, B. T. Galloway; *First Assistant Chief*, Albert F. Woods.

The Division of Vegetable Physiology and Pathology has for its object a study of the normal and abnormal life processes of plants. It seeks by investigations in the field and experiments in the laboratory to determine the causes of disease and the best means of preventing the same. It studies plant physiology in its bearing on pathology.

Division of Agrostology.—*Agrostologist*, F. Lamson-Scribner; *First Assistant Chief*, Jared G. Smith.

The Division of Agrostology is charged with the investigation of the natural history, geographical distribution, and uses of grasses and forage plants, their adaptation to special soils and climates, the introduction of promising native and foreign kinds into cultivation, and the preparation of publications and correspondence relative to these plants.

Division of Pomology.—*Pomologist*, Gustavus B. Brackett; *Assistant Pomologist*, W. A. Taylor.

The Division of Pomology collects and distributes information in regard to the fruit interests of the United States; investigates the habits and peculiar qualities of fruits, their adaptability to various soils and climates, and conditions of culture, and introduces new and untried fruits from foreign countries.

Division of Agricultural Soils.—*Chief*, Milton Whitney; *Assistant Chief*, Lyman J. Briggs.

The Division of Agricultural Soils has for its object the investigation of the texture and other physical properties of soils and their relation to crop production.

Office of Fiber Investigations.—*Special Agent in Charge*, Chas. Richards Dodge.

The Office of Fiber Investigations collects and disseminates information regarding the cultivation of textile plants, directs experiments in the culture of new and hitherto unused plants, and investigates the merits of new machines and processes for preparing them for manufacture.

Office of Public Road Inquiries.—*Director*, Roy Stone.

The Office of Public Road Inquiries collects information concerning the systems of road management throughout the United States, conducts investigations regarding the best method of road making, and prepares publications on this subject.

Division of Gardens and Grounds.—*Horticulturist and Superintendent of Gardens and Grounds*, William Saunders.

The Division of Gardens and Grounds is charged with the care and ornamentation of the park surrounding the Department buildings, and with the duties connected with the conservatories and gardens for testing and propagating economic plants.

Division of Publications.—*Chief*, Geo. Wm. Hill; *Assistant Chief*, Joseph A. Arnold; *Assistant in charge of Document and Folding Room*, Geo. F. Thompson.

The Division of Publications exercises general supervision of the Department printing and illustrations, and has charge of the distribution of all Department publications with the exception of those turned over by law to the Superintendent of Documents for sale at the price affixed by him; it issues, in the form of press notices, official information of interest to agriculturists, and distributes to agricultural publications and writers synopses of Department publications.

Division of Accounts and Disbursements.—*Chief*, Frank L. Evans; *Assistant Disbursing Officer* (in charge of Weather Bureau disbursements), A. Zappone; *Cashier*, Everett D. Yerby.

The Division of Accounts and Disbursements is charged with the adjustment of all claims against the Department; decides questions involving the expenditure of public funds; prepares contracts for annual supplies, leases, and agreements; issues requisitions for the purchase of supplies, requests for passenger and freight transportations; and attends to all business relating to the financial interests of the Department, including payments of every description.

DIVISION OF SEEDS.—*Chief*, Robert J. Whittleton.

The Division of Seeds is charged with the purchase and distribution of valuable seeds, bulbs, trees, shrubs, vines, cuttings, and plants, a certain portion of which are collected and purchased from foreign countries for experiments with reference to their introduction into this country. They are distributed in allotments to Senators, Representatives, Delegates in Congress, agricultural experiment stations, and the Secretary of Agriculture, as provided by law.

APPROPRIATIONS FOR THE DEPARTMENT OF AGRICULTURE FOR THE FISCAL YEARS ENDING JUNE 30, 1897 AND 1898.

	1897.	1898.
Salaries, Department of Agriculture	$313,860	$319,300
Furniture, cases, and repairs, Department of Agriculture	12,000	9,000
Library, Department of Agriculture	7,000	7,000
Museum, Department of Agriculture	3,000	3,000
Postage, Department of Agriculture	3,000	3,000
Contingent expenses, Department of Agriculture	25,000	25,000
Animal quarantine stations	12,000	12,000
Collecting agricultural statistics	110,000	110,000
Botanical investigations and experiments	15,000	15,000
Entomological investigations	20,000	20,000
Vegetable pathological investigations	20,000	20,000
Biological investigations	17,500	17,500
Pomological investigations	6,000	8,000
Laboratory, Department of Agriculture	12,400	12,400
Forestry investigations	20,000	20,000
Experimental gardens and grounds, Department of Agriculture	20,000	25,000
Soil investigations	10,000	10,000
Grass and forage plant investigations	10,000	10,000
Fiber investigations	5,000	5,000
Agricultural experiment stations [$750,000][1]	30,000	35,000
Nutrition investigations	15,000	15,000
Public road inquiries	8,000	8,000
Publications, Department of Agriculture	70,000	65,000
Sugar investigations	-----------	5,000
Purchase and distribution of valuable seeds	150,000	130,000
Salaries and expenses, Bureau of Animal Industry	650,000	675,000
Total	1,564,760	1,584,200
Weather Bureau.		
Salaries, Weather Bureau	150,540	150,540
Fuel, lights, and repairs, Weather Bureau	8,000	8,000
Contingent expenses, Weather Bureau	8,000	8,000
General expenses, Weather Bureau	717,232	717,162
Total for Weather Bureau	883,772	883,702
Grand total	2,448,532	2,467,902

[1] Of this amount $720,000 is paid directly to the experiment stations by the United States Treasury.

AGRICULTURAL COLLEGES AND OTHER INSTITUTIONS IN THE UNITED STATES HAVING COURSES IN AGRICULTURE.

State or Territory.	Name of institution.	Location.	President.
Alabama	State Agricultural and Mechanical College.	Auburn	W. L. Broun.
	State Normal and Industrial School.	Normal	W. H. Councill.
Arizona	University of Arizona	Tucson	M. M. Parker.
Arkansas	Arkansas Industrial University	Fayetteville	J. L. Buchanan.
California	University of California	Berkeley	M. Kellogg.
Colorado	State Agricultural College of Colorado.	Fort Collins	A. Ellis.
Connecticut	Storrs Agricultural College	Storrs	B. F. Koons.
Delaware	Delaware College	Newark	G. A. Harter.
	State College for Colored Students	Dover	W. C. Jason.
Florida	Florida Agricultural College	Lake City	W. F. Yocum.
	Florida State Normal and Industrial College.	Tallahassee	T. De S. Tucker.

AGRICULTURAL COLLEGES AND OTHER INSTITUTIONS IN THE UNITED STATES HAVING COURSES IN AGRICULTURE—Cont'd.

State or Territory.	Name of institution	Location.	President.
Georgia	Georgia State College of Agriculture and Mechanic Arts.	Athens	H. C. White.
	Georgia State Industrial College	College	R. R. Wright.
Idaho	University of Idaho	Moscow	F. B. Gault.
Illinois	University of Illinois	Urbana	A. S. Draper.
Indiana	Purdue University	Lafayette	J. H. Smart.
Iowa	Iowa State College of Agriculture and Mechanic Arts.	Ames	W. M. Beardshear.
Kansas	Kansas State Agricultural College	Manhattan	T. E. Will.
Kentucky	Agricultural and Mechanical College of Kentucky.	Lexington	J. K. Patterson.
	State Normal School for Colored Persons.	Frankfort	J. H. Jackson.
Louisiana	Louisiana State University and Agricultural and Mechanical College.	Baton Rouge	T. D. Boyd.
	Southern University and Agricultural and Mechanical College.	New Orleans	H. A. Hill.
Maine	The University of Maine	Orono	A. W. Harris.
Maryland	Maryland Agricultural College	College Park	R. W. Silvester.
Massachusetts	Massachusetts Agricultural College	Amherst	H. H. Goodell.
Michigan	Michigan Agricultural College	Agricultural College.	J. D. Snyder.
Minnesota	The University of Minnesota	Minneapolis	C. Northrop.
Mississippi	Mississippi Agricultural and Mechanical College.	Agricultural College.	S. D. Lee.
	Alcorn Agricultural and Mechanical College.	Westside	E. H. Triplett.
Missouri	School of Agriculture and Engineering of the University of Missouri.	Columbia	R. H. Jesse.
	Lincoln Institute	Jefferson City	I. E. Page.
Montana	The Montana College of Agriculture and Mechanic Arts.	Bozeman	James Reid.
Nebraska	Industrial College of the University of Nebraska.	Lincoln	G. E. MacLean.
Nevada	Nevada State University	Reno	J. E. Stubbs.
New Hampshire	The New Hampshire College of Agriculture and the Mechanic Arts.	Durham	C. S. Murkland.
New Jersey	Rutgers Scientific School. (The New Jersey State College for the Benefit of Agriculture and the Mechanic Arts.)	New Brunswick	Austin Scott.
New Mexico	New Mexico College of Agriculture and Mechanic Arts.	Mesilla Park	C. T. Jordan.
New York	Cornell University	Ithaca	J. G. Schurman.
North Carolina	The North Carolina College of Agriculture and Mechanic Arts.	West Raleigh	A. Q. Holladay.
	The Agricultural and Mechanical College for the Colored Race.	Greensboro	J. B. Dudley.
North Dakota	North Dakota Agricultural College	Agricultural College.	J. H. Worst.
Ohio	Ohio State University	Columbus	J. H. Canfield.
Oklahoma	Oklahoma Agricultural and Mechanical College.	Stillwater	G. E. Morrow.
Oregon	Oregon State Agricultural College	Corvallis	T. M. Gatch.
Pennsylvania	The Pennsylvania State College	State College	G. W. Atherton.
Rhode Island	Rhode Island College of Agriculture and Mechanic Arts.	Kingston	J. H. Washburn
South Carolina	Clemson Agricultural College	Clemson College	H. S. Hartzog.
	Colored Normal Industrial, Agricultural, and Mechanical College of South Carolina.	Orangeburg	T. E. Miller.
South Dakota	South Dakota Agricultural College	Brookings	J. W. Heston.
Tennessee	University of Tennessee	Knoxville	C. W. Dabney.
Texas	State Agricultural and Mechanical College of Texas.	College Station	R. H. Whitlock.
	Prairie View State Normal School	Prairieview	L. C. Anderson.
Utah	The Agricultural College of Utah	Logan	J. M. Tanner.
Vermont	University of Vermont and State Agricultural College.	Burlington	M. H. Buckham.
Virginia	Virginia Polytechnic Institute (State Agricultural and Mechanical College).	Blacksburg	J. M. McBryde.
	The Hampton Normal and Agricultural Institute.	Hampton	H. B. Frissell.
Washington	Washington Agricultural College and School of Science.	Pullman	E. A. Bryan.
West Virginia	West Virginia University	Morgantown	J. H. Raymond.
	The West Virginia Colored Institute	Farm	J. H. Hill.
Wisconsin	University of Wisconsin	Madison	C. K. Adams.
Wyoming	University of Wyoming	Laramie	F. P. Graves.

AGRICULTURAL EXPERIMENT STATIONS OF THE UNITED STATES, THEIR LOCATIONS, DIRECTORS, AND PRINCIPAL LINES OF WORK.[1]

Stations, locations, and directors.	Number in staff.	Number of teachers on staff.	Principal lines of work.
Alabama (College), Auburn: W. L. Broun	11	8	Botany; analysis of fertilizers and food materials; soil improvement; field experiments; horticulture; diseases of plants and animals.
Alabama (Canebrake), Uniontown: H. Benton	3	....	Field experiments; diseases of animals.
Arizona, Tucson: J. W. Toumey	9	4	Meteorology; field experiments; canaigre investigation; diseases of plants; entomology.
Arkansas, Fayetteville: R. L. Bennett	8	4	Chemistry of foods; field experiments; horticulture; diseases of plants; feeding animals; diseases of animals.
California, Berkeley: E. W. Hilgard	26	9	Physics; botany; meteorology; chemistry and geographical distribution of soils; field crops; horticulture; technology of wine and olive oil and zymology; chemistry of foods and feeding stuffs; entomology; drainage and irrigation; reclamation of alkali lands.
Colorado, Fort Collins: Alston Ellis	18	6	Chemistry; botany; meteorology; field experiments; horticulture; entomology; irrigation.
Connecticut (State), New Haven: S. W. Johnson	14	....	Chemistry; analysis and inspection of fertilizers and foods; field and pot experiments; horticulture; seed tests; diseases of plants; chemistry of feeding stuffs and dairy products.
Connecticut (Storrs), Storrs: W. O. Atwater	6	1	Food and nutrition of man and animals; bacteriology of dairy products; field experiments; dairying.
Delaware, Newark: A. T. Neale	6	4	Chemistry; field experiments; horticulture; diseases of plants; feeding experiments; diseases of animals; entomology; dairying.
Florida, Lake City: W. F. Yocum	8	4	Chemistry; field experiments; horticulture; entomology.
Georgia, Experiment: R. J. Redding	6	1	Field experiments; horticulture; pig feeding; dairying.
Idaho, Moscow: F. B. Gault	7	6	Physics; chemistry; botany; field experiments; entomology.
Illinois, Urbana: E. Davenport	10	7	Chemistry; bacteriology; field experiments; horticulture; forestry; diseases of plants; feeding experiments; entomology; dairying.
Indiana, Lafayette: C. S. Plumb	10	6	Chemistry; pot and field experiments; horticulture; feeding experiments; diseases of animals.
Iowa, Ames: C. F. Curtiss	16	15	Chemistry; field experiments; horticulture; diseases of plants; feeding experiments; entomology; dairying.
Kansas, Manhattan: Thos. E. Will	12	7	Soils; horticulture; seed breeding; diseases of plants; feeding experiments; diseases of animals; entomology.
Kentucky, Lexington: M. A. Scovell	9	3	Chemistry; soils; fertilizer analysis; field experiments; horticulture; diseases of plants; entomology; dairying.
Louisiana (Sugar), New Orleans: Wm. C. Stubbs	8	....	Chemistry; bacteriology; soils and soil physics; field experiments; horticulture; sugar making; drainage; irrigation.
Louisiana (State), Baton Rouge: Wm. C. Stubbs	9	8	Chemistry; botany; geology; bacteriology; soils; field experiments; horticulture; feeding experiments; entomology.

[1] The stations published during the fiscal year 1896–97 a total of 408 books and bulletins, with a total of 15,785 pages. These were distributed to over half a million addresses.

AGRICULTURAL EXPERIMENT STATIONS OF THE UNITED STATES, THEIR LOCATIONS, DIRECTORS, AND PRINCIPAL LINES OF WORK[1]—Continued.

Stations, locations, and directors.	Number in staff.	Number of teachers on staff.	Principal lines of work.
Louisiana (North) Calhoun: Wm. C. Stubbs	5	......	Chemistry; soils; fertilizers; field experiments; horticulture; stock raising; dairying.
Maine, Orono: C. D. Woods	12	6	Chemistry; botany; analysis and inspection of fertilizers and concentrated commercial feeding stuffs; horticulture; diseases of plants; food and nutrition of man and animals; diseases of animals; entomology; dairying.
Maryland, College Park: R. H. Miller	11	2	Chemistry; soils; field experiments; horticulture; feeding experiments; entomology.
Massachusetts, Amherst: H. H. Goodell	21	....	Chemistry; meteorology; analysis and inspection of fertilizers and concentrated commercial feeding stuffs; field experiments; horticulture; diseases of plants; digestion and feeding experiments; diseases of animals; entomology.
Michigan, Agricultural College: C. D. Smith	17	7	Botany and bacteriology; field experiments; horticulture; forestry; diseases of plants; feeding experiments; diseases of animals; entomology; dairying.
Minnesota, St. Anthony Park: W. M. Liggett	13	9	Chemistry; field experiments; horticulture; plant diseases; plant and animal breeding; feeding experiments; diseases of animals; entomology; dairying.
Mississippi, Agricultural College: W. L. Hutchinson	13	4	Chemistry; botany; soils; field experiments; horticulture; feeding experiments; entomology; dairying; irrigation.
Missouri, Columbia: H. J. Waters	11	6	Chemistry; field experiments; horticulture; diseases of plants; feeding experiments; diseases of animals; entomology; drainage.
Montana, Bozeman: S. M. Emery	7	4	Field experiments; diseases of plants; feeding experiments; diseases of animals; irrigation.
Nebraska, Lincoln: G. E. MacLean	17	8	Chemistry; botany; meteorology; field experiments; horticulture; forestry; feeding and breeding experiments; diseases of animals; entomology; irrigation.
Nevada, Reno: J. E. Stubbs	7	4	Chemistry; botany; soils; field experiments; horticulture; irrigation.
New Hampshire, Durham: C. S. Murkland	12	5	Chemistry; field experiments; feeding experiments; diseases of animals; dairying.
New Jersey (State), New Brunswick: E. B. Voorhees	10	1	Chemistry; analysis and control of fertilizers; field experiments; horticulture; food and nutrition of man; dairy husbandry; irrigation.
New Jersey (College), New Brunswick: E. B. Voorhees	9	4	Botany; diseases of plants; diseases of animals; entomology.
New Mexico, Mesilla Park: C. T. Jordan	10	5	Chemistry; botany; field experiments; horticulture; diseases of plants; entomology.
New York (State), Geneva: W. H. Jordan	19	....	Chemistry; meteorology; analysis and control of fertilizers; field experiments; horticulture; diseases of plants; feeding experiments; poultry experiments; dairying.
New York (Cornell), Ithaca: I. P. Roberts	17	7	Chemistry of soils and feeding stuffs; soils; fertilizer investigations; field experiments; horticulture; diseases of plants; diseases of animals; poultry experiments; entomology; dairying.

[1] The stations published during the fiscal year 1895-97 a total of 408 books and bulletins, with a total of 15,785 pages. These were distributed to over half a million addresses.

AGRICULTURAL EXPERIMENT STATIONS OF THE UNITED STATES, THEIR LOCATIONS, DIRECTORS, AND PRINCIPAL LINES OF WORK[1]—Continued.

Stations, locations, and directors.	Number in staff.	Number of teachers on staff.	Principal lines of work.
North Carolina, Raleigh: W. A. Withers	19	7	Chemistry; analysis and control of fertilizers; field experiments; horticulture; composition of feeding stuffs; digestion experiments; poultry experiments.
North Dakota, Agricultural College: J. H. Worst	12	6	Field experiments; horticulture; diseases of plants; feeding experiments; diseases of animals; dairying.
Ohio, Wooster: C. E. Thorne	15	....	Soils; field experiments; horticulture; diseases of plants; breeding and feeding experiments; entomology.
Oklahoma, Stillwater: G. E. Morrow	8	7	Botany; soils; field experiments; horticulture; stock feeding; entomology; irrigation.
Oregon, Corvallis: T. M. Gatch	9	9	Chemistry; soils; field crops; horticulture; diseases of plants; digestion and feeding experiments; entomology; dairying.
Pennsylvania, State College: H. P. Armsby	16	9	Chemistry; meteorology; fertilizer analysis; field experiments; feeding experiments; dairying.
Rhode Island, Kingston: J. H. Washburn	10	3	Chemistry; meteorology; soils; field and pot experiments; horticulture; diseases of plants; poultry experiments; oyster culture.
South Carolina, Clemson College: H. S. Hartzog	16	10	Soils; analysis and control of fertilizers; field experiments; horticulture; dairying.
South Dakota, Brookings: J. H. Shepard	9	5	Bacteriology; chemistry of soils and soil physics; field experiments; forestry; diseases of plants; entomology.
Tennessee, Knoxville: C. F. Vanderford	10	3	Chemistry; botany; field experiments; horticulture; entomology.
Texas, College Station: J. H. Connell	14	8	Chemistry; botany; field experiments; horticulture; diseases of plants; feeding experiments; diseases of animals; entomology.
Utah, Logan: L. Foster	11	9	Chemistry; bacteriology; meteorology; soils; field experiments; horticulture; forestry; feeding experiments; poultry; dairying; irrigation.
Vermont, Burlington: J. L. Hills	13	5	Chemistry; analysis and control of fertilizers; field experiments; horticulture; diseases of plants; feeding experiments; dairying.
Virginia, Blacksburg: J. M. McBryde	10	8	Chemistry; fertilizers; diseases of plants; diseases of animals; feeding experiments; entomology.
Washington, Pullman: E. A. Bryan	8	8	Chemistry; soils; bacteriology; field experiments; horticulture; diseases of plants; feeding experiments; entomology.
West Virginia, Morgantown: J. H. Stewart	12	6	Chemistry; analysis and control of fertilizers; field experiments; horticulture; feeding experiments; poultry experiments; entomology.
Wisconsin, Madison: W. A. Henry	19	9	Chemistry; soils; field experiments; horticulture; feeding experiments; diseases of animals; dairying; drainage and irrigation.
Wyoming, Laramie: F. P. Graves	10	6	Geology; botany; meteorology; waters; soils; fertilizers; field experiments; food analysis; feeding experiments; entomology.
Total	628	283	

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NOTES REGARDING DEPARTMENT PUBLICATIONS.

The publications of the U. S. Department of Agriculture are of three classes: (1) Serial publications, (2) scientific and technical reports, and (3) popular bulletins. The first two classes are issued in limited editions and are distributed free only to persons cooperating with or rendering the Department some service. Sample copies will be sent if requested, but generally applicants must apply to the Superintendent of Documents, Union Building, Washington, D. C., to whom all publications not needed for official use, except circulars and bulletins printed by law for free distribution, are turned over. They are disposed of by him at cost of printing.

The popular circulars and bulletins treat in a practical way of subjects of particular interest to farmers, are issued in large editions, and are for free distribution. The Farmers' Bulletins are of this class. Some of them are out of print. A list of such as are available for distribution at any time will be forwarded upon request.

There is no list of persons to whom all publications are sent. The Monthly List of Publications, issued the first of each month, will be mailed regularly to all who apply for it. In it are given the titles of all publications issued during the previous month, with a note explanatory of the character of each, thus enabling the reader to make intelligent application for such bulletins and reports as are certain to be of interest to him.

For the maps and bulletins of the Weather Bureau, requests and remittances should be directed to the Chief of that Bureau. Also the index (card form) of experiment-station literature is sold direct to applicants by the Office of Experiment Stations. For all other publications to which a price is affixed, application must be made to the Superintendent of Documents, Union Building, Washington, D. C., accompanied by the price thereof, and all remittances should be made to him and not to the Department of Agriculture. Such remittances should be made by postal money order and not by private check or postage stamps. The Superintendent of Documents is not permitted to sell more than one copy of any public document to the same person. The Public Printer may sell to one person any number not to exceed 250 copies, if ordered before the publication goes to press.

PUBLICATIONS ISSUED JANUARY 1, 1897, TO DECEMBER 31, 1897.

The following publications were issued by the United States Department of Agriculture during the period January 1, 1897, to December 31, 1897.

Those to which a price is attached, with the exception of publications of the Weather Bureau, must be obtained of the Superintendent of Documents, Union Building, Washington, D. C., to whom were turned over all copies not needed for official use, in compliance with section 67 of the act providing for the public printing and binding and the distribution of public documents. Remittances should be made to him by postal money order. Applications for those that are for free distribution should be made to the Secretary of Agriculture, Washington, D. C.:

OFFICE OF THE SECRETARY.

	Copies.
Farm Drainage. Farm. Bul. 40. (Two reprints)	30,000
Washed Soils: How to Prevent and Reclaim Them. Farm. Bul. 20. (Two reprints)	40,000
Report of the Secretary of Agriculture, 1896. (Two reprints)	36,000
Civil Service in the Department of Agriculture. Cir. 5	5,000
Sources of Principal Agricultural Imports of U. S. during Five Years ended June 30, 1896. Cir. 12, Sec. Foreign Markets	10,000
Agricultural Products Imported and Exported by U. S. in Years ended June 30, 1892–96, inc. Cir. 11, Sec. Foreign Markets	10,000
Freight Charges for Ocean Transportation of Products of Agriculture. Oct. 1, 1895, to Oct. 1, 1896. Bul. 12, Sec. Foreign Markets. 5 cents	5,000
Report of the Appointment Clerk for 1896	500
Distribution of Principal Agricultural Exports of U. S. during Five Years ended June 30, 1896. Cir. 13, Sec. Foreign Markets	10,000
Hamburg as a Market for American Products. Cir. 14, Sec. Foreign Markets	10,000
The Castor-Oil Plant. Misc. Cir. 1	2,500
The Mississippi River Flood. Mis. Cir. 2	5,000
The Mississippi River Flood. Misc. Cir. 3	5,000
Exports of Cotton from Egypt. Cir. 15, Sec. Foreign Markets	5,000

	Copies.
Protest Against Proposed Legislation Restricting Experiments of the Department of Agriculture. Cir. 2	10,000
Our Trade with Cuba from 1887-97. Cir. 16, Sec. Foreign Markets	10,000
An Ideal Department of Agriculture and Industries. Yearbook reprint	500
United States Wheat for Eastern Asia. Cir. 17, Sec. Foreign Markets	10,000
Hawaiian Commerce from 1887-97. Cir. 18, Sec. Foreign Markets	10,000
Austria-Hungary as a Factor in the World's Grain Trade; Recent Use of American Wheat in that Country. Cir. 19, Sec. Foreign Markets	10,000
Report of the Chief of the Section of Foreign Markets for 1897	250
Yearbook of the Department of Agriculture, 1896. 50 cents	500,000
Proceedings of National Convention for Suppression of Insect Pests and Plant Diseases by Legislation, at Washington, D. C., March 5 and 6, 1897. Misc. Bul. 5 cents	2,000

CONGRESSIONAL PUBLICATIONS.

Operations of Bureau of Animal Industry for Fiscal Year 1896. Sen. Doc. No. 45, 54th Cong., 2d sess	1,722
Letter from the Secretary of Agriculture, transmitting statement of employees. House Doc. No. 275, 54th Cong., 2d sess	1,722
Letter from the Secretary of Agriculture, transmitting report on the work and expenditures of agricultural experiment stations, fiscal year 1896. Sen. Doc. No. 137, 54th Cong., 2d sess	1,722
White-Pine Timber Supplies. Letter from the Secretary of Agriculture, transmitting statement regarding white-pine timber supplies. Sen. Doc. No. 40, 55th Cong., 1st sess. (With reprint)	6,000
Special Report on Diseases of the Horse. (Reprint.) 65 cents	75,000
Special Report on Diseases of Cattle and on Cattle Feeding. (Reprint.) 65 cents	60,000
Letter from the Secretary of Agriculture in regard to Senate bill 1063, entitled "A bill for the further prevention of cruelty to animals in the District of Columbia." Sen. Doc. No. 112, 55th Cong., 1st sess	1,722
Report of Chief of the Weather Bureau, 1895-96	4,000
Twelfth and Thirteenth Annual Reports of the Bureau of Animal Industry for the fiscal years 1895 and 1896	30,000
Report of the Secretary of Agriculture, 1897. (Preliminary)	30,000
Annual Reports of Department of Agriculture for Fiscal Year ended June 30, 1897. Report of the Secretary of Agriculture. Misc. Reports	3,000

DIVISION OF ACCOUNTS AND DISBURSEMENTS.

Report of Chief of Division of Accounts and Disbursements for 1896	250
Report of Chief of Division of Accounts and Disbursements for 1897	250

DIVISION OF AGROSTOLOGY.

Studies on American Grasses. Bul. 4. 10 cents	2,000
Report of the Agrostologist for 1896	250
Grasses and Forage Plants of the Dakotas. Bul. 6. 5 cents	5,000
A Report upon the Grasses and Forage Plants of Rocky Mountain Region. Bul. 5. 5 cents	2,000
Sorghum as a Forage Crop. Farm. Bul. 50	30,000
Studies on American Grasses. Bul. 8. 10 cents	1,000
American Grasses (illustrated). Bul. 7. 30 cents	1,000
Timothy in the Prairie Region. Reprint from Yearbook, 1896	500
Cowpeas (*Vigna catjang*). Cir. 5. (With reprint)	3,500
Alfalfa, or Lucern. Farm. Bul. 31. (Reprint)	20,000
Notes on the Grasses and Forage Plants of Iowa, Nebraska, and Colorado. Bul. 9. 5 cents	4,000
Meadows and Pastures: Formation and Cultivation in the Middle Eastern States. Farm. Bul. 66	30,000
The Renewing of Worn-Out Native Pastures. Cir. 4. (Revised edition)	2,000

DIVISION OF BIOLOGICAL SURVEY.

Bird Day in the Schools. Cir. 17. (Reprint)	3,000
Report of Chief of Division of Ornithology and Mammalogy, 1896	250
Some Common Birds in Their Relation to Agriculture. Farm. Bul. 54. (With reprint)	70,000

	Copies.
Extermination of Noxious Animals by Bounties. Reprint, Yearbook, 1896	500
The Blue Jay and Its Food. Reprint from Yearbook, 1896	500
North American Fauna No. 13. Revision of the North American Bats of the Family Vespertilionidæ. 10 cents	2,500
Report of Chief of Division of Biological Survey, 1897	100

DIVISION OF BOTANY.

Contributions from U. S. National Herbarium, Vol. V, No. 1. General Report on a Botanical Survey of the Cœur D'Alene Mountains in Idaho during the Summer of 1895. 10 cents	2,300
Notes on Some Pacific Coast Grasses. Cont. U. S. Nat'l Herb. Vol. I	100
Report of the Botanist for 1896	500
Wild Garlic. Cir. 9	15,000
Preliminary Revision of the North American Species of Cactus, Anhalonium and Lophophora. Cont. U. S. Nat'l Herb. Vol. I	500
List of Plants Collected by Dr. Edward Palmer in 1890 on Carmen Island. Cont. U. S Nat'l Herb. Vol. I	100
List of Plants Collected by C. S. Sheldon and M. A. Carleton in Indian Territory in 1891. Cont. U. S. Nat'l Herb. Vol. I	100
Systematic and Alphabetic Index to New Species of North American Phanerogams and Pteridophytes. Cont. U. S. Nat'l Herb. Vol. I	100
Three New Weeds of the Mustard Family. By Lyster H. Dewey, Assistant in Division of Botany. Cir. 10	10,000
Weeds and How to Kill Them. Farm. Bul. 28. (Two reprints)	40,000
Notes on the Plants Used by the Klamath Indians in Oregon. Cont. U. S. Nat'l Herb. Vol. I	2,500
The Water Hyacinth and Its Relation to Navigation in Florida. Bul. 18. 5 cents	1,500
The Vitality of Seed Treated with Carbon Bisulphide. Cir. 11	10,000
Seed Production and Seed Saving. Reprint from Yearbook, 1896	500
The Superior Value of Large, Heavy Seed. Reprint from Yearbook, 1896	500
Some Common Poisonous Plants. (With reprint.) Reprint from Yearbook, 1896	500
Migration of Weeds. Reprint from Yearbook, 1896	500
Studies of Mexican and Central American Plants. 10 cents	3,500
The Camphor Tree. Cir. 12. (With reprint)	10,000
Observations on Recent Cases of Mushroom Poisoning in the District of Columbia. Cir. 13	3,000

BUREAU OF ANIMAL INDUSTRY.

Facts About Milk. Farm. Bul. 42. (Three reprints)	110,000
Hog Cholera and Swine Plague. Farm. Bul. 24. (Three reprints)	140,000
Regulations for the Inspection and Quarantine of Animals Imported from Canada into the United States, January, 1897	3,000
Exports of Animals and their Products. Cir. 17	10,000
Report of the Chief of the Bureau of Animal Industry for 1896	500
The Cheese Industry of the State of New York. Bul. 15. 5 cents	10,000
Dairy Schools. Bul. 17. 10 cents. (With reprint)	16,000
Standard Varieties of Chickens. Farm. Bul. 51. (Three reprints)	300,000
The Dairy Herd: Its Formation and Management. Farm. Bul. 55. (With reprint)	70,000
List of Officials and Associations Connected with the Dairy Interests in the United States and Canada for 1897. Cir. 18	10,000
Butter Making on the Farm. Farm. Bul. 57	100,000
Factory Cheese and How it is Made. Cir. 19. (Reprint)	5,000
Care of Dairy Utensils. Reprint from Yearbook, 1896	1,000
The Country Slaughterhouse as a Factor in the Spread of Disease. Reprint from Yearbook, 1896	1,000
Preventive Vaccination Against Blackleg. Cir. 20	1,000
Directions for Use of Blackleg Vaccine. Cir. 21	3,000
The Dairy Industry in Missouri and Kansas. Bul. 18. 5 cents	6,500
Some Modern Disinfectants. Reprint from Yearbook, 1896	500
Creameries or Butter Factories: Advantages, Location, Organization, and Equipment. Reprint B. A. I. An. Rep., 1897	6,000

	Copies.
Care of Milk on the Farm. Farm. Bul. 63	20,000
Ducks and Geese: Standard Breeds and Management. Farm. Bul. 64	50,000
Directions for the Pasteurization of Milk. Cir. 1. (Revised edition)	2,000
Report of the Chief of the Bureau of Animal Industry for 1897	1,000

DIVISION OF CHEMISTRY.

Changes in and Additions to Methods of Analysis Adopted at the Thirteenth Annual Meeting of the Association of Official Agricultural Chemists. Cir. 2	2,000
Report of the Chief of the Division of Chemistry for 1896	250
Methods of Analysis Adopted by the Association of Official Agricultural Chemists, September 5, 6, and 7, 1895. Bul. 46. (Two reprints.) 5 cents	1,000
The Sugar Beet: Culture, Seed Development, Manufacture, and Statistics. Farm. Bul. 52. (With two reprints)	130,000
Proceedings of the Thirteenth Annual Convention of the Association of Official Agricultural Chemists, held at Washington, D. C., November 6, 7, and 9, 1896. Bul. 49. (With reprint.) 10 cents	2,250
Needed Reforms in Fertilizer Inspection. Cir. 3	200
Potash and its Function in Agriculture. Reprint from Yearbook, 1896	500
Proceedings of the Eleventh Annual Convention of the Association of Official Agricultural Chemists, held at Washington, D. C., August 23, 24, and 25, 1894. Bul. 43. (Reprint.) 25 cents	500
Proceedings of the Twelfth Annual Convention of the Association of Official Agricultural Chemists, held at Washington, D. C., September 5, 6, and 7, 1895. Bul. 47. (Reprint.) 10 cents	500
Experiments with Sugar Beets in 1892. Bul. 36. (Reprint.) 5 cents	500
Proceedings of the Eighth Annual Convention of the Association of Official Agricultural Chemists, held at the Columbian University, Washington, D. C., August 13, 14, and 15, 1891. Methods of Analysis of Dairy Products, Fermented Liquors, and Sugars. Bul. 31. (Reprint.) 15 cents	500
Report of the Chief of the Division of Chemistry for 1897	500

DIVISION OF ENTOMOLOGY.

Some Insects Injurious to Stored Grain. Farm. Bul. 45. (With three reprints)	120,000
Insects Affecting Domestic Animals: An Account of the Species of Importance in North America, with Mention of Related Forms Occurring on Other Animals. Bul. 5, new series. 20 cents. (With two reprints)	3,000
Report of the Entomologist for 1896	250
Insects Affecting the Cotton Plant. Farm. Bul. 47. (With reprint)	60,000
The Ambrosia Beetles of the United States. Reprint from Yearbook, 1896	100
The Plum Plant-louse. Reprint from Bul. 7, new series	100
Some Important Results of the Work of the Division of Entomology. Bul. 7, new series. 10 cents	3,000
The Mexican Cotton-boll Weevil. Cir. 18, second series	5,000
Important Insecticides: Directions for their Preparation and Use. Farm. Bul. 19. (Reprint)	30,000
The Clover Mite. Cir. 19, second series. (With two reprints)	6,000
Some Little Known Insects Affecting Stored Vegetable Products: A Collection of Articles Detailing Certain Original Observations Made Upon Insects of this Class. Bul. 8, new series. 5 cents	2,000
The Mexican Cotton-boll Weevil. Cir. 18. (Revised Spanish edition)	1,500
The Mexican Cotton-boll Weevil. Cir. 18; revision of No. 14. (German edition)	1,500
A Study in Insect Parasitism: A Consideration of the Parasites of the White-marked Tussock Moth, with an Account of Their Habits and Interrelations and with Descriptions of New Species. Technical Series No 5. 5 cents	1,500
General Index to Insect Life, 1888–1895	1,000
The Strawberry Weevil. Cir. 21, second series	5,000
The Woolly Aphis of the Apple. Cir. 20, second series	5,000
The Periodical Cicada in 1897. Cir. 22, second series	2,500
The Buffalo Tree-hopper. Cir. 23, second series	5,000

	Copies.
The Asparagus Beetles. Reprint from Yearbook, 1896	2,000
The Use of Steam Apparatus for Spraying. Reprint from Yearbook, 1896	1,000
The San Jose Scale and Its Nearest Allies. Bul. 6, technical series. 5 cents	1,500
Insect Control in California. Reprint from Yearbook, 1896	7,000
The Two-Lined Chestnut Borer (*Agrilus bilineatus* Weber). Cir. 24, second series	3,000
The Ox Warble (*Hypoderma lineata* Villers). Cir. 25, second series	3,000
Important Insecticides: Directions for their Preparation and Use. Farm. Bul. 19. (Third revised edition)	30,000
The Pear Slug (*Eriocampoides limacina* Retzius), by C. L. Marlatt, First Assistant Entomologist. Cir. 26, second series	5,000
The Present and Future of Applied Entomology in America. Reprint from Bul. 9, new series	100
Proceedings of the Ninth Annual Meeting of the Association of Economic Entomologists. Bul. 9, new series. 10 cents	2,000
Bee Keeping. Farm. Bul. 59. (With reprint)	40,000
Revision of the Tachinidæ of America North of Mexico. A Family of Parasitic Two-winged Insects. Bul. 7, technical series. 10 cents	1,500
Mosquitoes and Fleas. Cir. 13. (Revised edition)	2,000
Report of the Entomologist for 1897	250

OFFICE OF EXPERIMENT STATIONS.

Experiment Station Record. Vol. VIII, Nos. 4 to 12; Vol. IX, Nos. 1 to 3. 5 cents each	48,000
Food and Nutrition Investigations in New Jersey in 1895 and 1896. Bul. 35. 5 cents	3,500
The Carbohydrates of Wheat. Maize, Flour, and Bread, and the Action of Enzymic Ferments upon Starches of Different Origin. Bul. 34. 5 cents	3,500
Report of Committee on Methods of Teaching Agriculture. Cir. 32	3,000
Report of the Director of the Office of Experiment Stations for 1896	1,500
Dietary Studies at the Maine State College in 1895. Bul. 37. 5 cents. (With reprint)	4,500
Rules and Apparatus for Seed Testing. Cir. 34	3,000
Dietary Studies in New Mexico in 1895. Bul. 40. 5 cents	3,500
Notes on Irrigation in Connecticut and New Jersey. Bul. 36. 5 cents	4,000
Dairy Work at the Experiment Stations. Reprint from Record, Vol. VIII	200
Organization Lists of the Agricultural Experiment Stations and Institutions, with Courses in Agriculture, in the United States in 1897. Bul. 39. 5 cents	3,500
Dietary Studies with Reference to the Food of the Negro in Alabama in 1895 and 1896. Bul. 38. 5 cents	5,000
Cotton Culture in Egypt. Bul. 42. 5 cents	4,000
Constitution of the Association of American Agricultural Colleges and Experiment Stations. Cir. 36	2,000
Agricultural Education and Research in Belgium. Reprint from Yearbook, 1896	1,000
The Nitrogen-free Extract of Plants and Feeding Stuffs. Reprint from Record, Vol. VIII	200
Proceedings of the Tenth Annual Convention of the Association of American Agricultural Colleges and Experiment Stations, held at Washington, D. C., November 10-12, 1896. Bul. 41. 10 cents	2,000
Key to Subject Index of Literature of Agricultural Experiment Stations and Kindred Institutions. Cir. 23	500
The Feeding Value of Corn Stover. Reprint from Yearbook, 1896	500
Statistics of Land-Grant Colleges and Agricultural Experiment Stations, 1896. Cir. 35	3,000
Pruning and Training of Grapes. Reprint from Yearbook, 1896	1,000
Second Report of the Committee on Methods of Teaching Agriculture. Cir. 37. (With reprint)	5,000
Agricultural Associations in Belgium. Reprint from Record, Vol. IX	1,000
A Review of Publications on Agricultural Botany Issued in France during 1896	200
Some Books on Agriculture and Agricultural Science—published 1893–1896. Cir. 31	500

	Copies.
Losses in Boiling Vegetables and the Composition and Digestibility of Potatoes and Eggs. Bul. 43. 5 cents	4,500
Report of Preliminary Investigations on the Metabolism of Nitrogen and Carbon in the Human Organism, with a Respiration Calorimeter of Special Construction. Bul. 44. 5 cents	1,500
Report of Committee on Methods of Teaching Agriculture. Cir. 32. (Revised edition)	2,000
Methods and Results of Investigations on the Chemistry and Economy of Food. Bul. 21. (Reprint.) 15 cents	1,000
Broom Corn (*Andropogon vulgaris*). Cir. 28. (Revised edition)	2,000
Canaigre (*Rumex hymenosepalus*). Cir. 25. (Revised edition)	3,500
Report of the Director of the Office of Experiment Stations for 1897	2,000
The Manuring of Cotton. Farm. Bul. 48. (With reprints)	60,000
Leguminous Plants for Green Manuring and for Feeding. Farm. Bul. 16. (Two reprints)	50,000
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Snow and Ice Chart. Weekly, Jan., Feb., Mar., Dec., 1897	19,300
Daily Weather Map, January to December, 1897	291,580

SPECIAL AGENT FOR DISTRIBUTION OF SEED.

Report of the Special Agent on Seed Distribution for 1896	250

DIVISION OF SEEDS.

Report of the Chief of the Seed Division for 1896	100

METHODS OF CONTROLLING INJURIOUS INSECTS.

[The species marked with an asterisk (*) have gained entrance into America from foreign countries and represent twenty-eight out of the sixty-three species listed. The origin of those preceded with an interrogation point is in doubt.]

REMEDIES FOR IMPORTANT INSECTS.

*ANGOUMOIS GRAIN MOTH (*Sitotroga cerealella* Oliv.). Prompt thrashing of grain after harvesting; bisulphide of carbon in bins and granaries; storage in bulk.

?APPLE-ROOT PLANT-LOUSE (*Schizoneura lanigera* Hausm.). Kerosene emulsion under and above ground; scalding water poured freely about roots; bisulphide of carbon under ground about roots; powdered tobacco or ashes incorporated in the soil.

APPLE-TREE BORER, FLAT-HEADED (*Chrysobothris femorata* Fab.). Painting trunk and larger branches in June with strong soap solution, washing soda, or mixture of whitewash and Paris green.

?ARMY WORM (*Leucania unipuncta* Haw.). Burning over fields in winter; ditching; Paris green.

*ASPARAGUS BEETLE, COMMON (*Crioceris asparagi* Linn.). Prompt marketing of all canes; trap plants; dusting with lime or arsenical mixtures; jarring larvæ to ground on hot days, especially if soil be sandy.

*BEAN WEEVIL, COMMON (*Bruchus obtectus* Say). Treating with bisulphide of carbon in air-tight vessels.

*BLACK SCALE (*Lecanium oleæ* Barn.). Kerosene emulsion on young scale or treatment with hydrocyanic acid gas.

BLISTER BEETLES (*Epicauta vittata* Fab., *E. cinerea* Lec., *E. pennsylvanica* DeG., *Macrobasis unicolor* Kb.). Arsenicals, 1 pound to 100 gallons of water.

BOLL WORM. (*See* Corn ear worm.)

BUFFALO GNAT (*Simulium pecuarum* Riley). Smudges; oil, grease, etc., applied to stock.

*CABBAGE BUG, HARLEQUIN (*Murgantia histrionica* Hahn). Spring collecting from trap mustard; hand picking.

*CABBAGE WORMS (*Pieris rapæ* Sch., *Platella cruciferarum* Zell., *Plusia brassicæ* Riley). Pyrethrum; kerosene emulsion; Paris green, dry, with flour or lime—1 part of the poison in 50 to 100 of the diluent.

CANKERWORM, SPRING (*Paleacrita vernata* Peck). Arsenical mixtures in spray; trapping female moth in oil troughs or tar bands about trunks of trees.

*CARPET BEETLE, OR "BUFFALO MOTH" (*Anthrenus scrophulariæ* L.). Benzine; hot ironing of carpets over damp cloth; killing by steam.

CHINCH BUG (*Blissus leucopterus* Say). Burning wild grass land and all rubbish in early winter; kerosene emulsion; contagious disease; trap crops; ditching.

?CLOTHES MOTH, SOUTHERN (*Tinea biselliella* Hum.). Brushing and airing; benzine; naphthalene; packing in bags of paper or cotton cloth; cold storage.

*COCKROACH, GERMAN; CROTON BUG (*Phyllodromia germanica* L.). Pyrethrum or buhach; bisulphide of carbon in tight rooms or compartments away from fire.

*CODLING MOTH; APPLE WORM (*Carpocapsa pomonana* Linn.). Arsenicals; first application as soon as blossoms fall; second, one or two weeks later, just before the fruit turns down on the stem; trapping larvæ by applying bands to the tree; prompt destruction of infested fallen fruit.

*COTTON WORM (*Aletia xylina* Say). Paris green dusted on as dry powder.

CORN ROOT-WORM, Western (*Diabrotica longicornis* Say). Rotation of corn with oats or other crop.

*CORN STALK-BORER, LARGER (*Diatræa saccharalis* F.). Plowing under or burning stubble.

?CORN EAR WORM; BOLL WORM (*Heliothis armiger* Hbn.). Late fall plowing; poisoned baits; for cotton, planting corn as trap crop.

*CURRANT WORM, IMPORTED (*Nematus ribesii* Scop.). Hellebore, 1 ounce to 2 gallons water, in spray.

CUCUMBER BEETLE, STRIPED (*Diabrotica vittata* Fab.). Protecting young plants with netting; arsenicals.

CUTWORMS (Agrotis, Leucania, Mamestra, Hadena, Nephelodes, etc.). Distribution of poisoned green bait; late fall plowing; burning waste tracts and rubbish.

*ELM LEAF-BEETLE, IMPORTED (*Galerucella luteola* Müll.). Arsenicals, 1 pound to 100 gallons water, as soon as beetles appear and later for larvæ.

FLEA-BEETLE, STRIPED (*Phyllotreta vittata* Fab.). Kerosene emulsion, arsenicals.

*FLUTED SCALE (*Icerya purchasi* Mask.). Introduction of its ladybird enemy, *Novius cardinalis;* hydrocyanic acid gas treatment; soap, 1 pound to 2 gallons hot water.

*FRUIT-TREE BARK-BEETLE (*Scolytus rugulosus* Ratz.). Burning trap trees and infested trees at any time, but preferably in winter.

*GRAIN WEEVILS (*Calandra granaria* Linn., *C. oryza* Linn.). Bisulphide of carbon in bins and granaries; storage in large bulk.

GRAPE PHYLLOXERA (*Phylloxera vastatrix* Planch.). Submersion; bisulphide of carbon, kerosene emulsion, or resin compound about roots; use of resistant stocks.

GRAPEVINE LEAF-HOPPER (*Erythroneura vitis* Harr.). Spraying with kerosene emulsion in early morning; catching on tarred shield; cleaning up all leaves and rubbish in fall.

*GIPSY MOTH (*Ocneria dispar* L.). Spraying with arsenicals; hand collecting of cocoons and eggs; oiling egg masses; trapping larvæ.

*HESSIAN FLY (*Cecidomyia destructor* Say). Late planting; selection of wheat less subject to attack; rolling; pasturing to sheep; rotation of crops.

*HOP PLANT-LOUSE (*Phorodon humuli* Schr.). Destroying all wild plum trees in vicinity; spraying others in fall or spring with strong kerosene emulsion; spraying vines with kerosene emulsion or fish-oil soap; destroying vines after hops are picked.

*HORN FLY (*Hæmatobia serrata* R.-D.). Application of strong-smelling greases and oils to cattle, or of lime or plaster to dung.

LOCUST, CALIFORNIA DEVASTATING (*Melanoplus devastator* Scudd.). Poisoned bait of bran, sugar, and arsenic.

LOCUST, ROCKY MOUNTAIN (*Melanoplus spretus* Thos.). Catching with hopperdozers; ditching; burning; rolling; plowing under of eggs.

OX BOT (*Hypoderma lineata* Vill.). Strong-smelling fats and oils applied to cattle.

*OYSTER-SHELL BARK-LOUSE (*Mytilaspis pomorum* Bouché). Kerosene emulsion; strong soap or alkali washes.

PEACH-TREE BORER (*Sannina exitiosa* Say). Cutting out the larvæ or scalding them with hot water in late autumn or early spring; painting trunk with arsenicals in thick whitewash; wrapping trunk with grass, paper, etc.

*PEAR-TREE PSYLLA (*Psylla pyricola* Forst.). Kerosene emulsion: First, a winter application diluted seven times; second, in spring as soon as leaves are unfolded, diluted nine times.

PEAR-TREE SLUG (*Eriocampoides limacina* Klug.). Hellebore, 1 ounce to 2 gallons water in a spray; whale-oil soap, 12 pounds to 50 gallons water; arsenicals.

*PEA WEEVIL (*Bruchus pisorum* Linn.). Keeping seed over to second year; bisulphide of carbon in tight vessels.

PLUM CURCULIO (*Conotrachelus nenuphar* Herbst). Arsenical spray: First, after the bloom falls or as soon as foliage starts; second, a week or ten days after the last; collection of adults from trees by jarring.

POTATO BEETLE, COLORADO (*Doryphora decemlineata* Say). Arsenicals, 1 pound to 100 gallons of water.

*PURPLE SCALE OF THE ORANGE (*Mytilaspis citricola* Pack.). Kerosene emulsion, applied immediately after appearance of new brood.

ROSE-CHAFER (*Macrodactylus subspinosus* Fab.). Planting spiræas, etc., as trap plants, and collecting beetles in special pans; arsenicals; bagging grapes.

*SAN JOSE SCALE (*Aspidiotus perniciosus* Comst.). Soap wash (2 pounds to the gallon) as soon as leaves fall in autumn; in warm, dry climate, winter resin wash; fumigation with hydrocyanic acid gas.

*SCREW WORM (*Compsomyia macellaria* Fab.). Prompt burning or burying of dead animals; smearing wounds with fish oil; washing with carbolic acid.

SQUASH-VINE BORER (*Melittia ceto* Westw.). Planting early summer squashes to be destroyed; late planting of main crop; destruction of all vines attacked as soon as crop can be gathered; collecting moths.

SQUASH BUG (*Anasa tristis* De G.). Early burning of vines and all rubbish in fall; biweekly collection of eggs; trapping under shingles.

STRAWBERRY WEEVIL (*Anthonomus signatus* Say). Trap crops; protecting beds with cloth covering; using staminate varieties as fertilizers only and as few plants of the former as necessary; spraying with Paris green and Bordeaux mixture.

*SUGAR-CANE BORER (*Diatræa saccharalis* Fab.). Burning trash and laying down seed cane under ground.

WEBWORM, FALL (*Hyphantria cunea* Dr.). Prompt removal and destruction of webs and larvæ; arsenical spraying.

WHEAT ISOSOMA (*Isosoma grande* Riley). Burning stubble; rotation of crops.

*WHEAT PLANT-LOUSE (*Siphonophora avenæ* Fab.). Rotation of crops.

WHITE GRUBS; JUNE BEETLES (*Lachnosterna* spp.). Luring the beetles by lights over tubs into water with skim of kerosene. Against larvæ: Kerosene emulsion; liberal use of potash fertilizers; collecting after the plow.

WIREWORMS (*Drasterius elegans* Fab., *Melanotus fissilis* Say, and *Agriotes* spp.). Fall plowing; poisoned baits; rotation of crops.

PREPARATION AND USE OF INSECTICIDES.

ARSENICALS: PARIS GREEN, SCHEELE'S GREEN, AND LONDON PURPLE.—These three arsenicals practically take the place of all other insecticides for biting and gnawing insects living or feeding on the exterior of plants.

Paris green is a very fine crystalline powder, composed of arsenic, copper, and acetic acid, and costs about 20 cents a pound.

Scheele's green is similar to Paris green in color, and differs from it only in lacking acetic acid. It is a finer powder, more easily kept in suspension, and costs only about one-half as much per pound.

London purple is a waste product containing chiefly arsenic and lime. It is not as effective as the green poisons, and more apt to scald foliage. It costs about 10 cents a pound.

Either of these arsenicals may be used as follows:

The wet method.—Make into a thin paint in a small quantity of water, adding powdered or quicklime equal to the amount of poison used. Strain the mixture into the spray tank. Use either poison at the rate of a pound of dry powder in from 100 to 200 gallons of water. The stronger mixtures are for resistant foliage, such as that of the potato, and the weaker for sensitive foliage, such as that of the peach and plum.

The dry method.—It is ordinarily advisable to use the poison in the form of a spray, but in the case of cotton and some other low crops it may be dusted on the plants. Make the application preferably in early morning or late evening, when the dew is on, to enable the poison to better adhere to the plant. In cotton fields the powder is usually dusted over the plants from bags fastened to each end of a pole, which is carried on horse or mule back. The motion of the animal is sufficient to cause the distribution over the foliage. Garden vegetables may be dusted by hand from bags or powder bellows. For vegetables which are soon to be used as food, mix the poison with 100 times its weight of flour or lime, and apply merely enough to show evenly over the surface.

Fruit trees should never be sprayed when in bloom, on account of the liability of poisoning honeybees or other insects useful as cross fertilizers.

ARSENATE OF LEAD.—The advantages of this arsenical are that it shows plainly on the leaves, indicating at once which have been sprayed; remains much more easily suspended in water, and may be used in large proportions without danger to foliage. For sensitive foliage, or where no risk of scalding may be taken, it will prove useful.

It is prepared by combining, approximately, 3 parts arsenate of soda with 7 parts acetate of lead. From 1 to 10 pounds arsenate of lead are used with 150 gallons of water, 2 quarts of glucose being added to cause it to adhere better to the leaves. From 2 to 5 pounds will answer for most larvæ. The arsenate of lead costs 7 cents a pound wholesale, and glucose $16 a barrel.

ARSENIC BAIT.—It is not always practicable to apply poison directly to plants, and in such cases the use of poison bait is valuable, particularly for cutworms, wireworms, and grasshoppers or locusts.

Bran-arsenic bait.—This is made by combining 1 part by weight of white arsenic, 1 of sugar, and 6 of bran, to which enough water is added to make a wet mash. For grasshoppers or locusts, place a tablespoonful at the base of each tree or vine, or lay a line of it at the head of the advancing army, placing a tablespoonful every 6 to 8 feet, and following this up with another line in front of the first. For baiting cutworms, distribute the mash in small lots over the infested territory.

Green bait.—For the destruction of cutworms and wireworms, use preferably poisoned green succulent vegetation, such as freshly cut clover, distributing it in small bunches about the infested fields. The bunches of green vegetation should be dipped in a strong solution of arsenicals, and prevented from rapid drying by being covered with stones or boards. Renew as often as the bait becomes dry.

In the use of poisoned bait care must be exercised against its being eaten by domestic animals.

CARBON BISULPHIDE.—This substance, used in tight receptacles, is the cheapest and most effective remedy for all insects affecting stored food and seed material, natural-history specimens, etc., and is one of the best means against insects affecting the roots of plants in loose soils. It is a colorless liquid, with an offensive odor, which soon passes off. It readily volatilizes, and is deadly to insect life. The vapor is highly inflammable and explosive, and should be carefully kept from fire, even a lighted cigar in its proximity being a source of danger. Wholesale, it costs 10 cents a pound; retail, of druggists, 25 to 30 cents a pound.

For root lice of grape, apple, etc., put one-half ounce of bisulphide into holes about plants 10 to 16 inches deep, 1½ feet apart, and not closer to trunk than 1 foot. Make the holes with iron rod and close with foot, or use hand injectors. For root maggots, put a teaspoonful into a hole 2 or 3 inches from the plant and close immediately. For ant nests, pour an ounce of the liquid into each of several holes in the nests; close the opening with the foot or cover with a wet blanket for ten minutes, and then explode the vapor at mouth of holes with torch.

For stored-grain insects, distribute in shallow dishes over the bins; with open bins cover with oilcloth or blankets to retain the vapor. Keep bins or buildings closed for from twenty-four to thirty-six hours; then air them well. Disinfect infested grain in small bins before placing in large masses for long storage.

The bisulphide is applied at the rate of 1 pound to the ton of grain.

HYDROCYANIC ACID GAS.—This substance is chiefly used to destroy scale insects on fruit trees and nursery stock. The treatment consists in inclosing the tree or nursery stock with a tent and filling the latter with the poisonous gas.

The tents should be of blue or brown drilling, or 8-ounce duck, painted or oiled to make air-tight. The tent may be placed over small trees by hand and over large trees with a tripod or derrick. A tent and derrick for medium-sized trees cost from $15 to $25; for a tree 30 feet tall by 60 feet in circumference, about $60.

Refined potassium cyanide (98 per cent pure), commercial sulphuric acid, and water are used in generating the gas, the proportions being from two-thirds to 1 ounce, by weight, of the cyanide, slightly more than 1 fluid ounce of acid, and 3 fluid ounces of water to every 150 cubic feet of space inclosed.

Place the generator (any glazed earthenware vessel of 1 or 2 gallons' capacity) on the ground within the tent, and add the water, acid, and cyanide, the latter in large lumps, in the order named. The treatment should continue forty minutes. Bright, hot sunlight is apt to cause injury to foliage, and may be avoided by working on cloudy days or at night. One series of tents will answer for a county or large community of fruit growers.

KEROSENE.—Kerosene, or coal oil, is occasionally used directly against insects, although its important insecticide use is in combination with soap or milk emulsion. Under exceptional conditions it may be sprayed directly on living plants, and it has been so used in the growing season without injury. Ordinarily, however, when applied even in the dormant season on leafless plants, it is liable to do serious injury or to kill the plant outright. It is now being used to a certain extent mechanically combined with water in the act of spraying, and is less harmful in this way than when used pure, as it is broken up more finely and somewhat distributed; but the danger of use on tender plants is not avoided by this means. Many insects which can not be destroyed by ordinary insecticides may be killed by jarring them from the plants into pans of water on which a little kerosene is floating, or they may be shaken from the plants upon cloth or screens saturated with kerosene.

For the mosquito, kerosene has proved a very efficient preventive. Applied, at the rate of an ounce to 15 square feet, to the surface of small ponds or stagnant water in which mosquitoes are breeding, it forms a uniform film over the water and destroys all forms of aquatic insects, including the larvæ of the mosquito and the adult females which come to the surface of the water to deposit their eggs. The application retains its efficiency for several weeks.

KEROSENE EMULSIONS.—The kerosene emulsions apply to all such sucking insects as plant bugs, plant lice, scale insects, thrips, and plant mites, and to such biting insects as can not be safely poisoned.

Soap formula.—Kerosene, 2 gallons; whale-oil soap (or 1 quart soft soap), 1 to 2 pounds; water, 1 gallon.

Dissolve the soap in water by boiling, and add boiling hot, away from the fire, to the kerosene. Agitate violently for five minutes by pumping the liquid back upon itself with a force pump and direct-discharge nozzle throwing a strong stream, preferably one-eighth inch in diameter. The mixture will have increased about one-third in bulk, and assumed the consistency of cream. Well made, the emulsion should keep indefinitely, and should be diluted only as wanted for use.

In limestone or hard-water regions "break" the water with lye before using to make or dilute the emulsion, or use rainwater. Better than either, use the milk emulsion, with which the character of the water does not affect the result.

Milk formula.—Kerosene, 2 gallons; milk (sour), 1 gallon.

Heating is unnecessary; churn as in the former case for three to five minutes, or until a thick, buttery consistency results. Prepare the milk emulsion from time to time for immediate use, unless it can be stored in air-tight jars; otherwise it will soon ferment and spoil.

How to use the emulsions.—For summer applications for most plant lice and other soft-bodied insects, dilute with 15 to 20 parts of water; for the red spider and other plant mites, the same, with the addition of 1 ounce of powdered sulphur to the gallon; for scale insects, the larger plant bugs, larvæ and beetles, dilute with 7 to 9 parts water.

For subterranean insects, such as root lice, root maggots, "white grubs," etc., use either kerosene emulsion or resin wash, wetting the soil to the depth of 2 to 3 inches, and follow with copious waterings, unless in rainy season.

OILS: FISH OIL, TRAIN OIL, AND COTTON-SEED OIL.—These are sometimes used on domestic animals to rid them of vermin, and fish oil is one of the best-known repellents for the horn fly, buffalo gnat, and ox bot fly. Any of these oils or any grease, the more strong smelling the better, thinly smeared on animals at the points of attack by flies, will afford great protection. They are also valuable against lice affecting live stock, but must be used carefully, or they may cause the hair to fall off.

PYRETHRUM, OR INSECT POWDER.—This insecticide is sold under the names of buhach and Persian insect powder.

It acts on insects externally, through their breathing pores, and is fatal to many forms. It is not poisonous to man or the higher animals, and hence may be used where poisons would be objectionable. Its chief value is against household pests, such as roaches, flies, and ants, and in greenhouses, conservatories, and small gardens, where the use of poisons would be inadvisable.

It is used as a dry powder, pure or diluted with flour, when it may be puffed about rooms or wherever insects may occur. When used on plants, it is preferably applied in the evening. As a preventive, and also as a remedy for the mosquito, burning the powder in a tent or room will give satisfactory results. It may also be used as a spray, at the rate of 1 ounce to 3 gallons of water, but in this case should be mixed up some twenty-four hours before being applied. For immediate use a decoction may be prepared by boiling in water from five to ten minutes.

RESIN WASH.—This is valuable for scale insects wherever the occurrence of comparatively rainless seasons insures the continuance of the wash on the trees for a considerable period, and as winter washes in very mild climates, as southern

California, or wherever the multiplication of the insect continues almost without interruption throughout the year.

Formula for resin wash.

Resin	pounds	20
Caustic soda (70 per cent)	do	5
Fish oil	pints	2½
Water to make	gallons	100

Ordinary commercial resin is used, and the soda is that put up for soap establishments in large 200-pound drums. Smaller quantities may be obtained at soap factories, or the granulated caustic soda (98 per cent) used, 3½ pounds of the latter being the equivalent of 5 pounds of the former. Place these substances with the oil in the kettle, with water to cover them to a depth of 3 or 4 inches. Boil from one to two hours, occasionally adding water, until the compound resembles very strong black coffee. Dilute to one-third the final bulk with hot water or with cold water added slowly over the fire, making a stock mixture, to be diluted to the full amount as used. When sprayed, the mixture should be perfectly fluid and without sediment, and should any appear in the stock mixture reheating should be resorted to. For a winter wash, dilute one-third or one-half less.

SOAPS AS INSECTICIDES.—Any good soap is effective in destroying soft-bodied insects, such as plant lice and young or soft-bodied larvæ. The soaps made of fish oil, and sold under the name of whale-oil soaps, are especially valuable. For plant lice and delicate larvæ, such as the pear slug and others, a strength obtained by dissolving half a pound of soap in a gallon of water is sufficient. Soft soap will answer as well as hard, but at least double quantity should be taken.

As winter washes, the fish-oil soaps have proved the most effective means of destroying certain scale insects, and have been of especial service against the very resistant San Jose scale.

For winter applications, use the soap at the rate of 2 pounds to a gallon of water, making the application with a spray pump as soon as the leaves fall in the autumn, repeating, if necessary, in spring before the buds unfold.

SULPHUR.—Flowers of sulphur is one of the best remedies for plant mites, such as the "red spider," six-spotted orange mite, rust mite of the orange fruit, etc. Applied at the rate of 1 ounce to a gallon of water, or mixed with some other insecticide, such as kerosene emulsion, it is a very effective remedy. For the rust mite, sprinkling the powdered sulphur about under the trees is sometimes sufficient to keep the fruit bright. Sulphur is often used to rid poultry houses of vermin, and when fed to cattle is said to be a good means of ridding them of lice; or it may be mixed with grease, oil, etc., and rubbed into the skin.

Bisulphide of lime.—This chemical is even better than sulphur as a remedy for mites; as it is a liquid it can be diluted easily to any extent. It can be made very cheaply by boiling together in a small quantity of water equal parts of lime and flowers of sulphur. For mites, take 5 pounds of sulphur and 5 of lime, and boil in a small quantity of water until both are dissolved and a brownish liquid results. Dilute to 100 gallons.

IRRIGATION.

A water right is the right or privilege of using water from a canal, ditch, or stream for irrigating purposes, either in a definite quantity or upon a prescribed area of land, such right or privilege being customarily acquired either by priority of use or by purchase. In many parts of the arid region a water right is an exceedingly valuable property. The average value for the entire arid region, as determined by the Census of 1890, was $26 per acre, and there are fruit-growing districts in California where water rights have been sold as high as $1,500 per miner's inch, or from $100 to $500 per acre.

The "duty of water" is the extent of the service the water will perform when used for irrigating purposes, that is, the number of acres a given quantity of water will adequately irrigate under ordinary circumstances. This is usually from 100 to 200 acres for each second-foot. Where water is abundant, the duty has been known to be as low as 50 acres, and, where very scarce, as high as 500 acres to the second-foot. A second-foot is the quantity of water passing in one second in a stream 1 foot wide, 1 foot deep, flowing 1 foot per second.

A miner's inch is theoretically such a quantity of water as will flow through an aperture 1 inch square in a board 2 inches thick under a head of water of 6 inches in 1 second of time, and it is equal to 0.194 gallon, or 0.0259337 cubic foot per second, or to 11.64 gallons, or 1.556024 cubic feet, per minute. In Colorado the miner's inch legalized by statute equals 11.7 gallons per minute. The California miner's inch, however, equals only 9 gallons per minute.

TWENTY-FIVE MOST HARMFUL WEEDS

The following 25 weeds, selected as among the most injurious from the table of 200 given in the Yearbook for 1895, are all well established in this country. Most of them are widely distributed. Their complete extermination is practically impossible, but they may be kept in check or exterminated in small areas, so that comparatively little injury will result from them. The methods of eradication here given may well be applied to other weeds which agree with these in character and methods of propagation.

List of twenty-five weeds especially to be watched, with suggestions for their control and eradication.

Names, common and technical.	Origin; where now largely injurious.	Time of flowering.	Time of seeding.	Habit, height; color, size, and arrangement of flowers.	Duration; method of propagation and distribution.	Place of growth and products injured.	Methods of control and eradication.
BINDWEED, bearbind, English bindweed, morning glory. *Convolvulus arvensis.*	Old World. New England to Texas, Utah, California.	June to September.	August to November.	Running or climbing vine 2 to 8 feet long. White, 1 inch, solitary.	Perennial. Seeds in hay or in impure seed; running roots carried by cultivating tools and with nursery stock.	Rich loam. Grain, and hoed crops, especially garden crops.	Frequent hoeing or spudding; thorough continued cultivation; application of coal oil or carbolic acid; thick seeding with smothering crops.
BULL THISTLE, bird thistle, boar thistle, pasture thistle. *Carduus lanceolatus.*	Europe. New England to Kansas, Oregon, and California.	June and July.	July to September.	Erect, branching above, 3 to 6 feet. Purple, 2 inches, head.	Biennial. Seeds: wind, hay, and impure seed.	Grain fields, meadows, and recent clearings. Grain and hay.	Spudding in fall; mowing before the flowers open; cultivation with hoed crops.
BURDOCK, beggar's button, gobo, great dock. *Arctium lappa.*	Europe. New England to Wisconsin and Texas.	July to September.	August to October.	Erect, branching, 3 to 5 feet. Purple, one-half inch, head.	Biennial. Seeds carried by animals, and hay.	Pastures, fence rows, and grain fields. Wool, grain.	Repeated spudding, or mowing before the flowers appear; burning mature plants and burs picked from animals.
BUR GRASS, bear grass, hedgehog, Rocky Mountain sand bur, sand bur, sand spur. *Cenchrus tribuloides.*	Eastern United States. In sheep-raising localities in all States.	May to October.	June to November.	Spreading grass, 3 to 10 inches. Green, one-third inch, bur.	Annual. Seeds carried by animals and in wool.	Sandy pastures, sheep trails, sheep-washing places. Wool, pastures.	Cultivation; hoeing or burning small patches, especially about sheep-washing yards, shearing pens, etc.
CANADA THISTLE, creeping thistle, cursed thistle. *Carduus arvensis.*	Europe. New England to Missouri, Washington, and Oregon.	June to August.	July to September.	Erect, branching, 2 to 4 feet. Purple, three-fourths inch, head.	Perennial. Seeds carried by wind and in impure grain and grass seed; running roots scattered by cultivating tools.	Cultivated fields. Grain, pastures, meadows, and muck-land crops.	Frequent grubbing; mowing before the flowers appear; plowing three times in August; salting the plants and pasturing sheep on them; application of hot brine, kerosene, or carbolic acid.
CHARLOCK, wild mustard, yellow mustard. *Brassica sinapistrum.*	Europe. New England to Oregon.	May to August.	June to September.	Erect, branching, 2 to 4 feet. Yellow, one-half inch, racemes.	Annual. Seeds in grain and clover seed, and hay.	Grain fields and meadows. Spring wheat, oats, barley, and clover.	Hand pulling in grain fields; cultivation with hoed crops; use of clean seed; use of horse weeder.

List of twenty-five weeds especially to be watched, with suggestions for their control and eradication—Continued.

Names, common and technical.	Origin; where now largely injurious.	Time of flowering.	Time of seeding.	Habit, height; color, size, and arrangement of flowers.	Duration; method of propagation and distribution.	Place of growth and products injured.	Methods of control and eradication.
CHESS, cheat, wheat thief, Willard's brome grass. *Bromus inermis.*	Southern Europe. All grain-raising regions.	June to July.	July to August.	Erect, grass, 1 to 2 feet. Green, 1 line, spikelets in panicles.	Annual. Seeds in grain and grass seed.	Grain fields. All small grain.	Cultivation with hoed crops; use of cleaner seed grain; use of horse weeder in winter wheat.
COCKLEBUR, clot bur. *Xanthium canadense.*	Northern United States. All States.	June to September.	August to September.	Erect, branching, 1 to 3 feet. Green, one-fourth inch, head.	Annual. Seeds; burs carried by animals in wool, and by streams.	Fence rows, roadsides, pastures, and meadows. Wool and pastures.	Cultivation; burning mature plants before plowing; grubbing or mowing along fence rows and roadsides before the burs form; grazing by sheep.
CORN COCKLE, bastard nigella, cockle, rose campion. *Agrostemma githago.*	Europe. All wheat-raising States.	May to July.	July to August.	Erect, branching, 2 to 3 feet. Purple, 1 inch, solitary.	Annual. Seeds in grain seed.	Grain fields. Wheat, flour.	Use of clean seed; hand pulling in grain; cultivation with hoed crops; use of horse weeder.
DANDELION. *Taraxacum taraxacum.*	Europe. All States.	May to October.	May to November.	Stemless, flower stalks 3 to 10 inches. Yellow, 1 inch, head.	Perennial. Roots forming crown; seeds carried by wind and in grass seeds.	Meadows, pastures, lawns.	Cultivation; pulling or repeated spudding in lawns.
DOG FENNEL, Mayweed, stinking chamomile. *Anthemis cotula.*	Europe. In all States.	June to August.	July to September.	Ascending, branching, 10 to 20 inches. White, with yellow center, three-fourths inch, head.	Annual. Seeds in hay, and in grass seed.	Roadsides, meadows, pastures.	Mowing before flowers open; cultivation.
HORSE NETTLE, bull nettle, devil's potatoes, radical, sand brier. *Solanum carolinense.*	Southeastern United States. New Jersey to Iowa and southward.	June to September.	August to December.	Ascending, with spreading branches, 10 to 30 inches. Purple, 1 inch, short raceme.	Perennial. Running roots; distributed by cultivating tools; seeds in berries, carried by birds, and in hay.	Meadows, pastures, roadsides. All crops.	Cultivation alternating with thick seedings with annual leguminous crops or millet; repeated spudding; application of carbolic acid or hot brine.
HORSEWEED, butterweed, colt's tail, fleabane, mare's-tail. *Erigeron canadense.*	Eastern United States. In all States.	July to September.	August to October.	Erect, branching above, 3 to 5 feet. White, one-fourth inch, heads in cymes.	Annual. Seeds carried by wind and in hay.	Meadows, grain fields, and waste places. All crops.	Mowing before flowers open; cultivation; burning stubble before plowing; clearing out weeds and seeding waste places; use of horse weeder in grain.
JOHNSON GRASS, Australian millet, Cuba grass, evergreen millet, Means grass. *Andropogon halepense.*	Old World. North Carolina to Texas and California.	June to August.	July to September.	Erect, grass, 2 to 4 feet. Green or purple, one-eighth inch, panicle.	Perennial. Rootstocks carried in nursery stock and scattered by cultivating tools; seeds in hay or purposely sown.	Moist or sandy land. All crops except hay.	Close grazing induced by salting the plants; alternate cultivation and heavy cropping; plowing to expose rootstocks to frost or hot sun.

NUT GRASS, bitter coco, coco sedge, nut sedge. *Cyperus rotundus.*	Tropics. Virginia to Texas.	July to September.	August to November.	Erect, grass-like, 6 to 12 inches. Green, one-half line, spikes in umbels.	Perennial. Tubers: carried in nursery stock and by tools; seeds carried in hay.	All soils. Hoed crops.	Thorough cultivation, alternating with thick seedings with cowpeas, velvet beans, or Japan clover; confining hops over small patches.
OXEYE DAISY, bull's-eye, sheriff pink, white daisy, whiteweed. *Chrysanthemum leucanthemum.*	Europe. Maine to Virginia and Ohio.	May to July..	July to September.	Erect, sparingly branched, 10 to 20 inches. White with yellow center, 1 inch, heads.	Perennial. Seeds carried in clover seed and hay, planted for ornament.	Meadows and pastures.	Mowing early in June; cultivation with hoed crops; burning seed-bearing plants.
PIGEON GRASS, pussy grass, summer foxtail, yellow foxtail. *Chaetochloa glauca.*	Old World. In all States.	June to September.	July to October.	Erect, grass, in bunches, 10 to 40 inches high. Green, 1 line, bearded spike.	Annual. Seeds in grain and grass seed.	Broken land, especially grain fields and thinly seeded meadows and pastures.	Late cultivation in hoed crops; mowing or burning stubble; use of clean seed; seeding idle land.
PRICKLY LETTUCE, compass weed, milkweed, wild lettuce. *Lactuca scariola.*	Europe. New York to Iowa, and Utah to Idaho and Washington.	June to September.	July to November.	Erect, branching above, 3 to 6 feet. Yellow, one-fourth inch, heads in panicles.	Annual. Seeds carried by wind and in clover seed.	Everywhere. All crops.	Cultivation, heavy seeding; burning mature plants; hand pulling in grain; use of horse weeder.
RAGWEED, bitterweed, hogweed, little ragweed, richweed, Roman wormwood. *Ambrosia artemisiaefolia.*	Eastern United States. All States east of the Rocky Mountains.	July to September.	August to December.	Erect, branching, 1 to 6 feet. Staminate, yellow, one-fourth inch, heads in racemes; pistillate, green, one-fourth inch, axillary.	Annual. Seeds carried in grain, clover seed, hay, and wool, and blown over snow.	Roadsides, cultivated fields. All crops.	Late cultivation with hoed crops followed by seeding with winter annuals; burning or mowing wheat stubble and roadsides.
RIB GRASS, black plantain, buckhorn, buck plantain, deer tongue, English plantain, lance-leafed plantain, ripple grass. *Plantago lanceolata.*	Europe. In all States where red clover is cultivated.	June to October.	July to November.	Stemless, flower stalks 6 to 18 inches. White, one-sixteenth inch, spike.	Perennial. Root forming crown; seeds in hay, clover and grass seed.	Everywhere, especially in lawns and meadows. All crops.	Cultivation with hoed crops; spudding in lawns; use of clean clover seed.
RUSSIAN THISTLE, Russian cactus, Russian saltwort, Russian tumbleweed. *Salsola tragus.*	Russia. Ohio to Idaho, Colorado, and California.	July to September.	August to November.	Spreading, branching, 6 to 40 inches. Purplish, one-fourth inch, axillary.	Annual. Seeds sown by the plant as a tumbleweed, and carried in grain and flaxseed and by irrigating water.	Broken land, plowed fields, along roadsides, fire-breaks, and irrigating ditches. All grain crops.	Cultivation until August with hoed crops; burning or plowing stubble immediately after harvest; harrowing fire-breaks; use of horse weeder in grain.
SORREL, field sorrel, horse sorrel, red sorrel, red weed, sheep sorrel, sour weed. *Rumex acetosella.*	Europe. New England to Wisconsin and southward; Washington and Oregon.	May to October.	June to November.	Erect, sparingly branched, 6 to 12 inches. Red, one-eighth inch, panicle.	Perennial. Running rootstocks; seeds in clover seed, grass seed, and hay.	Meadows, pastures, and grain fields.	Cultivation; increased fertilization; application of lime to acid soils to stimulate grass and clover; reseeding worn-out pastures.

List of twenty-five weeds especially to be watched, with suggestions for their control and eradication—Continued.

Names, common and technical.	Origin: where now largely injurious.	Time of flowering.	Time of seeding.	Habit, height; color, size, and arrangement of flowers.	Duration; method of propagation and distribution.	Place of growth and products injured.	Methods of control and eradication.
WILD CARROT, bird's nest, devil's plague, Queen Anne's lace. *Daucus carota.*	Old World. New England to Ohio and southward to Georgia.	July to September.	August to December.	Erect, branching, 2 to 4 feet. White, 1 line, umbels.	Biennial. Seeds carried by animals, wind, and in impure clover seed.	Meadows, pastures, and waste land. Hay and grain.	Cultivation; repeated mowing when in flower; grubbing, pulling, increased fertilization and seeding; burning mature plants.
WILD ONION, crow garlic, field garlic, wild garlic. *Allium vineale.*	Europe. Pennsylvania to South Carolina and Tennessee, Indiana and Illinois.	June to July.	July to August.	Stemless, flower stem 1 to 2 feet. White, 1 line, umbels.	Perennial. Bulbs carried in nursery stock and scattered by tools; bulblets and seeds in grain.	Everywhere. Dairy products, grain, flour.	Cultivation with hoed crops; alternating with dense-growing leguminous crops; application of carbolic acid.
YELLOW DOG FENNEL, fennel. *Helenium autumnale.*	Texas and Mexico. Georgia to Texas.	July to October.	August to November.	Erect, branching, 1 to 3 feet. Yellow, one-fourth inch, head.	Annual. Seeds carried in hay.	Meadows, pastures, and grain fields. All crops.	Cultivation with hoed crops; mowing before the flowers open.

TREES IMPORTANT IN FORESTRY.

The following list contains 100 species, selected from the 450 species of trees of the United States, which may be at present considered of highest value. This does not exclude the possibility of extending the list as investigation proceeds.

The relative value of the different species here enumerated is indicated in three classes by difference in type, as follows: First grade, **WHITE PINE**; second grade, JEFFREY PINE; third grade, *PITCH PINE.*

The size stated refers to averages of mature trees; the + sign denoting that larger dimensions are not uncommon.

A. CONIFERS.

(Evergreens and needle-leafed trees, with a few exceptions.)

The most valuable forest trees, as well on account of their usefulness as for their effects in forestry, due to the evergreen foliage of most of them persistent through several years; most capable of covering extensive areas exclusively, and with deciduous trees most excellent aids in forestry on account of their habit of growth and their soil-improving qualities; practically not capable of reproduction by sprouting from the stocks or cuttings; mostly periodical seeders; persistent growers.

Pines.—The most useful conifers and most important forest trees, mostly of the plain; reaching desirable development in comparatively dry, even barren situations. Mostly needing light; tolerably rapid growers; best on light sandy soils with clay subsoil.

Characteristics.—Leaves arranged in twos, threes, or fives in one sheath; cones with thickened scales; seeds almond-shaped, nut-like, of mottled appearance, with their wings only lightly attached; maturing the second year, and preserving their germinating power well. Sixty to seventy species, of which thirty-five are indigenous to the United States.

Wood.—Very variable, very light and soft in "soft" pine, such as white pine; of medium weight to heavy and quite hard in "hard" pine, of which Longleaf or Georgia pine is the extreme form. Usually it is stiff, quite strong, of even texture, and more or less resinous. The sapwood is yellowish-white; the heartwood, orange-brown. Pine shrinks moderately, seasons rapidly and without much injury; it works easily; is never too hard to nail (unlike oak or hickory); it is mostly quite durable, and if well seasoned is not subject to the attacks of boring insects. The heavier the wood, the darker, stronger, and harder it is, and the more it shrinks and checks. Pine is used more extensively than any other kind of wood. It is the principal wood in common carpentry, as well as in all heavy construction, bridges, trestles, etc. It is also used in almost every other wood industry, for spars, masts, planks, and timbers in shipbuilding, in car and wagon construction, in cooperage, for crates and boxes, in furniture work, for toys and patterns, railway ties, water pipes, excelsior, etc. Pines are usually large trees with few branches, the straight, cylindrical, useful stem forming by far the greatest part of the tree; they occur in vast forests, a fact which greatly facilitates their utilization.

List of one hundred species of trees of the United States most valuable for timber, with notes on their range of distribution, cultural requirements, and the character and uses of their wood.

Name of species and limit of size.	Regions of abundant growth.	Characteristics and uses of wood.	Soil and climate, and characteristics of growth.
1. **WHITE PINE**..............	Northern; wide range, forming forests to Southern mountains.	Light, soft, not strong, heartwood durable in contact with the soil; *free from resin and easily worked.*	Best on light, sandy, fresh, deep soils, but successful on a large range of soils from dry to moist. Rapid grower; endures some shade; hardy, but little tolerant of drought.
(*Pinus strobus* Linn.) Height, 120 feet +; diameter, 3 feet +.	Best development in region of the Great Lakes.	Immense quantities used for *lumber* of different kinds, cabinet work, timber, shingles, laths, and inferior fuel.	The *most important* conifer of the United States; good quality, however, only in centenarians. Is best mixed with deciduous trees; of rather slow, but high percentage of germination; plant one or two-year-old transplanted seedlings, or sow.
2. **RED PINE**.............. (Norway Pine.)	Northern; associated mostly with White Pine.	Light, harder and stronger than that of White Pine; elastic, very resinous; wide sapwood; hence young timbers, piles, etc.; not durable.	Soils like those of White Pine; adapted to many soils, but best quality of timber produced in well-drained sands. Extremely hardy; *vigorous* and *rapid* grower.
(*Pinus resinosa* Ait.) Height, 100 feet +; diameter, 2½ feet +.	Greatest development from Michigan to Minnesota.	Used chiefly for *lumber*, timber, and piles; in the trade, handled together with White Pine.	Should be favored in northern and northeastern planting with White Pine and deciduous trees. So far, seed very expensive and difficult to obtain.

List of one hundred species of trees of the United States most valuable for timber, etc.—Continued.

Name of species and limit of size.	Regions of abundant growth.	Characteristics and uses of wood.	Soil and climate, and characteristics of growth
3. *PITCH PINE* (*Pinus rigida* Miller.) Height, 50 feet +; diameter, 1¼ feet +.	Northeastern and Middle Atlantic States.	Light, brittle, harder, and stronger than that of White Pine. Employed chiefly for fuel and charcoal, but occasionally for inferior lumber and mine props.	Best on fresh to moist sand, but will succeed on dry, barren, sandy, or rocky soils, and even on wet, cold, swampy ground, or seacoasts liable to floods. A rapid grower, and when young hardy and indifferent to drought; light-needing; an early seeder; sprouts from the stump; not easily transplanted; best and *easily* propagated from *seed;* mainly for *seacoast* planting.
4. *JACK PINE* (SCRUB PINE. PRINCE'S PINE.) (*Pinus divaricata* (Ait.) Gord.) Height, 60 feet +; diameter, 1 foot +.	Northern (in United States), forming forests far north. Greatest development north of Lake Superior.	Among the lighter "hard pines". Employed chiefly for fuel and ties.	Common on sandy, barren soil. Valuable only as first cover for northern pine-barrens. Rapid grower in its youth and easily handled; very hardy, enduring heat and cold well; successful on the plains.
5. *SCRUB PINE* (*Pinus virginiana* Mill.) Height, 80 feet +; diameter, 2 feet +.	Middle Atlantic region	Extensively used for fuel; pump logs, water pipes, occasionally for piles and coarse lumber.	Common on poor, dry, sandy, gravelly, and clayey soils; less frequent in rich soils. Moderately rapid grower, quickly taking possession of old, worn-out fields and washed lands.
6. **LONGLEAF PINE** (SOUTHERN PINE. YELLOW PINE. GEORGIA PINE. HARD PINE.) (*Pinus palustris* Miller.) Height, 100 feet +; diameter, 2½ feet +.	South Atlantic and Gulf States.	Heavy, hard, tough, and very strong; *very durable, very resinous.* Chiefly for *lumber;* shipbuilding, fencing, ties; good fuel. The *turpentine*, tar, pitch, and spirits of turpentine of United States market derived almost entirely from this tree.	Well-drained, loose, deep sandy loam or gravel The slow growth of first five years (quasi-endogenous) makes its forestry problematic; development dependent on atmospheric moisture; least shade-enduring of pines. Rare but plentiful seeder; germinates freely; can therefore be propagated by sowing seed in permanent place. Most valuable pine of the South, but for best quality requires long period of growth (two hundred years?).

7. **SHORTLEAF PINE** ...... (BULL PINE. YELLOW PINE. SPRUCE PINE.) (*Pinus echinata* Miller.) Height, 90 feet +; diameter, 2 feet +.	Middle Atlantic and Southern States; associated mostly with hardwood trees. Best development in western Louisiana, southern Arkansas, and eastern Texas.	Medium "hard pine".................. Used chiefly for furniture *lumber*. Very much like that of Longleaf Pine, but somewhat inferior; in some localities bled for turpentine.	More common on light sandy soil than on low borders of swamps. A rather slow grower; will succeed on the poorest soil. Easily reproduced; good seeder; light needing.
8. **CUBAN PINE** .... (SLASH PINE. SWAMP PINE. BASTARD PINE.) (*Pinus heterophylla* (Ell.) Sudw.) Height, 90 feet +; diameter, 2 feet +.	Southern and southeastern coast; local in swamps and near water courses. Best development in eastern Florida.	Heaviest and strongest of our hard pines; not distinguished in the market from Longleaf Pine. Employed for construction, timber, and lumber; yields resinous matter; equal to Longleaf Pine.	Light sandy soil; somewhat indifferent to drainage. *Rapid grower; easily reproduced;* matures seed yearly; competing with the Longleaf Pine on wet sags; light-needing.
9. **LOBLOLLY PINE** .... (OLD-FIELD PINE.) (*Pinus tæda* Linn.) Height, 100 feet +; diameter, 2½ feet +.	Southeastern.................. Greatest development in Virginia and North Carolina.	Wood typical "hard pine;" mostly coarse-grained; wide sap; very variable in quality. Used principally for lumber of an inferior quality and for fuel; yields very little *resin*.	Low, moist, or dry sandy soils and abandoned fields. Adapted to a wide range of sites. Rapid grower; *light-needing;* seeds persistently and plentifully. A useful concomitant of Southern forestry.
10. *SPRUCE PINE*............... (OLD-FIELD PINE OF FLORIDA. CEDAR PINE. WHITE PINE.) (*Pinus glabra* Walter.) Height, 80 feet +; diameter, 2 feet +.	Southeastern States........... Best development in Alabama and Mississippi.	Light, *soft, easily worked*, brittle, not strong nor durable; resembles that of *Pinus tæda;* not resinous, coarse-grained, wide sap. Rarely cut; for inside work; not distinguished in the market from Loblolly and Shortleaf Pine lumber.	Grows on better and moister soils than *Pinus tæda*. Loblolly Pine hummocks and rich bottom lands; rare; usually isolated or in groups. A rapid grower; shade-enduring.
11. **BULL PINE** .... (YELLOW PINE. HEAVY-WOODED PINE.) (*Pinus ponderosa* Douglas.) Height, 200 feet +; diameter, 12 feet +.	Rocky Mountains to the Pacific, up to high elevations; forming forests. Best developed on western slope of Sierras of northern and central California.	Very variable in quality, brittle, strong; not durable. Employed largely for lumber, mining timber, ties, and fuel.	Dry, rocky ridges and prairies, sometimes in swamps; but best in deep loamy sand. Vigorous, rapid grower; very hardy, except when quite young. Well adapted to dry, windy, exposed places; succeeds on Western prairies. The pine for reforesting southern exposures of the Western mountain regions.

List of one hundred species of trees of the United States most valuable for timber, etc.—Continued.

Name of species and limit of size.	Regions of abundant growth.	Characteristics and uses of wood.	Soil and climate, and characteristics of growth.
12. JEFFREY PINE (BULL PINE.) (*Pinus jeffreyi* Murray.) Height, 100 feet +; diameter, 4 feet +.	California and Oregon: western slopes of Sierra Nevada above 6,000 feet.	Quality and uses like Bull Pine.	Replacing Bull Pine; rare.
13. *BRISTLE-CONE PINE.* (*Pinus aristata* Engelm.). Height, 100 feet; diameter, 4 feet.	Local—Rocky Mountains and southeastern California; above 7,500 feet.	Light, soft, not strong. In Nevada employed for mining-timber.	Dry, gravelly ridges. The White Pine for cover of high elevations in southern Rocky Mountains.
14. **SUGAR PINE.** (*Pinus lambertiana* Dougl.) Height, 150 feet +; diameter, 4 feet +.	Western Pacific slope. Best development in Sierras of central and northern California above 4,000 feet; lower in Oregon.	Typical "soft pine," like the White Pine of eastern United States, and used similarly. Seeds large and edible.	Very rapid grower. Quite hardy in the East. Best Pine for reforestation in its native habitat.
15. *MONTEREY PINE.* (*Pinus radiata* Don.) Height, 80 feet +; diameter, 2 feet +.	Local—California coast, south of San Francisco.	Light, soft, brittle, not strong; according to some authorities, tough and of good repute.	Light, well-drained soils, and on drifting sands. Easily propagated; seed of very high percentage of germination; very rapid grower. Useful for reforesting Western barrens.

II. SPRUCES.—Next in importance to the pines, though the wood is less resinous, weaker, and not so durable. Of northern or mountain habitat, in cool situations and moist soils: endures shade and grows mostly with rapidity and persistency. The Norway Spruce of Europe appears, so far, superior for forestry to the native species.

Characteristics.—Leaves single, rigid, sharp-pointed, four-cornered, bristling mostly all around the twigs; cones oblong, hanging, with thin, persistent scales; seeds resembling those of the pines, but usually smaller, more uniform in color, and angular: mature the first year, and preserve power of germination well; mostly periodical, but seeds abundantly; crown pyramidal; about twelve species, of which five are indigenous. Spruce wood resembles soft pine, is light, soft, stiff, moderately strong, less resinous than pine; has no distinct heartwood, and is of whitish color; used like soft pine, but also employed as resonance wood, and preferred for paper pulp. Spruces, like pines, form extensive forests. They are more frugal, thrive on thinner soils, and bear more shade, but usually require a more humid climate. "Black" and "white" spruce, as applied by lumbermen, usually refer to narrow and wide ringed forms of the Black Spruce (*Picea mariana*).

List of one hundred species of trees of the United States most valuable for timber, etc.—Continued.

Name of species and limit of size.	Regions of abundant growth.	Characteristics and uses of wood.	Soil and climate, and characteristics of growth.
16. BLACK SPRUCE	Mainly northeastern;* forming forests.	Light, soft, strong	Light, dry, stony soils; much smaller in cold, wet swamps.
(*Picea mariana* (Mill.) B. S. P.) Height, 80 feet; diameter, 1½ feet +.	Best development north of latitude 50°.	Used most largely for pulp, also for lumber, shipbuilding, posts, piles, poles, ties; *tougher, stronger*, and more *elastic* than that of white pine; not good fuel.	Endures less shade than Norway Spruce; rapid grower.
17. WHITE SPRUCE (*Picea canadensis* (Mill.) B. S. P. Height, 100 feet; diameter, 1½ feet +.	Mainly northeastern and extending into Rocky Mountains; forming forests.	Like the Black Spruce, from which the timber is not distinguished in commerce, and used for the same purposes.	Like Black Spruce, but probably better adapted to western planting, being hardier.
18. ENGELMANN SPRUCE	Western mountain regions and northward; high elevation.	Very light, soft, not strong	Dry, gravelly slopes, 5,000 to 11,500 feet.
(WHITE SPRUCE.) (*Picea engelmanni* Engelm.)	Best development in central Rocky Mountain region, between 9,000 and 10,000 feet.	Resembles the wood of eastern spruces in quality and uses.	A tree for reforestation of mountain slopes along water courses.
Height, 100 feet +; diameter, 3 feet +.		Used chiefly for lumber; bark used in tanning. (?)	
19. SITKA SPRUCE (TIDE-LAND SPRUCE.)	Alaska and Northwestern coast: low elevations.	Light, soft, not strong (according to others strong); superior to that of other native species, but almost always coarse-grained.	Moist soil and climate, at least a moist subsoil, shady situations. *Rapid grower.*
(*Picea sitchensis* Carrière.) Height, 150 feet +; diameter, 6 feet +.		Used chiefly as lumber for construction, interior finish, fencing, boat-building; cooperage, woodenware, boxes.	Probably hardy in Northeastern and Middle States, in shaded positions.

*Includes also the Red Spruce (*Picea rubra*), this being the principal timber spruce of the region.

III. FIRS.—Important to forestry mainly on account of their great endurance of shade. Of northern and mountain distribution; still more dependent on moisture of climate and cool or at least evenly tempered situations than the spruces, and in their youth mostly less hardy; usually grow slowly, but persistently. Some exotics seem to be of more value than the native species (*Abies nordmanniana*).

Characteristics.—Leaves single, flat, rather blunt, arranged somewhat comb-like on the twigs. Cones cylindrical, standing erect on the branches; scales thin, and falling away when mature; seeds triangular, partly inclosed by a more or less persistent wing; mature first year, but do not preserve their power of germination well. Frequent and abundant seeders. Crown conical. About eighteen species, of which eight are indigenous.

The name is frequently applied to wood and to trees which are not fir: most commonly to spruce, but also, especially in English markets, to pine. The wood resembles spruce in color, quality, and uses, but is easily distinguished from it, as well as from pine and larch, by the absence of resin ducts.

List of one hundred species of trees of the United States most valuable for timber, etc.—Continued.

Name of species and limit of size.	Regions of abundant growth.	Characteristics and uses of wood.	Soil and climate, and characteristics of growth.
20. WHITE FIR (BALSAM FIR. BLACK BALSAM.) (*Abies concolor* (Gord.) Parry.) Height, 100 feet +; diameter, 4 feet +.	Southwestern mountains and Pacific slope; high elevations. Best development in Sierras of California.	Very light, soft, not strong Occasionally manufactured into lumber, butter tubs, and used for other domestic purposes.	Moist slopes and canyons, between 3,000 and 9,000 feet; cool and shady situations.
21. *BALSAM FIR* (BALM OF GILEAD FIR.) (*Abies balsamea* Miller.) Height, 70 feet +; diameter, 1½ feet +.	Northeastern States and northward.	Very light, soft; not strong nor durable in contact with the soil. Used for common lumber (box-boards) and pulp wood.	Cold, damp woods and swamps. Rapid grower. Valuable only as undergrowth, or as nurse, and in imperfectly drained situations.
22. GREAT SILVER FIR (WHITE FIR.) (*Abies grandis* Lindl.) Height, 200 feet; diameter, 5 feet +.	Northwestern coast Best development in western Washington and Oregon, along river bottoms.	Light, soft, not strong For lumber, cooperage, etc.	Bottom lands; rich moist soil. Very hardy and rapid grower; affected less by late frosts and occasional droughts than most firs.

23. NOBLE FIR. (*Abies nobilis* Lindl.) Height, 200 feet +; diameter, 5 feet +.	Northwestern coast; wide range; always near mountain tops and high elevations; found often in groves dispersed through extensive forests.	Light, hard, elastic, and tolerably strong	Probably hardy east of the Rocky Mountains, with proper protection.
	Best development in Sierra Nevada, from Columbia River to northern California.	Excellent lumber for interior finish. Sold in market as "larch."	Requiring moist atmosphere for best development.
24. AMABILIS FIR. (*Abies amabilis* (Loud.) Forbes.) Height, 100 feet +; diameter, 4 feet +. According to others, 250 feet high and 5 feet in diameter.	Northwestern coast, mostly associated with the preceding species.	....	Gravelly soils.
	Best development on mountains south of Columbia River; 3,000 to 4,000 feet.	Like Noble Fir, with which it is cut and marketed.	Will probably prove hardy in Eastern States.

IV. BASTARD SPRUCES.—Under this name may be grouped the Hemlocks and Douglas Spruce, formerly classed with the spruces and firs proper. Mostly of northern distribution, and therefore best adapted to cool, moist situations; enduring considerable shade. Some of the species grow very rapidly.

Characteristics.—Leaves single flat, linear, with distinct stalks (petioles) somewhat comb-like in their arrangement on the twigs. Cones usually small, with thin scales, hanging from the ends of the branches. Seeds, partly inclosed in a persistent wing; resemble those of the firs, but of smaller size; mature the first year, do not keep well; low percentage of germination. Branches pendant; crown spindle-like in form. Two genera, comprising seven species, five of which are indigenous.

The wood of the Douglas Spruce resembles the common "hard pine" (Red, Loblolly, etc.) in texture and grain, resembles the larch in color, and is used for all purposes for which pine is employed, the excellent dimensions naturally leading to its preference for many purposes.

The wood of the Eastern Hemlock is used chiefly for dimension stuff, also for boards, and recently for pulp; but it has been well demonstrated that the wood is well suited even for finishing lumber, and that the prevailing prejudice against it is as unwarranted in the case of the Eastern as in that of the Western Hemlock. The appearance of the wood in oil finish is very satisfactory.

List of one hundred species of trees of the United States most valuable for timber, etc.—Continued.

Name of species and limit of size.	Regions of abundant growth.	Characteristics and uses of wood.	Soil and climate, and characteristics of growth.
25. **DOUGLAS SPRUCE**	Rocky Mountain region to Pacific; wide range; forming forests.	Rather heavy, hard, strong, durable.	Accommodates itself to many soils, but prefers a deep and moist cool and well-drained one; succeeds well on a dry slaty soil, and on sand dunes and exposed situations.
(RED FIR. YELLOW FIR. OREGON PINE.)	Best development in western Oregon and Washington.	Used chiefly for *lumber* and in construction, for ties, piles, and fuel; bark employed in tanning.	Surpasses almost all of the conifers in the *rapidity* of its growth, and endures *drought* better than most of them; *shade-enduring*.
(*Pseudotsuga taxifolia* (Poir.) Britt.)			
Height, 300 feet +; diameter, 10 feet +.			One of the largest and most important forest trees of the West. For Eastern planting seed should be procured from Colorado or Montana. Repairs damage very readily.
26. HEMLOCK	Northern and Eastern States, forming forests.	Light, soft, rather strong, not durable; mostly fine-grained, and peculiar for holding nails well.	Light, alluvial loam, well-drained, but cool and moist situations.
(*Tsuga canadensis* (Linn.) Carr.)	Best development probably in Canada.	Usually manufactured into coarse lumber; used also for ties, construction, etc. The *tan-bark* of this species is the principal one used in Northern States.	Grows slowly when young, but tolerably rapidly after four or five years; endures shade.
Height, 80 feet +; diameter, 3 feet +.			Excellent nurse tree for white pine, with which it is usually associated.
27. WESTERN HEMLOCK	Northwestern States, between 1,000 and 4,000 feet.	Rather heavy, hard, strong	A substitute for the above species on the Pacific Coast.
(*Tsuga mertensiana* (Bong.) Carr.)	Best development in western Oregon and Washington.	Employed somewhat for coarse lumber; would make good finishing material.	An exceedingly rapid grower, even on poor soils.
Height, 180 feet +; diameter, 6 feet +.		The bark contains tannin, but is too thin for economic use.	Very shade enduring, forming large part of the undergrowth in its habitat.

V. DECIDUOUS CONIFERS.—Though botanically not classed together, yet in forestry they may be considered allied, as the yearly fall of leaves improves the soil, while the absence of foliage during the winter and early spring distinguishes them from the evergreens, and their extreme need of light requires similar forest management. The Larches are of Northern or mountain habitat and the Bald Cypress of local southern distribution, but all are adapted to various situations. The European Larch probably surpasses the Northeastern Tamarack in every respect.

Characteristics.—Larches: Leaves in clusters, slender and soft. Cones small, egg-shaped, or elongated, with thin scales. Seeds small, triangular, nut-like in shape; mature the first year. Produces seed frequently and abundantly. Seeds keep well, but are of low percentage of germination.

Bald Cypress: Leaves single, sharp-pointed, very small and scanty, comb-like in the arrangement on the young twigs. Cones ball-like, with thick, woody scales, falling apart when mature. Seeds irregularly triangular-shaped, with hard, thick, wood-like shell; mature yearly abundantly, and keep well.

List of one hundred species of trees of the United States most valuable for timber—Continued.

Name of species and limit of size.	Regions of abundant growth.	Characteristics and uses of wood.	Soil and climate, and characteristics of growth.
28. **BALD CYPRESS** ... ... (*Taxodium distichum* Rich.) Height, 150 feet; diameter, 8 feet.	South Atlantic and Gulf States, forming forests in swamps and pine-barren ponds.	Moderately light, soft, and stiff; *very durable* in contact with the soil. Used largely in manufacture of *lumber* for construction and interior finish, *shingles*, for ties, posts, cooperage.	Indifferent to imperfect drainage and flooding, but capable of rapid growth on well-drained, moist, sandy soils, and hardy as far north as latitude 39° and 40°, and even on Western prairies. Positively light-needing. To be recommended for extensive planting in favorable situations, where even, superior lumber may be expected.
29. *TAMARACK*.................. (BLACK LARCH. HACKMATACK.) (*Larix laricina* (Du Roi) Koch.) Height, 80 feet; diameter, 1 foot +.	Northeastern (in United States). Best development probably north of the United States boundary.	Heavy, hard, very *strong; moderately durable* in contact with the soil. Employed largely for upper knees of vessels, *ship timbers*, posts, *ties*, *telegraph poles*, and occasionally for lumber.	North of United States boundary, found on moist uplands; south in United States, in cold, wet swamps; but probably of more value when grown on deep, moist, well-drained soils, in cool situations. Rapid and persistent grower; light-needing. Deserves attention in Northern forestry, but only in mixed growths.
30. **WESTERN LARCH**...... (TAMARACK.) (*Larix occidentalis* Nutt.) Height, 100 feet +; diameter, 4 feet +.	Northwestern; elevations between 2,500 and 5,000 feet. Best development in valley of Flathead River, Montana.	Heavy, very hard, strong; durable in contact with the soil. Chiefly for posts, ties, fuel, and occasionally for lumber.	An important tree as a Western representative of the foregoing species, occupying dry slopes in dry climate.

VI. CYPRESS FAMILY.—Under this head may well be grouped the junipers and so-called cedars, to which can be added the California redwoods. Characterized mostly by the shingle-like arrangement of their small, scaly leaves, the small, roundish fruit (a cone, or *berry-like ?*), and by the usually upright habit of the branches and scanty fall of leaves.

Their great endurance of shade makes them valuable adjuncts to forestry; otherwise of only secondary importance. Of the many species contained in seven genera, but fourteen are found in the United States.

Wood light, soft, stiff, not strong, of fine texture; sap and heartwood distinct, the former lighter, the latter a dull, grayish brown, or red. The wood seasons rapidly, shrinks and checks but little, and is very durable. Used like soft pine, but owing to its great durability preferred for shingles, etc. Small sizes used for posts, ties, etc. Cedars usually occur scattered, but they form in certain localities forests of considerable extent.

List of one hundred species of trees of the United States most valuable for timber—Continued.

Name of species and limit of size.	Regions of abundant growth.	Characteristics and uses of wood.	Soil and climate, and characteristics of growth.
31. **RED JUNIPER** (SAVIN.) (*Juniperus virginiana* Linn.) Height, 50 feet +; diameter, 1½ feet +.	Eastern United States Best development in valley of Red River, Texas.	*Light, soft*, brittle, fine-grained; very *durable* in contact with the soil. Fence posts, ties, telegraph and telephone poles, piles, cabinetwork, and almost alone for wood of lead *pencils*.	Prefers a mild climate; deep swamps, borders of streams, ridges, hills; will thrive on a rather dry, loose soil. Easily propagated from seed and cuttings. Perhaps the most important conifer for Southwestern prairie planting, enduring drought and partial shade. Tolerably rapid grower.
32. WHITE CEDAR. (*Chamæcyparis thyoides* (Linn.), B. S. P.) Height, 70 feet +; diameter, 1½ feet +.	Atlantic and Gulf States to central Mississippi. Most abundant and best developed in Virginia and North Carolina.	Light, soft, fine-grained; *very durable* in contact with the soil. Used principally for shingles, ties, posts, telephone and telegraph poles, piles, cooperage, boat building, wooden ware.	Always in low, marshy, or wet ground, where it thrives well and grows rapidly. Endures moist, upland soils, but with slow growth. Very shade-enduring; easy to propagate from seed or cuttings.
33. PORT ORFORD CEDAR (*Chamæcyparis lawsoniana* (Murr.) Parl.) Height, 150 feet +; diameter, 8 feet +.	Small range; in Oregon along western coast from Coos Bay, Oregon, to Crescent City, Cal.	Light, hard, strong, close-grained; very durable lumber for interior finish, ties, posts, and for boat and ship building.	Commonly in low, moist, rich soil. Apparently hardy in the Northeastern States and succeeds on deep, rich, upland soils and maintains itself in clay loam.
34. **YELLOW CEDAR** (*Chamæcyparis nootkatensis* (Lamb.) Spach.) Height, 150 feet +; diameter, 5 feet +.	Northwest coast region, from Mt. Jefferson northward. Most common on the seacoast north of United States boundary.	Light, hard, brittle, very fine-grained, and durable. Cut without distinction together with Pacific arbor vitæ; largely used for doors, blinds, interior finish, cabinetwork.	Like Arbor Vitæ.
35. *ARBOR VITÆ* (WHITE CEDAR.) (*Thuja occidentalis* Linn.) Height, 50 feet +; diameter, 1½ feet.	Northeastern States and northward.	Light, soft; not strong; *very durable* in contact with the soil. Used chiefly and largely for posts, ties, telephone and telegraph poles, and shingles.	Will grow well in any soil not too stiff; often forming dense, pure growths in wet, boggy swamps. Rapid grower; easily propagated; desirable for undergrowth and to fill out places where other trees fail to come.

36. GIANT ARBOR VITÆ ..... (RED CEDAR. YELLOW CEDAR.) (*Thuja plicata* Don.) Height, 150 feet +; diameter, 9 feet +.	Northwestern coast and from Humboldt, Cal., to British Columbia. Best development north of Seattle.	Light, soft, brittle; not strong; very durable in contact with the soil. Used principally for interior finish, cabinetmaking, shingles, cooperage, fencing. Indians of Northwest employ it exclusively for making canoes.	Like the above species, on Pacific Coast.
37. INCENSE CEDAR .... (BASTARD CEDAR. POST CEDAR. INCENSE CEDAR.) (*Libocedrus decurrens* Torr.) Height, 100 feet +; diameter, 6 feet +.	In interior valley between Coast range and Sierra from middle Oregon to California; (between 3,000 and 8,500 feet.)	Light, soft, brittle, not strong; very durable in contact with the soil; but according to others not at all so. Used for fencing, posts, water-flumes, and other home consumption; often "pecky."	Slopes and valleys, in well-drained and dry soils. Rapid grower; of excellent appearance. In the East probably adapted only to Southern States; succeeds excellently at Washington, D. C.
38. **REDWOOD**.................. (*Sequoia sempervirens* Endl.) Height, 300 feet +; diameter, 20 feet +.	California coast from Oregon southward; forest-forming.	Light, soft, brittle, not strong; very durable in contact with the soil. The chief and most valuable building timber of the Pacific Coast. In California used almost entirely for shingles, posts, ties, poles, telegraph poles, water tanks, tubs, etc.	Low, moist, well-drained situations and damp climate; not on dry hillsides. Vigorous and persistent grower; shade-enduring; sprouts from the stump. Highly important for California forestry; perhaps also for that of Southern States.
39. *BIG-TREE* .... (*Sequoia washingtoniana* (Winsl.) Sudw.) Height, 350 feet +; diameter, 35 feet +.	California; very local and isolated.	Light, soft, brittle, weak; exceedingly durable in contact with the soil. Once locally used for lumber, fencing, shingles, construction, etc.	Moist situations, between 4,000 and 6,000 feet. Probably only of historical interest.

B. BROAD-LEAFED TREES.

(With few exceptions these trees are deciduous.) Neither a strictly botanical nor a strictly practical classification in large groups has been attempted, but a sequence within botanical relations, and an arrangement according to the nature of the seed has been more or less observed, placing first the acorn and nut-bearing trees, next those with hard, wingless seeds, and lastly, those with soft and winged seeds.

THE OAKS.—Wood very variable, usually very heavy and hard, very strong and tough, porous, and of coarse texture; the sapwood whitish, the heart "oak" brown to reddish brown. It shrinks and checks badly, giving trouble in seasoning, but stands well, is durable, and little subject to attacks of insects. Oak is used for many purposes: in shipbuilding, for heavy construction, in common carpentry, in furniture, car, and wagon work, cooperage, turnery, and even in wood carving; also in the manufacture of all kinds of farm implements, wooden mill machinery, for piles and wharves, railway ties, etc. The oaks are medium to large sized trees, forming the predominant part of a large portion of our broad-leafed forests, so that these are generally "oak forests," though they always contain a considerable proportion of other kinds of trees. Three well-marked kinds—white, red, and live oak—are distinguished and kept separate in the market. Of the two principal kinds white oak is the stronger, tougher, less porous, and more durable. Red oak is usually of coarser texture, more porous, often brittle, less durable, and even more troublesome in seasoning than white oak. In carpentry and furniture work, red oak brings about the same price at present as white oak. The red oaks everywhere accompany the white oaks, and, like the latter, are usually represented by several species in any given locality. Live oak, once largely employed in shipbuilding, possesses all the good qualities (except that of size) of white oak, even to a greater degree. It is one of the heaviest, hardest, and most durable building timbers of this country; in structure it resembles the red oaks, but is much less porous.

List of one hundred species of trees of the United States most valuable for timber—Continued.

Name of species and limit of size.	Regions of abundant growth.	Characteristics and uses of wood.	Soil and climate, and characteristics of growth.
40. **WHITE OAK**	North Central, Central, and Eastern States.	Heavy, hard, strong, tough, durable in contact with the soil.	Grows well on a great variety of soils, but best on deep, moderately moist, well-drained loamy sand, and in warm situations. Slow but persistent grower; light-needing; capable of enduring shade, but not with advantage. Most valuable of the American oaks.
(*Quercus alba* Linn.) Height, 100 feet +; diameter, 3 feet +.	Best development on western slopes of Alleghany Mountains and valley of Ohio River.	Chiefly for shipbuilding, construction of all kinds, *cooperage*, carriage and wagon stock, *agricultural implements*, fencing, posts, ties, *piles*, cabinetmaking, interior finish, coarse lumber, and fuel.	
41. **COW OAK**	Southeastern	Equal to the White Oak	Moist, rich soil; will endure flooding.
(SWAMP CHESTNUT OAK, BASKET OAK.) (*Quercus michauxii* Nutt.) Height, 100 feet +; diameter, 3 feet +.	Best development on the rich bottom lands of southeastern Arkansas and Louisiana.	Largely employed in the manufacture of agricultural implements, wheel stocks, cooperage, baskets, fencing and fuel.	The most valuable of the White Oaks for the Gulf States.
42. **CHINQUAPIN OAK**	Central and Middle Atlantic region.	Very much like White Oak	Best in deep, rich, moist, well-drained bottom lands, but grows well and is not uncommon on dry, fertile, limestone soils; it also succeeds on clayey and sandy soils of uplands.
(*Quercus acuminata* (Michx.) Houba.) Height, 80 feet +; diameter, 3 feet +.	Largest growth in lower Ohio Valley.	Employed largely in cooperage, wagon-making, for ties, posts, and coarse lumber.	
43. LIVE OAK	Southern States	Very heavy, hard, *strong*, tough, and durable.	Warm, loamy soil, retentive of moisture, and free from overflow.
(*Quercus virginiana* Miller.) Height, 80 feet +; diameter, 3 feet +.	Greatest development in Southern Atlantic States.	Once largely employed in shipbuilding, but now only occasionally; somewhat for tool stock.	One of the most *rapid* growers *of all the oaks; most shade-enduring;* evergreen foliage. Especially desirable for Southern forestry.

44. *CAÑON LIVE OAK* (MAUL OAK. VALPARAISO OAK.) (*Quercus chrysolepis* Liebm.) Height, 80 feet +; diameter, 5 feet +.	Pacific States, 3,000 to 8,000 feet elevation.	Very heavy, hard, tough; very strong. Employed considerably in the manufacture of agricultural implements, wagons, etc.	Warm, dry, sunny exposures. Most valuable of the Pacific oaks. Foliage evergreen.
45. TAN-BARK OAK (PEACH OAK.) (*Quercus densiflora* Hook. & Arnott.) Height, 60 feet +; diameter, 2 feet +.	Pacific coast. Best development in redwood belt on California coast.	Heavy, hard, strong; inferior to other white oaks; valued chiefly for tan bark.	Well drained, rich soils. Shade-enduring. Foliage evergreen.
46. CHESTNUT OAK (ROCK CHESTNUT OAK.) (*Quercus prinus* Linn.) Height, 80 feet +; diameter, 3 feet +.	Northeastern. Best development in southern Alleghany Mountains.	Somewhat less valuable than White Oak. Less valuable than the foregoing species. Used chiefly for fencing, ties, and somewhat for coarse lumber. Valued principally for *tan bark*.	For planting on rocky banks and hillsides; never in any but well-drained situations.
47. **BUR OAK** (MOSSY-CUP OAK. OVER-CUP OAK.) (*Quercus macrocarpa* Michx.) Height, 100 feet +; diameter, 3½ feet +.	Mainly Northeastern United States; extends farthest west and northwest of any of the Eastern oaks.	Heavy, hard, strong, tough; most *durable* in contact with the soil of any of American oaks. Employed for the same purposes as that of White Oak; more durable, but porous.	Requires better soil than White Oak—deep, rich loam; more shade-enduring. A Western substitute for White Oak, and especially recommended for prairie planting.
48. **POST OAK** (IRON OAK.) (*Quercus minor* (Marsh.) Sarg.) Height, 80 feet +; diameter, 2½ feet +.	East of the Rocky Mountains.	Equal to White Oak. Chiefly for fencing, ties, fuel, and occasionally for carriage stock, cooperage, and other construction; usually not distinguished from White Oak in the market.	Well-drained gravelly uplands, clay barrens, and poor sandy loams. Recommended for Western planting.

List of one hundred species of trees of the United States most valuable for timber—Continued.

Name of species and limit of size.	Regions of abundant growth.	Characteristics and uses of wood.	Soil and climate, and characteristics of growth.
49. OVERCUP OAK	Southeastern United States	Like White Oak and used for the same purposes.	Chiefly in wet or submerged swamps, but grows well in well-drained bottom lands and on rich, gravelly or sandy loam uplands.
(*Quercus lyrata* Walt.)	Best developed in Arkansas and adjacent Texas.		
Height, 80 feet +; diameter, 2 feet +.			
50. SWAMP WHITE OAK	Northeastern United States	Like the White Oak and used for the same purposes, but perhaps more durable in contact with the soil.	In deep moist or inundated swamps and low banks of water courses. Succeeds in all loose, rich, fairly moist upland soils.
(*Quercus platanoides* (Lam.) Sudw.)	Best development in region south of the Great Lakes.		
Height, 90 feet +; diameter, 2 feet +.			
51. **RED OAK**	East of Rocky Mountains	Heavy, hard, strong; inferior in quality to White Oaks.	Thrives in all soils, except an undrained one.
(*Quercus rubra* Linn.)	Most northerly of Atlantic oaks.	Largely employed for cooperage, manufacture of furniture, and for interior finish. Important for *tan-bark*.	The most *rapid* in growth of all the oaks. Sprouts vigorously from stump; of importance for tan-bark coppices.
Height, 100 feet +; diameter, 3½ feet +.	Best development in Massachusetts.		
52. **BLACK OAK**	East of longitude 96°, United States.	Heavy, hard, strong, not tough	Gravelly uplands; poorer soils than White Oak requires.
(YELLOW-BARK OAK. YELLOW OAK. QUERCITRON OAK.)	Best development in North Atlantic States.	Used for cooperage, agricultural implements, construction, and extensively for furniture and interior finish. Superior to White Oak for some purposes. Important for tan bark.	Next to the Red Oak in rapidity of growth.
(*Quercus velutina* Lam.)			
Height, 80 feet +; diameter, 3 feet +.			
53. SPANISH OAK	Central, Southeastern, and Southern States.	Heavy, very hard and strong; not durable.	Dry, barren soils; rapid grower.
(RED OAK.)	Best development in South Atlantic and Gulf States.	Used for cooperage, construction, and fuel. Important for tan bark.	
(*Quercus digitata* (Marsh.) Sudw.)			
Height, 80 feet +; diameter, 3 feet +.			

54. WATER OAK. (DUCK OAK. POSSUM OAK. SPOTTED OAK.) (*Quercus nigra* Linn.) Height, 75 feet +; diameter, 3 feet +.	Central, Southern, and Southeastern States. Greatest development in eastern Gulf region.	Heavy, hard, strong. Chiefly for fuel; also for cooperage and construction—hewn and sawn dimension timber sometimes passing for White Oak in inspection.	Heavy undrained soil; exceedingly rapid grower. A useful *concomitant* in Southern planting.
55. **BEECH**. (*Fagus atropunicea* (Marsh.) Sudw.) Height, 100 feet +; diameter, 3 feet +.	East of Mississippi and Missouri rivers. Best development probably on "bluff" formations of Lower Mississippi basin.	Heavy, hard, stiff, strong, of rather coarse texture; white to light brown; not durable in the ground, and subject to the inroads of boring insects; shrinks and checks considerably in drying; works and stands well and takes a good polish. Used for furniture, in turnery, for handles, lasts, etc.	Fresh, rich, but not necessarily a deep soil; limestone soils. For rocky, exposed situations. Rapid grower and *enduring shade* exceedingly well, a fact which renders it one of the most valuable aids in forestry.
56. CHESTNUT. (*Castanea dentata* (Marsh.) Borkh.) Height, 90 feet +; diameter, 14 feet +.	Northeastern and Middle Atlantic States. Best development on western slopes of Allegheny Mountains.	Light, moderately soft, stiff, not strong, of coarse texture. Shrinks and checks considerably in drying, works easily, stands well, and is very durable. Used in cabinetwork, cooperage, for railway ties, telegraph poles, and locally in heavy construction.	*Well drained* gravelly soils; succeeds on rocky hillsides with soil of sufficient looseness and depth; on northern and eastern exposures; will thrive on rather poor sand; slow and uncertain in stiff, clayey soil; on limestone only when well fissured. Exceedingly *rapid* grower; moderately shade-enduring; sprouts most vigorously and *persistently* from the stump; *large yield per acre*.
57. **BLACK WALNUT**. (*Juglans nigra* Linn.) Height, 100 feet +; diameter, 4 feet +.	Northeastern, Central, and Southeastern States. Best development on southern slopes of Allegheny Mountains and in bottom lands of southwestern Arkansas and Indian Territory.	Wood heavy, hard, strong, of coarse texture. Shrinks moderately in drying; works and stands well; takes a good polish; for a long time the favorite cabinet wood in this country; the dark heart wood used largely as a veneer for inside finish and cabinetwork; also in turnery, for gunstocks, etc.	Deep, loose, fresh to moist, warm, and sandy loam; will grow in a dry and compact soil, but not in a wet one. Hardy and rapid grower, especially in height; only centenarians produce first-class quality of lumber, but useful timber may be produced in 40 to 60 years. Sprouts freely from the stump. Not recommended for arid or subarid regions nor for uplands.
58. *BUTTERNUT*. (WHITE WALNUT.) (*Juglans cinerea* Linn.) Height, 80 feet +; diameter, 2 feet +.	Northeastern States. Best development in basin of Ohio River.	Light, soft, durable, not strong. Employed chiefly for cabinetwork and interior finish.	Prefers a deep, rich, *cool* loam; suited to cooler sites and colder climate than the foregoing species. Rapid grower when young.

THE HICKORIES, AND OTHER HARD-SEEDED VARIETIES.—*The Hickories.*—Wood very heavy, hard, and strong, tough, of rather coarse texture, smooth, and of straight grain. The broad sapwood white, the heart reddish nut brown. It dries slowly, shrinks and checks considerably; is not durable in the ground, or if exposed, and, especially the sapwood, is always subject to the inroads of boring insects.

Hickory excels as carriage and wagon stock, but is also extensively used in the manufacture of implements and machinery, for tool handles, timber pins, for harness work and cooperage. The hickories are tall trees with slender stems, never form forests, occasionally small groves, but usually occur scattered among other broad-leafed trees in suitable localities. The following species all contribute more or less to the hickory of the markets:

List of one hundred species of trees of the United States most valuable for timber—Continued.

Name of species and limit of size.	Regions of abundant growth.	Characteristics and uses of wood.	Soil and climate, and characteristics of growth.
59. SHAGBARK HICKORY (SHELLBARK HICKORY.) (*Hicoria ovata* (Mill.) Britt.) Height, 100 feet +; diameter, 2 feet +.	Eastern United States; wide range. Best development west of the Allegheny Mountains.	Very heavy, very hard, strong, *tough, elastic; not durable* in contact with the soil or exposed to the weather. Used chiefly for agricultural implements, *carriage stock*, ax and tool handles, baskets, etc.; best fuel.	Deep, fresh soil; a compact soil not objectionable; not on poor, dry, or wet soils. At first slow, but afterwards rapid grower; sprouts well from the stump. Moderately shade enduring. Somewhat liable to injury by frost.
60. BITTERNUT (PIGNUT. SWAMP HICKORY.) (*Hicoria minima* (Marsh.) Britt.) Height, 80 feet +; diameter, 2 feet +.	Eastern United States; wide range.	Heavy, rather hard, strong, tough; less valuable than that of Shagbark Hickory. Largely for ox yokes, hoop poles, and fuel.	To replace Shagbark Hickory on low, moist, or wet ground. Sprouts well from the stump. Less liable to frost than Shagbark Hickory, but more subject to the ravages of insects.
61. MOCKERNUT (BULLNUT. KINGNUT. BLACK HICKORY. BIG-BUD HICKORY. WHITE-HEART HICKORY.) (*Hicoria alba* (Linn.) Britt.) Height, 90 feet +; diameter, 3 feet +.	Eastern United States; wide range. Most abundant and generally distributed in the Southern States.	Very heavy, hard, tough, strong Used for much the same purposes as that of Shagbark Hickory, very variable according to site; resembling Shagbark Hickory.	To replace Shagbark Hickory on poorer and drier soils; will succeed even on *barrens*. Sprouts well from the stump, but slow grower; liable to attacks of insects.
62. SHELLBARK HICKORY (BOTTOM SHELLBARK.) (*Hicoria laciniosa* (Michx. f.) Sarg.) Height, 70 feet +; diameter, 3 feet +.	Central United States; local	Like Shagbark Hickory, and employed for much the same purposes.	Rich, deep soil; especially adapted to well-drained bottom lands, but succeeds with slower growth on drier uplands. Climatically confined.

63. **PECAN** (ILLINOIS NUT.) (*Hicoria pecan* (Marsh.) Britt.) Height, 75 feet +; diameter, 2 feet +.	Southwestern, but widely cultivated in Southern States. Best development in Arkansas and Indian Territory.	Like Shagbark Hickory. Used chiefly for handle stocks, etc. Edible *nuts* an important article of commerce.	Deep, rich bottom land, but succeeds fairly on upland soils of moderate richness. Rapid grower; for Southwestern planting. More valuable perhaps for production of fruit than for timber purposes.
64. **BLACK CHERRY** (RUM CHERRY.) (*Prunus serotina* Ehrhart.) Height, 90 feet +; diameter, 2 feet +.	Eastern United States; wide range.	Rather heavy, hard, strong. Of light-red color. Chiefly for *cabinetwork* and *interior finish*.	Adapted to almost any soil and situation; best in deep, well-drained soil; will succeed also on dry soil. Very rapid grower, very soon reaching a useful size for cabinet wood. Endures considerable *shade* when young. The *wide range of sites* to which it is adapted, its rapid growth and endurance of shade place it among the most valuable forest trees of the United States, especially for Western planting. Not infected by caterpillars in forest plantations.
65. SWEET GUM (LIQUIDAMBER. RED GUM. STAR-LEAVED GUM. BILSTED.) (*Liquidambar styraciflua* Linn.) Height, 100 feet +; diameter, 3 feet +.	Southeastern States. Greatest development in basin of Mississippi River.	Rather heavy and soft; strong, stiff, tough, not durable when exposed to the weather; shrinks and warps readily. Manufactured into lumber, clapboards, and coarse boards, mottled forms becoming popular for cabinetwork, veneering plates, hat blocks, baskets, etc.	Succeeds on a great variety of soils: a tree of the swamp as well as of dry soils; best on light, dry, sandy and soils retentive of moisture. Rapid grower. Insect proof and generally healthy.
66. LOCUST (LOCUST. YELLOW LOCUST.) (*Robinia pseudacacia* Linn.) Height, 80 feet +; diameter, 1½ feet +.	Southern Alleghany region. Alleghany Mountains; local; but by cultivation widely distributed east of Rocky Mountains.	Heavy, very hard and strong; very *durable* in contact with the soil; shrinks considerably and suffers in seasoning. Employed largely for *fence posts*, in turnery, construction, treenails, wagon hubs, etc.	Poor, loose sands give best quality of timber; not succeeding well in compact soils, but will thrive on a thin one, and grows quickest on a rich, sandy loam. Very *rapid* grower while young; needs light very much; sprouts *persistently* and *vigorously* from the roots. To be only sparingly dispersed among shady companions, which will afford protection against the attacks of borers. Easily propagated from seed, also by cuttings, suckers, and stakes. For short rotations and coppice management.

List of one hundred species of trees of the United States most valuable for timber—Continued.

Name of species and limit of size.	Regions of abundant growth.	Characteristics and uses of wood.	Soil and climate, and characteristics of growth
67. HONEY LOCUST	Central States	Heavy, hard, strong; very *durable* in contact with the soil.	Low, rich bottom land; rarely on high dry, sterile hills; but often common on rich uplands, where it grows rapidly.
(SWEET LOCUST. HONEY SHUCKS. THREE-THORNED ACACIA. BLACK LOCUST.)	Best development in bottom land of lower Ohio River basin. Widely cultivated for hedges and ornament.	For *fence-posts*, rails, hubs, construction, etc.	Very *rapid grower; needs light.*
(*Gleditsia triacanthos* Linn.)			*Easily* grown from seed, but not from cuttings. Less liable to insect ravages; otherwise to be treated like Black Locust, which it is recommended to replace in Southern localities.
Height, 90 feet +; diameter, 2 feet +.			
68. *HACKBERRY*	Northern and mainly east of the Rocky Mountains.	Heavy, hard, strong; difficult to split; shrinks moderately, works well.	Will grow tolerably well on the most barren and poorest soils, but best in a fertile one, cool and moist, where it is of rapid growth.
(NETTLE-TREE).	Best development in basin of Ohio River.	Employed chiefly for fencing, but occasionally in the manufacture of cheap furniture.	In Western planting recommended only as an adjunct.
(*Celtis occidentalis* Linn.)			
Height, 80 feet +; diameter, 3 feet +.			
69. *RED MULBERRY*	East of longitude 98°	Rather heavy, hard, strong, and very durable.	Deep, rich loam, but grows well on poorer dry soil; endures shade.
(*Morus rubra* Linn.)	Best development in basins of lower Ohio and Mississippi rivers.	Employed for fence posts, in cooperage, snaths, and other tool stock, boat-building, etc.	For Southwestern planting.
Height, 60 feet +; diameter, 2 feet +.			
70. *MAGNOLIA*	Southern and Gulf States	Heavy; of medium weight, hardness, and strength; very white.	Cool, moist hummocks, with rich, deep, loose soil.
(SOUTHERN EVERGREEN. BIG LAUREL. BULL BAY.)	Best development along Mississippi in Gulf region.	Suitable for cabinetwork and interior finish.	Not hardy in Northern States; for strictly Southern climate.
(*Magnolia fœtida* (Linn) Sarg.)			
Height, 70 feet +; diameter, 2 feet.			

71. CUCUMBER TREE .... (*Magnolia acuminata* Linn.) Height, 90 feet +; diameter, 3 feet +.	Mainly Middle Atlantic region. Best development in the southern Alleghany Mountain region.	Light, soft, moderately durable. Closely resembling the Tulip-tree, and used for the same purposes.	In cool, moist, deep, rich soils of mountain slopes, valleys, and "coves." Succeeds also in fresh sandy or gravelly soils of moderate richness.
72. **TULIP-TREE** .... (WHITE WOOD. YELLOW POPLAR.) (*Liriodendron tulipifera* Linn.) Height, 120 feet +; diameter, 4 feet +.	Eastern States .... Greatest development in valley of lower Wabash River, and on Western slope of Alleghany Mountains in Tennessee, North Carolina, and the Virginias.	Light, soft, stiff, not strong, nor very durable; shrinks, but seasons without much injury. Manufactured into *lumber* for interior finish, boxes, shelving, clapboards, panels of carriages, shingles, cheap furniture; pumps, wooden ware, boat building.	Deep, light, loamy, sandy, or clayey soils, in cool, moist situations. Tolerably rapid and persistent grower. Needs light very much; hardy. Poor seeder, and low percentage of germination: seed to "lie over." Sprouts fairly from stump. One of the largest and most valuable of the deciduous soft woods.
73. HARDY CATALPA .... (*Catalpa speciosa* Warder.) Height, 80 feet +; diameter, 3 feet +.	South Central States: rare, but widely cultivated for ornament. Best development in valley of lower Wabash River.	Light, soft, not strong; *very durable* in contact with the soil. Employed chiefly for *ties*, *posts*, rails: suitable for interior finish and used somewhat for cabinet wood.	Adapted to a great variety of soils: best on low, rich bottom lands. Very rapid grower: sprouts vigorously from the stump; *shade enduring*. Good seeder and keeper. Readily propagated from seed, cuttings, and layers. Desirable tree for Western planting. Foliage subject to ravages of insects.
74. COMMON CATALPA .... (*Catalpa catalpa* (Linn.) Karst.) Height, 40 feet +; diameter, 1½ feet +.	Gulf States, but widely cultivated for ornament.	Like the Hardy Catalpa, and used for the same purposes in the South.	Like the preceding, to be used in Southwestern planting, to which it is best adapted.

THE ASHES, MAPLES, ELMS, ETC.—The wood of the ashes is heavy, hard, strong, stiff, quite tough, not durable in contact with soil, straight grained, rough on the split surface, and coarse in texture. The wood shrinks moderately, seasons with little injury, "stands" well, and takes a good polish. In carpentry ash is used for finishing lumber, stairways, panels, etc.; it is used in shipbuilding, in the construction of cars, wagons, carriages, etc., in the manufacture of farm implements, machinery, and especially of furniture of all kinds, and also for harness work; for barrels, baskets, oars, tool handles, hoops, clothespins, and toys. The trees of the several species of ash are rapid growers, of small to medium height with stout trunks; they form no forests, but occur scattered in almost all our broad-leafed forests.

List of one hundred species of trees of the United States most valuable for timber—Continued.

Name of species and limit of size.	Regions of abundant growth.	Characteristics and uses of wood.	Soil and climate, and characteristics of growth.
75. **WHITE ASH**	Eastern; wide range	Heavy, hard, *strong, very elastic;* old timber brittle. Very valuable.	Depth, looseness, and moisture of soil of most importance. Best in moist atmosphere of northern and eastern exposures. Will succeed in wet and compact soil if well drained, but maintains itself with slow growth in a light and dry one.
(*Fraxinus americana* Linn.)	Best development in lower Ohio basin.	Employed chiefly in the *manufacture* of agricultural implements, carriages, handles, oars, interior finish, cabinetwork, furniture, and flooring.	Rapid grower; light needing, thinning out rapidly, and therefore requiring shady, slower growing companions. Sprouts vigorously and persistently from the stump. Often a poor seeder; seed not easily kept, tending to "lie over." Liable to attacks of borer and to frost when young.
Height, 100 feet +; diameter, 3 feet +.			
76. **BLACK ASH**	Northern and Northeastern States.	Rather heavy, rather soft, tough, *elastic*, not very durable when exposed.	Soils like those for *F. americana*, but *indifferent to drainage*, and more dependent on moisture; therefore well adapted to undrained situations in cool climate; otherwise like *americana*.
(HOOP ASH. GROUND ASH.)	The most northerly of the ashes.	Lately much used for interior finish and cabinetwork, fencing, barrel hoops, baskets, and fuel.	
(*Fraxinus nigra* Marsh.)			
Height, 90 feet +; diameter, 2½ feet +.			
77. GREEN ASH	Western States east of Rocky Mountains and South: most common and best developed in the Mississippi Valley.	Heavy, hard, strong	Less dependent on humidity of soil than the White Ash, but prefers a deep, cool, moist soil, and will succeed even on inundated lands.
(*Fraxinus lanceolata* Borkh.)		Often employed for same purpose as that of White Ash, but somewhat inferior to it in quality.	Rapid but not persistent grower. Seed germinates readily.
Height, 50 feet +; diameter, 1½ feet +.			The ash for Western planting.

78. BLUE ASH (*Fraxinus quadrangulata* Michx.) Height, 70 feet +; diameter, 2 feet +.	Central States Best development in basin of lower Wabash River.	Heavy, hard; as valuable as any of the ashes, and *most durable* of all when exposed to alternate dryness and moisture. Used for much the same purposes as that of White Ash, but principally in *carriage making* and flooring. Very superior for hayfork and other tool handles.	Less dependent on moisture than other ashes; prefers a rich, deep, moist soil, and grows well on dry limestone soils. Recommended for Western planting.
79. OREGON ASH (*Fraxinus oregona* Nutt.) Height, 60 feet +; diameter, 1½ feet +.	Northwestern coast region Best development in bottom lands of southwestern Oregon.	Rather heavy, sometimes brittle, not strong; similar to that of White Ash. Employed chiefly in the manufacture of furniture, carriage and wagon frames, cooperage, fuel.	Moist soils and climate.
80. **SUGAR MAPLE** (HARD MAPLE. SUGAR-TREE.) (*Acer saccharum* Marsh.) Height, 100 feet +; diameter, 3 feet +.	Eastern United States and northward. Best development in region of the Great Lakes.	Heavy, *hard*, *strong*, tough; not durable, and subject to attack of boring insects. Employed chiefly in the *manufacture* of furniture, shoe lasts and pegs, saddletrees, turnery, interior finish, flooring; in shipbuilding, for keels, keelsons, shoes; *excellent fuel*. The "bird's-eye" and "curled" maple of this species are much prized in cabinetmaking. Furnishes the maple sugar of commerce.	Best on moderately deep, loose, well drained, strong, loamy, and calcareous soil, in moist, cool position; will grow also on stiff clay, if not too wet, and on stony hillsides, if not too dry. Tolerably rapid and persistent grower; moderately shade enduring; does not sprout well from the stump. Not well adapted to dry regions.
81. SILVER MAPLE (WHITE MAPLE. SOFT MAPLE.) (*Acer saccharinum* Linn.) Height, 90 feet +; diameter, 3 feet +.	Eastern United States Best development in basin of lower Ohio River.	Rather heavy, soft, brittle, not very strong, nor durable when exposed to the weather or soil. Used in the manufacture of furniture, flooring, for fuel. Yields a good quality of maple sugar.	Adapted to a variety of soils and climates, but best on rich, moist soil. *Very rapid* but not persistent grower; light needing; sprouts vigorously from the stump; liable to injury from winds; comparatively free from insects. Especially recommended as a nurse in Western planting.
82. RED MAPLE (SOFT MAPLE WATER MAPLE. SWAMP MAPLE.) (*Acer rubrum* Linn.) Height, 90 feet +; diameter, 3 feet +.	Eastern United States and northward; wide range. Greatest development in valleys of lower Wabash and Yazoo rivers.	Slightly heavier and harder than that of Silver Maple; not strong nor durable; inferior to that of Sugar Maple, but superior to Silver Maple. Used chiefly for cabinetmaking, in turnery, for wooden ware, gunstocks, light fuel.	Best on low, wet soils, but will thrive in moderately dry situations. Rapid, but moderately persistent grower; endures more *shade* than *A. saccharinum* L.; sprouts vigorously from the stump. Usefulness in dry climates questionable.

List of one hundred species of trees of the United States most valuable for timber—Continued.

Name of species and limit of size.	Regions of abundant growth.	Characteristics and uses of wood.	Soil and climate, and characteristics of growth.
83. OREGON MAPLE	Pacific slope	Rather light, hard, strong; said to be one of the best and most valuable woods of Pacific coast.	Rich bottom lands.
(CALIFORNIA MAPLE. BROAD-LEAFED MAPLE.)	Best development on rich bottom lands of southern Oregon.	In Oregon, employed largely in the manufacture of furniture, ax and broom handles, snowshoe frames, etc. The "curled" wood of this species is highly prized in cabinetmaking.	Rapid grower in moist climate.
(*Acer macrophyllum* Pursh.)			Important on the Pacific slope.
Height, 90 feet +; diameter, 4 feet +.			
84. *BOX ELDER*	East of Rocky Mountains, rather Southern and Western.	Light, soft, not strong; inferior	Best on low, rich ground, but will succeed on upland.
(ASH-LEAVED MAPLE.)	Best development in valleys of Wabash and Cumberland rivers.	Manufactured chiefly into paper pulp, wooden ware, and used somewhat in cooperage and for interior finish, fuel, etc.	Rapid but not persistent grower; sprouts well from the stump; hardy. *Easily propagated.*
(*Acer negundo* Linn.)			For forestry purposes, imported only as *nurse* and soil cover, especially in Western planting.
Height, 50 feet +; diameter, 2 feet +.			
85. **WHITE ELM**	East of the Rocky Mountains	Heavy, hard, strong, very *tough*, but not durable; inferior; often difficult to split.	Adapted to a great variety of soils, but best on a rich, loose, moist one; requires less moisture than the ashes; bears occasional flooding.
(AMERICAN ELM. WATER ELM.)	Probably attains its best developments near its northern limits.	Employed principally for wheel and chair stock, coarse lumber, flooring, furniture, cooperage, and fuel.	Rapid and persistent grower; sprouts well; endures moderate shade.
(*Ulmus americana* Linn.)			Important in forestry mainly as a *nurse* and for soil-cover.
Height, 100 feet +; diameter, 3½ +.			Recommended for Western planting.
86. **CORK ELM**	Northeastern United States	Heavy, hard, very strong, tough, and *elastic*; superior to that of other elms.	Rich, moist, heavy, loamy soils.
(HICKORY ELM. WHITE ELM. CLIFF ELM.)	Best development in southern Ontario and Michigan.	Extensively used in the *manufacture* of agricultural implements, wheel stock, for ties, bridge-building and ship timber, rails, bicycle rims, and all places where a very tough noncleavable wood is needed.	Probably to take the place of the White Elm in forestry.
(*Ulmus racemosa* Thomas.)			
Height, 90 feet +; diameter, 2 feet +.			
87. *WING ELM*	Southeastern United States	Heavy, hard, tough. Used for wheel stock, tool handles, coarse lumber, and fuel.	Most commonly on dry, gravelly uplands, but frequently in moist bottoms and along water courses. Very adaptive and to be used in Southwestern planting in place of the White Elm.
(*Ulmus alata* Michx.)	Best development west of the Mississippi River.		
Height, 80 feet +; diameter, 2 feet +.			

88. *SLIPPERY ELM.* (RED ELM. MOOSE ELM.) (*Ulmus pubescens* Thomas.) Height, 60 feet +; diameter, 2 feet +.	Northern Atlantic and Gulf States. Best development in Western States.	Heavy, hard, strong; more durable than other elms. Used principally for wheel stock, sills, posts, ties, rails, fuel. Large quantities of the inner bark used for medicinal purposes.	Rich, moist, well-drained soil; much like that of the White Elm, but will bear drier and more elevated situations. Rapid, but not persistent grower. Easily propagated.
89. YELLOW BIRCH. (GRAY BIRCH.) (*Betula lutea* Michx. f.) Height, 80 feet +; diameter, 3 feet +.	Northeastern United States and northward. Best development north of the Great Lakes.	Heavy, hard, and strong. Chiefly for furniture, wheel hubs, pill and match boxes, button and tassel molds, and extensively for *fuel.* Valuable for *cabinet* wood and building purposes.	Cool, moist atmosphere preferable. Capable of thriving on poor, but best on a moderately deep, loose, moist sand; hardy and very adaptive as to soils. Rapid and tolerably persistent grower; sprouting qualities greatly dependent on site. Vigorously in moist soils. Light needing. Easily propagated.
90. SWEET BIRCH. (CHERRY BIRCH. MAHOGANY BIRCH.) (*Betula lenta* Linn.) Height, 60 feet +; diameter, 3 feet +.	Same range as Yellow Birch.	Heavy, very strong, hard like that of Yellow Birch, but rose-colored, and perhaps more valuable for cabinet-work. Much used in the manufacture of *furniture* and for fuel.	Same as above species, but apparently not as rapid nor as persistent a grower.
91. RIVER BIRCH. (*Betula nigra* Linn.) Height, 80 feet +; diameter, 3 feet.	Eastern States. Best developed in the South Atlantic and Lower Mississippi Valley regions.	Rather light, hard, strong, close grained, considerably used for furniture, interior finishing, turnery, bowls, other wooden ware, and fuel.	Almost exclusively on moist or inundated bottoms, along streams, and near ponds. Succeeds very well on moist, rich, porous, upland soils. Important as a substitute for Northern birches in Southwestern planting.
92. *CANOE BIRCH.* (WHITE BIRCH. PAPER BIRCH.) (*Betula papyrifera* Marshall.) Height, 60 feet +; diameter, 2 feet +.	Northwestern, Northern, and Northeastern in United States. Reaches a higher latitude than any other American deciduous tree.	Rather heavy, hard, tough, strong; not durable. Extensively employed in the manufacture of spools, shoe lasts and pegs, *turnery* of other kinds; lately much used in making *pulp;* excellent *fuel.*	Mostly on sandy soils in northern climates. Not on clay lands where the Yellow Birch thrives.
93. *WHITE BIRCH.* (OLD-FIELD BIRCH. GRAY BIRCH.) (*Betula populifolia* Marsh.) Height, 30 feet +; diameter, 1 foot +.	Northeastern coast region.	Rather heavy, soft, not strong nor durable. Employed largely for spools, shoe-pegs, *wood pulp*, hoop poles, and fuel.	Adapted to drier and poorer soils than other birches. Short-lived; rapid grower; *sprouts readily* from the stump. Probably least important of the birches.

List of one hundred species of trees of the United States most valuable for timber—Continued.

Name of species and limit of size.	Regions of abundant growth.	Characteristics and uses of wood.	Soil and climate, and characteristics of growth.
94. **BASSWOOD**	East of the Mississippi and Missouri rivers; wide range.	Light, soft, not strong; easily worked	Deep, moderately loose, and somewhat moist soil; can endure a wet soil, but will not thrive on a dry one.
(AMERICAN LINDEN. BEE-TREE. LIME-TREE.)	Greatest development in valley of Lower Wabash River.	Employed largely in the manufacture of wooden ware, cheap furniture, *paper pulp*, for *panels*, bodies of carriages, clapboards, lumber, in turnery, and for bakers' light fuel.	Rapid and persistent grower; sprouts vigorously from the stump; endures moderate shade
(*Tilia americana* Linn.)			Not very hardy, but in cool situations a desirable adjunct in forestry.
Height, 100 feet +; diameter, 3 feet +.			
95. WHITE BASSWOOD	Middle and South Atlantic region.	Like the preceding; not being distinguished in the market, and used for the same purpose.	Deep, rich, moist, well-drained soils of mountain coves, lower slopes, and on the banks of streams; frequent also on rich limestone soils of the plain, and succeeds on dry, gravelly, clayey, and sandy soils of moderate richness; important for Southern planting in place of the Northern basswood.
(*Tilia heterophylla* Vent.)	Best development in southern Alleghanies.		
Height, 60 feet +; diameter, 3 feet +.			
96. SYCAMORE	East of the Mississippi and Missouri rivers.	Rather heavy, rather hard, not very strong.	Rich, moist, soil, low ground, thriving in swamps subject to overflow; grows well on moist upland.
(BUTTONWOOD. BUTTON-BALL-TREE. WATER BEECH.)	Best development in bottom lands of the Ohio and Mississippi rivers.	Extensively used in the manufacture of cigar and tobacco boxes, furniture, interior, for butchers' blocks, ox yokes, and coarse planks; lately much used for making butter and lard trays and wooden bowls. Little used for fuel, owing to difficulty in splitting.	Wide climatic range, but liable to frost when young; light needing; secondary in forestry.
(*Platanus occidentalis* Linn.)			
Height, 120 feet +; diameter, 6 feet +.			
97. COTTONWOOD	East of the Rocky Mountains	Very light, soft, not strong nor durable	Adapted to a variety of soils, but best in a moist, strong, loamy one.
(CAROLINA POPLAR. BIG COTTONWOOD. NECKLACE POPLAR).		The wood shrinks moderately (some crossgrained forms warp excessively), but checks little; is easily worked. Used as building and furniture lumber, in cooperage for sugar and flour barrels, for crates and boxes (especially cracker boxes), for wooden ware, and paper-pulp.	Exceedingly *rapid* grower; sprouts vigorously from the stump; light needing; *thinning out rapidly;* short lived and exhaustive to the soil; most readily propagated.
(*Populus deltoides* Marsh.)			Has been recommended for planting on Western prairies, chiefly on account of its rapidity of growth, ease of procuring plant material, and of propagation. In forestry should be used only as a nurse with better and shady kinds.
Height, 100 feet +; diameter, 4 feet +.			

98. *LARGE-TOOTH ASPEN* (WHITE POPLAR.) (*Populus grandidentata* Michx.) Height, 60 feet +; diameter, 2 feet +.	Northern and Northeastern States.	Light, soft, not strong nor durable. Employed chiefly in the manufacture of wood pulp, and used somewhat in turnery and for wooden ware.	Northern States, in moist situations; grows well in all fresh upland soils.
99. *BALM OF GILEAD* (BALSAM POPLAR. TACAMAHAC.) (*Populus balsamifera* Linn.) Height, 70 feet +; diameter, 3 feet +.	Northern United States.	Very light, soft, not strong. Quality of timber quite equal to that of any poplars, but little used where it is abundant, except for pulp. Suitable for wooden ware and uses like cottonwood.	A substitute for cottonwood in the most northern localities. Thrives in moist, rich, well-drained soils.
100. *ASPEN* (AMERICAN ASPEN.) (*Populus tremuloides* Michx.) Height, 50 feet +; diameter, 1½ feet +.	Northern and Southwestern (in United States); in Pacific region, from 6,000 to 10,000 feet elevation.	Light, soft, not strong nor durable. Employed largely in the manufacture of paper-pulp; in Pacific region used occasionally for flooring, in turnery, and for fencing and light fuel.	Of value mainly as a tree naturally covering denuded mountain sides and as a quick-growing nurse for better kinds.

USEFUL BIRDS AND HARMFUL BIRDS.

Twenty-five species which are decidedly beneficial to agriculture and should be rigidly protected.

Common name.	Scientific name.	Character of food.
Marsh Hawk	*Circus hudsonius*	Mice, other small mammals, reptiles, and insects.
Red-shouldered Hawk.	*Buteo lineatus*	Meadow mice, pine mice, and other small mammals and insects.
Swainson's Hawk	*Buteo swainsoni*	Grasshoppers, crickets, and small mammals.
Ferruginous Rough-leg.	*Archibuteo ferrugineus*	Principally western ground squirrels (Spermophiles.)
Sparrow Hawk	*Falco sparverius*	Meadow mice and grasshoppers.
Barn Owl	*Strix pratincola*	Rats, mice, shrews, gophers, and some insects.
Long eared Owl	*Asio wilsonianus*	Mice and a few other small mammals constitute about 90 per cent of the food.
Short-eared Owl	*Asio accipitrinus*	
Barred Owl	*Syrnium nebulosum*	Rabbits, mice, squirrels, crayfish, and frogs.
Screech Owl	*Megascops asio*	Mice, beetles, grasshoppers, and other insects.
Yellow-billed Cuckoo.	*Coccyzus americanus*	Injurious insects; caterpillars, especially tent caterpillars; some Colorado potato beetles.
Black-billed Cuckoo	*Coccyzus erythrophthalmus.*	
Hairy Woodpecker	*Dryobates villosus*	Injurious insects; wood-boring larvæ constitute more than 25 per cent of the food.
Downy Woodpecker	*Dryobates pubescens*	
Flicker	*Colaptes auratus*	Injurious insects; ants constitute nearly 50 per cent of the food.
Meadowlark	*Sturnella magna*	Over 60 per cent harmful insects, especially grasshoppers.
Baltimore Oriole	*Icterus galbula*	About 80 per cent injurious insects, especially caterpillars and beetles whose larvæ are known as wire worms.
Tree Sparrow	*Spizella monticola*	Immense quantities of noxious weed seed in winter.
Chipping Sparrow	*Spizella socialis*	Injurious insects in summer. Seeds of noxious weeds in spring and fall.
Song Sparrow	*Melospiza fasciata*	
Rose-breasted Grosbeak.	*Zamelodia ludoviciana*	Colorado potato beetle and other injurious insects.
House Wren	*Troglodytes aëdon*	Beetles, grasshoppers, bugs, caterpillars, and spiders form its entire food.
Chickadee	*Parus atricapillus*	Minute insects (bark lice) and insect eggs.
Robin	*Merula migratoria*	Beetles, grasshoppers, caterpillars, and wild fruit.
Bluebird	*Sialia sialis*	About 25 per cent grasshoppers, with many caterpillars and spiders.

Five species which are injurious to agriculture and unworthy of protection.

Common name.	Scientific name.	Character of food.
Sharp-shinned Hawk.	*Accipiter velox*	Poultry, game birds, and many small insectivorous birds.
Cooper's Hawk	*Accipiter cooperii*	
Goshawk	*Accipiter atricapillus*	Poultry and game birds.
Duck Hawk	*Falco peregrinus anatum*	Game and insectivorous birds.
English Sparrow	*Passer domesticus*	Grain (especially wheat and oats), fruit buds, and blossoms.

AMOUNT AND COST OF GRASS SEED PER ACRE.

Amount to sow per acre of seed of principal grasses and forage plants, weight per bushel, and cost of seed per acre.

Name.	Soil, climate, use, and manner of propagating.	Amount to sow per acre, in pounds, standard quality.	Weight per bushel.	Cost of seed per acre.
			Pounds.	
Redtop (*Agrostis alba.*)	Moist, damp soil. Transplant small turf cuttings in autumn. Late pasturage or lawns in North. In mixtures, 5 to 10 per cent.	9.7	8–32	$1.45
Reed canary grass (*Phalaris arundinacea.*)	Stiff, wet lands and flooded fields. Requires moisture. Valuable hay cut young. Binds loose banks near running water; firm sod on marshy ground.	21.0	44–48	7.35

AMOUNT AND COST OF GRASS SEED PER ACRE—Continued.

Amount to sow per acre of seed of principal grasses and forage plants, weight per bushel, and cost of seed per acre—Continued.

Name.	Soil, climate, use, and manner of propagating.	Amount to sow per acre, in pounds, standard quality.	Weight per bushel.	Cost of seed per acre.
			Pounds.	
Meadow grass (*Poa pratensis.*)	Soils strongly calcareous. Pasture; a good bottom grass for meadows; lawn grass.	17.5	....	$2.10
Sheep's fescue (*Festuca ovina.*)	Light, dry soils, especially shallow, and silicious. Bottom grass; sheep pastures. Only in mixtures.	28.0	10-15	4.20
Creeping fescue (*Festuca rubra.*)	Valuable in pasture and bottom. Withstands drought, cold, and shade. Binds poor land, especially moist sands and railway banks.	42.5	10-15	8.50
Brome grass (*Bromus inermis.*)	Valuable for light soils, especially in regions subject to extremes of heat or long periods of drought. Alone or in mixtures.	44.0	....	8.80
Rye grass (*Lolium perenne.*)	Excellent and lasting pasture grass for heavy soils in moist, cool climates. Rarely sown alone.	55.0	18-30	4.95
Italian rye grass (*Lolium italicum.*)	Rich and rather moist lands. Regarded in Europe as one of best for hay. Lasts only 2 or 3 years.	48.5	12-24	3.56
Orchard grass (*Dactylis glomerata.*)	Any soil except very wet; withstands shade. Much aftermath.	35.0	12-16	5.60
Meadow fescue (*Festuca pratensis.*)	Thrives in either dry or wet soils. Valuable hay or pasture grass.	52.0	12-26	7.80
Yellow oat grass (*Trisetum flavescens.*)	Temporary or permanent pastures. Marly or calcareous soil; all light land rich in humus.	29.0	5½	24.65
Timothy (*Phleum pratense.*)	Alone or mixed with redtop or clover. Moist loams or clays. On dry ground yield is light.	16.0	48	1.50
Meadow foxtail (*Alopecurus pratensis.*)	Endures cold. Strong soil, stiff loam or clay. One of best for irrigation. Very early.	23.0	6	6.21
Vernal grass (*Anthoxanthum odoratum.*)	Almost any soil; only in mixtures, 1 to 2 pounds with permanent pasture or meadow grasses.	30.0	....	15.00
Crested dog's tail (*Cynosurus cristatus.*)	Especially loams, light clays, marls, moist, loamy sands. Withstands drought. Thrives in shade. Nutritive value high.	25.0	20-32	7.50
Alsike clover (*Trifolium hybridum.*)	Strongest clay or peaty soil; peculiarly adapted to damp ground. Bears heavy frosts. Sow August or February.	12.3	94-100	1.00
Sainfoin (*Onobrychis sativa.*)	Good and open subsoil, free from water. Sown alone in April.	[1] 78.0	40	6.25
Red clover (*Trifolium pratense.*)	Best in rich, loamy soil; good clays and soils of alluvial nature. Standard fodder.	18.0	64	2.50
White clover (*Trifolium repens.*)	Thrives on mellow land containing lime, and on all soils rich in humus. Resists drought. Generally used in mixtures for pastures or lawns.	10.5	63	2.94
Kidney vetch (*Anthyllis vulneraria.*)	Cultivated for grazing; warm soils, manured and of proper depth. Resists drought.	17.5	60-64	4.58
Alfalfa (lucern) (*Medicago sativa.*)	Any calcareous soil with permeable subsoil. Especially adapted to the warm and dry regions. Requires irrigation.	25.0	61-63	3.25
Trefoil (*Medicago lupulina.*)	Any soil containing sufficient moisture and lime. Most successful on clay marls. A substitute for better clover.	18.0	64-66	2.16
Bird's-foot trefoil (*Lotus corniculatus.*)	Dry or moist, sandy or clayey soils. Well suited to dry, high elevations.	11.0	60	4.40
Goats' rue (*Galega officinalis.*)	Excellent fodder plant for warm, sheltered situations. Thrives only in deep soil with subsoil not wet.	22.0	....	4.14

[1] Unshelled.

THE METRIC SYSTEM.

The metric system of weights and measures furnishes the only legal standards in France, Germany, Austria-Hungary, Italy, and thirteen other leading nations. It is lawful in Great Britain, Japan, and the United States, but is not generally used. Its principal advantages are these: Ten units of any order, except in the *quintal* and *tonne*, make 1 unit of the next higher order; the base unit in each form of measurement is scientifically established and is as nearly invariable as possible; the names of denominations above the base unit are always made by prefixing in ascending order the Greek numeral derivatives deca, hecto, kilo, and myria, while those below are made by prefixing the Latin numeral derivatives deci, centi, and milli to the name of the base (thus 10 meters make a decameter, etc., while a meter contains ten decimeters, etc.); and finally, the use of this system by so many peoples adds to the benefit to be derived from its adoption by others.

The base unit of length is the meter, which is one ten-millionth of the distance from the equator to the pole; the base unit of area (square measure) is the are, which is 1 square decameter; of cubic measure the stere, which is a cubic meter. The base unit of weight is the gram, which is the weight of a cubic centimeter of distilled water at sea level at 4° C. nearly; the base unit of capacity is the liter, which holds water enough to weigh 1 kilogram at sea level at 4° C. nearly.

The following tables furnish the equivalents of the principal units in the metric and English systems of weights and measures.

Metric units in English equivalents.

Meter	39.37 inches	3.28083 feet	1.09363 yards.
Kilometer	39,370 inches	3,280.83 feet	1,093.63 yards.
Are		1,076.4 square feet	119.60 square yards.
Hectare	2.471 acres	107.64 square feet	11,960 square yards.
Stere		35.3165 cubic feet	1.308 cubic yards.
Liter	33.8 fluid ounces	1.0567 quarts (liquid)	0.02838 bushel.
Gram	15.43234 grains	0.03527 ounce avoirdupois	0.0022 pound avoirdupois.
Kilogram			2.2 pounds avoirdupois.

English units in metric equivalents.

Foot	0.3048 meter	3.048 decimeters	30.48 centimeters.
Mile	1,609.344 meters	1.609 kilometers	
Acre	40.4685 ares	0.4046 hectare	
Cord	3.624 steres		
Perch (of masonry)	0.7 stere		
Gallon (U.S.)	3.7854 liters	0.037 hectoliter	378.54 centiliters.
Pound	0.4535 kilogram	4.535 hectograms	453.5 grams.
Ton (2,000 pounds)	907.1 kilograms	0.9071 tonne	
Bushel	35.237 liters		

SOME FOREIGN MONETARY UNITS.

In actual business transactions valuations of foreign coins vary slightly from the figures given below. Rates of exchange in commercial use are subject to change daily.

Equivalents of foreign coins in United States money.

Pound sterling (Great Britain)	$4.8665	Colon (Cuba)	$0.926
Pound sterling (Egypt)	4.943	Peso (Colombia, Ecuador)	.424
Franc[1] (France, Switzerland, Belgium)	.193	Peso (Chile)	.365
Mark (Germany)	.238	Peso (Central America)	.416
Crown (Austria-Hungary)	.203	Peso (Argentina)	.965
Crown (Sweden, Norway, Denmark)	.268	Dollar (Mexico)	.46
Ruble (Russia)	.772	Dollar (British North America)	1.00
Piaster (Turkey)	.044	Dollar (Newfoundland)	1.014
Florin (Netherlands)	.402	Yen (Japan)	.498
Milreis (Brazil)	.546	Tael[2] (China)	$0.62 to .69
Milreis (Portugal)	1.08	Rupee (India)	.201
Boliviano (Bolivia)	.424	Sol (Peru)	.424

[1] The lira of Italy, bolivar of Venezuela, peseta of Spain, drachma of Greece, and mark of Finland are also worth 19.3 cents each.

[2] There is a different value for the tael for every commercial center in China, but it is within the limits given.

TREATMENT FOR FUNGOUS DISEASES OF PLANTS—FORMULAS FOR FUNGICIDES.

In the following table the plants affected are arranged alphabetically, and in columns opposite each name are given the number of times and methods of making the various treatments. Following the names of the fungicides are numbers in parentheses, which refer to the formulas for making them. The formulas follow the table, the numerals in the table corresponding to the numbers of the formulas:

Fungous diseases of plants and methods of treatment.

Disease.	First application.	Second application.	Third application.	Fourth application.	Fifth application.	Remarks.
Almond or apricot shot-hole fungus.	Ammoniacal copper carbonate solution (1) when leaves unfold.	Same fungicide ten or twelve days later.	Same fungicide fourteen days later.	Same fungicide fourteen days later, if necessary.	....	
Apple scab........	Bordeaux mixture (2), 60-gallon formula, when fruit buds are unfolding.	Same fungicide when flower clusters are expanding.	Same fungicide when petals are falling.	Same fungicide when fruit is one-half inch in diameter, if wet weather prevails.	Same fungicide two weeks later, if wet weather prevails.	Paris green may be combined with the fungicide in a proportion of 4 ounces to every 50 gallons of the mixture, to prevent ravages of codling moth.
Barley smut........	Soak seed in cold water four hours.	Place in sacks and leave for four hours.	Soak seed in water at a temperature of 126° to 128° for five minutes.	....	....	
Cherry leaf blight..	Bordeaux mixture (2), 60-gallon formula, after foliage is fully developed.	Same fungicide fourteen days later.	Same fungicide fourteen days later.	Same fungicide fourteen days later.	Same fungicide fourteen days later.	A sixth application may be necessary. The treatment is especially applicable to nursery stock, and the endeavor should be made to keep the upper and lower surfaces of the newly developing foliage covered with the fungicide.
Cherry and plum black knot.	Bordeaux mixture (2), 22-gallon formula, before leaves appear.	Same fungicide two weeks later.	Same fungicide two weeks later.	Same fungicide two weeks later.	....	The knots should be cut off and burned whenever possible. Painting the cut surfaces with kerosene or linseed oil will tend to prevent the return of the knots.
Grape black rot	Bordeaux mixture (2), 50-gallon formula, before buds open.	Same fungicide when leaves are one-third grown.	Same fungicide just before blooming.	Same fungicide two weeks later.	Ammoniacal copper carbonate solution (1), two weeks later.	A sixth application may be necessary, and it should be made with ammoniacal copper carbonate solution. In dry weather it is probable that the number of sprayings may be less.
Grape downy mildew.	Bordeaux mixture (2), 60-gallon formula, when leaf buds open.	Same fungicide when leaves are half grown.	Same fungicide when plants are in bloom.	Same fungicide when fruit is half grown.	....	As this disease and black rot frequently occur together, the same applications will generally answer for both. If more than four applications be made, as may be necesssary in wet seasons, ammoniacal copper carbonate solution should be used to prevent spotting the fruit.

Fungous diseases of plants and methods of treatment—Continued.

Disease.	First application.	Second application.	Third application.	Fourth application.	Fifth application.	Remarks.
Oat smut	Soak seed for one minute in warm water at 110° to 120° (3).	Soak seed in hot water at 132° for ten minutes.				After the second soaking, if not needed for immediate use, the seed should be spread out to dry and then put in clean bags, which have been previously sterilized by boiling.
Orange sooty mold.	Resin wash (4) in January or February.	Same wash ten days to two weeks later.	Same wash in May or August.			Special care should be taken to wet the under surfaces of the leaves. Usually two sprayings in winter are sufficient.
Peach curl	Bordeaux mixture (2), 50-gallon formula, just before buds unfold.	Same fungicide when leaves are half grown.	Same fungicide two weeks later.	Same fungicide two weeks later.		
Pear leaf blight	Bordeaux mixture (2), 50-gallon formula, when buds are swelling.	Same fungicide when leaves are half grown.	Same fungicide two weeks later.	Same fungicide two weeks later.	Same fungicide two weeks later.	This is especially for the nursery. In the orchard the first and second treatments may be omitted.
Pear scab	Bordeaux mixture (2), 50-gallon formula, when fruit buds open.	Same fungicide just before blossoming.	Same fungicide when petals fall.	Same fungicide when fruit is one-half inch in diameter.		
Plum, prune, and peach leaf rust.	Ammoniacal copper carbonate solution (1) when trees cease to bloom and when in leaf.	Same fungicide three weeks later.	Same fungicide two weeks later.			
Potato rot or blight and Macrosporium disease.	Bordeaux mixture (2), 22-gallon formula, when plants are 6 inches high.	Same fungicide two weeks later.	Same fungicide two weeks later.	Same fungicide two weeks later.		For best results potatoes should be dug as soon as plants wither, not allowing them to remain in the ground until cold weather.
Potato scab	Cut and soak potatoes in corrosive sublimate solution (5) one hour and thirty minutes.					
Quince fruit spot and leaf blight.	Bordeaux mixture (2), 60-gallon formula, after blossoms fall.	Same fungicide two weeks later.	Same fungicide two weeks later.	Same fungicide two weeks later.	Same fungicide two weeks later.	A sixth application may be necessary in case of very wet weather.
Wheat stinking smut.	Soak seed for one minute in warm water at 110° to 120° F. (3).	Soak seed for ten minutes in hot water (132°).	Cool seed with cold water and spread out to dry.			

FORMULAS FOR FUNGICIDES.

(1) *Ammoniacal copper carbonate solution:*

Copper carbonate	ounces	5
Ammonia (26 per cent)	pints	3
Water	gallons	50

Place the copper carbonate in a wooden pail and make a paste of it by the addition of a little water. Then pour on the ammonia and stir until all the copper is dissolved. If the 3 pints of ammonia is not sufficient to dissolve the copper, add more until no sediment remains. Pour into a barrel and dilute with 45 or 50 gallons of water, and the mixture is then ready for use.

(2) *Bordeaux mixture:*

Copper sulphate	pounds	6
Strong fresh lime	do	4
Water	gallons	50

In a barrel or other suitable vessel place 25 gallons of water. Weigh out 6 pounds of copper sulphate, tie the same in a piece of coarse gunny sack, and suspend it just beneath the surface of the water. In another vessel slack 4 pounds of lime, using care to obtain a smooth paste, free from grit and small lumps. To accomplish this, place the lime in an ordinary water pail and add only a small quantity, say a quart, of water at first. When the lime begins to crack and crumble and the water to disappear add another quart or more, exercising care that the lime at no time gets too dry. Toward the last considerable water will be required; if added carefully and slowly a perfectly smooth paste will be obtained. When the lime is slacked add sufficient water to the paste to bring the whole up to 25 gallons. When the copper sulphate is entirely dissolved and the lime is cool, pour the lime milk and copper sulphate solutions slowly together at the same time into a barrel holding 50 gallons. The milk of lime should be thoroughly stirred before pouring, and the barrel of liquid should then receive a final stirring for at least three minutes. For the 22-gallon formula use 22 gallons of water instead of 50. For further directions in making large quantities see Farmers' Bulletin No. 38, pp. 5–8.

(3) *Hot-water treatment:*

This treatment is used for smuts of oats and wheat. Place two large kettles or two wash boilers on a stove; provide a reliable thermometer, and a coarse sack or basket for the seed. A special vessel for holding the grain may be made of wire or perforated tin. The vessel should never be entirely filled with grain, and in the kettles there should be about five or six times as much water by bulk as there is grain in the basket. In the first kettle keep the temperature of the water at from 110° to 120° F. and in the other at 132° to 133°, never letting it fall below 130° lest the fungous spores may not be killed, nor rise above 135° lest the grain be injured. Place the grain in the basket and then sink it into the first kettle. Raise and lower it several times and shake it so that all the grain may become wet and uniformly warm. Remove it from the first kettle and plunge it into the second, where it should receive ten minutes' treatment. Shake about repeatedly and also raise the basket containing the grain completely out of the water five or six times during the treatment. If the temperature falls below 132°, let the basket remain a few moments longer; if it rises, a few moments less. Have at hand cold and boiling water with which to regulate the temperature. At the expiration of the ten minutes remove the grain and plunge into cold water, after which spread it out to dry. The seed may be sown at once, before thoroughly dry, or may be dried and stored until ready for use. In treating oats keep them in water at 132° for ten minutes and spread out to dry without plunging into the cold water.

(4) *Resin wash:*

Resin	pounds	20
Caustic soda (98 per cent)	do	4¼
Fish oil (crude)	pints	3
Water to make	gallons	15

Place the resin, caustic soda, and fish oil in a large kettle. Pour over them 13 gallons of water and boil until the resin is thoroughly dissolved, which requires from three to ten minutes after the materials begin to boil. While hot add enough water to make just 15 gallons. When this cools, a fine yellowish precipitate settles to the bottom of the vessel. The preparation must therefore be thoroughly stirred each time before measuring out to dilute, so as to mix the precipitate uniformly with the clear, dark, amber-brown liquid, which forms by far the greater part of the stock preparation. When desired for use, take 1 part of the stock preparation to 9 parts of water. If the wash be desired for immediate use, the materials, after boiling and while still hot, may be poured directly into the spray tank and diluted with cold water up to 150 gallons.

(5) *Corrosive sublimate solution:*

Corrosive sublimate	ounces	2¼
Water	gallons	15

This solution is used for potato scab. The corrosive sublimate is dissolved in about 2 gallons of hot water, and after an interval of ten or twelve hours diluted with 13 gallons of water. The potatoes to be planted are immersed in the solution for one and one-half hours, after which they are spread out to dry, then cut and planted as usual. A half barrel is a convenient receptacle for the solution. The potatoes may be put into a coarse sack and suspended in the liquid, first being washed. Corrosive sublimate is very poisonous, and should be kept out of the way of children and animals. All treated tubers should be planted, or, if not planted, destroyed.

Potassium sulphide:

Potassium sulphide	ounces	2½
Water	gallons	5

Dissolve the potassium sulphide in water, and the mixture is ready for use.

FOODS FOR MAN.

Ordinary food materials, such as meat, fish, eggs, potatoes, wheat, etc., consist of—

Refuse.—As the bones of meat and fish, shells of shellfish, skins of potatoes, bran of wheat, etc.

Edible portion.—As the flesh of meat and fish, the white and yolk of eggs, wheat flour, etc. The edible portion consists of water and nutritive ingredients, or nutrients. The nutritive ingredients are *protein*, *fats*, *carbohydrates*, and *mineral matters*.

The water, refuse, and salt of salted meat and fish are called nonnutrients. In comparing the values of different food materials for nourishment they are left out of account.

USES OF NUTRIENTS.

Food is used in the body to build and repair tissue and to furnish energy. The manner in which the valuable constituents are utilized in the body may be expressed in tabular form as follows:

Protein White (albumen) of eggs, curd (casein) of milk, lean meat, gluten of wheat, etc.	Forms tissue (muscles, tendon, and probably fat).	All serve as *fuel* and yield *energy* in form of heat and muscular strength.
Fats Fat of meat, butter, olive oil, oils of corn and wheat, etc.	Form fatty tissue.	
Carbohydrates Sugar, starch, etc.	Transformed into fat.	
Mineral matters (ash) Phosphates of lime, potash, soda, etc.	Aid in forming bone, assist in digestion, etc.	

The fuel value of food.—Heat and muscular power are forms of force or energy. The energy is developed as the food is consumed in the body. The unit commonly used in this measurement is the calorie, the amount of heat which would raise the temperature of a pound of water 4° F.

The following general estimate has been made for the average amount of potential energy in 1 pound of each of the classes of nutrients:

	Calories.
In 1 pound of protein	1,860
In 1 pound of fats	4,220
In 1 pound of carbohydrates	1,860

In other words, when we compare the nutrients in respect to their fuel values, their capacities for yielding heat and mechanical power, a pound of protein of lean meat or albumen of egg is just about equivalent to a pound of sugar or starch, and a little over 2 pounds of either would be required to equal a pound of the fat of meat or butter or the body fat.

Within recent years analyses of a large number of samples of foods have been made in this country. In the table below the average results of a number of these analyses are given.

Average composition of American food products.[1]

Food materials (as purchased).	Refuse.	Water.	Protein.	Fat.	Carbohydrates.	Ash.	Fuel value per pound.
ANIMAL FOOD.							
Beef, fresh:							
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Calories.*
Chuck, including shoulder	19.9	54.1	15.3	9.9	....	0.8	705
Chuck ribs	13.3	50.1	15.0	20.8	....	.8	1,155
Flank	3.8	54.4	16.7	24.3	....	.8	1,335
Loin	12.6	53.3	15.9	17.3	....	.9	1,025
Neck	28.4	46.3	13.9	10.7	....	.7	710
Ribs	20.2	44.9	13.6	20.6	....	.7	1,120
Rib rolls	....	64.8	18.7	15.6	....	.9	1,005
Round	8.5	63.0	18.7	8.8	....	1.0	720
Rump	18.5	47.3	14.4	19.0	....	.8	1,070
Shank, fore	36.5	44.1	13.1	5.7	....	.6	485
Shoulder clod	14.6	57.9	16.8	9.7	....	1.0	725
Fore quarter	19.8	49.3	14.1	16.1	....	.7	940
Hind quarter	16.3	52.0	15.3	15.6	....	.8	945

[1] Condensed from detailed tables in Bulletin No. 28 of the Office of Experiment Stations of this Department.

Average composition of American food products—Continued.

Food materials (as purchased).	Refuse.	Water.	Protein.	Fat.	Carbohydrates.	Ash.	Fuel value per pound.
ANIMAL FOOD—continued.							
Beef, corned, pickled, and dried:	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Calories.*
Corned beef	9.4	49.6	14.2	22.8	----------	4.0	1,225
Tongue, pickled	6.0	58.9	11.6	19.2	----------	4.3	1,025
Dried, salted, and smoked	----------	50.8	31.8	6.8	0.6	10.0	890
Veal:							
Breast	21.4	53.1	15.1	9.6	----------	.8	685
Leg	10.5	65.0	18.5	5.0	----------	1.0	555
Leg cutlets	4.0	65.6	20.0	9.5	----------	.9	775
Forequarter	24.5	54.2	14.6	6.0	----------	.7	525
Hind quarter	20.7	56.2	15.7	6.6	----------	.8	570
Lamb and mutton:							
Flank	----------	42.0	13.9	43.4	----------	.7	2,090
Leg, hind	13.8	50.3	15.3	19.7	----------	.9	1,115
Shoulder	21.5	47.0	13.4	17.4	----------	.7	985
Fore quarter	21.1	40.6	11.9	25.7	----------	.7	1,305
Hind quarter, without tallow and kidney	16.7	45.6	13.5	23.5	----------	.7	1,215
Pork, fresh:							
Flank cut	71.2	17.0	5.1	6.4	----------	.3	365
Ham	42.4	35.7	10.7	10.6	----------	.6	645
Loin	16.0	42.3	13.5	27.5	----------	.7	1,410
Shoulder	32.5	35.9	10.4	20.7	----------	.5	1,065
Tenderloin	----------	65.1	19.5	14.4	----------	1.0	970
Pork, salted, cured, and pickled:							
Ham, smoked	12.7	35.9	14.1	33.2	----------	4.1	1,665
Shoulder, smoked	18.9	30.7	12.4	33.0	----------	5.0	1,625
Salt pork	----------	7.3	1.8	87.2	----------	3.7	3,715
Bacon, smoked	8.1	17.8	9.6	60.2	----------	4.3	2,720
Soups:							
Celery, cream of	----------	88.6	2.1	2.8	5.0	1.5	250
Meat stew	----------	85.7	4.5	3.5	5.1	1.2	325
Tomato	----------	90.0	1.8	1.1	5.6	1.5	185
Poultry:							
Chicken	30.0	45.6	13.4	10.2	----------	.8	680
Turkey	22.7	42.4	15.7	18.4	----------	.8	1,070
Fish:							
Cod, dressed	29.9	58.5	10.6	.2	----------	.8	205
Halibut, steaks or sections.	17.7	61.9	15.1	4.4	----------	.9	465
Mackerel, whole	44.6	40.4	10.0	4.3	----------	.7	370
Perch, yellow, dressed	35.1	50.7	12.6	.7	----------	.9	265
Shad, whole	50.1	35.2	9.2	4.8	----------	.7	375
Fish, salt:							
Cod	24.9	40.3	16.0	.4	----------	18.4	315
Shellfish:							
Oysters, "solids"	----------	88.3	6.1	1.4	3.3	.9	235
Eggs:							
Hens' eggs	[1] 10.5	66.0	13.1	9.5	----------	.9	645
Dairy products, etc.:							
Butter	----------	----------	----------	[2] 82.4	----------	----------	3,475
Whole milk	----------	87.0	3.3	4.0	5.0	.7	325
Skim milk	----------	90.5	3.4	.3	5.1	.7	170
Buttermilk	----------	91.0	3.0	.5	4.8	.7	165
Condensed milk	----------	30.5	8.2	7.1	52.3	1.9	1,425
Cream	----------	74.0	2.5	18.5	4.5	.5	910
Cheese	----------	35.6	28.2	32.0	----------	4.2	1,875
VEGETABLE FOOD.							
Flour, meal, etc.:							
Entire wheat flour	----------	12.1	14.2	1.9	70.6	1.2	1,660
Graham flour	----------	11.8	13.7	2.2	70.3	2.0	1,655
Roller process flour	----------	12.5	11.3	1.1	74.6	.5	1,645
Macaroni and vermicelli	----------	10.8	11.7	1.6	72.9	3.0	1,640
Crushed wheat	----------	10.5	11.9	1.7	74.5	1.4	1,680
Buckwheat flour	----------	14.3	6.1	1.0	77.2	1.4	1,590
Corn meal, bolted	----------	12.9	8.9	2.2	75.1	.9	1,655
Oatmeal	----------	7.2	15.6	7.3	68.0	1.9	1,860
Rice	----------	12.4	7.8	.4	79.0	.4	1,630
Tapioca	----------	11.6	.4	.3	87.5	.2	1,650
Starch	----------	----------	----------	----------	98.0	----------	1,825
Bread, pastry, etc.:							
White bread	----------	35.4	9.5	1.2	52.8	1.1	1,205
Brown bread	----------	40.0	5.0	2.4	50.7	1.9	1,135
Graham bread	----------	32.3	8.5	1.8	55.9	1.5	1,275

[1] Average per cent shell in several determinations.
[2] Average per cent butter fat found in the ninety-day Columbian butter test.

Average composition of American food products—Continued.

Food materials (as purchased).	Refuse.	Water.	Protein.	Fat.	Carbohydrates.	Ash.	Fuel value per pound.
VEGETABLE FOOD—cont'd.							
Bread, pastry, etc.—Cont'd.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Calories.*
Rye bread	....	31.8	10.1	.7	55.9	1.5	1,255
Cake [1]	....	20.4	7.0	8.1	63.4	1.1	1,650
Cream crackers	....	7.0	9.3	13.1	69.2	1.4	2,010
Oyster crackers	....	4.3	11.0	8.8	74.2	1.7	1,955
Soda crackers	....	8.0	10.3	9.4	70.0	1.8	1,900
Pie [1]	....	44.8	4.6	9.5	39.6	1.5	1,220
Sugars:							
Molasses	....	25.7	2.7	....	68.0	3.6	1,315
Sugar, granulated	....	....	....	....	100.0	....	1,860
Maple sirup	....	....	....	....	70.1	....	1,395
Vegetables:							
Beans, dried	....	13.2	22.3	1.8	59.1	3.6	1,590
Beans, Lima, green	....	68.5	7.1	.7	22.0	1.7	570
Beans, string	....	87.3	2.2	.4	9.4	.7	235
Beets	20.0	70.0	1.3	.1	7.7	.9	170
Cabbage	15.0	76.8	1.8	.3	4.9	1.2	140
Celery	....	94.4	1.4	.1	3.0	1.1	85
Corn, green (sweet), edible portion	....	81.3	2.8	1.1	14.1	.7	330
Cucumbers	15.0	81.6	.7	.2	2.1	.4	60
Lettuce	18.0	77.1	1.1	.3	2.7	.8	85
Onions	10.0	78.6	1.5	.4	8.9	.6	210
Parsnips	20.0	63.9	1.3	.5	12.9	1.4	285
Peas (*Pisum sativum*), dried	....	10.8	24.1	1.1	61.5	2.5	1,640
Peas (*Pisum sativum*), green	50.0	39.0	2.2	.3	8.0	.5	200
Peas (cowpeas), dried	....	13.0	21.3	1.4	60.9	3.4	1,590
Potatoes	15.0	67.1	1.8	.1	15.3	.7	325
Sweet potatoes	15.0	58.9	1.5	.6	23.1	.9	480
Spinach	....	92.4	2.1	.5	3.1	1.9	120
Squash	50.0	43.3	.8	.3	5.2	.4	125
Tomatoes	....	94.4	.8	.4	3.9	.5	105
Turnips	30.0	62.2	1.0	.1	6.1	.6	135
Vegetables, canned:							
Corn, green	....	75.7	2.8	1.3	19.3	.9	465
Peas (*Pisum sativum*), green	....	85.3	3.6	.2	9.8	1.1	255
Tomatoes	....	94.0	1.2	.2	4.0	.6	105
Fruits, berries, etc., fresh:							
Apples	25.0	61.5	.4	.4	12.4	.3	255
Bananas	40.0	44.5	.7	.5	13.7	.6	290
Grapes	25.0	59.1	1.0	1.3	13.3	.3	320
Lemons	30.0	62.5	.7	.6	5.8	.4	145
Oranges	27.0	64.5	.6	.4	7.1	.4	160
Pears	25.0	62.9	.5	.6	10.6	.4	235
Raspberries	....	85.8	1.0	....	12.6	.6	255
Strawberries	10.0	81.8	.9	.6	6.1	.6	155
Watermelons	58.0	39.0	.2	....	2.7	.1	55
Fruits, dried:							
Apples	....	36.2	1.4	3.0	57.6	1.8	1,225
Dates	12.0	18.3	1.9	4.5	61.9	1.4	1,375
Figs	....	22.5	5.1	....	70.0	2.4	1,395
Raisins	....	14.0	2.5	4.7	74.7	4.1	1,635
Miscellaneous:							
Cocoanut, prepared	....	3.5	6.3	57.4	31.5	1.3	3,125
Chocolate	....	10.3	12.5	47.1	26.8	3.3	2,720
Cocoa, powdered	....	4.6	21.6	28.9	37.7	7.2	2,320

[1] Average of a number of kinds.

DIETARY STANDARDS.

Dietary studies have been made in considerable numbers in different countries. The results of such studies and experiments to determine the amount of food required by men engaged in different occupations have resulted in the adoption of dietary standards. Some of these follow.

Standards for daily dietaries.

	Nutrients.			Fuel value.
	Protein.	Fat.	Carbohydrates.	
European:	*Pound.*	*Pound.*	*Pounds.*	*Calories.*
Man at moderate work	0.26	0.12	1.10	3,055
Man at hard work	.32	.22	.99	3,370
American:				
Man without muscular work	.20			3,000
Man with light muscular work	.22			3,000
Man with moderate muscular work	.28			3,500
Man with hard muscular work	.39			4,500

The table of composition of food materials shows the amount of water, protein, fat, carbohydrates, and ash content and the total fuel value per pound. The protein, fat, and carbohydrates all furnish energy. In addition to furnishing energy, protein forms tissue. Since protein and energy are the essential features of food, dietary standards may be expressed in their simplest form in terms of protein and energy alone.

Observation has shown that as a rule a woman requires less food than a man, and the amount required by children is still less, varying with the age. It is customary to assign certain factors which shall represent the amount of nutrients required by children of different ages and by women as compared with adult man. The various factors which have been adopted are as follows:

Factors used in calculating meals consumed in dietary studies.

One meal of woman equivalent to 0.8 meal of man at moderate muscular labor.
One meal of boy 14 to 16 years of age, inclusive, equivalent to 0.8 meal of man.
One meal of girl 14 to 16 years of age, inclusive, equivalent to 0.7 meal of man.
One meal of child 10 to 13 years of age, inclusive, equivalent to 0.6 meal of man.
One meal of child 6 to 9 years of age, inclusive, equivalent to 0.5 meal of man.
One meal of child 2 to 5 years of age, inclusive, equivalent to 0.4 meal of man.
One meal of child under 2 years of age equivalent to 0.3 meal of man.

These factors are based in part upon experimental data and in part upon arbitrary assumptions. They are subject to revision when experimental evidence shall warrant more definite conclusions.

METHOD OF CALCULATING DIETARIES.

The following may be taken as an illustration of the way in which the table of composition of food products and the dietary standards may be practically applied. Suppose the family consists of four adults and that there are on hand or may be readily purchased the following food materials: Oatmeal, milk, sugar, eggs, lamb chops, roast beef, potatoes, sweet potatoes, rice, bread, cake, bananas, tea, and coffee. From these materials menus for three meals might be arranged as follows:

Breakfast.—Oatmeal, milk, sugar, lamb chops, bread, butter, and coffee.

Dinner.—Roast beef, white (Irish) potatoes, sweet potatoes, rice pudding, and tea.

Supper.—Bread, butter, cake, and bananas.

The amounts required of the several articles of food may be readily approximated by any person experienced in marketing or preparing food for a family. Thus, it may be assumed that four adults would consume for breakfast 1½ pounds lamb chops, one-half pound oatmeal, one-half pound bread, 6 ounces milk, 2 ounces sugar, and 2 ounces butter. From the table of composition of food materials the nutritive ingredients which these foods furnish may be easily calculated. Thus, if oatmeal contains 15.6 per cent protein and furnishes 1,860 calories per pound, one-half pound would contain 0.078 pound protein (0.5 lb. × 0.156 = 0.078 lb.) and yield 930 calories, and if lamb chops contain 15.3 per cent protein and furnish 1,115 calories per pound, 1½ pounds of lamb chops would furnish 0.23 pound protein (1.5 lb. × 0.153 = 0.2295 lb.) and 1,673 calories. The others may be calculated in the same way.

The assumed quantities of food materials which the four persons would consume in a day and the calculated protein content and fuel value would be as follows:

Menu for family of four adults for one day.

Food materials.	Weights.		Protein.	Fuel value.
	Pounds.	*Ounces.*	*Pound.*	*Calories.*
Breakfast:				
Oatmeal		8	0.078	930
Milk		6	.017	122
Sugar		2		232
Lamb chops (from leg)	1	8	.229	1,673
Bread		8	.048	603
Butter		2		434
Coffee [1]			.010	417
Total			.382	4,411
Dinner:				
Roast beef (chuck)	1	12	.270	1,233
Potatoes		12	.013	244
Sweet potatoes		12	.011	360
Bread		6	.036	453
Butter		2		434
Rice		4	.020	407
Eggs		4	.033	161
Milk		6	.012	122
Sugar		2		232
Tea			.010	410
Total			.405	4,056
Supper:				
Bread		12	.071	904
Butter		2		434
Bananas		12	.005	217
Cake		8	.035	825
Total			.111	2,380
Total for 3 meals			.898	10,847
Average for 1 person			.224	2,712

[1] Coffee and tea in themselves have little or no nutritive value. In the menu, allowance is made for the milk or cream and the sugar that would ordinarily be added.

The American dietary standard for a man at moderate muscular work calls for 0.28 pound protein and 3,500 calories. It will be seen that the menu suggested above is insufficient, that is, more food must be supplied. For instance, cheese might be added for dinner and pork and beans and milk for supper. The amounts of protein and energy which a sufficient quantity of these articles for four persons would supply are shown in the following table:

Food added to bring the day's menu up to the dietary standard.

Food materials.	Weights.		Protein.	Fuel value.
	Pounds.	*Ounces.*	*Pound.*	*Calories.*
Cheese		4½	0.073	553
Beans		12	.167	1,193
Pork		4	.004	829
Milk	2		.017	650
Total amount added to menu			.251	3,225

These additions would make the total protein 1.149 pounds and the total fuel value 14,072 calories for four persons, or for one person[1] 0.287 pound protein and 3,518 calories, which are approximately the amounts required by the dietary standard.

Following the above method the value of any menu chosen may be easily calculated. It should be borne in mind that approximate rather than absolute agreement with the dietary standard is sought. It is not the purpose to furnish a prescription for definite amounts of food materials, but rather to supply the means of judging whether the food habits of families accord in general with what research has shown to be most desirable from a physiological standpoint. If economy is necessary a study of the tables will show that it is possible to devise menus which will furnish the requisite amounts of nutrients and energy at comparatively low cost.

COMPOSITION OF TYPICAL AMERICAN FLOURS.

A comparison of the values for food of the principal kinds of American flour may be made from the following tables. It will be remembered that the proteids, carbohydrates, and gluten are the principal nutrients. The ash, water, and fiber may be considered as waste, while the ether extract is comparatively unimportant.

HIGH-GRADE PATENT FLOUR.

A high-grade American patent flour has approximately the following composition:

	Per cent.
Water	12.75
Proteids (factor 6.25)	10.50
Ether extract (oil)	1.00
Crude ash	.50
Moist gluten	26.00
Dry gluten	10.00
Carbohydrates (factor 6.25)	75.25

COMMON MARKET FLOUR.

It is probable that as a whole the flours which are exposed for sale in a market like that of Washington, D. C., will be representative of the flours of the whole country, as very little of the local supply comes from the wheat grown in the vicinity. The data obtained, therefore, from the analyses of a large number of samples bought in the open market may be relied upon as giving a fair indication of what a typical common market bulk flour is. The composition of such a typical flour, as indicated by the data recently obtained, is approximately as follows:

	Per cent.
Water	12.25
Proteids (factor 6.25)	10.20
Moist gluten	24.50
Dry gluten	9.25
Ether extract	1.30
Ash	.60
Fiber	.30
Carbohydrates (factor 6.25)	75.65

[1] For the sake of simplifying the calculation no distinction is made between men and women.

BAKERS' FLOUR.

The typical American flour which is sold under the name of bakers' flour, and which, as a rule, is regarded as somewhat inferior to the high-grade patent flours, has a composition which, as determined by the foregoing analyses, is approximately represented by the following numbers:

	Per cent.
Water	11.75
Proteids (factor 6.25)	12.30
Dry gluten	13.10
Moist gluten	34.70
Ether extract	1.30
Ash	.60
Carbohydrates (factor 6.25)	74.05

To be noticed is the practically identical composition of the bakers' flour with the high-grade patent flours. The chief differences are found in the fact that the bakers' flours are drier, containing about 1 per cent less moisture. They have, too, a distinctly higher percentage of proteids as compared with the high-grade flours, due to the fact, doubtless, that large quantities of the outer part of the kernels enter into the composition of these flours. The quantities of gluten are more than correspondingly increased, which indicates that the glutinous part of the proteids tends to accumulate in flours of this character, and this is due to the nature of the milling process and to the separation of the various parts of the wheat kernel. The quantity of oil is also higher than in the high-grade flours, showing a less perfect degermination of the grain during the milling process. The ash is also slightly higher than in the high-grade flours, while the carbohydrates are somewhat lower, due to the higher percentage of proteids.

In a general comparison of bakers' flours with high-grade patent flours it is seen that the nutritive ratio is much narrower in the bakers' flour, and the percentage of proteids higher. Judged by the common theories of nutrition, therefore, the bakers' flour would make a bread better suited to the laboring man, while the high-grade patent flours would form a bread with a greater tendency to produce fat and animal heat.

FLOUR OF SMALL MILLS.

In another class wheat flours have been collected of the miscellaneous samples which were not capable of classification, by reason of their names or descriptions, with the three preceding grades of flours. These flours doubtless represent the product of small mills, and are derived from the most diversified sources. As would be expected, they show among themselves a considerable degree of variation, although the mean composition does not differ very greatly from that of the previously described grades. The typical flour of this miscellaneous class, judged by the data which have been obtained, has the following approximate composition:

	Per cent.
Water	12.85
Proteids (factor 6.25)	10.30
Moist gluten	26.80
Dry gluten	10.20
Ether extract	1.05
Ash	.50
Carbohydrates (factor 6.25)	75.30

The important feature of such a typical flour is its almost exact identity, from a commercial point of view, with the high-grade patent flours. The averages of the two classes are so nearly alike that they could be interchanged with each other with no appreciable modification of chemical composition. This fact emphasizes in a most marked degree the points which have been brought out in the previous discussions; viz., that the commercial value of flour depends almost exclusively upon the nature of the milling process and upon the color and general appearance of the flour, and has little or nothing to do with nutritive properties.

SELF-RAISING FLOURS.

The small importance, from a commercial point of view, of a self-raising flour gives little encouragement for the endeavor to establish a typical standard for this class of nutrients. It is evident without discussion that the self-raising properties of a flour are due to the incorporation therewith of some of the ordinary chemical leavening agents which are commonly used. In other words, by mixing with the flour an ordinary baking powder, or the essential leavening constituents thereof, the so-called self-raising flour is produced. This flour, it is evidently intended, should be used immediately for bread making without being subjected to any previous fermentation.

Only a few samples of self-raising flours have been examined in the Department. A typical self-raising flour, representing nearly the mean of the samples examined, has the following composition:

	Per cent.
Moisture	12.30
Proteids (factor 6.25)	10.10
Moist gluten	27.00
Dry gluten	9.65
Ether extract	.70
Ash	4.00
Carbohydrates (factor 6.25)	72.90

The principal variation in this flour from the others here noted is in the amount of ash. The normal quantity of ash is seen to be about 0.5 and the increase by the use of constituents to secure the raising of the loaf is 3.5 per cent. This seems to indicate, when considered in connection with other facts, that the better plan is to add the leavening agents to the flour at the time of baking.

EFFECT UPON SOIL OF GROWING VARIOUS CROPS.

The following tables show the amounts of the principal elements of fertility, namely, nitrogen, potash, and phosphoric acid, removed by the principal field and garden crops of this country. By use of them the farmer can estimate with more assurance of accuracy than is usual, the condition in which his ground is left after cultivating and removing any crop included in the list. This is of especial value where commercial fertilizers are much used.

As an example of the use proposed for the data here furnished: Suppose a farmer takes from an acre of ground 30 bushels of barley. This would be 1,440 pounds. Accordingly, there would be removed 14.40 x 1.51 = 21.744 pounds of nitrogen, 14.40 x .48 = 6.912 pounds of potash, and 14.40 x .08 = 1.152 of phosphoric acid. If the farmer knows approximately how much of these elements his land contained at the beginning of the season, or how much he has added in the shape of commercial fertilizers, he can judge whether it will be necessary to supply more of any or all of these elements for the next season. He also can better determine by an examination of the table what crop should come next in rotation.

Total amount of mineral matter and the amount of fertilizing constituents removed from the soil by certain field and garden crops.

[The quantities of ash and fertilizing constituents are stated in pounds for the quantities of material given in column A. The percentages of water show whether the data given are for materials in the fresh or dried condition.]

Kind of crop.	A. Weight of material.	Water.	Quantity of ash and fertilizing constituents contained in the weight of material given in column A.			
			Ash.	Nitrogen.	Potash. (K_2O)	Phosphoric acid. (P_2O_5)
	Pounds	*Per cent.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Asparagus stems [1]	100	93.96	0.67	0.29	0.29	0.08
Barley, grain [2],[3],[1]	100	10.8-14.3	2.45	1.51-1.76	0.48- .60	0.79- .88
Beets, sugar [4]						
Roots (65-80 per cent of entire plant).	1,000	70-80	5.45-11.4	1.6 -4.0	2.1 -3.3	.51-1.1
Leaves (20-35 per cent of entire plant).	1,000	85-90	18.1 -31.5	2.8 -3.8	2.7-10.0	.9 -2.4
Cabbages [1]	100	90.52	1.40	.38	.43	.11
Carrots [1]	100	88.59	1.02	.16	.51	.01
Clover (red and scarlet) [1] (Trifolium pratense and incarnatum.)	100	80-82.5	------------	.43- .53	.46- .49	.39
Clover hay (red clover) [1]	100	11.33	6.93	2.07	2.20	.38
Clover hay (scarlet clover) [1]	100	18.30	7.70	2.05	1.31	.40
Corn (field) kernels [2],[3],[1]	100	10.88	1.50-1.53	1.60-1.82	.40- .51	.53- .70
Corn (field) kernels and cob [1]	100	8.96	------------	1.41	.47	.57
Corn (sweet) kernels [5]	100	82.36	.56	.46	.24	.07
Other parts required to produce 100-pound kernels:						
Stalks	413.3	80.86	5.17	1.16	1.69	.58
Husks	46.7	86.19	.26	.08	.10	.03
Cobs	106.6	80.10	.63	.22	.23	.05
Stalks, husks, and cobs	566.6	------------	6.06	1.46	2.02	.66
Total	666.6	------------	6.62	1.92	2.26	.73
Corn (sweet) (quantity necessary to produce 100 pounds corn in the ear, including husk): [5]						
Kernels	39.5	82.36	.22	.18	.09	.03
Cobs	42.1	80.10	.25	.09	.09	.02
Husks	18.4	86.19	.10	.03	.04	.01
Kernels, cobs, and husks	100	------------	.57	.30	.22	.06
Stalks	163	80.86	2.04	.46	.67	.23
Total	263	------------	2.61	.76	.89	.29
Cotton (quantity producing 100 pounds of lint): [6]						
Roots	83	Air-dry.	------------	.76	1.06	.43
Stems	219	Air-dry.	------------	3.20	3.09	1.29
Leaves	192	Air-dry.	------------	6.16	3.46	2.28
Bolls	135	Air-dry.	------------	3.43	2.44	1.30
Seed	218	Air-dry.	------------	6.82	2.55	2.77
Lint	100	Air-dry.	------------	.34	.46	.10
Total required to produce 100 pounds lint	947	Air-dry.	------------	20.71	13.06	8.17
Cowpea [1]	100	78.81	1.47	.27	.31	.10
Eggplant [1]	100	92.93	.50	.18	------------	------------

[1] Bulletin No. 15, Office of Experiment Stations.
[2] Bulletin No. 45, Division of Chemistry, p. 53.
[3] Bulletin No. 13, pt. 9. Division of Chemistry.
[4] Extremes of data given by Champion & Pellet and Stammer (Bulletin No. 27, Division of Chemistry); and by Zscheye and Schauer (Zeitschrift für Rübenzucker Industrie, 1892, 738).
[5] Calculated from data given in Maine Station Report for 1889 and from the data derived therefrom and found in Bulletin No. 15 of the Office of Experiment Stations.
[6] Bulletin No. 33, Office of Experiment Stations.

Total amount of mineral matter and the amount of fertilizing constituents removed from the soil by certain field and garden crops—Continued.

[The quantities of ash and fertilizing constituents are stated in pounds for the quantities of material given in column A. The percentages of water show whether the data given are for material in the fresh or dried condition.]

Kind of crop.	A. Weight of material.	Water.	Quantity of ash and fertilizing constituents contained in the weight of material given in column A.			
			Ash.	Nitrogen.	Potash. (K_2O)	Phosphoric acid. (P_2O_5)
Flax (crop grown on 1 acre):[1]	*Pounds*	*Per cent.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Straw	1,800		59.39	18.00	23.04	7.87
Seed	1,724		71.54	56.24	20.60	32.00
Fiber	600		5.53		.13	.72
Whole plant	4,124		136.46		43.77	40.59
Flax (quantity producing 100 pounds of fiber):[1]						
Straw	300		9.90	3.00	3.84	1.31
Seed	287½		11.92	9.37	3.43	5.33
Fiber	100		.92		.02	.12
Whole plant	687½		22.74		7.29	6.76
Hemp (amount produced by 1 acre):[1]						
Leaves	1,975				56.46	18.70
Stems	3,000				44.44	12.91
Clean fiber	1,000				.40	1.61
Whole plant	5,975			62.74	101.30	33.22
Hemp (amount required to produce 100 pounds of fiber):[1]						
Leaves	197.5				5.65	1.87
Stems	300				4.44	1.29
Clean fiber	100				.04	.16
Whole plant	597.5			6.27	10.13	3.32
Lettuce, leaves[2]	100	86.28	1.71	.36		
Oats, grain[3,4,2]	100	10.1-18.2	3-3.5	1.9-2.1	.56-.62	.82-.85
Okra[2]	100	87.41	.74	.32		
Onions[2]	100	87.55	.57	.14	.10	.04
Parsnips[2]	100	80.34	1.03	.22	.62	.19
Potatoes, Irish, tubers[2]	100	79.75	.99	.21	.29	.07
Potatoes, sweet, tubers[2]	100	71.26	1.00	.24	.37	.08
Pumpkins, whole fruit[2]	100	92.27	.63	.11	.09	.16
Rice, grain, unhulled	100	Air-dry.	[3] 3.26	[3] 1.34	[4] .28	[4] .58
	100	Air-dry.	[6] 7.28	[6] 1.19	[5] .21	[5] .47
Rye[3,2]	100	10.6-14.9	1.90	1.76-1.96	.54	.82
Squashes, whole fruit[2]	100	94.88	.41	.11		
Sugar cane, leaves and tops removed[7]	2,000	75.00		3.4	2.17	1.48
Timothy, hay[2]	100	7.52	4.93	1.26	.90	.53
Tobacco:						
Leaf[8]	100	7.5-11	11-22	1.1-4.2	2-6	.4-.7
Stalks (30 to 50 pounds for each 100 pounds of leaf)[9]	100	6.18	13.28	3.71	5.02	.65
Tomatoes, fruit[2]	100	93.64	.47	.16	.27	.05
Turnips, roots[2]	100	90.46	.80	.18	.39	.10
Wheat, grain, winter[3,2]	100	10.6-14.8	1.75	1.96-2.36	.61	.89

[1] Bulletin No. 94, p. 4, California Agric. Exp. Station.
[2] Bulletin No. 15, Office of Experiment Stations.
[3] Bulletin No. 45, Division of Chemistry, p. 53.
[4] Bulletin No. 13, pt. 9, Division of Chemistry.
[5] Wolff's Aschen-Analysen.
[6] Bulletin No. 24 of the Louisiana Agric. Exp. Station.
[7] Stubbs's Sugar Cane, Vol. I, p. 123.
[8] Minima and Maxima of a large dumber of analyses published in Bulletin No. 51 of the Virginia Agric. Exp. Station.
[9] Average of four analyses published in Bulletin No. 14 of the Virginia Agric. Exp. Station.

RESTORATION OF FERTILITY OF SOIL.

Soil from which the elements essential to the profitable growing of farm crops have been removed may be restored in a way to give ample returns for the necessary labor. This may be by planting leguminous crops, as clover or cowpeas, by sowing commercial fertilizers, or by use of manure of farm animals. Exact calculations for results with leguminous crops are not available, but the amount of commercial fertilizer to be used and the benefit to be derived from farm animals may be reckoned from the following tables.

Analyses of fertilizers.

[The words "available phosphoric acid" as used in this table denote that portion which is dissolved by neutral ammonium citrate solution under standard conditions. This indicates, as nearly as the chemist is able to determine at present, the part of the phosphoric acid contained in the various fertilizers which is readily available to growing plants when the material in question is applied to the soil. In the case of dried blood, cotton-seed meal, and many other organic fertilizers, practically all of the phosphoric acid becomes available as rapidly as it is liberated by the decay of these substances when placed in the soil.]

Material.	Nitrogen.	Available phosphoric acid.	Insoluble phosphoric acid.	Total phosphoric acid.	Potash.	Chlorine.
COMMERCIAL FERTILIZERS.						
1. Supplying nitrogen:	*Per cent.*	*Per ct.*	*Per ct.*	*Per cent.*	*Per cent.*	*Per cent.*
Nitrate of soda	15.5 to 16					
Sulphate of ammonia	19 to 20.5					
Dried blood (high grade)	12 to 14					
Dried blood (low grade)	10 to 11			3 to 5		
Concentrated tankage	11 to 12.5			1 to 2		
Tankage (bone)	5 to 6			11 to 14		
Dried fish scrap	7 to 9			6 to 8		
Cotton-seed meal	6.5 to 7.5			1.5 to 2	2 to 3	
Castor pomace	5 to 6			1 to 1.5	1 to 1.5	
2. Supplying phosphoric acid:						
South Carolina rock phosphate			26 to 28	26 to 28		
South Carolina rock superphosphate (dissolved South Carolina rock phosphate)		12 to 15	1 to 3	13 to 16		
Florida land rock phosphate			33 to 35	33 to 35		
Florida pebble phosphate			26 to 32	26 to 32		
Florida superphosphate (dissolved Florida phosphate)		14 to 16	1 to 4	16 to 20		
Boneblack			32 to 36	32 to 36		
Boneblack superphosphate (dissolved boneblack)		15 to 17	1 to 2	17 to 18		
Ground bone	2.5 to 4.5	5 to 8	15 to 17	20 to 25		
Steamed bone	1.5 to 2.5	6 to 9	16 to 20	22 to 29		
Dissolved bone	2 to 3	13 to 15	2 to 3	15 to 17		
Thomas slag				[1] 11.4 to 23		
3. Supplying potash:						
Muriate of potash					50	45 to 48
Sulphate of potash (high grade)					48 to 52	.5 to 1.5
Sulphate of potash and magnesia					26 to 30	1.5 to 2.5
Kainite					12 to 12.5	30 to 32
Sylvinite					16 to 20	42 to 46
Cotton-hull ashes [2]				7 to 9	20 to 30	
Wood ashes (unleached) [2]				1 to 2	2 to 8	
Wood ashes (leached) [2]				1 to 1.5	1 to 2	
Tobacco stems	2 to 3			3 to 5	5 to 8	
FARM MANURES.						
Cattle excrement (solid, fresh)	.29			.17	.10	
Cattle urine (fresh)	.58				.49	
Hen manure (fresh)	1.10			.85	.56	
Horse excrement (solid)	.44			.17	.35	
Horse urine (fresh)	1.55				1.50	
Human excrement (solid)	1.00			1.09	.25	
Human urine	.60			.17	.20	
Pigeon manure (dry)	3.20			1.90	1.00	
Sheep excrement (solid, fresh)	.55			.31	.15	
Sheep urine (fresh)	1.95			.01	2.26	
Swine excrement (solid, fresh)	.60			.41	.13	
Swine urine (fresh)	.43			.07	.83	
Barnyard manure (average)	.49			.32	.43	

[1] In good Thomas slag at least 80 per cent of the phosphoric acid should be soluble in ammonium citrate; that is, available.

[2] Cotton-hull ashes contain about 10 per cent of lime, unleached wood ashes 30 to 35 per cent, and leached wood ashes 35 to 40 per cent.

BARNYARD MANURE.

Barnyard manure contains all the fertilizing elements required by plants in forms that insure plentiful crops and permanent fertility to the soil. It not only enriches the soil with the nitrogen, phosphoric acid, and potash which it contains, but it also renders the stored-up materials of the soil more available, improves the mechanical condition of the soil, makes it warmer, and enables it to retain more moisture or to draw it up from below.

Amount and value of manure produced by different farm animals

[New York Cornell Experiment Station.]

Animal.	Per 1,000 pounds of live weight.			Value of manure per ton.
	Amount per day.	Value per day.[1]	Value per year.[1]	
	Pounds.	*Cents.*		
Sheep	34.1	7.2	$26.09	$3.30
Calves	67.8	6.2	24.45	2.18
Pigs	83.6	16.7	60.88	3.29
Cows	74.1	8.0	29.27	2.02
Horses	48.8	7.6	27.74	2.21

[1] Valuing nitrogen at 15 cents, phosphoric acid at 6 cents, and potash at 4½ cents per pound.

Barnyard manure is a very variable substance, its composition and value depending principally upon (1) age and kind of animal; (2) quantity and quality of food; (3) proportion of litter, and (4) method of management and age of manure.

Value of manure as affected by kind of animal and of feed.—Mature animals neither gaining nor losing weight excrete practically all the fertilizing constituents consumed in the food. Growing animals and milch cows excrete from 50 to 75 per cent of the fertilizing constituents of the food; fattening or working animals from 90 to 95 per cent. As regards the fertilizing value of equal weights of manure in its normal condition, farm animals probably stand in the following order: Poultry, sheep, pigs, horses, cows.

The amounts of fertilizing constituents in the manure stand in direct relation to those in the food. As regards the value of manure produced, the concentrated feeding stuffs, such as meat scrap, cotton-seed meal, linseed meal, and wheat bran, stand first, the leguminous plants (clover, peas, etc.) second, the grasses third, cereals (oats, corn, etc.) fourth, and root crops, such as turnips, beets, and mangel-wurzels, last.

Saving of manure.—Barnyard manure is a material which rapidly undergoes loss. When it is practicable to haul the manure from the stalls and pen and spread it on the field at frequent intervals the losses of valuable constituents need not be very great; but when the manure must be stored for some time preservatives may be used with profit. The loss from destructive fermentation may be almost entirely prevented by the use of absorbents, such as superphosphate and kainite, and especially by keeping the manure moist and excluding the air.

Amounts of different preservatives to be used per head daily.

Preservative.	Per horse, 1,000 pounds' weight.		Per cow, 880 pounds' weight.		Per pig, 220 pounds' weight.	Per sheep, 110 pounds' weight.
	Lbs.	*Ozs.*	*Lbs.*	*Ozs.*	*Ounces.*	*Ounces.*
Superphosphate	1	0	1	2	3	2¼
Gypsum	1	9	1	12	4⅜	3⅝
Kainite	1	2	1	5	4	3⅛

If kainite is used, it should be applied to the fresh manure and covered with litter, so that it does not come in contact with the feet of the animals. All preservatives are more effective if applied before decomposition sets in.

Loss from leaching may be prevented by storage under cover or in pits. Extremes of moisture and temperature are to be avoided, and uniform and moderate fermentation is the object to be sought. To this end it is advisable to mix the manure from the different animals thoroughly in the heap and keep the mass compact.

Use of manure.—Barnyard manure is justly held in high esteem as a general fertilizer, but it has a forcing effect when fresh, and is therefore better suited to grasses and forage plants than to plants grown for seed, such as cereals. Direct applications, especially to root crops, such as sugar beets, potatoes, or tobacco, often prove injurious. This result can, as a rule, be avoided by applying the manure some months before the planting of the crop or by using only well-rotted manure.

Barnyard manure is not applied to fruit trees with the same good results that attend its use in the case of field crops, garden truck, etc. It does not stimulate fruiting to the same extent as do the mineral fertilizers. Its tendency is to produce a large growth but a poor quality of fruit. Oranges, in particular, become coarse, thick skinned, and sour under its influence.

As a rule, the best results are likely to be obtained by using commercial fertilizing materials in connection with barnyard manure, either in compost or separately.

DISTANCES APART FOR PLANTING FRUITS IN COMMERCIAL PLANTATIONS.

The distances suitable for fruit trees and plants in commercial plantations vary considerably in different regions. The more important factors in determining the proper distance for any given species are, the fertility of the soil, the supply of soil moisture, the habit of growth and relative vigor of the varieties, and the necessity of providing sufficient space for operating spraying machinery in combating insects and fungi. Observation of local practice affords the safest guide in doubtful cases.

	Distance in feet.		Distance in feet.		Distance in feet.
Apple	40 × 40	Cherries, sour	20 × 20	Almond	24 × 24
	33 × 33		16 × 16		20 × 20
	32 × 16	Peach	20 × 20	Chestnut	40 × 40
Apple, dwarf	15 × 15		20 × 16		30 × 30
	10 × 10		18 × 18		20 × 20
Pear	24 × 24		13 × 13	Pecan	50 × 50
	20 × 20	Plum	20 × 20		40 × 40
	16 × 16		18 × 18	Walnut	50 × 50
Pear, dwarf	16 × 16		16 × 16		40 × 40
	12 × 12	Fig	40 × 40	Blackberries	6 × 8
Quince	16 × 16		20 × 20		6 × 6
	12 × 12	Kaki	20 × 20	Raspberries	6 × 4
Apricots	30 × 30	Olive	25 × 25	Currants and gooseberries.	6 × 8
	25 × 25		20 × 20		6 × 4
	20 × 20	Orange and lemon	30 × 30	Strawberries	1 × 4
Cherries, sweet	30 × 30		25 × 25		1 × 3
	24 × 24	Grape	8 × 10		1 × 1
	20 × 20		6 × 8	Cranberries	2 × 2

REVIEW OF WEATHER AND CROP CONDITIONS, SEASON OF 1897.

[From Climate and Crop Division, Weather Bureau.]

An elaborate and detailed review of the weather and crop conditions of the United States, during the period of planting, cultivation, and harvesting, for obvious reasons can not be given in the few pages to which this paper is limited.

The following summary, therefore, is confined to a brief discussion of the condition of the more important staples and marked climatic features during the crop season of 1897, and the presentation of meteorological tables and diagrams showing the departures from normal temperature and precipitation during the period from January 1 to October 25.

An explanation of the diagrams and more detailed reference to the temperature and rainfall data contained in the tables will be found at the end of this paper.

SUMMARY OF THE SEASON, BY WEEKS.

March was a very wet month in the States of the central valleys and on the central and north Pacific coasts, while there was more than the average precipitation over much the greater part of the country east of the Rocky Mountains. The month averaged colder than usual in the valleys of the Upper Missouri and Red River of the North, throughout the Rocky Mountain region, and on the Pacific coast, the first and second decades being exceptionally cold from Minnesota westward, the average temperature for the week ending the 15th ranging from 20° to 35° below the normal in Montana, the Dakotas, and northern Minnesota. In all districts east of the Mississippi River and from the Lower Missouri River southward to the Gulf coast and Rio Grande Valley, the month averaged milder than usual, the temperature excess ranging from 3° to 6° per day over the greater part of the territory named.

Farming operations were retarded by wet weather in the States of the central valleys, and at the close of the month the season was considered backward, notwithstanding there was an excess in temperature. By the close of the month some corn had been planted as far north as Tennessee and the southern portions of Missouri and Kansas, while farther south greater progress had been made, planting in Texas and northern Louisiana being about completed. Cotton planting in Texas had progressed favorably, and some had been planted in South Carolina, but in other States of the cotton belt practically no planting had been done up to the close of the month. Wheat was winter killed to some extent in Missouri, Iowa, Illinois, Indiana, Wisconsin, and Ohio, and in Michigan and Indiana the crop sustained damage by floods, but in Kansas, Oklahoma, Arkansas, and Texas it was in promising condition.

By April 12 corn planting was finished in portions of the more southerly States and was in progress as far north as Missouri and Virginia, but preparations for planting in Tennessee and the States of the Ohio Valley were much retarded by excessive moisture. Some improvement was reported in the condition of winter wheat in Missouri, and in portions of Indiana, and in Kansas, Oklahoma, Arkansas, Tennessee, Kentucky, the Virginias, and Maryland the crop was growing finely, with favorable conditions reported from Ohio, southern Michigan, and Nebraska. By the middle of April but little spring wheat had been sown, and seeding was principally confined to the southern portion of the spring-wheat region, none having been sown in North Dakota, where the soil was too wet. Cotton planting was more general and was in active progress over the central portions of the cotton belt, some having been planted as far north as North Carolina. The week ending April 12 having proved unusually cool throughout the Gulf States and central valleys, with frosts as far south as the northern portions of the Gulf States from the 8th to the 10th, garden products and fruits sustained some injury and cotton in Texas was unfavorably affected.

The week ending April 19 was also abnormally cool throughout the central and southern portions of the country, with freezing temperature as far south as the Lower Missouri and Ohio valleys, further retarding corn planting, but in New England and in the Rocky Mountain and Pacific coast States it was milder than usual. At this date the condition of winter wheat in the principal winter-wheat

States of the central valleys was very unpromising, and in Wisconsin, Illinois, and Indiana considerable was plowed up for other crops. By this time some spring wheat had been seeded in the uplands of the Dakotas and Minnesota, where, however, excessive moisture continued to delay seeding, but good progress had been made in Iowa and seeding was about completed in Nebraska. Some oats had been sown in South Dakota and Michigan, while farther south, including the Atlantic coast States, the bulk of the crop had been sown. Owing to excessive moisture, some rotting was reported from Ohio and Illinois, but the outlook for oats was generally favorable, exceptionally so in the Southern States. Cotton planting was in progress in Oklahoma, southeastern Missouri, Tennessee, and the Carolinas, and was nearing completion over central and southern Mississippi. The cool weather continued injurious in Texas.

The temperature conditions of the week ending April 26 were very favorable, but there was too much rain in the States of the Missouri and Upper Mississippi valleys.

The succeeding week (ending May 3) was too cool throughout the States of the central valleys, but the light rainfall in the valleys of the Upper Mississippi, the Red River of the North, and the Missouri afforded favorable opportunity for farm work, which had been much delayed in consequence of excessive rains the previous week. In the Rocky Mountain States and in Oregon this week was decidedly favorable, but it was somewhat too cool in Washington.

The week ending May 10 was exceptionally favorable in the States of the Upper Mississippi and Missouri valleys, both for farm work and growth of crops, but in the Southern States the conditions were less favorable, being too cool, and in some sections too dry. Under the favorable conditions prevailing in the principal corn States planting was being pushed rapidly, and was in progress as far north as southern New England, Michigan, and South Dakota. In the Middle Atlantic States and southward of the Ohio and Lower Missouri rivers corn planting was generally nearing completion. In the Southern States insects were reported numerous and destructive to corn, which was also unfavorably affected by the low temperatures and in some sections by drought. Spring-wheat seeding was practically completed over the northern portion of the spring-wheat region, and over the central and southern portions the early sown had a good start and was growing well. Winter wheat continued promising in the Middle Atlantic States, Kentucky, and Tennessee, and some improvement was reported from Ohio and Indiana. In Oregon and Washington the outlook for winter wheat was very promising, but in California the crop had been greatly injured by hot winds. Cotton made slow progress over the central and eastern portions of the cotton belt, the weather being too cool, and complaints of insects and bad stands were quite general, while the effects of drought were unfavorable in some sections. In Texas, however, the condition of the crop was generally improved, but it was suffering for rain over the southern and eastern portions of the State.

The week ending May 17 in the central valleys was favorable for farming operations, but too cool for rapid germination and growth. On the Atlantic coast the temperature conditions were more favorable, which, with abundant rains, caused rapid advance of crops, but farm work was retarded to some extent as a result of excessive moisture. In the States of the Rocky Mountain and Pacific coast regions the weather conditions of this week were exceptionally favorable.

The week ending May 24 was generally favorable for farm work, but in the States of the central valleys, lake region, and Middle Atlantic coast cool nights proved unfavorable for some crops, while need of rain began to be felt in the central Mississippi and Lower Missouri valleys and in the South Atlantic States. Cotton experienced a general improvement in Texas, Alabama, Arkansas, and Georgia, but cool nights proved injurious in Tennessee and Mississippi. In Indiana and Ohio, where corn planting had been much retarded, rapid progress was made. Planting was well advanced in Michigan, and continued in Wisconsin, Minnesota, and North Dakota. Considerable replanting was necessary in Nebraska, Missouri, Illinois, Kentucky, and portions of Kansas. Winter wheat continued in promising condition in the Middle Atlantic States and Tennessee, but the outlook in Kentucky was less favorable. In Illinois the condition of the crop was so poor that some fields were plowed up for corn. During this week spring wheat made good progress except in North Dakota, where little improvement was experienced.

The week ending May 31 was generally unfavorable, being much too cool in all districts east of the Rocky Mountains and too dry in the Southern States, while excessive rains in New England retarded farm work. On the Pacific coast this week was favorable in California and Washington, but too dry in Oregon.

The week ending June 7 was unseasonably cool and unfavorable to crop growth throughout the central valleys, Lake Region, New England, and the Middle Atlantic States, but in the Southern States the temperature conditions were more favorable. On the Pacific coast rain was badly needed.

By the middle of June corn, while generally backward, had made good progress in the principal corn States, but as a result of cool weather and frosts, suffered serious injury in Wisconsin, Minnesota, and North Dakota; and in New England, the northern portions of the Middle Atlantic States, and the Upper Ohio Valley its growth was retarded. The cotton crop experienced a general improvement throughout the cotton belt, and was generally clean, with insects less numerous. It however needed warm, dry weather over northern Texas and showers in other sections of the State. Except on the Pacific coast, winter wheat had made further improvement, and harvesting was in progress in southern Kansas, Missouri, and Illinois, having been nearly completed in some of the more southerly States. On the Pacific coast the condition of winter wheat was only fair in Oregon; in California high temperatures had proved injurious, but the reports from Washington were more favorable. Spring wheat was reported as improved in Minnesota and North Dakota, where the effects of low temperature had been injurious.

Except over the central Rocky Mountain region and California, where it was unseasonably cool, the week ending June 21 was generally favorable for the growth and cultivation of crops.

While somewhat too cool for the best results in the more northerly districts, with excessive heat in the Southern States, damaging local storms in portions of New Jersey, Alabama, Kentucky, and Missouri, and need of rain in portions of the Ohio Valley, Gulf States, western Kansas, and Colorado, the week ending June 28 was, upon the whole, favorable for the growth and cultivation of crops and the harvesting of grain. Cotton made rapid growth in Oklahoma and Texas, and a general improvement was reported from other portions of the cotton region, although in the central and eastern portions the plant was reported small and backward, and a general rain was much needed over the central and western portions. Corn made further improvement in the principal corn States, having made rapid growth in Illinois, Missouri, Kansas, Nebraska, and Oklahoma. In the more northerly sections, however, the crop continued backward, and hot winds in Texas and drought in Arkansas and the east Gulf States rendered the outlook less favorable than previously reported. Winter-wheat harvesting continued under favorable conditions. By this date (June 28) harvesting was in progress as far north as the southern portion of Illinois, Indiana, and Ohio, and the crop was maturing rapidly in the more northerly sections. Excessive rains caused some injury to the wheat in shock, and harvesting in California was somewhat retarded by cool weather and showers over the northern part of the State, while Oregon and Washington experienced beneficial rains. Spring wheat generally made favorable progress and the early sown was heading.

In the States of the central valleys, Lake Region, and New England the week ending July 5 was very favorable, the high temperatures being especially beneficial to corn. In the Southern States the conditions were, however, less propitious, excessive heat and absence of rain proving injurious to most crops. In the principal corn States, corn made rapid growth, but in the Southern States it was suffering for rain, while in Missouri excessive rains retarded cultivation. The bulk of the winter-wheat crop was harvested south of the fortieth parallel; i. e., about the latitude of the central portions of Ohio, Indiana, and Illinois. Harvesting in Missouri was retarded by heavy rains, which caused further damage to grain in shock. In Nebraska good progress had been made with winter-wheat harvest, which was about to begin in Michigan. In California, the grain was reported as shrunken less as a result of hot winds than had been anticipated.

The week ending July 12 was exceptionally warm over the greater part of the country east of the Rocky Mountains, but was generally favorable, except in some of the Southwestern States, which were much in need of rain. In all States of the central valleys corn made rapid growth, and cultivation was finished, except in the more northerly sections. Over the central and eastern portions of the cotton belt there was a general improvement in the condition of cotton, but in Missouri, Arkansas, and Texas it was suffering from drought; picking had begun in Texas. Winter-wheat harvesting continued in the more northerly sections east of the Rocky Mountains and in California, and had begun in Oregon. Spring wheat continued in promising condition over the northern portion of the spring-wheat region, but its condition was somewhat less favorable over the southern portions, hot winds having affected the crop injuriously in portions of South Dakota and rust having caused damage to some extent in Iowa; the outlook in Oregon and Washington continued excellent. During this week light frosts occurred in Idaho and Nevada, but caused no serious damage.

While the week ending July 19 was generally favorable, some damage resulted from excessive rains and local storms in portions of New York, New Jersey, and northeastern Alabama, and the drought continued in portions of North Carolina, Texas, Tennessee, Missouri, and Kansas. In the principal corn States of the central valleys, with the exception of portions of Kansas and Missouri, corn made favorable progress, the reports indicating rapid growth in Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, South Dakota, Nebraska, and Iowa, but it was not altogether well cultivated in the last-named State. There was a general improvement in the condition of cotton in the central and eastern portion of the cotton belt, and also in portions of the western section. In Texas, however, rain was needed, and cotton was shedding badly in some localities in the central and southern portions of the State. Winter-wheat harvest east of the Rocky Mountains was completed, except in the more northerly sections, and harvesting continued on the Pacific coast, the weather conditions in Washington and Oregon being very favorable. Some spring wheat had been harvested in Nebraska and it was ripening in Iowa and Oregon; in the Dakotas the weather conditions were not favorable for the late sown; in Minnesota a splendid crop was promised on the highlands, but the outlook on the lowlands was less favorable.

The week ending July 26 was very favorable to agricultural interests on the Pacific coast and generally in the States of the central valleys, east Gulf, south and middle Atlantic coast, but over portions of New England, and the valleys of the Ohio and Red River of the North there was too much rain, while drought prevailed over the greater part of Texas and in portions of Arkansas, Missouri, and Kansas. Excessive rains caused damage to grain in shock in portions of the Ohio Valley, Tennessee, and middle Atlantic States, and severe and damaging local storms occurred in portions of New England, New York, and New Jersey. Corn continued to make rapid growth in the States of the central valleys, Lake Region, New England, and the middle Atlantic coast, but in central and southern Kansas, Texas, and Louisiana it was suffering serious injury from drought. Cotton generally made favorable progress, although complaints of rust and shedding were received from portions of the eastern section, and drought was causing the bolls to open prematurely in southern Texas. Owing to excessive rains this week was not favorable for completing winter-wheat harvest where unfinished in some of the more northerly sections, and spring wheat sustained injury by heavy rains in North Dakota. In Minnesota, except on lowlands, and in South Dakota the outlook for spring wheat was promising; in Washington and Oregon the crop was nearing maturity in excellent condition.

The weather conditions of the week ending August 2 were generally favorable in the south Atlantic and east Gulf States and in the Ohio and Upper Mississippi valleys and upper lake region, but in New England and over the greater portion of the middle Atlantic States, including western New York and portions of the Upper Ohio Valley it was too wet, while the States of the Lower Missouri Valley suffered seriously from hot, dry winds, and drought prevailed over the greater part of Texas and in portions of Arkansas, Tennessee, and Louisiana. The conditions on the Pacific coast continued favorable. Much injury was done to the hay crop and to maturing and shocked grain by heavy rains in New England and portions of the middle Atlantic States. Considerable plowing for fall seeding was done in Illinois, Ohio, Tennessee, and Virginia.

In the States of the central valleys and in the Atlantic coast and east Gulf districts the week ending August 9 was generally favorable, but portions of Missouri, western Tennessee, Mississippi, and Kentucky suffered from drought and excessive heat. In the west Gulf States the week was very unfavorable, owing to excessive heat and drought. On the Pacific coast the general conditions were favorable, although very warm in Oregon and Washington. Corn continued to make favorable progress and, while rains proved beneficial in Nebraska and Kansas, the crop had been permanently injured in portions of these States. At this time it was estimated that the bulk of the crop would be safe from injury by frost by September 15, and that the late planted would be safe by October 1. Except over portions of North Carolina, Florida, Tennessee, Arkansas, Missouri, and Oklahoma, where cotton made fair progress, this week was not favorable for cotton, complaints of shedding being general over the southern portions of the belt, while worms and rust were reported from some sections. In Texas, Louisiana, and Arkansas cotton on uplands was suffering from drought. Picking was becoming general over the central and southern portions of the cotton region, and "first" bales were marketed in Alabama, Mississippi, Arkansas, and Florida. Spring-wheat harvest in the Dakotas and Minnesota was well advanced, but was delayed by rains to some extent in South Dakota, where a part of the crop, which was overripe, sustained injury. Very favorable reports concerning wheat continued from Oregon and Washington, although hot winds in the last-named State were detrimental.

Drought continued in portions of Missouri, Tennessee, and southern Texas, and the need of rain began to be felt in Indiana, Illinois, Iowa, and portions of Virginia and North Carolina during the week ending August 16, while there was too much rain in New England. The conditions were generally favorable for crops in the Southern States, in Oklahoma, Kansas, Nebraska, South Dakota, Wisconsin, Michigan, Ohio, and in the Middle Atlantic States. On the North Pacific coast the week, although very warm, was favorable for harvesting. In the principal corn States of the central valleys the weather was not wholly favorable, being too cool and over a large area too dry. Good rains, however, improved the corn crop in Kansas and Nebraska. The week was generally favorable to cotton, except in North Carolina and portions of South Carolina, Missouri, and southern Texas, where it suffered from drought, but generous rains over the greater part of the cotton belt arrested premature opening and shedding. The spring-wheat harvest was about finished this week in South Dakota and southern Minnesota and was progressing in the northern part of the latter State and in North Dakota, where heavy rains caused injury to overripe grain and interfered with harvesting. Spring-wheat harvest was also in progress under favorable conditions in Oregon and Washington.

The week ending August 23 was very unfavorable in the States of the central valleys, Lake Region, New England, and over the greater part of the Gulf and South Atlantic States, more particularly to the important staples corn and cotton. This week was marked by exceptionally low temperatures over the greater part of the country east of the Rocky Mountains, and light frosts occurred in the lake region and Upper Mississippi Valley. Drought continued over portions of the Virginias, North Carolina, Tennessee, Missouri, and southwestern Texas, and began to be felt in portions of Nebraska, Iowa, Illinois, Indiana, and Ohio, while excessive rains caused damage along the Gulf and South Atlantic coasts. On the Pacific coast and in the Rocky Mountain region the week was generally favorable, although unusually warm in Oregon and Washington. Spring-wheat harvest continued in northern Minnesota and the Dakotas, but was delayed by local rain in North Dakota, where some of the overripe wheat was lost. Wheat harvest continued under favorable conditions in Oregon and Washington, being well advanced in Oregon.

The succeeding week, ending August 30, proved too cool in the lake region and New England and too dry in the States of the central valleys, but in the Middle and South Atlantic and Gulf States and generally throughout the Rocky Mountain and Pacific coast regions it was favorable. Early corn matured rapidly in Iowa, Missouri, Kansas, Nebraska, and South Dakota, but the crop made slow progress in Illinois, Indiana, Michigan, Wisconsin, and Minnesota, and the late crop was generally needing warmth and moisture. As a result of the rains of the previous week, late corn in the Gulf States was greatly improved. The general absence of rain in the Southern States during this week was very favorable for cotton picking, which became general over the central portions of the cotton belt, but the crop as a whole did not make favorable progress, although it did well in some sections. This week marked the practical completion of the wheat harvest in the northern portion of the spring-wheat region. In Washington and Oregon the weather proved especially favorable for thrashing the heavy wheat crop harvested in those States. Owing to the dry condition of the soil, plowing for fall seeding made slow progress in the States of the central valleys and lake region, but the soil and weather conditions were more favorable in New England and the Middle Atlantic States, where considerable progress was made. Some wheat was sown in Kansas, Michigan, and in the Middle Atlantic coast States.

September 6 closed an exceptionally warm week in the States of the Missouri and central Mississippi valleys and middle Rocky Mountain slope, where the average daily temperature excess ranged from 6 to 15 degrees per day. In the central valleys and Southern States this week proved unfavorable, owing to the general absence of rain and prevalence of high temperatures. Hot, dry winds caused injury in the States of the lower Missouri and central Mississippi valleys, while rains, unusually heavy for the season, in Oregon and Washington interfered with harvesting and thrashing in those States, but caused no serious injury to grain. Corn was very unfavorably affected in the principal corn-producing States, the high temperature and absence of rain having checked the growth of the late crop and caused premature ripening, while hot winds proved injurious, particularly in the States of the lower Missouri Valley. The conditions, however, in the Lake Region, Ohio Valley, New England, and the Middle Atlantic States were more favorable to corn, and the crop generally did well. The general condition of cotton was less favorable than in the previous week, there being a marked deterioration in the condition of the crop in portions of the middle and eastern sections of the cotton belt, the absence of rain causing it to open rapidly and to some extent prematurely. In portions of south and southwest Texas, however, showers improved late cotton and the "top" crop, but over the northern portions of the State the conditions were unfavorable except for picking, which progressed rapidly.

From September 6 to 13 exceptionally high temperatures prevailed in nearly all districts east of the Rocky Mountains, with a general absence of rain, except showers, in the Gulf States and upper lake region. With sufficient moisture, the conditions would have been most favorable to corn, but in the important corn States the crop, more particularly late planted, suffered seriously by being prematurely ripened. By this time much of the crop was safe from frost and cutting had begun. Cotton suffered further injury, and its general condition was less favorable than in the preceding week, marked deterioration occurring in the Carolinas, Georgia, Tennessee, Arkansas, and Oklahoma. Heat and drought over the greater part of the cotton belt stopped growth and caused much premature opening and shedding, while rains in Florida retarded picking. Scattered heavy rains also interfered with picking in portions of Texas, and caused slight damage by washing out open cotton in some places, but proved beneficial where the crop was still growing. In portions of central and southern Texas late cotton and the "top" crop were seriously damaged by rust and insects. Throughout the cotton belt cotton opened freely and picking made rapid progress, the indications pointing to completion of picking earlier than usual. Plowing and seeding of fall grain were much delayed, except in New England and portions of the Middle Atlantic States, where the soil conditions were favorable.

The week ending September 20 was warmer than usual, except in New England and over the eastern Rocky Mountain slope, where it was cooler. It proved favorable for ripening and securing crops, but in the central Mississippi and Ohio valleys, Tennessee, and over portions of the South Atlantic States it was too dry for fallowing and seeding. Corn continued to mature rapidly, but in some of the more important corn-producing States the late crop did not fill well, and the reports indicated that much would be chaffy. Cutting progressed rapidly under favorable conditions and promised to be practically completed in some of the more important corn States by the close of the month. On the Pacific coast weather conditions were favorable, the absence of rain in California being especially advantageous for curing raisins and drying fruit. Cotton continued to open rapidly and picking was vigorously pushed, the reports indicating that much the greater part of the crop over the central and eastern portions of the belt would be secured by the middle of October. In Texas picking was interrupted over the greater part of the State by rains, which, while damaging open cotton, proved beneficial to the late crop. Cotton also sustained some damage from rains in Florida during this week.

The period from September 21 to 27 was practically rainless from the Mississippi River westward, and only light showers fell over the region from the Great Lakes to the east Gulf coast. On the South Atlantic coast, however, and in portions of New England and the Middle Atlantic States, the rainfall exceeded the average, being very heavy in Florida, eastern Georgia, and South Carolina. Upon the whole, the week was very favorable for maturing and gathering crops, but like the preceding weeks, it was very unfavorable for germination of sown grain, as well as for fallowing and seeding, which were much delayed generally throughout the Central and Western and in some of the Southern States. In Nebraska, however, a large acreage of wheat had been sown, and much of it was up and looking well. In the Atlantic coast States the conditions were more favorable for fall seeding, with which work satisfactory progress was made. The frosts of the early part of this week proved injurious to late corn in portions of Ohio, Kentucky, Pennsylvania, and New York, but farther west no serious injury was reported. Cotton picking was pushed forward rapidly in all sections of the cotton belt, although interrupted somewhat in the Carolinas, eastern Georgia, and Florida by heavy rains. The crop suffered further deterioration in Arkansas and portions of Mississippi and Louisiana, and was damaged from rains in the Carolinas.

SEASONAL TEMPERATURE AND RAINFALL CONDITIONS.

During the period covered by the weekly climate and crop bulletins, from March 1 to September 27 (two hundred and eleven days), there was an excess of heat in the Southern States, central Mississippi, lower Missouri, and lower Ohio valleys, and in all districts on the Atlantic coast, except northern New England. Over the greater portion of the East Gulf States and from the lower Missouri Valley southward to the Texas coast the average daily temperature excess ranged from 1 to 2 degrees per day for the season, being greatest over northeastern Texas and western Arkansas. The average daily seasonal excess reached or exceeded 1 degree or more per day over portions of the Lake Region and the Middle Atlantic States. Throughout the Rocky Mountain and Pacific coast regions the season averaged cooler than usual, with the exception of the Sacramento Valley, where it was slightly warmer. During the earlier part of the season the deficiency in the Rocky Mountain and Pacific coast districts was very marked, but the latter part of the season being warm, the decided deficiencies were largely overcome by September 27.

The season closed with marked deficiency in rainfall, as compared with the average, in the Central and West Gulf States, where the actual rainfall during the period from March 1 to September 27 ranged from 55 to 80 per cent of the seasonal average, like deficiency also existing in southeastern Virginia and eastern North Carolina. Except over limited areas, the seasonal precipitation was also deficient in the Upper Mississippi and Lower Missouri valleys, over the eastern portion of the Rocky Mountain region, and in California.

The seasonal rainfall was excessive in New England, eastern New York, New Jersey, the Florida peninsula, over an area extending from the Lake Region southward to northern Georgia, in the valley of the Red River of the North, southern Rocky Mountain region, and on the north Pacific coast, the greatest excess occurring on the east coast of southern Florida, where nearly 20 inches more than the average seasonal amount fell.

EXPLANATIONS OF DIAGRAMS AND TABLES.

The diagrams (figs. 44 and 45) illustrate the conditions of temperature and precipitation for the period from January 1 to March 29 and subsequently for each seven-day period ending at 8 a. m. Monday, from April 5 to October 25. The heavy horizontal line indicates normal and the solid and broken irregular lines indicate, respectively, the average departures from normal temperature (degrees per day) and precipitation (tenths of inches) for the several districts as determined from the records of the Weather Bureau stations. The number of records used in determining the average departures for each district can be ascertained from the tables which supply data from which similar diagrams for individual stations may be constructed.

The tables contain in detail the data upon which the diagrams are based, and it is believed that the explanation of the latter, together with the column headings of the former, render further explanation unnecessary. It should be borne in mind, however, that the temperature departure is the average daily for the periods indicated in headings of both diagrams and tables, and that the precipitation departure is the excess or deficiency determined by a comparison of the total amount for each week with the normal for the corresponding period.

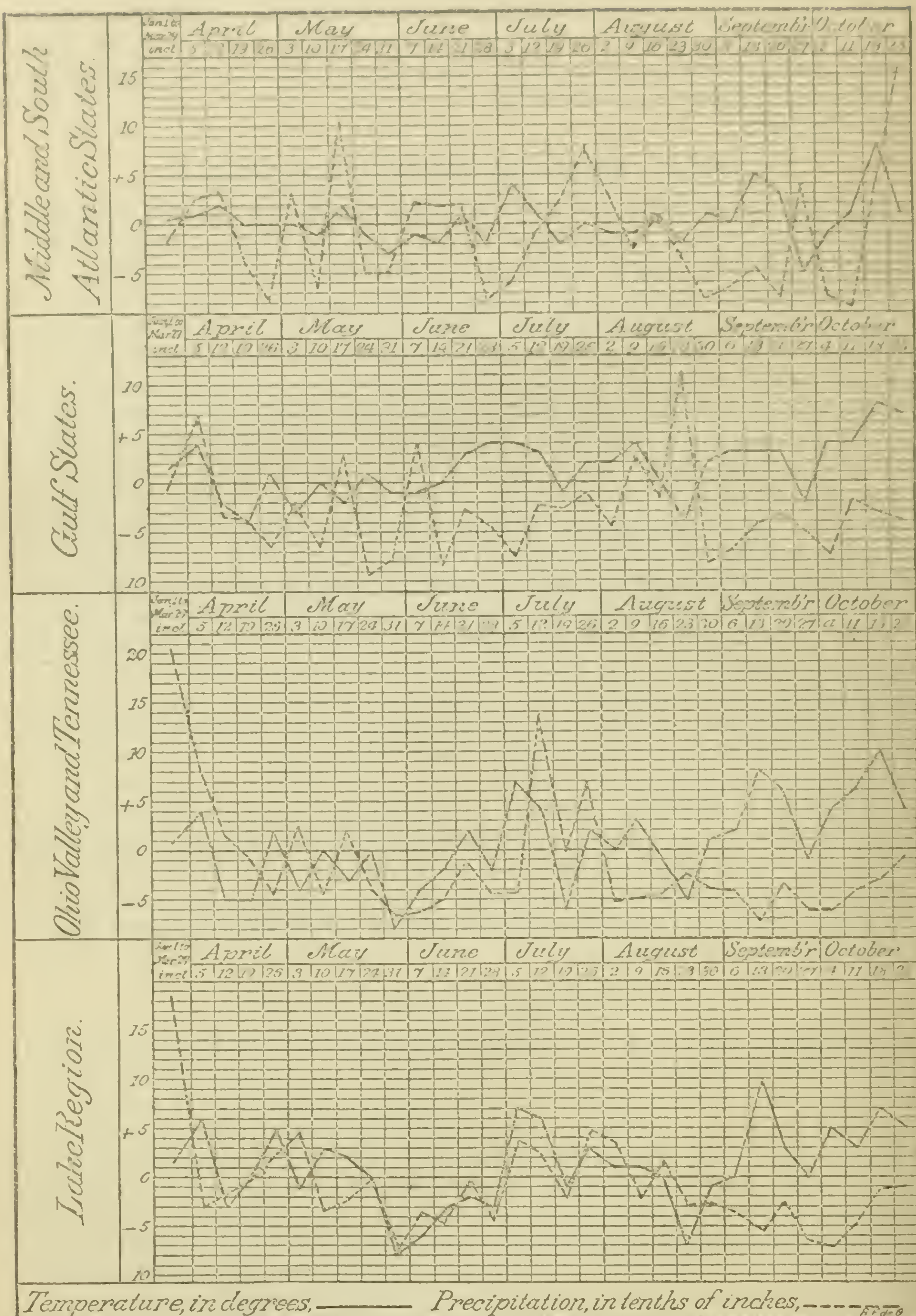

FIG. 44.—Temperature and precipitation departures for the season of 1897 from the normal of many years, for the Middle and South Atlantic States, the Gulf States, the Ohio Valley and Tennessee, and the Lake Region.

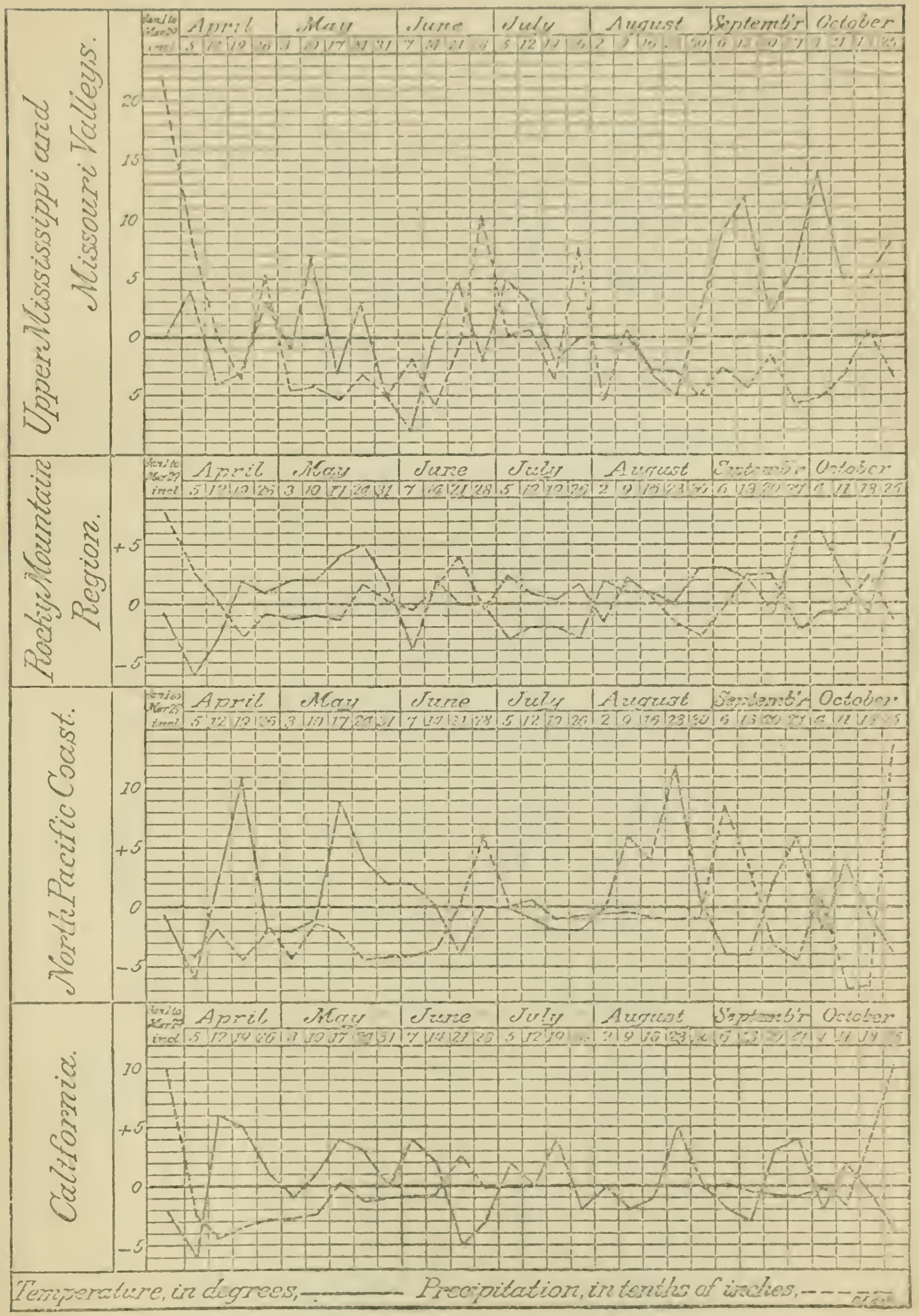

FIG. 45.—Temperature and precipitation departures for the season of 1897 from the normal of many years, for the Upper Mississippi and Missouri Valleys, the Rocky Mountain Region, the North Pacific Coast, and California.

Temperature departures for the season of 1897 from the normal based upon observations for many years.

Sections.	From Jan. 1 to Mar. 29, inclusive.	For weeks ending—													
		April—				May—					June—				
		5.	12.	19.	26.	3.	10.	17	24.	31.	7.	14.	21.	28.
Middle and South Atlantic States	+0.5	+1	+2	0	0	0	−1	+2	−1	−3	−1	−2	+1	2
Gulf States	+1.4	+4	−2	−4	+1	−3	0	−2	+1	−1	−1	0	+3	+4
Ohio Valley and Tennessee	+.8	+4	−5	−5	+2	−4	0	−3	0	−8	−4	−2	+2	−2
Lake Region	+1.6	+6	−3	0	+5	−1	+3	+2	0	−8	−6	−3	−2	−3
Upper Mississippi and Missouri valleys	−.1	+4	−4	−3	+3	−1	+7	−3	+3	−5	−8	0	+5	−2
Rocky Mountain Region	−.7	−6	−3	+2	+1	+2	+2	+4	+5	+2	−4	+2	0	0
North Pacific coast	−.7	−6	....	+11	−2	−2	−1	+9	+4	+2	+2	0	−4	0
California	−2.0	−6	+6	+5	+1	−1	+1	+4	+3	0	+4	+2	−5	−3

Sections.	For the weeks ending—																
	July—				August—					September—				October—			
	5.	12.	19.	26.	2.	9.	16.	23	30.	6.	13.	20.	27.	4.	11.	18.	25.
Middle and South Atlantic States	+4	+1	−2	0	−1	−1	+1	−2	+1	0	+5	+3	−5	−1	+1	8	+1
Gulf States	+4	+3	−1	+2	+2	+4	0	−4	+2	+3	+3	+3	−2	−4	+4	8	+7
Ohio Valley and Tennessee	+7	+4	−6	+2	0	+3	−1	−5	+1	+2	+8	+6	−1	+4	+6	10	+5
Lake Region	+7	+6	−1	+3	+1	+1	0	−7	−1	0	+10	+3	0	+5	+3	7	+5
Upper Mississippi and Missouri valleys	+5	+3	−2	0	0	0	−3	−5	+2	+9	+12	+2	+6	+14	+5	5	+8
Rocky Mountain Region	−3	−2	−2	−3	+2	+1	+1	0	+3	+3	+2	−1	+6	+6	+2	1	+6
North Pacific coast	0	−1	−2	−2	0	+6	+4	+12	+1	−4	−4	−2	+6	−2	+4	2	0
California	+2	0	+4	−2	0	−2	−1	−5	0	−2	−3	+3	+4	−2	−2	1	−4

Precipitation departures for the season of 1897 from the normal based upon observations for many years.

Sections.	From Jan. 1 to Mar. 29, inclusive.	For weeks ending— April— 5.	12.	19.	26.	May— 3.	10.	17.	24.	31.	June— 7.	14.	21.	28.
Middle and South Atlantic States	—0.19	+0.27	+0.33	—0.34	—0.77	+0.32	—0.64	+1.05	—0.49	—0.48	+0.23	+0.20	—0.21	—0.77
Gulf States	— .07	+ .69	— .34	— .38	— .65	— .19	— .66	+ .29	— .94	— .77	+ .41	— .84	— .25	— .42
Ohio Valley and Tennessee	+2.06	+ .79	+ .16	— .08	— .44	+ .25	— .44	+ .19	— .37	— .67	— .62	— .49	— .11	— .43
Lake Region	+1.86	— .29	— .16	— .03	+ .21	+ .47	— .34	— .21	— .01	— .72	— .35	— .46	— .03	— .44
Upper Mississippi and Missouri valleys	+2.21	+ .82	+ .01	— .34	+ .53	— .45	— .41	— .53	— .31	— .49	— .19	— .58	— .06	+1.03
Rocky Mountain Region	+ .78	+ .27	+ .02	— .28	— .08	— .12	— .10	— .14	+ .17	+ .03	— .05	— .16	+ .40	— .05
North Pacific Coast	....	— .42	— .19	— .44	— .18	— .43	— .12	— .20	— .44	— .42	— .42	— .34	+ .02	— .01
California	+1.00	— .25	— .44	— .35	— .28	— .27	— .23	+ .03	— .12	— .10	— .08	— .07	+ .27	— .01

Sections.	For weeks ending— July— 5.	12	19.	26.	August— 2.	9.	16.	23.	30.	September— 6.	13.	20.	27.	October— 4.	11.	18.	25.
Middle and South Atlantic States	—0.59	—0.07	+0.26	+0.79	+0.27	—0.26	+0.08	—0.32	—0.77	—0.63	—0.43	—0.74	+0.40	—0.73	—0.85	+0.39	+1.58
Gulf States	— .76	— .21	— .26	— .10	—0.43	+ .27	— .17	+1.11	— .81	— .69	— .42	— .33	— .51	— .74	— .18	— .31	— .39
Ohio Valley and Tennessee	— .42	+1.38	— .01	+ .70	— .52	— .49	— .45	— .25	— .39	— .41	— .72	— .35	— .62	— .62	— .42	— .31	— .07
Lake Region	+ .38	+ .27	— .22	+ .48	+ .34	— .21	+ .16	— .29	— .28	— .35	— .55	— .26	— .65	— .71	— .46	— .11	— .10
Upper Mississippi and Missouri valleys	+ .02	+ .06	— .35	+ .77	— .53	+ .08	— .28	— .28	— .49	— .26	— .43	— .15	— .57	— .50	— .32	+ .06	— .35
Rocky Mountain Region	+ .24	+ .09	+ .03	+ .17	— .16	+ .22	+ .06	— .16	— .28	— .01	+ .26	+ .26	— .22	— .08	— .05	+ .24	— .15
North Pacific coast	+ .02	+ .05	— .10	— .07	— .06	— .04	— .08	— .10	— .08	+ .86	+ .36	— .31	— .44	— .12	— .68	— .66	+1.36
California	— .02	.00	.00	.00	— .01	— .01	— .01	.00	— .01	+ .01	— .04	— .07	— .09	— .01	— .17	+ .43	+1.02

Temperature departures for the season of 1897 from the normal based upon observations for many years.

Stations.	From Jan. 1 to Mar. 29, inclusive.	For weeks ending— April— 5.	12.	19.	26.	May— 3.	10.	17.	24.	31.	June— 7.	14.	21.	28.
New England:														
Eastport, Me	+0.6	+2	-3	+2	-1	+1	0	0	0	-3	-3	-2	-1	-2
Portland, Me	+2.2	+3	+1	+4	+1	+1	-1	0	0	-5	-6	-9	-4	-2
Boston, Mass	+2.8	+3	+2	+6	+6	-2	0	+6	+3	-2	-5	-9	-3	-1
Middle Atlantic States:														
Albany, N. Y	+ .8	+4	+1	+2	+4	0	+1	+3	-1	-6	-3	-6	-5	-5
New York, N. Y	+ .1	+2	+1	0	-1	0	0	+3	-1	-4	-4	-6	-3	-3
Philadelphia, Pa	+1.0	+3	+4	+2	+3	+3	-1	+5	+1	-4	-2	-6	-2	-6
Washington, D. C	+1.1	0	0	-1	+2	0	-1	+2	0	-6	-3	-6	-2	-5
Lynchburg, Va	- .1	0	0	-1	+1	-2	-4	+1	-1	-6	-1	-4	-2	-3
Norfolk, Va	+ .9	-1	+4	+1	+2	+1	-2	+4	-1	-3	-2	-2	+2	-3
South Atlantic States:														
Charlotte, N. C	- .8	-2	0	-1	0	0	-1	0	+1	-3	0	0	+2	0
Wilmington, N. C	+ .1	0	+3	0	-3	0	-3	+1	-2	-2	0	+1	+2	0
Charleston, S. C	+ .8	+1	+4	+1	-1	-1	0	+2	-1	0	+1	0	+3	0
Savannah, Ga	+ .3	+1	+1	-1	-2	0	-2	+1	-1	0	+2	+1	-3	-3
Jacksonville, Fla	+1.1	+4	+1	-2	-2	0	-3	+1	-2	-1	-1	-3	+4	-4
Gulf States:														
Atlanta, Ga	- .4	-3	-1	-4	-1	-3	-1	-2	+4	-1	+1	-2	+4	+4
Mobile, Ala	+1.0	+4	-2	-6	-2	-4	-2	-3	0	-4	-1	-1	+2	+3
Montgomery, Ala	+ .7	+1	-1	-5	-1	-4	-1	-3	-1	-3	0	+4	+3	+4
Vicksburg, Miss	+2.2	+7	-2	-5	+1	-5	0	-4	+1	-2	-2	0	+3	+4
New Orleans, La	+1.2	+4	-2	-5	0	-4	-1	0	+1	-1	-1	0	+1	+4
Shreveport, La	+2.3	+6	-5	-5	+2	-4	+1	-4	-1	0	-2	-2	+3	+3
Fort Smith, Ark	+2.5	+5	-5	-5	+4	-1	+3	-1	+4	+1	-3	+1	+4	+7
Little Rock, Ark	+ .8	+5	-4	-3	+3	-3	+1	-3	-4	-2	-4	0	+3	+6
Palestine, Tex	+3.0	+6	-1	-4	+2	-4	+3	-2	+2	+1	-1	-1	+2	+4
Galveston, Tex	+ .4	+5	+1	-3	+1	-4	0	-1	-1	-2	-1	0	+1	+1
San Antonio, Tex	+2.0	+7	0	-4	0	-2	+2	+1	-1	-2	+1	-1	+3	+1
Ohio Valley and Tennessee:														
Memphis, Tenn	+1.0	+6	-3	-5	+1	-3	+1	-5	+2	-3	-4	0	-1	+3
Nashville, Tenn	+1.5	+4	-2	-5	0	-4	-1	-4	+1	-6	-5	-1	[illegible]	-1
Chattanooga, Tenn	+ .7	-3	-3	-5	-1	-3	-3	-4	+3	-2	0	+1	+4	+3
Louisville, Ky	+ .6	+5	-7	-7	+2	-4	+1	-4	-1	-10	-4	-2	+3	+5
Indianapolis, Ind	+ .3	+6	-8	-6	+3	-6	+3	-4	-3	-11	-7	-2	+1	-5
Cincinnati, Ohio	- .1	+6	-7	-5	+3	-5	+1	-3	-1	-11	-5	-3	+2	-5
Columbus, Ohio	+1.4	+8	-5	-4	+4	-3	+3	-2	0	-10	-3	-4	0	-3
Pittsburg, Pa	+1.3	+4	-6	-4	+4	-1	+2	-1	-1	-11	-4	-6	-3	-5
Lake Region:														
Oswego, N. Y	+1.5	+3	-1	+2	+6	+3	+1	+5	+1	-8	-3	-6	-5	-4
Buffalo, N. Y	+2.9	+8	-1	+2	+5	+6	+3	+4	-2	-7	-3	-4	-4	-4
Cleveland, Ohio	+1.4	+6	-4	0	+7	-1	+3	+2	0	-11	-4	-5	-2	-5

Detroit, Mich	− .5	+ 5	− 5	− 4	+ 3	− 5	+ 3	+ 1	− 1	− 11	− 6	− 5	− 3	− 4
Alpena, Mich	+ 4.8	+ 6	+ 1	+ 2	+ 4	− 4	+ 4	+ 2	+ 1	− 6	− 6	− 2	− 5	− 2
Grand Haven, Mich	+ 1.5	+ 11	− 6	− 3	+ 1	− 4	+ 3	− 2	− 2	− 8	− 7	− 3	+ 1	− 4
Milwaukee, Wis	+ 2.2	+ 8	− 4	− 1	+ 5	− 5	+ 6	+ 4	+ 3	− 8	− 8	− 1	+ 2	− 2
Chicago, Ill	− .6	+ 5	− 7	− 2	+ 6	− 4	+ 5	+ 1	+ 3	− 5	− 7	0	+ 1	− 5
Duluth, Minn	+ 1.2	+ 5	− 2	+ 1	+ 5	+ 2	+ 5	+ 1	+ 1	− 5	− 10	+ 1	− 7	− 1
Upper Mississippi Valley:														
St. Paul, Minn	− 1.0	+ 7	− 3	− 3	+ 3	− 2	+ 10	− 4	0	− 7	− 14	− 1	+ 4	− 5
La Crosse, Wis	− .2	+ 7	− 3	− 6	+ 4	− 2	+ 10	− 2	− 2	− 11	− 12	− 3	+ 5	− 4
Davenport, Iowa	+ 1.6	+ 6	− 5	− 4	+ 4	− 2	+ 8	− 5	+ 2	− 7	− 8	+ 1	+ 6	− 4
Des Moines, Iowa	+ 1.9	+ 5	− 6	− 3	+ 1	− 2	+ 7	− 5	+ 3	− 5	− 7	− 1	+ 7	− 3
Springfield, Ill	+ .1	+ 5	− 7	− 6	+ 1	− 6	+ 5	− 4	+ 2	− 7	− 6	0	+ 5	− 4
Cairo, Ill	+ 2.2	+ 6	− 5	− 3	+ 1	− 3	+ 2	− 4	+ 1	− 6	− 5	0	+ 4	− 2
St. Louis, Mo	+ 1.3	+ 6	− 7	− 4	+ 4	− 3	+ 2	− 3	+ 2	− 8	− 7	0	+ 6	− 3
Missouri Valley:														
Springfield, Mo	+ 1.0	+ 6	− 8	− 7	+ 2	− 5	− 1	− 1	+ 7	− 2	− 5	− 1	+ 3	+ 3
Kansas City, Mo	+ .5	+ 8	− 5	− 3	+ 5	− 1	+ 5	− 3	+ 5	− 5	− 6	− 2	+ 7	+ 2
Concordia, Kans	+ 3.4	+ 3	− 4	− 3	+ 7	− 2	+ 3	− 1	+ 6	− 2	− 6	0	+ 7	+ 4
Omaha, Nebr	+ 1.4	+ 4	− 4	− 3	+ 2	− 2	+ 6	− 4	+ 4	− 5	− 9	− 1	+ 7	− 3
Valentine, Nebr	....	− 3	− 4	− 1	+ 3	+ 2	+ 7	0	+ 5	+ 1	− 10	− 2	+ 5	0
Huron, S. Dak	− 3.0	+ 2	0	− 3	+ 2	+ 2	+ 9	− 2	+ 3	− 3	− 11	− 1	+ 5	− 3
Extreme Northwest:														
Moorhead, Minn	− .1	+ 10	+ 2	+ 2	+ 5	+ 4	+ 14	− 1	+ 4	− 4	− 12	0	+ 4	− 5
Bismarck, N. Dak	− 4.4	+ 2	− 2	0	+ 1	+ 3	+ 14	− 2	+ 2	− 3	− 10	+ 4	+ 4	− 4
Williston, N. Dak	− 5.4	0	− 1	+ 1	+ 3	+ 6	+ 9	− 1	+ 6	− 1	− 8	+ 5	+ 6	− 5
Rocky Mountain Slope:														
Havre, Mont	− 4.9	− 4	+ 2	+ 5	+ 5	+ 5	+ 6	+ 8	+ 8	+ 4	− 6	+ 6	0	− 1
Helena, Mont	− 1.6	− 7	− 2	+ 4	+ 1	+ 4	+ 5	+ 10	+ 9	+ 5	− 6	− 4	− 4	− 3
Spokane, Wash	+ 1.9	− 4	− 1	+ 8	+ 1	− 1	+ 1	+ 9	+ 6	+ 2	− 2	− 1	− 5	+ 2
Salt Lake City, Utah	− 3.0	− 10	− 6	+ 4	− 5	+ 3	+ 3	+ 5	+ 5	+ 8	− 3	+ 7	− 5	0
Cheyenne, Wyo	− 2.3	− 12	− 8	0	+ 1	+ 4	+ 4	+ 3	+ 5	+ 2	− 7	+ 2	0	0
North Platte, Nebr	+ 3.0	0	− 6	− 1	+ 1	+ 3	+ 2	− 2	+ 7	0	− 6	− 2	+ 2	− 1
Denver, Colo	− 1.9	− 9	− 5	+ 2	+ 2	+ 6	+ 5	+ 2	+ 6	+ 2	− 5	+ 1	0	0
Dodge City, Kans	+ 1.9	− 2	− 4	0	+ 7	− 2	+ 1	+ 1	+ 5	− 1	− 4	+ 1	+ 4	+ 4
Abilene, Tex	+ 1.6	+ 2	0	− 4	+ 2	− 4	− 1	− 1	+ 1	− 4	− 3	− 4	+ 3	+ 3
Santa Fe, N. Mex	− 1.6	− 8	− 2	+ 1	+ 2	0	− 1	+ 3	+ 1	− 2	− 2	0	+ 1	0
El Paso, Tex	− 1.0	− 4	0	+ 1	+ 1	− 1	+ 1	+ 2	+ 4	0	0	0	+ 1	+ 2
Phoenix, Ariz	....	− 9	+ 2	+ 7	− 2	+ 1	+ 1	+ 4	+ 2	+ 4	+ 2	+ 4	− 5	− 2
Pacific Coast:														
Portland, Oreg	* .4	− 6	+ 1	+ 12	− 2	− 2	− 2	+ 10	+ 4	+ 4	+ 2	− 3	− 3	0
Roseburg, Oreg	− 1.9	− 7	− 3	+ 10	− 2	− 3	0	+ 8	+ 4	+ 1	+ 3	+ 2	− 4	− 1
Red Bluff, Cal	− 2.8	− 8	+ 5	+ 9	+ 1	+ 1	+ 2	+ 10	+ 8	+ 2	+ 10	+ 7	− 13	− 7
Sacramento, Cal	− 3.1	− 6	+ 7	+ 9	+ 1	0	+ 1	+ 5	+ 5	+ 1	+ 8	+ 4	− 6	− 5
San Francisco, Cal	− 2.8	− 5	+ 7	+ 2	+ 3	− 4	+ 1	+ 3	+ 2	− 2	+ 4	− 2	− 1	0
Los Angeles, Cal	− 1.0	− 6	+ 5	+ 2	+ 1	− 2	0	+ 1	+ 1	0	+ 1	+ 3	− 2	− 3
San Diego, Cal	− .2	− 4	+ 4	+ 1	0	− 1	− 1	+ 1	0	0	− 1	0	− 2	0

Temperature departures for the season of 1897 from the normal based upon observations for many years.

Stations.	For week ending— July— 5.	12.	19.	26.	August— 2.	9.	16.	23.	30.	September— 6.	13.	20.	27.	October— 4.	11.	18.	25.
New England:																	
Eastport, Me	−4	−2	0	−1	−2	+1	−2	0	+1	0	+4	−3	0	−2	−1	+6	0
Portland, Me	−7	−1	−1	0	−6	+1	−2	−1	−1	−1	+5	−2	−2	−4	−2	+9	−2
Boston, Mass	−2	+5	+3	0	−5	+1	+2	−1	+1	−1	+7	−1	0	−2	+1	+12	−1
Middle Atlantic States:																	
Albany, N. Y	+1	+9	+1	+2	−5	+1	0	−3	−1	−2	+6	−1	−2	−2	−1	+9	+1
New York, N. Y	0	+3	−1	−1	−4	−1	−1	−3	−1	−1	+8	+2	−5	−2	−1	+9	0
Philadelphia, Pa	+3	+5	0	+1	−4	−2	0	0	+2	0	+10	+2	−4	0	+1	+9	0
Washington, D. C	+2	+2	−3	+1	−2	−3	0	−1	0	−2	+9	+4	−5	−3	+1	+8	0
Lynchburg, Va	+3	+1	−6	−1	0	0	+1	−3	+1	+1	+7	+8	−4	0	+1	+10	+2
Norfolk, Va	+4	0	−2	+2	0	−1	+2	0	+2	+1	+7	+4	−2	−2	+2	+8	+2
South Atlantic States:																	
Charlotte, N. C	+7	+1	−6	+1	+2	−2	+1	−5	+2	0	+7	+7	−5	0	+3	+9	+2
Wilmington, N. C	+6	−2	−2	0	+1	−2	+2	−2	+3	0	+2	+3	−5	−1	+3	+8	+1
Charleston, S. C	+4	−2	−2	0	+1	−1	+1	−1	+3	+1	+2	+3	−7	−1	+3	+7	+2
Savannah, Ga	+6	−2	−2	−1	+2	0	+1	−1	+3	0	0	+3	−9	−1	+3	+8	+1
Jacksonville, Fla	+6	−1	−1	+1	0	+1	+1	+1	+2	+1	0	+3	−8	−1	+2	+8	+1
Gulf States:																	
Atlanta, Ga	+7	+1	−5	−1	+1	+1	0	−6	+3	+4	+4	+7	−1	+2	+5	+8	+2
Mobile, Ala	+3	+1	−2	+2	+1	+4	−1	−4	+1	+1	+2	+3	−3	+4	+3	+9	+2
Montgomery, Ala	+5	+2	−2	+3	+3	+4	0	−6	+2	+2	+2	+5	−3	+2	+4	+10	+2
Vicksburg, Miss	+5	+2	−2	+1	+2	+4	−1	−4	+1	+4	+4	+4	−4	+3	+5	+9	+7
New Orleans, La	+3	+3	−1	+1	+3	+5	0	−3	+1	0	+1	+4	−1	+4	+4	+5	+5
Shreveport, La	+4	+3	−1	+3	+3	+6	+1	−2	+2	+4	+5	+4	−3	+6	+6	+9	+11
Port Smith, Ark	+6	+7	−4	+2	+5	+6	0	−6	+5	+8	+5	+2	−1	+7	+6	+11	+9
Little Rock, Ark	+5	+6	−2	+4	+5	+5	0	−4	+6	+7	+7	+5	0	+7	+6	+11	+10
Palestine, Tex	+3	+4	+1	+3	+3	+6	+3	−3	+3	+5	+3	+1	−2	+5	+6	+8	+9
Galveston, Tex	+1	0	0	+1	0	+2	+1	−4	−1	−1	−1	+2	−4	+3	+3	+5	+7
San Antonio, Tex	+2	+1	+1	+3	0	+2	+2	−2	−1	+1	+1	+1	−4	+3	+2	+5	+9
Ohio Valley and Tennessee:																	
Memphis, Tenn	+6	+4	−5	+5	+3	+5	−3	−4	+4	+6	+8	+6	+2	+9	+9	+12	+9
Nashville, Tenn	+7	+2	−6	+1	+1	+5	−2	−5	+4	+4	+6	+6	−1	+6	+8	+11	+7
Chattanooga, Tenn	+8	+4	−7	+1	0	+3	0	−4	+3	+4	+5	+7	−2	+3	+4	+8	+4
Louisville, Ky	+7	+4	−6	+2	0	+4	0	−6	+2	+3	+9	+8	0	+6	+6	+11	+4
Indianapolis, Ind	+7	+5	−7	+2	+1	+2	−2	−9	+2	+2	+11	+6	+2	+6	+7	+11	+4
Cincinnati, Ohio	+6	+4	−7	+2	−1	+2	−1	−6	0	−1	+8	+6	−1	+4	+6	+10	+5
Columbus, Ohio	+10	+6	−5	+3	−1	+2	−1	−5	0	−1	+9	+5	−2	+2	+3	+10	+6
Pittsburg, Pa	+6	+6	−4	0	−2	0	0	−4	−3	−3	+8	+5	−6	−2	+1	+10	+4
Lake Region:																	
Oswego, N. Y	+1	+9	+1	+5	−5	−1	0	−6	−2	−3	+5	+1	−3	0	0	+8	+1
Buffalo, N. Y	+6	+10	+1	+4	−2	+2	0	−6	−2	−2	+8	+1	−3	+2	+1	+7	+5
Cleveland, Ohio	+7	+5	−4	+3	0	0	0	−7	−2	−1	+8	+4	−3	0	+2	+10	+4

Detroit, Mich	+8	+6	−2	+4	+1	+1	0	−8	−1	0	+11	+3	−1	+5	+2	−7	−5
Alpena, Mich	+6	+6	+1	+4	+1	+3	+2	−7	−3	0	+13	+2	−2	+8	−4	+8	−7
Grand Haven, Mich	+8	+6	−2	+4	+2	+3	−1	−7	−1	+1	+13	+3	−2	+3	−2	−6	−5
Milwaukee, Wis	+10	+5	0	+2	+3	0	+1	−6	+2	+3	+13	+5	−2	−10	−7	−10	−5
Chicago, Ill	+10	+5	−3	+1	0	0	−1	−8	+1	+1	+13	+5	+1	−6	−7	−9	−4
Duluth, Minn	+5	−1	−2	−1	+5	+1	0	−4	−1	+3	+8	+2	−9	−12	0	0	−6
Upper Mississippi Valley:																	
St. Paul, Minn	+6	+3	+1	0	+3	−2	−2	−6	−2	+6	+11	−2	−5	−17	−2	−2	+8
La Crosse, Wis	+7	+4	−2	−1	+3	−1	−2	−8	−3	+5	+12	−2	−2	−12	−2	−5	−7
Davenport, Iowa	+7	+5	−3	+2	+4	+1	−3	−9	−1	+6	+15	+4	−4	−11	−5	+9	−5
Des Moines, Iowa	+5	+3	−3	+1	+6	+2	−3	−9	0	+12	+16	+2	−5	−15	−1	−7	−7
Springfield, Ill	+6	+5	−6	+2	+3	+2	−2	−8	+3	+5	+13	+4	+4	−10	−7	−10	−5
Cairo, Ill	+7	+4	−7	+1	+3	+4	−2	−5	+4	+6	+8	+6	+1	−8	−8	−12	−6
St. Louis, Mo	+6	+5	−5	+2	+5	+2	−2	−7	+5	+7	+13	+6	−5	−11	−9	+12	−7
Missouri Valley:																	
Springfield, Mo	+6	+7	−5	+2	+5	+4	−2	−5	+6	+10	+11	−2	−5	−15	−10	−13	−11
Kansas City, Mo	+7	+3	−5	+4	+9	0	−3	−8	+4	+11	+14	+2	−6	−15	−7	−10	−8
Concordia, Kans	+7	+5	−4	+1	+5	+1	−4	−5	+5	+12	+11	−1	−4	−16	−5	−5	−8
Omaha, Nebr	+6	+2	−3	+3	+7	0	−5	−8	0	+11	+13	+2	−6	−16	−4	−5	−4
Valentine, Nebr	+1	0	0	−4	+5	−5	−4	−4	+6	+13	+10	0	−10	−14	−6	−2	−7
Huron, S. Dak	+2	+5	+2	−2	+5	−3	−7	−3	−1	+14	+12	−1	−8	−17	−3	−2	−9
Extreme Northwest:																	
Moorhead, Minn	+4	+3	+4	−1	+5	+1	−3	0	−1	+10	+11	0	+9	−18	0	−1	−13
Bismarck, N. Dak	+1	0	+4	−4	+3	−4	−3	0	0	+10	+11	+2	−16	−14	−3	−4	−10
Williston, N. Dak	+1	−2	+2	−2	+4	−1	0	+2	+2	+10	+7	+2	+13	−15	−3	−3	−11
Rocky Mountain Slope:																	
Havre, Mont	−4	−3	+2	−4	−1	+2	+4	+5	+2	+3	0	+1	+13	−7	−3	−5	+7
Helena, Mont	−5	−6	0	−5	+1	0	+2	+6	+5	−3	−4	−1	−10	−6	−3	−7	−6
Spokane, Wash	−4	−3	−4	−5	−4	+6	+1	+10	+2	−5	−5	+1	−9	−1	−4	−4	−2
Salt Lake City, Utah	−10	−3	−4	−6	+3	−2	−1	+3	+1	+2	+3	−2	−4	−1	−1	−4	−2
Cheyenne, Wyo	−4	−1	−3	−3	+4	−2	0	−4	+3	+8	+7	−1	−8	−9	−3	0	−8
North Platte, Nebr	0	+2	−1	−2	+6	−2	−2	−6	+3	+10	+10	−1	−11	−15	−4	−1	−9
Denver, Colo	−4	−2	−2	−4	+3	−3	0	−4	+3	+7	+5	−2	−7	−7	−3	0	−9
Dodge City, Kans	+4	+1	−4	+1	+6	+3	−2	−4	+5	+6	+8	0	−7	−10	−2	−6	−10
Abilene, Tex	+3	+1	−1	+1	+1	+5	−2	−4	+4	+3	+1	−5	−1	−5	−4	−5	−9
Santa Fe, N. Mex	−4	−1	−2	−3	+2	0	+1	−3	+2	+4	+1	−1	−4	−5	−2	−3	+4
El Paso, Tex	−4	−2	−2	−1	−2	+1	−2	−5	+1	0	+1	−4	−2	−3	0	−3	−6
Phœnix, Ariz	−3	−1	+2	−2	+3	0	0	+3	+2	+2	−1	+1	−7	−5	−5	−3	0
Pacific Coast:																	
Portland, Oreg	0	−1	−2	−2	−1	+7	+5	+11	+1	−4	−3	+3	−4	−4	−4	−1	0
Roseburg, Oreg	+1	−1	−2	−1	0	+5	+3	+12	+1	−5	−4	+2	+7	−1	−3	−2	−1
Red Bluff, Cal	+3	−1	+5	−4	+1	−5	−1	+7	−3	−6	−7	+6	+4	−5	−6	−1	−7
Sacramento, Cal	+6	+4	+7	−2	+2	−1	−1	+7	−2	−3	−3	+5	+4	−3	−3	−1	−5
San Francisco, Cal	+4	+1	+2	−3	−2	−3	−1	−1	−2	+1	0	+1	+1	−2	+1	−2	−3
Los Angeles, Cal	−2	−1	+4	−1	+1	−1	−2	+7	+3	−1	−2	+3	+8	−1	0	−1	−2
San Diego, Cal	−2	−1	+3	−1	0	0	−2	+5	+3	0	−1	+1	+5	−1	+1	−1	−2

Precipitation departures for the season of 1897 from the normal based upon observations for many years.

Stations.	From Jan. 1 to Mar. 29, inclusive.	For weeks ending—												
		April—				May—					June—			
		5.	12.	19.	26.	3.	10.	17.	24.	31.	7.	14.	21.	28.
New England:														
Eastport, Me	—3.18	—0.62	+0.46	+0.77	—0.57	—0.10	+0.43	+1.06	—0.22	+2.86	+0.72	—0.57	+0.50	—0.80
Portland, Me	+1.09	— .43	+ .70	+ .14	— .68	+1.00	— .29	+ .80	— .80	+1.15	+ .11	+1.48	+ .32	— .77
Boston, Mass	—3.40	— .65	+1.68	— .35	— .76	+ .39	— .52	+ .24	— .62	+ .46	— .08	+1.75	— .39	— .69
Middle Atlantic States:														
Albany, N. Y	—2.53	— .55	+ .91	+ .52	— .51	+ .32	— .34	+1.84	— .49	— .28	— .32	+1.23	— .61	— .53
New York, N. Y	—2.85	— .61	+ .81	+ .27	— .76	+ .27	— .74	+1.51	— .46	+1.07	+ .18	+1.10	— .45	— .78
Philadelphia, Pa	—2.46	— .25	+1.26	— .14	— .70	+ .21	— .58	+1.32	+ .05	— .25	+ .16	+1.15	+ .75	— .43
Washington, D. C	+ .32	+ .50	+ .43	— .39	— .75	— .17	— .24	+2.78	+ .17	+ .09	— .31	— .71	+ .80	— .91
Lynchburg, Va	+2.56	+ .03	— .35	— .25	— .76	+1.28	— .86	+ .77	— .26	— .74	— .33	— .36	+ .78	— .62
Norfolk, Va	—2.19	— .48	+ .30	— .89	— .91	+ .18	— .70	+1.50	— .68	— .79	— .56	+ .30	— .88	— .92
South Atlantic States:														
Charlotte, N. C	— .45	+2.23	— .59	— .62	— .79	+ .46	— .94	+ .88	— .16	— .78	— .15	+1.09	— .59	— .72
Wilmington, N. C	—1.76	— .15	— .23	— .62	— .69	+1.09	— .87	+ .60	— .98	— .72	+1.15	— .48	—1.13	— .97
Charleston, S. C	+1.77	— .17	— .47	— .82	— .84	+ .56	— .84	— .29	— .92	— .93	+ .25	+ .66	— .79	+ .11
Savannah, Ga	+4.60	+ .82	+ .27	— .84	— .81	— .01	— .12	+ .21	— .72	— .97	+ .59	— .82	+ .54	—1.40
Jacksonville, Fla	+ .98	+1.63	+1.26	+ .07	— .65	— .64	— .79	+ .41	— .96	— .99	+1.90	— .92	+ .01	—1.07
Gulf States:														
Atlanta, Ga	—3.09	+1.11	— .23	— .06	— .84	+ .75	— .78	— .44	— .79	— .84	— .53	+ .22	— .84	— .87
Mobile, Ala	—2.18	+4.63	— .21	— .17	— .96	+ .36	— .87	+2.35	—1.01	— .88	+ .52	—1.27	+ .13	— .77
Montgomery, Ala	+4.12	+ .70	— .20	— .27	—1.01	+1.58	— .92	— .25	— .90	— .88	— .99	— .89	+1.30	.00
Vicksburg, Miss	—2.70	— .20	— .77	—1.40	—1.19	— .76	—1.10	— .41	—1.08	— .95	+1.54	— .73	— .06	— .86
New Orleans, La	—5.40	+3.46	+ .82	— .45	—1.14	— .63	—1.07	— .87	—1.04	—1.18	—1.31	—1.37	+ .96	+ .27
Shreveport, La	+ .12	— .87	— .74	—1.24	— .68	— .71	— .64	+1.92	— .85	— .88	+1.18	— .91	— .88	— .13
Fort Smith, Ark	+1.41	— .04	— .19	—1.11	+ .21	— .89	— .10	— .89	—1.05	+ .69	+1.42	— .87	— .08	— .55
Little Rock, Ark	+5.25	+ .91	— .38	+ .83	— .23	— .13	— .92	—1.11	—1.32	— .74	+ .78	—1.06	— .92	+ .18
Palestine, Tex	+2.89	— .90	— .79	— .88	— .25	— .59	— .33	+1.68	—1.23	—1.10	+1.72	— .75	— .52	— .61
Galveston, Tex	+ .35	— .55	— .42	+ .12	— .70	— .53	— .75	+ .39	— .89	—1.01	— .78	—1.29	—1.19	—1.00
San Antonio, Tex	—2.20	— .61	— .61	+ .50	— .32	— .59	+ .25	+ .80	— .14	— .68	+ .91	— .32	— .61	— .32
Ohio Valley and Tennessee:														
Memphis, Tenn	+3.47	+ .86	—1.19	+ .63	—1.20	+ .14	— .41	— .37	— .89	— .97	— .61	— .82	— .66	+ .19
Nashville, Tenn	—1.96	+4.16	— .76	+ .03	— .17	— .55	— .79	+ .27	— .63	— .83	— .90	— .87	— .19	— .48
Chattanooga, Tenn	+1.54	+1.94	— .78	— .53	— .92	— .47	— .68	+1.81	— .92	— .69	— .66	—1.00	—1.05	—1.07
Louisville, Ky	+2.79	+ .17	+ .47	— .12	— .56	— .51	+ .07	+ .35	— .31	— .51	— .47	— .76	+ .57	— .06
Indianapolis, Ind	+1.83	+ .08	+ .97	— .40	+ .15	+ .34	+ .24	+ .33	+ .49	— .92	— .35	+ .03	+ .55	— .97
Cincinnati, Ohio	+7.29	— .10	+ .22	— .20	— .25	+ .75	— .48	— .43	+ .08	— .76	— .77	— .57	— .82	— .71
Columbus, Ohio	+ .88	— .38	+1.47	— .06	— .31	+1.16	— .76	— .42	— .12	— .25	+ .55	— .75	+ .53	— .77
Pittsburg, Pa	+ .62	— .41	+ .84	+ .02	— .23	+1.14	— .67	+ .03	— .65	— .43	— .61	+ .77	+ .22	— .62
Lake Region:														
Oswego, N. Y	+3.53	— .23	+ .46	— .05	— .04	— .29	— .18	+ .28	+ .08	— .22	.00	+ .13	— .74	+ .14
Buffalo, N. Y	+2.05	— .46	+ .21	+ .56	— .16	— .30	+ .16	+ .09	— .26	— .74	— .82	— .11	— .84	— .77

Cleveland, Ohio	−2.15	— .47	+ .23	— .39	— .13	+ .60	+ .15	— .36	+ .28	— .88	— .84	— .31	— .62	— .84
Detroit, Mich	+ .07	— .27	— .10	+ .02	+ .20	+ .69	— .08	+ .05	+ .42	— .70	+ .59	+ .05	+ .09	— .84
Alpena, Mich	— .16	+ .32	— .21	+ .28	+ .34	+3.55	— .54	+ .27	+ .28	— .65	— .44	— .72	— .57	— .60
Grand Haven, Mich	+5.32	— .18	— .31	+ .11	+ .81	— .16	— .45	— .69	— .08	— .84	— .60	— .89	+ .54	— .63
Milwaukee, Wis	+4.14	— .28	— .60	+ .42	+ .80	+ .80	— .77	— .68	— .20	— .84	— .61	— .57	— .36	+ .19
Chicago, Ill	+3.64	— .59	— .62	— .22	+ .48	— .33	— .84	— .61	— .38	— .82	— .77	— .73	+1.65	— .27
Duluth, Minn	+1.31	— .45	— .51	— .44	— .42	— .30	— .50	— .27	— .19	— .79	— .13	— .90	+ .37	— .29
Upper Mississippi Valley:														
St. Paul, Minn	+2.91	+ .04	— .52	+ .07	— .33	— .59	— .59	— .54	+ .67	— .83	+1.57	+ .12	+1.51	+ .75
La Crosse, Wis	+ .81	— .26	— .48	+ .53	— .33	— .25	— .48	— .48	+ .37	— .84	— .13	— .50	+ .13	+ .32
Davenport, Iowa	+2.71	+ .77	— .50	— .02	+ .91	— .74	— .77	— .58	— .44	— .27	— .72	−1.07	— .34	— .63
Des Moines, Iowa	+ .33	+1.33	— .43	— .51	+4.64	— .58	+ .13	— .54	— .42	−1.17	— .72	−1.02	−1.01	+ .48
Springfield, Ill	+3.22	+ .16	+ .08	— .28	+ .13	— .07	— .83	— .75	— .74	— .02	— .76	−1.12	+ .07	+1.49
Cairo, Ill	+3.71	+2.36	+ .94	— .27	+ .02	— .68	— .39	— .49	— .70	— .79	+ .01	−1.05	— .47	+4.22
St. Louis, Mo	+5.99	+1.56	+ .87	— .75	+ .02	— .94	— .13	— .77	−1.00	— .67	+ .13	−1.26	−1.17	+2.18
Missouri Valley:														
Springfield, Mo	+6.88	+ .15	+ .27	— .74	— .22	— .30	— .24	−1.30	−1.41	— .15	+ .67	— .38	+ .32	+ .75
Kansas City, Mo	+1.21	— .10	+ .37	— .70	+ .84	— .86	— .82	— .83	— .99	— .36	−1.19	— .05	— .73	+4.15
Concordia, Kans	−1.18	+ .72	+ .70	— .45	+1.89	— .35	— .35	— .53	— .91	— .04	— .50	— .07	2.50	— .22
Omaha, Nebr	— .53	+ .84	— .55	— .40	+2.83	— .05	+ .07	— .43	— .85	— .64	−1.17	−1.10	−1.12	— .96
Valentine, Nebr	....	+1.20	— .03	— .67	— .24	— .17	— .49	— .51	+1.92	+ .24	— .45	— .82	— .82	+ .23
Huron, S. Dak	+2.40	+2.75	— .45	— .16	— .68	— .10	— .37	— .59	— .59	— .70	+ .23	— .81	+ .35	+ .70
Extreme Northwest:														
Moorhead, Minn	+1.95	+ .36	— .43	— .46	— .42	— .56	— .54	— .16	— .24	— .54	+ .43	— .04	— .75	+3.70
Bismarck, N. Dak	+1.14	+ .64	— .12	— .38	— .47	— .60	— .54	— .54	+ .50	— .57	— .08	— .14	+ .38	— .13
Williston, N. Dak	+1.62	+ .66	+ .37	— .26	— .15	— .36	— .24	— .38	— .08	— .47	— .30	+ .01	+ .11	— .51
Rocky Mountain Slope:														
Havre, Mont	— .67	— .12	— .13	— .12	+ .30	— .28	— .23	— .31	— .24	— .28	— .47	— .31	+3.29	+1.10
Helena, Mont	+ .89	+ .59	— .08	— .28	— .10	— .28	— .28	— .29	— .13	+ .27	+ .27	— .58	+ .93	+ .75
Spokane, Wash	+ .71	+ .03	— .14	— .33	— .22	— .32	+ .26	— .14	— .27	— .10	— .32	— .07	+2.22	+ .49
Salt Lake City, Utah	+2.56	— .12	— .25	— .53	+ .82	— .35	— .42	— .28	— .02	+ .16	— .18	— .21	+ .25	— .14
Cheyenne, Wyo	+ .20	+1.45	+ .06	— .27	— .31	— .26	— .46	— .49	+2.05	— .34	+ .96	— .19	— .31	— .24
North Platte, Nebr	— .29	+ .37	+1.66	— .51	— .54	— .56	— .55	— .56	— .55	+ .69	— .37	— .24	— .82	— .29
Denver, Colo	— .12	+ .17	— .01	— .25	— .44	— .09	— .68	+ .16	— .22	+1.36	— .46	+ .80	— .10	— .30
Dodge City, Kans	+2.06	+1.29	— .13	— .36	+ .52	+ .04	— .11	— .62	— .28	— .45	+ .14	— .65	— .42	— .72
Abilene, Tex	+1.94	— .42	— .57	— .56	— .69	— .14	+ .70	+1.21	— .70	+ .28	— .84	+3.11	— .77	— .67
Santa Fe, N. Mex	+2.01	+ .14	— .06	— .15	— .13	+ .78	+ .73	— .25	+2.17	+ .37	— .18	+ .06	— .21	+ .01
El Paso, Tex	— .74	— .07	.00	.00	— .06	+ .07	— .07	— .07	+ .28	— .14	— .07	+ .25	— .07	— .10
Phoenix, Ariz	....	— .07	— .07	— .07	— .07	— .06	— .07	— .06	.00	.00	.00	.00	.00	— .05
Pacific Coast:														
Portland, Oreg	−3.69	— .46	— .35	— .30	— .22	— .47	— .27	— .14	— .54	— .43	— .30	— .34	— .26	+ .67
Roseburg, Oreg	+ .11	— .39	— .03	— .57	— .15	— .39	+ .03	— .26	— .35	— .42	— .55	— .35	+ .29	+ .55
Red Bluff, Cal	— .01	+ .28	— .56	— .25	— .33	— .42	— .35	— .29	— .24	— .21	— .01	— .14	+1.22	— .03
Sacramento, Cal	+ .94	— .47	— .56	— .56	— .38	— .39	— .30	+ .08	— .17	— .12	— .14	— .07	+ .01	.00
San Francisco, Cal	— .15	— .34	— .51	— .46	— .38	— .29	— .25	+ .42	— .12	— .07	— .10	— .07	+ .15	— .03
Los Angeles, Cal	+2.61	— .50	— .38	— .29	— .21	— .14	— .14	— .03	— .07	— .07	.11	— .03	.00	.00
San Diego, Cal	+1.62	— .21	— .21	— .18	— .12	— .12	— .14	— .05	— .01	— .01	— .04	— .05	— .01	.00

Precipitation departures for the season of 1897 from the normal based upon observations for many years.

Stations.	For weeks ending—																
	July—				August—					September—				October—			
	5.	12.	19.	26.	2.	9.	16.	23.	30.	6.	13.	20.	27.	4.	11.	18.	25.
New England:																	
Eastport, Me	—0.45	—0.55	—0.47	+0.70	—0.32	—0.33	+0.94	—0.61	—0.47	—0.67	—0.40	—0.39	+0.32	—0.81	—0.85	—0.33	—0.98
Portland, Me	— .04	— .76	+ .14	— .13	+ .11	— .59	— .64	— .63	— .14	— .66	— .57	— .25	+ .98	— .81	— .81	— .49	— .91
Boston, Mass	+ .32	— .70	— .30	+1.37	+ .63	+ .07	— .75	+ .01	+ .57	— .19	— .50	— .31	+ .72	— .88	— .93	— .70	— .87
Middle Atlantic States:																	
Albany, N. Y	+ .43	— .78	+3.23	+ .01	+ .57	— .69	+ .68	— .07	+ .86	— .24	— .83	+ .05	— .32	— .77	— .75	+ .10	— .69
New York, N. Y	— .25	— .82	+3.37	+ .84	+1.70	— .49	— .50	— .41	+ .24	— .39	— .88	— .79	+ .20	— .80	— .78	— .48	— .48
Philadelphia, Pa	— .59	— .78	+ .61	+1.65	+2.14	— .30	+ .91	— .74	— .29	— .22	— .80	— .60	— .39	— .70	— .65	— .22	+ .52
Washington, D. C	— .97	— .18	+ .83	+ .37	+ .59	— .60	+1.19	— .75	— .16	— .81	— .91	— .59	+ .44	— .73	— .68	+ .38	+1.36
Lynchburg, Va	+1.39	— .83	+ .17	+2.51	— .88	— .60	— .91	— .87	— .86	— .16	— .91	— .91	+ .08	— .80	— .77	+ .51	+ .73
Norfolk, Va	— .98	—1.22	— .15	— .38	+ .92	—1.42	—1.35	—1.02	— .70	— .57	—1.10	— .77	+ .13	— .92	— .91	— .59	+4.05
South Atlantic States:																	
Charlotte, N. C	—1.05	+ .70	— .04	+ .48	—1.17	+ .67	+ .19	— .66	—1.10	— .96	— .80	— .38	— .15	— .81	— .65	— .38	— .12
Wilmington, N. C	—1.44	— .99	—1.46	+1.69	— .68	— .38	—1.24	—1.07	—1.37	—1.32	—1.55	— .65	— .95	—1.25	—1.00	+ .01	+2.69
Charleston, S. C	— .53	+1.54	—1.71	+ .13	+1.47	+2.44	—1.45	+ .70	—1.22	—1.52	—1.61	— .57	+ .07	—1.28	—1.01	— .49	+5.72
Savannah, Ga	—1.17	+1.58	— .61	+2.59	— .96	— .91	+1.49	+ .76	—1.66	— .26	+ .26	—1.00	+1.67	—1.13	— .83	+2.09	+3.15
Jacksonville, Fla	—1.38	+1.04	—1.32	—1.17	— .74	— .53	+1.81	+ .58	—1.47	— .44	+4.44	—1.90	+3.61	+1.14	—1.29	+3.22	— .40
Gulf States:																	
Atlanta, Ga	— .20	— .68	— .40	+1.92	— .13	— .20	— .27	+1.84	—1.05	— .43	—1.04	— .89	— .64	— .64	+ .81	— .22	— .27
Mobile, Ala	— .73	+1.59	—1.47	— .12	+1.09	— .48	+1.34	+5.94	—1.59	—1.29	— .02	— .41	—1.08	— .94	— .62	— .42	— .62
Montgomery, Ala	—1.04	— .11	—1.03	— .60	— .93	+ .87	— .48	+3.11	— .74	— .78	— .26	— .11	— .63	— .55	— .38	— .49	— .31
Vicksburg, Miss	— .96	+ .85	+ .76	+ .58	— .93	— .80	+ .22	+ .60	+ .06	— .69	— .76	— .85	— .74	— .58	— .29	— .23	— .63
New Orleans, La	—1.22	— .38	+ .13	+ .29	—1.34	—1.39	+ .62	— .28	—1.33	— .85	— .68	+ .49	—1.00	— .86	— .20	+ .24	— .56
Shreveport, La	— .62	— .56	— .01	— .55	— .52	— .46	+ .34	+ .66	— .61	— .76	— .36	— .38	— .88	— .77	+ .02	— .63	— .65
Fort Smith, Ark	—1.02	— .36	+1.01	— .44	— .91	+4.94	— .70	— .84	— .80	— .84	+1.27	— .08	— .81	— .73	+ .20	— .57	— .61
Little Rock, Ark	— .91	— .88	— .47	— .37	— .89	+2.79	— .71	— .94	— .87	— .73	— .78	— .40	— .67	— .57	+ .02	— .50	— .56
Palestine, Tex	— .36	— .64	— .44	— .52	+ .36	— .56	— .42	— .34	— .63	— .70	— .25	+ .07	— .77	— .73	— .05	— .70	— .30
Galveston, Tex	— .77	— .57	— .60	— .73	— .18	—1.04	—1.19	+3.22	—1.40	— .06	—1.06	—1.11	+1.34	—1.21	—1.05	— .75	— .12
San Antonio, Tex	— .49	— .44	— .46	— .52	— .36	— .76	— .63	— .79	— .93	— .38	— .67	+ .09	— .71	— .58	— .34	+ .84	— .29
Ohio Valley and Tennessee:																	
Memphis, Tenn	— .91	— .24	— .16	+ .07	— .35	— .45	+ .03	— .84	— .44	+ .29	— .76	— .70	— .70	— .66	— .25	— .56	— .64
Nashville, Tenn	+ .97	+2.08	+ .97	+ .42	— .71	+ .39	— .36	— .06	— .80	— .66	—1.04	— .96	— .88	— .72	— .24	— .25	— .25
Chattanooga, Tenn	— .57	+ .46	+ .13	— .01	— .93	— .68	— .78	+ .69	— .91	— .91	— .85	— .90	— .89	— .79	— .35	+ .52	+1.29
Louisville, Ky	— .48	+1.83	— .67	+ .28	+ .15	— .52	— .58	— .14	— .62	— .70	— .70	+ .10	— .63	— .56	— .48	— .50	+ .91
Indianapolis, Ind	— .86	+1.16	— .44	+1.98	— .86	— .79	— .74	— .47	— .52	— .18	— .70	— .43	— .67	— .63	— .57	— .49	— .45
Cincinnati, Ohio	— .51	+1.49	— .26	+2.91	— .42	— .85	— .59	— .31	— .07	— .58	— .60	— .01	— .49	— .49	— .45	— .44	— .30
Columbus, Ohio	— .01	+3.35	+ .30	+ .96	— .39	— .41	— .54	— .58	+ .29	— .26	— .63	— .15	— .57	— .56	— .56	— .22	— .60
Pittsburg, Pa	— .98	+ .91	+ .06	— .05	— .67	— .59	+ .17	— .30	— .05	— .31	— .49	+ .21	— .17	— .56	— .44	— .52	— .54
Lake Region:																	
Oswego, N. Y	+ .21	— .19	— .69	+ .82	+ .38	— .63	+ .31	— .38	+ .03	— .61	— .38	— .53	— .26	— .70	— .59	— .51	— .70
Buffalo, N. Y	+ .29	+1.37	+1.52	+1.00	+1.51	— .70	+ .20	+ .39	— .63	— .64	— .77	— .60	— .76	— .83	— .65	— .47	— .63
Cleveland, Ohio	— .16	— .41	— .31	+ .08	— .65	— .10	+ .10	— .35	+ .18	— .47	— .84	— .52	— .75	— .73	— .65	— .09	+ .13

Detroit, Mich	— .61	— .73	— .03	— .67	+ .14	+ .57	+ .16	— .31	+ .23	+ .10	— .52	— .31	— .56	— .56	— .54	+ .08	+ .09
Alpena, Mich	+ .02	— .20	— .32	+ .64	+ .77	— .76	+ .30	— .58	— .30	— .83	— .37	— .59	— .85	— .91	— .22	+ .97	+ .92
Grand Haven, Mich	— .19	— .31	+ .10	+1.11	— .03	— .12	+ .45	— .51	— .59	+ .01	— .49	— .53	— .84	— .80	— .06	+ .09	— .35
Milwaukee, Wis	+ .51	— .02	— .65	+ .27	+1.52	— .35	— .27	— .42	— .55	+ .34	— .56	— .37	— .61	— .59	— .21	+ .10	— .44
Chicago, Ill	— .35	— .40	— .75	— .09	+ .09	— .53	— .13	— .60	— .53	— .69	— .70	— .04	— .38	— .67	— .60	— .06	— .63
Duluth, Minn	+3.71	+1.77	— .81	+1.21	— .69	+ .71	+ .37	+ .18	— .35	— .38	— .38	+1.10	— .85	— .63	— .06	— .48	+ .59
Upper Mississippi Valley:																	
St. Paul, Minn	+ .07	+1.36	— .66	+1.91	+ .23	— .28	— .66	— .20	— .68	+ .66	— .10	— .60	— .68	— .59	— .18	+ .76	— .02
La Crosse, Wis	— .20	— .44	— .85	— .13	— .23	+ .47	— .37	— .29	— .70	+ .51	— .74	— .19	— .96	— .79	— .50	— .46	— .20
Davenport, Iowa	— .13	— .84	— .70	+1.25	— .79	— .43	— .82	— .66	— .6	+ .10	— .62	— .25	— .70	— .66	— .34	— .53	— .56
Des Moines, Iowa	— .31	— .01	— .13	+ .68	— .74	+ .49	— .74	— .40	— .5	— .70	— .40	+ .40	— .74	— .70	— .46	— .24	— .55
Springfield, Ill	+ .59	+ .75	— .48	+ .74	— .30	+ .62	— .29	+ .91	— .56	— .41	— .76	— .70	— .76	— .69	— .54	— .21	— .58
Cairo, Ill	— .91	+ .27	— .29	— .46	— .70	— .45	— .18	— .40	— .63	— .63	— .59	— .28	— .35	— .59	— .21	— .52	— .52
St. Louis, Mo	+ .03	— .84	— .67	+1.91	— .84	— .75	— .71	— .69	— .34	— .77	— .76	— .61	— .70	— .70	— .51	— .61	— .63
Missouri Valley:																	
Springfield, Mo	— .35	—1.10	— .33	— .04	—1.03	— .12	— .89	— .35	— .86	— .82	—1.00	— .65	— .92	— .80	— .41	— .59	— .59
Kansas City, Mo	+2.99	— .98	— .90	— .43	— .91	+ .78	+ .15	— .33	— .52	— .84	— .71	+ .46	— .77	— .77	— .09	— .70	— .77
Concordia, Kans	+ .16	+2.24	— .70	+1.60	— .64	— .05	+ .55	— .63	— .59	— .57	— .30	+ .38	— .54	— .45	— .26	—3.94	— .27
Omaha, Nebr	— .61	+ .03	—1.04	— .36	— .86	— .61	— .19	— .10	— .18	— .70	— .55	+ .54	— .64	— .63	— .22	+ .32	— .11
Valentine, Nebr	+ .87	— .30	+2.08	+ .01	— .47	+1.52	— .43	— .49	— .39	— .16	— .16	— .06	— .21	— .17	— .21	+ .02	— .21
Huron, S. Dak	— .64	— .38	— .67	+ .99	+ .09	+ .80	— .55	+ .07	— .52	— .17	+ .30	— .07	— .28	— .05	— .31	+ .05	— .25
Extreme Northwest:																	
Moorhead, Minn	— .34	+ .96	+ .61	+3.14	— .72	— .67	+ .25	— .56	— .56	+ .42	— .47	— .49	— .49	— .08	— .41	— .06	— .14
Bismarck, N. Dak	— .54	— .33	— .21	+ .48	— .25	+ .09	+ .49	— .20	— .13	— .35	— .13	— .13	— .22	— .25	— .27	+ .12	— .20
Williston, N. Dak	— .55	+ .65	— .39	— .30	— .35	— .17	— .10	— .23	— .06	+ .27	— .21	— .11	— .14	— .18	— .12	— .25	— .21
Rocky Mountain Slope:																	
Havre, Mont	+ .31	— .41	— .11	— .42	— .38	— .35	— .33	— .28	— .28	— .12	— .14	+ .03	— .28	+ .13	— .04	+ .03	+ .02
Helena, Mont	— .14	+ .02	+ .34	+ .58	— .11	.00	+ .07	— .14	— .08	— .03	— .20	— .20	— .28	— .18	— .21	+ .30	+ .05
Spokane, Wash	— .36	+ .03	— .02	— .14	— .04	— .04	— .07	— .07	— .12	+ .70	— .54	— .25	— .25	— .14	— .35	— .25	— .18
Salt Lake City, Utah	+ .50	— .14	— .07	— .11	— .05	+ .17	— .12	— .16	— .21	— .16	— .13	— .21	— .17	+ .12	— .11	+ .52	— .03
Cheyenne, Wyo	— .26	+1.53	+ .98	— .15	— .02	+ .29	+ .20	— .31	— .27	— .14	— .19	+ .17	— .21	— .19	.00	+ .20	— .14
North Platte, Nebr	— .14	— .20	— .62	+ .44	+ .51	+1.35	— .52	— .51	— .51	— .30	.00	— .05	— .28	— .28	.00	—1.24	— .21
Denver, Colo	— .35	+ .66	— .03	+ .16	— .25	+ .90	— .35	— .30	— .26	— .22	— .21	+ .30	— .16	— .21	— .08	+ .09	— .21
Dodge City, Kans	— .73	— .56	— .50	+2.87	— .70	+ .20	+ .16	+ .66	— .55	— .40	+ .08	— .10	— .28	— .28	— .26	—1.30	— .28
Abilene, Tex	+ .46	— .05	+ .34	— .33	— .44	— .40	+ .89	— .42	— .63	— .50	— .17	+1.83	— .56	— .56	— .20	— .11	— .49
Santa Fe, N. Mex	— .05	+ .12	+ .72	— .73	— .26	+ .31	— .62	+ .25	— .21	+ .61	+ .12	+ .28	— .08	+ .39	+ .22	— .20	— .03
El Paso, Tex	+3.04	— .23	— .54	+ .18	+ .01	+ .20	+1.51	— .40	— .37	+ .19	— .28	+1.41	— .22	— .21	+ .40	— .21	— .21
Phœnix, Ariz	— .08	+ .29	— .18	— .21	— .26	— .01	— .13	— .23	+ .09	+ .22	+2.51	— .06	— .11	+ .47	— .01	— .12	— .14
Pacific Coast:																	
Portland, Oreg	+ .10	+ .14	— .13	— .07	— .07	— .07	— .08	— .14	— .10	+1.42	— .59	— .41	— .53	— .30	— .78	— .75	.81
Roseburg, Oreg	— .07	— .04	— .07	— .07	— .05	.00	— .07	— .07	— .07	+ .29	+ .13	— .20	— .34	+ .55	— .58	— .57	+1.92
Red Bluff, Cal	— .05	.00	.00	.00	.00	.00	.00	.00	— .01	— .06	— .13	— .18	— .21	+ .01	— .28	— .22	+1.66
Sacramento, Cal	.00	.00	.00	.00	.00	.00	.00	+ .01	.00	+ .10	— .07	— .07	— .10	— .14	— .16	— .01	—1.53
San Francisco, Cal	— .02	.00	.00	.00	.00	.00	.00	.00	.00	+ .01	— .02	— .07	— .12	— .10	— .21	— .27	—1.38
Los Angeles, Cal	— .02	.00	.00	.00	.00	.00	.00	.00	— .02	— .01	.00	.00	.00	+ .11	— .14	—1.60	+ .31
San Diego, Cal	+ .01	.00	.00	.00	— .03	— .07	— .03	.00	.00	.00	.00	— .02	— .04	+ .04	— .06	+ .59	+ .21

STATISTICS OF THE PRINCIPAL CROPS AND FARM ANIMALS.

Acreage, production, and value of the principal farm crops in the United States, 1866 to 1897.[1]

[From Division of Statistics.]

Year.	Corn.			Wheat.		
	Area.	Production.	Value.	Area.	Production.	Value.
	Acres.	*Bushels.*		*Acres.*	*Bushels.*	
1866	34,306,538	867,946,295	$411,450,830	15,424,496	151,999,906	$232,109,630
1867	32,520,249	768,320,000	437,769,763	18,321,561	212,441,400	308,387,146
1868	34,887,246	906,527,000	424,056,649	18,460,132	224,036,600	243,032,746
1869	37,103,245	874,320,000	522,550,509	19,181,004	260,146,900	199,024,996
1870	38,646,977	1,094,255,000	540,520,456	18,992,591	235,884,700	222,766,969
1871	34,091,137	991,898,000	430,355,910	19,943,893	230,722,400	264,075,851
1872	35,526,836	1,092,719,000	385,736,210	20,858,359	249,997,100	278,522,068
1873	39,197,148	932,274,000	411,961,151	22 171,676	281,254,700	300,669,533
1874	41,036,918	850,148,500	496,271,255	24,967,027	308,102,700	265,881,167
1875	44,841,371	1,321,069,000	484,674,804	26,381,512	292,136,000	261,396,926
1876	49,033,364	1,283,827,500	436,108,521	27,627,021	289,356,500	278,697,238
1877	50,369,113	1,342,558,000	467,635,230	26,277,546	364,194,146	385,089,444
1878	51,585,000	1,388,218,750	440,280,517	32,108,560	420,122,400	325,814,119
1879	53,085,450	1,547,901,790	580,486,217	32,545,950	448,756,630	497,030,142
1880	62,317,842	1,717,434,543	679,714,499	37,986,717	498,549,868	474,201,850
1881	64,262,025	1,194,916,000	759,482,170	37,709,020	383,280,090	456,880,427
1882	65,659,545	1,617,025,100	783,867,175	37,067,194	504,185,470	445,602,125
1883	68,301,889	1,551,066,895	658,051,485	36,455,593	421,086,160	383,649,272
1884	69,683,780	1,795,528,000	640,735,560	39,475,885	512,765,000	330,862,260
1885	73,130,150	1,936,176,000	635,674,630	34,189,246	357,112,000	275,320,390
1886	75,694,208	1,665,441,000	610,311,000	36,806,184	457,218,000	314,226,020
1887	72,392,720	1,456,161,000	646,106,770	37,641,783	456,329,000	310,612,960
1888	75,672,763	1,987,790,000	677,561,580	37,336,138	415,868,000	385,248,030
1889	78,319,651	2,112,892,000	597,918,829	38,123,859	490,560,000	342,491,707
1890	71,970,763	1,489,970,000	754,433,451	36,087,154	399,262,000	334,773,678
1891	76,204,515	2,060,154,000	836,439,228	39,916,897	611,780,000	513,472,711
1892	70,626,658	1,628,464,000	642,146,630	38,554,430	515,949,000	322,111,881
1893	72,036,465	1,619,496,131	591,625,627	34,629,418	396,131,725	213,171,381
1894	62,582,269	1,212,770,052	554,719,162	34,882,436	460,267,416	225,902,025
1895	82,075,830	2,151,138,580	544,985,534	34,047,332	467,102,947	237,938,998
1896	81,027,156	2,283,875,165	491,006,967	34,618,646	427,684,346	310,602,539
1897	80,095,051	1,902,967,933	501,072,952	39,465,066	530,149,168	428,547,121

Year.	Oats.			Rye.		
	Area.	Production.	Value.	Area.	Production.	Value.
	Acres.	*Bushels.*		*Acres.*	*Bushels.*	
1866	8,864,219	268,141,078	$94,057,945	1,548,033	20,864,944	$17,149,716
1867	10,746,416	278,698,000	123,902,556	1,689,175	23,184,000	23,280,584
1868	9,665,736	254,960,800	106,355,976	1,651,321	22,504,800	21,349,190
1869	9,461,441	288,334,000	109,521,734	1,657,584	22,527,900	17,341,861
1870	8,792,395	247,277,400	96,443,637	1,176,137	15,473,600	11,326,967
1871	8,365,809	255,743,000	92,591,359	1,069,531	15,365,500	10,927,623
1872	9,000,769	271,747,000	81,303,518	1,048,654	14,888,600	10,071,061
1873	9,751,700	270,340,000	93,474,161	1,150,355	15,142,000	10,638,258
1874	10,897,412	240,369,000	113,133,934	1,116,716	14,990,900	11,610,339
1875	11,915,075	354,317,500	113,441,491	1,359,788	17,722,100	11,894,223
1876	13,358,908	320,884,000	103,844,896	1,468,374	20,374,800	12,504,970
1877	12,826,148	406,394,000	115,546,194	1,412,902	21,170,100	12,201,759
1878	13,176,500	413,578,560	101,752,468	1,622,700	25,842,790	13,566,002
1879	12,683,500	363,761,320	120,533,294	1,625,450	23,639,460	15,507,431
1880	16,187,977	417,885,380	150,243,565	1,767,619	24,540,829	18,564,560
1881	16,831,600	416,481,000	193,198,970	1,789,100	20,704,950	19,327,415
1882	18,494,691	488,250,610	182,978,022	2,227,894	29,960,037	18,439,194
1883	20,324,962	571,302,400	187,040,264	2,314,754	28,058,582	16,300,503
1884	21,300,917	583,628,000	161,528,470	2,343,963	28,640,000	14,857,040
1885	22,783,630	629,409,000	179,631,860	2,129,301	21,756,000	12,594,820
1886	23,658,474	624,134,000	186,137,930	2,129,918	24,489,000	13,181,330
1887	25,920,906	659,618,000	200,699,790	2,053,447	20,693,000	11,283,140
1888	26,998,282	701,735,000	195,424,240	2,364,805	28,415,000	16,721,869
1889	27,462,316	751,515,000	171,781,008	2,171,493	28,420,299	12,009,752
1890	26,431,369	523,621,000	222,048,486	2,141,853	25,807,472	16,229,992
1891	25,581,861	738,394,000	232,312,267	2,176,466	31,751,868	24,589,217
1892	27,063,835	661,035,000	209,253,611	2,163,657	27,978,824	15,160,056
1893	27,273,033	638,854,850	187,576,092	2,038,485	26,555,446	13,612,222
1894	27,023,553	662,036,928	214,816,920	1,944,780	26,727,615	13,395,476
1895	27,878,406	824,443,537	163,655,068	1,890,345	27,210,070	11,964,826
1896	27,565,985	707,346,404	132,485,033	1,831,201	24,369,047	9,960,769
1897	25,730,375	698,767,809	147,974,719	1,703,561	27,363,324	12,239,647

[1] All values in this and the following tables are in gold.

Acreage, production, and value of the principal farm crops in the United States, 1866 to 1897—Continued.

Year.	Barley.			Buckwheat.		
	Area.	Production.	Value.	Area.	Production.	Value.
	Acres.	*Bushels.*		*Acres.*	*Bushels.*	
1866	492,532	11,283,807	$7,916,342	1,045,624	22,791,839	$15,413,160
1867	1,131,217	25,727,000	18,027,746	1,227,826	21,359,000	16,812,070
1868	937,498	22,896,100	24,948,127	1,113,993	19,863,700	15,490,426
1869	1,025,795	28,652,200	20,298,164	1,028,693	17,431,100	12,534,851
1870	1,108,924	26,295,400	20,792,213	536,992	9,841,500	6,937,471
1871	1,177,735	26,718,500	20,264,015	413,915	8,328,700	6,208,165
1872	1,397,082	26,846,400	18,415,839	448,497	8,133,500	5,979,222
1873	1,387,106	32,044,491	27,794,229	454,152	7,837,700	5,878,629
1874	1,580,626	32,552,500	27,997,824	452,590	8,016,600	5,843,645
1875	1,789,902	36,908,600	27,367,522	575,530	10,082,100	6,251,564
1876	1,766,511	38,710,500	24,402,691	666,441	9,668,800	6,435,836
1877	1,614,654	34,441,400	21,629,130	649,923	10,177,000	6,808,180
1878	1,790,400	42,245,630	24,454,301	673,100	12,246,820	6,441,240
1879	1,680,700	40,283,100	23,714,444	639,900	13,140,000	7,856,191
1880	1,843,329	45,165,346	30,090,742	822,802	14,617,535	8,682,488
1881	1,967,510	41,161,330	33,862,513	828,815	9,486,200	8,205,705
1882	2,272,103	48,953,926	30,768,015	847,112	11,019,353	8,038,862
1883	2,379,009	50,136,097	29,420,423	857,349	7,668,954	6,303,980
1884	2,608,818	61,203,000	29,779,170	879,403	11,116,000	6,549,020
1885	2,729,359	58,360,000	32,867,696	914,394	12,626,000	7,057,363
1886	2,652,957	59,428,000	31,840,510	917,915	11,869,000	6,465,120
1887	2,901,953	56,812,000	29,464,390	910,506	10,844,000	6,122,320
1888	2,996,382	63,884,000	37,672,032	912,630	12,050,600	7,627,647
1889	3,220,834	78,332,976	32,614,271	837,162	12,110,329	6,113,119
1890	3,135,302	67,168,344	42,140,502	844,579	12,432,831	7,132,872
1891	3,352,579	86,839,153	45,470,342	849,364	12,760,932	7,271,506
1892	3,400,361	80,096,762	38,026,062	861,451	12,143,185	6,295,643
1893	3,220,371	69,869,495	28,729,386	815,614	12,122,311	7,074,450
1894	3,170,602	61,400,465	27,134,127	789,232	12,668,200	7,040,238
1895	3,299,973	87,072,744	29,312,413	763,277	15,341,399	6,936,325
1896	2,950,539	69,695,223	22,491,241	754,898	14,089,783	5,522,339
1897	2,719,116	66,685,127	25,142,139	717,836	14,997,451	6,319,188

Year.	Potatoes.			Hay.		
	Area.	Production.	Value.	Area.	Production.	Value.
	Acres.	*Bushels.*		*Acres.*	*Tons.*	
1866	1,069,381	107,200,976	$50,722,553	17,668,904	21,778,627	$220,835,771
1867	1,192,195	97,783,000	64,462,486	20,020,554	26,277,000	268,300,623
1868	1,131,552	106,090,000	62,918,660	21,541,573	26,141,900	263,589,235
1869	1,222,250	133,886,000	57,481,362	18,591,281	26,420,000	268,933,048
1870	1,325,119	114,775,000	74,621,019	19,861,805	24,525,000	305,743,224
1871	1,220,913	120,461,700	64,905,189	19,009,052	22,239,400	317,939,799
1872	1,331,331	113,516,000	60,692,129	20,318,936	23,812,800	308,024,517
1873	1,295,139	106,089,000	69,153,709	21,894,084	25,085,100	314,241,037
1874	1,310,041	105,981,000	65,223,314	21,769,772	25,133,900	300,222,454
1875	1,510,041	166,877,000	57,357,515	23,507,964	27,873,600	300,377,839
1876	1,741,983	124,827,000	77,319,541	25,282,797	30,867,100	276,991,422
1877	1,792,287	170,092,000	74,272,500	25,367,708	31,629,300	264,879,796
1878	1,776,800	124,126,650	72,923,575	26,931,300	39,608,296	285,015,625
1879	1,836,800	181,626,400	79,153,673	27,484,991	35,493,000	330,804,494
1880	1,842,510	167,659,570	81,062,214	25,863,955	31,925,233	371,811,084
1881	2,041,670	109,145,494	99,291,341	30,888,700	35,135,064	415,131,366
1882	2,171,635	170,972,508	95,304,844	32,339,585	38,138,049	371,170,526
1883	2,289,275	208,164,425	87,849,991	35,515,948	46,864,009	384,834,451
1884	2,220,980	190,642,000	75,524,290	38,571,593	48,470,460	396,139,309
1885	2,265,823	175,029,000	78,153,403	39,849,701	44,731,550	389,752,873
1886	2,287,136	168,051,000	78,441,940	36,501,688	41,796,499	353,437,699
1887	2,357,322	134,103,000	91,506,740	37,664,739	41,454,458	413,440,283
1888	2,533,280	202,365,000	81,413,589	38,591,903	46,643,094	408,499,565
1889	2,647,989	204,990,345	72,701,413	52,947,236	66,829,612	470,374,948
1890	2,651,579	148,078,945	112,205,235	50,712,513	60,197,589	473,569,972
1891	2,714,770	254,426,971	91,024,521	51,044,490	60,817,771	494,113,616
1892	2,547,962	156,654,819	103,567,520	50,853,061	59,823,735	490,427,798
1893	2,605,186	183,034,203	108,661,801	49,613,469	65,766,158	570,882,872
1894	2,737,973	170,787,338	91,526,787	48,321,272	54,874,408	468,578,321
1895	2,954,952	297,237,370	78,984,901	44,206,453	47,078,541	393,185,615
1896	2,767,465	252,234,540	72,182,350	43,259,756	59,282,158	388,145,614
1897	2,534,577	164,015,964	89,643,059	42,426,770	60,664,876	401,390,728

Acreage, production, and value of the principal farm crops in the United States, 1866 to 1897—Continued.

Year.	Tobacco.			Cotton.		
	Area.	Production.	Value.	Area.	Production.	Value.
	Acres.	*Pounds.*		*Acres.*	*Bales.*	
1866	520, 107	388, 128, 684	$37, 398, 393	....	2, 097, 254	$204, 561, 896
1867	494, 333	313, 724, 000	29, 572, 660	....	2, 519, 554	199, 583, 510
1868	427, 189	320, 982, 000	29, 822, 873	....	2, 366, 467	226, 794, 168
1869	481, 101	273, 775, 000	25, 520, 065	7, 933, 000	3, 122, 551	261, 067, 037
1870	330, 668	250, 628, 000	24, 010, 018	9, 985, 000	4, 352, 317	292, 703, 086
1871	350, 769	263, 196, 100	23, 292, 645	8, 911, 000	2, 974, 351	242, 672, 804
1872	416, 512	342, 304, 000	31, 647, 817	9, 560, 000	3, 930, 508	280, 552, 629
1873	480, 878	372, 810, 000	28, 421, 703	10, 816, 000	4, 170, 388	289, 853, 486
1874	281, 662	178, 355, 000	21, 066, 515	10, 982, 000	3, 832, 991	228, 113, 080
1875	559, 049	379, 347, 000	26, 453, 881	11, 635, 000	4, 632, 313	233, 109, 945
1876	540, 457	381, 002, 000	25, 923, 894	11, 500, 000	4, 474, 069	211, 655, 041
1877	....	....	....	11, 825, 000	4, 773, 865	235, 721, 194
1878	542, 850	392, 546, 700	22, 093, 240	12, 266, 800	4, 694, 942	193, 467, 706
1879	492, 100	391, 278, 350	22, 727, 524	12, 595, 500	4, 735, 082	242, 140, 987
1880	602, 516	446, 296, 889	36, 414, 615	15, 475, 300	5, 708, 942	280, 266, 242
1881	646, 239	449, 880, 014	43, 372, 336	16, 851, 000	5, 456, 048	294, 135, 547
1882	671, 522	513, 077, 558	43, 189, 950	16, 791, 557	6, 957, 000	309, 696, 500
1883	638, 739	451, 515, 641	40, 455, 362	16, 777, 993	5, 700, 600	250, 594, 750
1884	724, 668	541, 504, 000	44, 160, 151	17, 439, 612	5, 682, 000	253, 993, 385
1885	752, 520	562, 736, 000	43, 265, 598	18, 300, 865	6, 575, 300	269, 989, 812
1886	750, 210	532, 537, 000	39, 468, 218	18, 454, 603	6, 254, 460	309, 381, 938
1887	598, 620	386, 240, 000	40, 977, 259	18, 641, 067	7, 020, 209	337, 972, 453
1888	747, 326	565, 795, 000	43, 666, 665	19, 058, 591	6, 940, 898	354, 454, 340
1889	695, 301	488, 256, 619	32, 396, 740	20, 171, 896	7, 472, 511	402, 951, 814
1890	722, 198	522, 215, 116	43, 100, 532	20, 809, 053	8, 652, 597	369, 568, 858
1891	742, 945	556, 877, 039	47, 492, 584	20, 714, 937	9, 035, 379	326, 513, 298
1892	725, 195	498, 621, 686	46, 728, 959	18, 067, 924	6, 700, 365	262, 252, 286
1893	702, 952	483, 023, 963	39, 155, 442	19, 525, 000	7, 493, 000	274, 479, 637
1894	523, 103	406, 678, 385	27, 760, 739	23, 687, 950	9, 476, 435	287, 120, 818
1895	633, 950	491, 544, 000	35, 574, 220	20, 184, 368	7, 161, 094	260, 338, 096
1896	594, 749	403, 004, 320	24, 258, 070	23, 273, 209	8, 532, 705	291, 811, 564
1897	....	....	....	....	....	....

Acreage, production, value, and disposition of the corn crop of the United States in 1897, by States.

[From Division of Statistics.]

States and Territories.	Crop of 1897.			Stock on hand March 1, 1898.		Retained and consumed in county where grown.	Shipped out of county where grown.
	Acreage.	Production.	Value.				
	Acres.	*Bushels.*		*Bushels.*	*Per ct.*	*Bushels.*	*Bushels.*
Maine	9, 903	366, 411	$172, 213	106, 259	29	359, 083	7, 328
New Hampshire	24, 064	818, 176	368, 179	335, 452	41	809, 994	8, 182
Vermont	45, 237	1, 583, 295	680, 817	569, 986	36	1, 567, 462	15, 833
Massachusetts	39, 486	1, 283, 295	603, 149	282, 325	22	1, 270, 462	12, 833
Rhode Island	8, 494	263, 314	142, 190	78, 994	30	252, 781	10, 533
Connecticut	45, 258	1, 425, 627	698, 557	470, 457	33	1, 368, 602	57, 025
New York	494, 682	15, 335, 142	6, 134, 057	5, 674, 003	37	14, 875, 088	460, 054
New Jersey	271, 283	8, 545, 414	3, 247, 257	3, 589, 074	42	7, 519, 964	1, 025, 450
Pennsylvania	1, 246, 281	44, 866, 116	15, 254, 479	17, 497, 785	39	38, 584, 860	6, 281, 256
Delaware	219, 773	6, 373, 417	1, 912, 025	3, 505, 379	55	3, 059, 240	3, 314, 177
Maryland	616, 774	20, 353, 542	6, 106, 063	9, 362, 629	46	12, 212, 125	8, 141, 417
Virginia	1, 752, 898	31, 552, 164	11, 989, 822	14, 198, 474	45	27, 765, 904	3, 786, 260
North Carolina	2, 409, 505	31, 323, 565	13, 469, 133	15, 035, 311	48	29, 130, 915	2, 192, 650
South Carolina	1, 700, 881	15, 307, 929	7, 500, 885	6, 429, 330	42	14, 236, 374	1, 071, 555
Georgia	2, 924, 824	32, 173, 064	15, 443, 071	13, 512, 687	42	31, 207, 872	965, 192
Florida	476, 372	3, 810, 976	2, 096, 037	1, 486, 281	39	3, 582, 317	228, 659
Alabama	2, 543, 694	30, 524, 328	14, 041, 191	12, 820, 218	42	28, 998, 112	1, 526, 216
Mississippi	2, 092, 824	30, 345, 948	13, 655, 677	14, 566, 055	48	28, 525, 191	1, 820, 757
Louisiana	1, 269, 149	21, 575, 533	9, 708, 990	10, 140, 501	47	20, 281, 001	1, 294, 532
Texas	3, 901, 359	72, 175, 142	29, 591, 808	22, 374, 294	31	68, 566, 385	3, 608, 757
Arkansas	2, 223, 785	35, 580, 560	14, 232, 224	14, 588, 030	41	33, 445, 726	2, 134, 834
Tennessee	3, 032, 028	63, 672, 588	22, 922, 132	28, 015, 939	44	51, 574, 796	12, 097, 792
West Virginia	694, 053	17, 004, 298	6, 801, 719	6, 121, 547	36	15, 813, 997	1, 190, 301
Kentucky	2, 803, 728	64, 485, 744	22, 570, 010	26, 439, 155	41	57, 392, 312	7, 093, 432
Ohio	2, 835, 864	92, 165, 580	23, 041, 395	35, 022, 920	38	74, 654, 120	17, 511, 460
Michigan	990, 511	31, 201, 096	8, 424, 296	9, 984, 351	32	29, 329, 030	1, 872, 066
Indiana	3, 660, 844	109, 825, 320	23, 063, 317	40, 635, 368	37	79, 074, 230	30, 751, 090
Illinois	7, 167, 018	232, 928, 085	48, 914, 898	102, 488, 357	44	135, 098, 289	97, 829, 796
Wisconsin	1, 019, 551	33, 645, 183	8, 411, 296	10, 430, 007	31	29, 607, 761	4, 037, 422
Minnesota	993, 880	25, 840, 880	6, 201, 811	8, 785, 899	34	22, 481, 566	3, 359, 314
Iowa	7, 589, 281	220, 089, 149	37, 415, 155	99, 040, 117	45	165, 066, 862	55, 022, 287

Acreage, production, value, and disposition of the corn crop of the United States in 1897, by States—Continued.

States and Territories.	Crop of 1897.			Stock on hand March 1, 1898.		Retained and consumed in county where grown.	Shipped out of county where grown.
	Acreage.	Production.	Value.				
	Acres	*Bushels.*		*Bushels.*	*Per ct.*	*Bushels.*	*Bushels.*
Missouri	6,612,457	171,923,882	$41,261,732	61,892,598	36	147,854,539	24,069,343
Kansas	9,024,596	162,442,728	35,737,400	58,479,382	36	129,954,182	32,488,546
Nebraska	8,042,283	241,268,490	41,015,643	118,221,560	49	159,237,203	82,031,287
South Dakota	993,987	23,855,688	5,009,694	8,826,605	37	20,277,335	3,578,353
North Dakota	25,060	426,020	136,326	68,163	16	408,979	17,041
Montana	1,065	19,170	12,460	4,026	21	19,170	
Wyoming	2,359	28,308	14,154	3,963	14	27,176	1,132
Colorado	176,525	3,353,975	1,274,510	1,106,842	33	3,152,736	201,238
New Mexico	24,503	661,581	383,717	145,548	22	568,960	92,621
Arizona							
Utah	8,477	186,494	102,572	39,164	21	175,304	11,190
Nevada							
Idaho							
Washington	6,477	116,586	64,122	9,327	8	114,254	2,332
Oregon	13,258	331,450	175,668	46,403	14	318,192	13,258
California	60,720	1,912,680	1,071,101	439,916	23	1,530,144	382,536
Oklahoma							
Total	80,095,051	1,902,967,933	501,072,952	782,870,651	41.1	1,491,350,595	411,617,337

Acreage, production, value, and disposition of the wheat crop of the United States in 1897, by States.

[From Division of Statistics.]

States and Territories.	Crop of 1897.			Stock on hand March 1, 1898.		Retained and consumed in county where grown.	Shipped out of county where grown.
	Acreage.	Production.	Value.				
	Acres.	*Bushels.*		*Bushels.*	*Per ct.*	*Bushels.*	*Bushels.*
Maine	1,494	24,651	$26,130	10,353	42	24,651	
New Hampshire	511	8,176	8,994	1,962	24	8,094	82
Vermont	3,518	59,806	62,198	14,952	25	59,208	598
Massachusetts							
Rhode Island							
Connecticut	150	3,000	3,000	750	25	3,000	
New York	344,608	7,374,611	6,637,150	2,138,637	29	5,530,958	1,843,653
New Jersey	116,464	2,154,584	2,003,763	646,375	30	1,594,392	560,192
Pennsylvania	1,434,498	28,259,611	25,716,246	9,608,268	34	18,368,747	9,890,864
Delaware	57,187	1,229,520	1,155,749	295,085	24	356,561	872,959
Maryland	639,430	12,277,056	11,417,662	2,700,952	22	3,928,658	8,348,398
Virginia	704,322	8,451,864	7,775,715	2,197,485	26	5,240,156	3,211,708
North Carolina	521,210	4,169,680	3,919,499	1,125,814	27	3,961,196	208,484
South Carolina	87,095	757,726	894,117	106,082	14	742,571	15,155
Georgia	173,824	1,633,946	1,682,964	294,110	18	1,568,588	65,358
Florida							
Alabama	30,286	302,860	305,889	27,257	9	281,660	21,200
Mississippi	1,237	12,370	12,246	2,598	21	12,246	124
Louisiana							
Texas	444,826	7,028,251	6,255,143	983,955	14	4,919,776	2,108,475
Arkansas	169,821	1,783,120	1,497,821	481,442	27	1,604,808	178,312
Tennessee	897,540	10,052,448	9,549,826	2,111,014	21	6,634,616	3,417,832
West Virginia	439,062	5,883,431	5,236,254	1,765,029	30	4,942,082	941,349
Kentucky	903,187	12,283,343	10,932,175	2,579,502	21	8,598,340	3,685,003
Ohio	2,251,428	38,049,133	33,483,237	10,653,757	28	19,405,058	18,644,075
Michigan	1,519,240	23,700,144	20,619,125	6,162,037	26	14,694,089	9,006,055
Indiana	2,513,477	32,675,201	29,080,929	6,861,792	21	16,010,848	16,664,353
Illinois	1,465,570	11,578,003	10,304,423	1,736,700	15	8,567,722	3,010,281
Wisconsin	615,262	7,690,775	6,460,251	2,307,232	30	6,152,620	1,538,155
Minnesota	4,607,008	59,891,104	46,116,150	14,972,776	25	25,154,264	34,736,840
Iowa	1,011,778	13,153,114	9,864,836	3,551,341	27	9,864,836	3,288,278
Missouri	1,567,162	14,104,458	11,988,789	2,679,847	19	10,860,433	3,244,025
Kansas	3,096,655	47,998,152	35,518,632	8,639,667	18	16,799,353	31,198,799
Nebraska	1,893,286	27,452,647	18,942,326	6,863,162	25	10,981,059	16,471,588
South Dakota	2,680,156	21,441,248	14,794,461	4,288,250	20	6,432,374	15,008,874
North Dakota	2,752,772	28,353,552	20,981,628	3,969,497	14	5,103,639	23,449,913
Montana	69,792	2,268,240	1,542,403	476,330	21	2,041,416	226,824
Wyoming	19,083	477,075	333,952	114,498	24	400,743	76,332
Colorado	213,231	5,117,544	3,582,281	1,228,211	24	2,302,895	2,814,649
New Mexico	178,452	4,282,848	3,212,136	899,398	21	3,511,935	770,913

Acreage, production, value, and disposition of the wheat crop of the United States in 1897, by States—Continued.

States and Territories.	Crop of 1897. Acreage.	Crop of 1897. Production.	Crop of 1897. Value.	Stock on hand March 1, 1898.	Stock on hand March 1, 1898.	Retained and consumed in county where grown.	Shipped out of county where grown.
	Acres	*Bushels.*		*Bushels.*	*Per ct.*	*Bushels.*	*Bushels.*
Arizona	20,599	370,782	$274,379	66,741	18	333,704	37,078
Utah	151,940	3,190,740	2,169,703	1,084,852	34	2,233,518	957,222
Nevada	34,298	833,441	750,097	200,026	24	541,737	291,704
Idaho	123,076	2,707,672	1,895,370	758,148	28	1,353,836	1,353,836
Washington	856,368	20,124,648	13,684,761	6,238,641	31	6,641,134	13,483,514
Oregon	1,067,943	18,155,031	13,071,622	4,901,858	27	8,169,764	9,985,267
California	3,239,402	32,394,020	26,887,037	4,535,163	14	11,337,907	21,056,113
Oklahoma	546,818	10,389,542	7,896,052	1,038,954	10	3,948,026	6,441,516
Total	39,465,066	530,149,168	428,547,121	121,320,500	22.9	261,223,218	269,125,950

Acreage, production, value, and disposition of the oat crop of the United States in 1897, by States.

[From Division of Statistics.]

States and Territories.	Crop of 1897. Acreage.	Crop of 1897. Production.	Crop of 1897. Value.	Stock on hand March 1, 1898.	Stock on hand March 1, 1898.	Retained and consumed in county where grown.	Shipped out of county where grown.
	Acres.	*Bushels.*		*Bushels.*	*Per ct.*	*Bushels.*	*Bushels.*
Maine	133,540	4,139,740	$1,324,717	1,862,883	45	3,932,753	206,987
New Hampshire	30,236	1,058,260	402,139	349,226	33	1,047,677	10,583
Vermont	105,971	3,497,043	1,119,054	1,503,728	43	3,392,132	104,911
Massachusetts	15,274	488,768	161,293	156,406	32	488,768	----------
Rhode Island	3,690	118,080	40,147	66,125	56	114,538	3,542
Connecticut	20,999	608,971	207,050	188,781	31	596,792	12,179
New York	1,482,356	45,953,036	12,407,320	22,057,457	48	40,898,202	5,054,834
New Jersey	102,226	2,555,650	766,695	638,912	25	2,351,198	204,452
Pennsylvania	1,129,168	31,842,538	8,597,485	12,737,015	40	26,110,881	5,731,657
Delaware	18,710	411,620	94,673	115,254	28	214,042	197,578
Maryland	80,758	1,938,192	503,930	658,985	34	1,317,971	620,221
Virginia	436,091	5,233,092	1,517,597	1,726,920	33	4,605,121	627,971
North Carolina	447,737	5,820,581	2,153,615	1,338,734	23	5,587,758	232,823
South Carolina	247,129	3,830,500	1,723,725	344,745	9	3,677,280	153,220
Georgia	394,110	5,517,540	2,317,367	662,105	12	5,407,189	110,351
Florida	43,979	395,811	209,780	47,497	12	379,979	15,832
Alabama	302,295	3,929,835	1,689,829	432,282	11	3,851,238	78,597
Mississippi	119,330	1,670,620	735,073	267,299	16	1,653,914	16,706
Louisiana	35,963	665,334	252,827	139,720	21	658,681	6,653
Texas	652,446	16,311,150	4,404,010	3,588,453	22	12,233,362	4,077,788
Arkansas	310,872	5,284,824	1,743,992	1,743,992	33	5,073,431	211,393
Tennessee	384,289	3,842,890	1,076,009	960,722	25	3,304,885	538,005
West Virginia	157,121	3,142,420	942,726	1,131,271	36	2,953,875	188,545
Kentucky	435,662	7,841,916	2,117,317	2,352,575	30	7,214,563	627,353
Ohio	934,606	29,907,392	5,981,478	11,364,809	38	22,729,618	7,177,774
Michigan	882,325	22,940,450	5,276,304	8,258,562	36	17,664,146	5,276,304
Indiana	1,116,112	33,706,582	6,404,251	10,449,040	31	19,886,883	13,819,699
Illinois	2,899,953	92,798,496	16,703,729	36,191,413	39	45,471,263	47,327,233
Wisconsin	1,827,215	62,125,310	11,803,809	27,335,136	44	42,245,211	19,880,099
Minnesota	1,582,577	41,147,002	7,817,930	16,870,271	41	30,448,781	10,698,221
Iowa	3,457,370	103,721,100	16,595,376	42,525,651	41	61,195,449	42,525,651
Missouri	1,003,553	22,078,166	4,194,852	7,506,576	34	19,208,004	2,870,162
Kansas	1,611,670	38,680,080	6,962,414	14,698,430	38	31,330,865	7,349,215
Nebraska	1,668,745	51,731,095	7,759,664	23,278,993	45	32,073,279	19,657,816
South Dakota	629,348	13,647,656	2,456,578	6,004,969	44	11,191,078	2,456,578
North Dakota	495,528	11,397,144	2,963,257	4,786,800	42	10,941,258	455,886
Montana	61,664	2,589,888	854,663	1,165,450	45	2,356,798	233,090
Wyoming	13,693	479,255	167,739	148,569	31	464,877	14,378
Colorado	87,310	2,968,540	949,933	1,068,674	36	2,107,663	860,877
New Mexico	7,290	258,795	106,106	38,819	15	212,212	46,583
Arizona	----------	----------	----------	----------	----------	----------	----------
Utah	23,953	838,355	276,657	352,109	42	653,917	184,438
Nevada	----------	----------	----------	----------	----------	----------	----------
Idaho	28,834	1,046,674	334,936	512,870	49	586,137	460,537
Washington	79,636	3,822,528	1,337,885	1,529,011	40	2,446,418	1,376,110
Oregon	179,868	5,755,776	2,014,522	2,417,426	42	3,568,581	2,187,195
California	57,173	1,029,114	504,266	154,367	15	771,836	257,279
Oklahoma	----------	----------	----------	----------	----------	----------	----------
Total	25,730,375	698,767,809	147,974,719	271,729,032	38.9	494,620,504	204,147,306

Cotton crop of 1896–97.

[From Division of Statistics.]

States and Territories.	Movement and mill purchases. (a)			Taken from ports and other States. (a)			Total crop. (a)
	Movement by rail and water.	Bought by mills.	Total.	Taken from other States.	Taken from ports.	Total.	
Alabama	777,199	68,658	845,857	12,068		12,068	833,789
Arkansas	614,733	1,459	616,192	10,549		10,549	605,643
Florida	48,780		48,780	50		50	48,730
Georgia	1,241,598	227,831	1,469,429	166,827	3,262	170,089	1,299,340
Indian Territory	87,705		87,705				87,705
Kansas	61		61				61
Kentucky	414	24,214	24,628	24,214		24,214	414
Louisiana	623,392	14,922	638,314	56,141	14,922	71,063	567,251
Mississippi	1,224,265	16,863	1,241,128	40,128		40,128	1,201,000
Missouri	24,119	2,435	26,554	2,435		2,435	24,119
North Carolina	322,046	245,177	567,223	43,350	2,078	45,428	521,795
Oklahoma	35,251		35,251				35,251
South Carolina	675,215	297,782	972,997	24,637	11,897	36,534	936,463
Tennessee	228,325	30,746	259,071	22,290		22,290	236,781
Texas	2,164,462	12,499	2,176,961	47,759	6,501	54,260	2,122,701
Utah	123		123				123
Virginia	11,539	39,405	50,944	39,405		39,405	11,539
Total	8,079,227	981,991	9,061,218	489,853	38,660	528,513	8,532,705

a In commercial bales.

The world's cotton production, by countries.

[From Division of Statistics.]

Country.	1834. (*a*)	1892. (*a*)	Country.	1834. (*a*)	1892. (*a*)
Fiji Islands		550	Africa	85,000	125,000
Italy		570	Brazil	75,000	281,000
Tahiti		1,150	Asiatic Russia		375,000
Malta		4,600	Korea		500,000
Java		6,500	Egypt	63,700	1,398,000
Greece		9,700	China		1,500,000
Persia		41,000	India	462,500	2,902,000
Peru and West Indies	20,000	58,000	United States	1,150,000	10,688,000
Mexico	87,500	80,000	Elsewhere	32,500	
Japan		91,500			
Turkey	275,000	117,000	Total world's crop	2,251,200	18,179,570

a In 100-pound bales.

The above table is intended as an approximate estimate of the world's cotton crop at the present time, as compared with 1834, a considerable proportion of which is home consumption; hence the greater magnitude of the crop here shown as compared with that in the first table. The figures for the latter year were compiled by Levi Woodbury, Secretary of the Treasury (Doc. No. 146, 1836). The figures under the column for 1892 were compiled from the latest reports of United States consuls for that and subsequent years and from other reliable authorities.

The world's cotton crop—1865 to 1895.

[From Division of Statistics. Thousands of bales, except imports into the United States.]

Commercial year.	United States.			Imports into Europe from all other countries (in bales of 400 pounds).						Total crop of the world.	Proportion.	
	Total crops United States. (*a*)	Imports into United States (bales of 400 lbs.).	Price middling upland, New York.	Brazil.	Egypt.	Turkey, etc.	Peru, West Indies, etc.	East Indies and China.	Total.		United States.	Other countries.
			Cents.								*Pr. ct.*	*Pr. ct.*
1865	*b* 300	90,083	83.38	150	549	239	84	1,316	2,338	2,695	13.25	86.75
1866	2,269	15,706	43.20	222	279	161	77	1,721	2,460	5,011	50.91	49.09
1867	2,097	2,315	31.59	220	305	129	103	1,390	2,147	4,593	53.25	46.75
1868	2,519	1,287	24.85	309	355	145	85	1,476	2,370	5,137	53.86	46.14
1869	2,366	3,805	29.01	281	353	207	92	1,578	2,511	5,171	51.52	48.48

a In commercial bales. *b* Estimated.

The world's cotton crop—1865 to 1895—Continued.

Commercial year.	United States.			Imports into Europe from all other countries (in bales of 400 pounds).						Total crop of the world.	Proportion.	
	Total crops United States. (*a*)	Imports into United States (bales of 400 lbs.).	Price middling upland, New York.	Brazil.	Egypt.	Turkey, etc.	Peru, West Indies, etc.	East Indies and China.	Total.		United States.	Other countries.
			Cents.								*Pr. ct.*	*Pr. ct.*
1870	3,122	4,245	23.98	217	379	136	79	1,057	1,868	5,291	64.69	35.31
1871	4,352	2,992	16.95	281	396	119	130	1,384	2,310	7,075	67.35	32.65
1872	2,974	7,235	20.48	377	489	138	121	1,526	2,651	5,915	55.18	44.82
1873	3,930	11,064	18.15	243	484	143	105	1,155	2,130	6,452	66.99	33.01
1874	4,170	9,065	17.00	252	532	93	98	1,317	2,292	6,869	66.63	33.37
1875	3,832	5,373	15.00	216	552	88	69	1,420	2,345	6,551	64.20	35.80
1876	4,632	6,129	13.00	169	749	89	55	1,134	2,196	7,344	70.00	30.00
1877	4,474	6,641	11.73	149	625	89	37	930	1,830	6,741	72.85	27.15
1878	4,773	7,580	11.28	68	458	51	73	813	1,463	6,849	79.37	20.63
1879	5,074	7,484	10.83	47	616	31	42	868	1,604	7,248	77.87	22.13
1880	5,761	8,869	12.02	78	583	24	33	1,074	1,792	8,312	78.44	21.56
1881	6,605	11,125	11.34	135	727	26	33	1,098	2,019	9,589	78.85	21.15
1882	5,456	10,850	12.16	166	597	38	32	1,677	2,510	8,570	70.71	29.29
1883	6,949	10,204	10.63	154	620	24	30	1,520	2,348	10,406	77.44	22.56
1884	5,713	17,549	10.64	130	703	62	30	1,553	2,478	8,963	72.35	27.65
1885	5,706	12,789	10.54	99	808	65	29	943	1,944	8,350	76.72	23.28
1886	6,575	12,681	9.44	96	709	46	30	1,306	2,187	9,686	77.42	22.58
1887	6,505	9,811	10.25	208	734	41	28	1,575	2,586	10,037	74.15	25.85
1888	7,046	13,744	10.27	151	638	27	34	1,141	1,991	9,991	80.07	19.93
1889	6,938	19,933	10.71	91	760	28	35	1,600	2,514	10,499	75.79	24.21
1890	7,311	21,515	11.53	118	788	30	43	1,887	2,866	11,386	74.83	25.17
1891	8,652	52,272	9.03	123	971	28	47	1,264	2,433	12,604	80.69	19.31
1892	9,035	71,659	7.64	86	1,206	63	49	1,122	2,526	13,214	80.88	19.12
1893	6,700	108,420	8.24	206	1,120	69	58	1,092	2,545	10,521	75.81	24.19
1894	7,549	69,265	7.67	153	1,398	48	25	1,162	2,786	11,668	76.13	23.87
1895	9,476	123,330	6.26	*b* 162	1,104	......	......	774	2,040	13,157	84.50	15.50

a In commercial bales. *b* Includes countries other than Brazil.

This table does not give the actual cotton production of the world, but only so far as shown by the United States crops and the imports into Europe from all other cotton-producing countries. There is comparatively little home consumption of raw cotton in Peru, the West Indies, Turkey, and Egypt. On the contrary, East India in recent years has consumed large quantities of her own growth. The crops of China and Japan are unknown, but the former is estimated at 1,500,000 bales and the latter (including Java) at about 100,000 bales of 400 pounds, all of which is consumed at home. A small amount of cotton was exported from China to Europe during the cotton famine, from 1861 to 1866, which is included in the above table. To arrive at the world's crop, in uniform bales of 400 pounds, the United States crops were reduced from commercial bales to bales of 400 pounds and added to total imports into Europe.

The world's consumption of cotton.

[In thousands of bales of 400 pounds each.]

Year.	Great Britain.	Continent of Europe.	United States.	East Indies.	Total.
1880-81	3,572	2,956	2,118	371	9,017
1881-82	3,640	3,198	2,197	389	9,424
1882-83	3,744	3,380	2,375	447	9,946
1883-84	3,666	3,380	2,244	520	9,810
1884-85	3,433	3,255	1,909	584	9,181
1885-86	3,628	3,465	2,278	630	10,001
1886-87	3,694	3,640	2,423	711	10,468
1887-88	3,841	3,796	2,530	771	10,938
1888-89	3,770	4,069	2,685	870	11,394
1889-90	4,016	4,280	2,731	988	12,015
1890-91	4,233	4,538	2,958	1,155	12,884
1891-92	3,977	4,524	3,220	1,142	12,863
1892-93	3,583	4,576	3,189	1,147	12,495
1893-94	4,040	4,784	2,830	1,199	12,853
1894-95	4,080	5,096	3,219	1,342	13,737

This table (compiled by Messrs. Ellison & Co., Liverpool) includes the cotton actually consumed by all the leading countries of the world engaged in its manufacture with modern machinery, except Brazil, Canada, China, Japan, and Mexico.

Wheat crop of the world, 1893 to 1897.

[From Division of Statistics.]

Countries.	1893.	1894.	1895.	1896.	1897.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
United States	396,132,000	460,267,000	467,103,000	427,684,000	530,149,000
Ontario	22,416,000	20,507,000	18,183,000	19,184,000	29,760,000
Manitoba	16,108,000	17,714,000	32,777,000	14,825,000	18,837,000
Rest of Canada	4,126,000	6,362,000	6,500,000	6,800,000	8,000,000
Total Canada	42,650,000	44,583,000	57,460,000	40,809,000	56,597,000
Mexico	6,731,000	8,570,000	10,035,000	10,000,000	12,000,000
Total North America	445,513,000	513,420,000	534,598,000	478,493,000	598,746,000
Chile	19,000,000	16,000,000	15,000,000	12,000,000	10,500,000
Argentina	57,000,000	80,000,000	60,000,000	48,000,000	32,000,000
Uruguay	5,703,000	8,915,000	10,000,000	6,000,000	3,600,000
Total South America	81,703,000	104,915,000	85,000,000	66,000,000	46,100,000
Great Britain	50,800,000	61,038,000	38,348,000	58,851,000	53,327,000
Ireland	1,666,000	1,532,000	1,109,000	1,191,000	1,200,000
Total United Kingdom	52,466,000	62,570,000	39,457,000	60,042,000	54,527,000
Norway	275,000	275,000	260,000	300,000	300,000
Sweden	3,893,000	4,362,000	3,705,000	4,704,000	4,572,000
Denmark	4,661,000	4,162,000	3,467,000	3,689,000	3,700,000
Netherlands	4,971,000	4,166,000	4,282,000	5,400,000	4,400,000
Belgium	17,305,000	17,618,000	18,730,000	19,200,000	19,000,000
France	279,754,000	344,184,000	339,599,000	340,271,000	251,298,000
Spain	95,266,000	105,600,000	81,218,000	69,772,000	86,647,000
Portugal	5,500,000	9,000,000	7,000,000	5,600,000	9,000,000
Italy	135,228,000	121,595,000	118,162,000	145,233,000	86,919,000
Switzerland	3,300,000	4,500,000	5,000,000	4,800,000	4,300,000
Germany	110,040,000	110,681,000	103,160,000	110,539,000	107,800,000
Austria	43,660,000	48,190,000	41,767,000	39,160,000	35,187,000
Hungary	158,425,000	141,855,000	158,012,000	149,954,000	89,912,000
Croatia-Slavonia	8,223,000	8,786,000	8,661,000	9,614,000	6,271,000
Bosnia-Herzegovina	2,000,000	2,000,000	2,000,000	2,050,000	2,000,000
Total Austria-Hungary	212,308,000	200,831,000	210,440,000	200,778,000	133,370,000
Roumania	60,745,000	43,587,000	68,502,000	71,194,000	36,448,000
Bulgaria	35,987,000	30,600,000	37,000,000	48,275,000	30,739,000
Servia	8,726,000	7,500,000	9,400,000	9,300,000	6,000,000
Montenegro	250,000	250,000	220,000	220,000	200,000
Turkey in Europe	20,000,000	20,000,000	21,500,000	24,000,000	17,800,000
Greece	6,500,000	5,500,000	4,000,000	4,800,000	3,000,000
Russia proper	371,851,000	339,667,000	292,272,000	300,423,000	238,557,000
Poland	21,603,000	16,749,000	17,387,000	19,476,000	17,808,000
North Caucasus	68,307,000	61,678,000	67,127,000	45,148,000	29,883,000
Finland	127,000	148,000	100,000	98,000	90,000
Total Russia in Europe	461,888,000	418,242,000	376,886,000	365,145,000	286,338,000
Total Europe	1,519,063,000	1,515,223,000	1,451,988,000	1,493,262,000	1,146,358,000
Siberia	22,130,000	35,421,000	30,899,000	34,160,000	42,835,000
Central Asia	7,000,000	6,000,000	7,462,000	12,830,000	11,087,000
Trans-Caucasia	47,000,000	47,000,000	47,000,000	42,000,000	40,000,000
Total Russia in Asia	76,130,000	88,421,000	85,361,000	88,990,000	93,922,000
Turkey in Asia	48,000,000	45,000,000	46,000,000	44,000,000	48,000,000
Cyprus	2,000,000	2,000,000	2,200,000	2,400,000	2,400,000
Persia	20,000,000	22,000,000	22,000,000	20,000,000	20,000,000
British India	268,539,000	252,784,000	234,379,000	181,997,000	176,668,000
Japan	16,847,000	20,308,000	20,341,000	18,000,000	18,000,000
Total Asia	431,516,000	430,513,000	410,281,000	355,387,000	358,990,000
Algeria	20,907,000	28,900,000	24,400,000	17,600,000	16,000,000
Tunis	4,000,000	10,700,000	7,500,000	5,600,000	6,000,000
Egypt	10,000,000	12,000,000	14,000,000	12,000,000	12,000,000
Cape Colony	4,014,000	3,195,000	2,542,000	2,257,000	2,200,000
Total Africa	38,921,000	54,795,000	48,442,000	37,457,000	36,200,000

Wheat crop of the world, 1893 to 1897—Continued.

Countries.	1893.	1894.	1895.	1896.	1897.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
West Australia	443,000	537,000	176,000	194,000	252,000
South Australia	9,531,000	14,047,000	8,027,000	6,116,000	2,893,000
Queensland	477,000	426,000	562,000	128,000	620,000
New South Wales	7,032,000	6,708,000	7,263,000	5,359,000	9,132,000
Victoria	15,282,000	15,736,000	11,807,000	5,848,000	7,299,000
Tasmania	1,051,000	860,000	899,000	1,202,000	1,327,000
New Zealand	8,642,000	5,046,000	3,727,000	7,059,000	6,113,000
Total Australasia	42,458,000	43,360,000	32,461,000	25,906,000	27,636,000

RECAPITULATION BY CONTINENTS.

North America	445,513,000	513,420,000	534,598,000	478,493,000	598,746,000
South America	81,703,000	104,915,000	85,000,000	66,000,000	46,100,000
Europe	1,519,063,000	1,515,223,000	1,451,988,000	1,493,262,000	1,146,358,000
Asia	431,516,000	430,513,000	410,281,000	355,387,000	358,990,000
Africa	38,921,000	54,795,000	48,442,000	37,457,000	36,200,000
Australasia	42,458,000	43,360,000	32,461,000	25,906,000	27,636,000
Grand total	2,559,174,000	2,662,226,000	2,562,770,000	2,456,505,000	2,214,030,000

The best estimates which can be obtained for the principal wheat growing countries of the Southern Hemisphere for the year 1897–98 are given below:

Argentina	50,000,000
Chile	15,000,000
Uruguay	8,500,000
Australasia (including New Zealand)	30,500,000
India	198,000,000

Average yield per acre of the principal farm crops, 1893 to 1897.

[From Division of Statistics.]

States and Territories.	Corn.					Wheat.				
	1893.	1894.	1895.	1896.	1897.	1893.	1894.	1895.	1896.	1897.
	Bush.	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*
Maine	30.3	39.9	42.0	37.0	37.0	16.0	21.1	19.2	22.0	16.5
New Hampshire	31.7	34.3	40.2	42.0	34.0	15.0	20.0	19.3	21.0	16.0
Vermont	32.4	40.8	45.6	41.0	35.0	16.8	22.7	29.0	24.5	17.0
Massachusetts	33.5	34.5	43.9	43.0	32.5	------	------	------	------	------
Rhode Island	24.4	31.4	30.9	34.0	31.0	------	------	------	------	------
Connecticut	28.2	31.0	37.9	38.0	31.5	------	------	------	------	20.0
New York	29.5	28.2	35.6	34.0	31.0	14.5	14.8	18.1	16.0	21.4
New Jersey	25.9	33.1	33.0	33.0	31.5	14.5	15.3	12.4	15.3	18.5
Pennsylvania	24.5	32.0	33.5	40.0	36.0	14.0	15.0	16.6	14.0	19.7
Delaware	24.6	22.0	21.0	22.0	29.0	14.7	13.0	11.6	18.0	21.5
Maryland	24.2	22.9	26.8	32.0	33.0	13.5	15.3	17.0	17.0	19.2
Virginia	18.9	19.1	18.6	21.5	18.0	11.2	9.5	9.3	9.3	12.0
North Carolina	12.3	13.4	14.5	12.0	13.0	8.2	5.0	6.9	7,3	8.0
South Carolina	7.7	11.2	11.1	9.0	9.0	6.3	5.6	6.4	6.8	8.7
Georgia	11.1	11.7	13.0	11.0	11.0	7.2	6.9	6.2	8.0	9.4
Florida	9.7	10.1	11.2	10.0	8.0	------	------	------	------	------
Alabama	11.5	13.7	15.9	12.5	12.0	8.2	8.3	7.5	8.0	10.0
Mississippi	13.1	17.2	15.8	13.5	14.5	7.5	9.8	8.0	8.5	10.0
Louisiana	14.2	16.2	18.8	13.0	17.0	------	------	------	------	------
Texas	17.6	19.0	26.4	9.5	18.5	10.5	15.1	5.7	11.7	15.8
Arkansas	16.2	19.2	21.5	13.5	16.0	8.0	8.8	9.4	8.0	10.5
Tennessee	21.3	21.9	25.0	23.0	21.0	9.2	8.1	8.8	8.5	11.2
West Virginia	21.7	18.5	24.2	30.0	24.5	11.5	12.1	10.6	10.3	13.4
Kentucky	23.5	23.0	31.2	28.0	23.0	11.3	12.5	10.9	8.7	13.6
Ohio	23.8	26.3	32.6	41.0	32.5	14.5	19.0	13.3	9.0	16.9
Michigan	23.7	23.2	33.8	38.0	31.5	13.2	15.8	13.2	12.8	15.6
Indiana	24.7	28.9	32.8	35.0	30.0	14.1	18.4	9.2	9.0	13.0
Illinois	25.7	28.8	37.4	40.5	32.5	11.5	18.2	11.0	14.7	7.9
Wisconsin	29.8	20.7	31.8	37.0	33.0	13.3	16.5	15.5	13.3	12.5
Minnesota	28.3	18.4	31.2	30.5	26.0	9.6	13.5	23.0	14.2	13.0
Iowa	33.9	15.0	35.1	39.0	29.0	11.5	14.8	19.5	16.0	13.0
Missouri	27.9	22.0	36.0	27.0	26.0	9.5	15.3	12.0	11.7	9.0
Kansas	21.3	11.2	24.3	28.0	18.0	8.4	10.4	7.7	10.6	15.5

Average yield per acre of the principal farm crops, 1893 to 1897—Continued.

States and Territories.	Corn.					Wheat.				
	1893.	1894.	1895.	1896.	1897.	1893.	1894.	1895.	1896.	1897.
	Bush.	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*
Nebraska	25.2	6.0	16.1	27.5	30.0	8.7	7.0	12.0	14.0	14.5
South Dakota	23.7	4.2	11.1	26.0	24.0	8.5	6.6	12.0	11.2	8.0
North Dakota	20.7	19.2	21.3	35.0	17.0	9.6	11.8	21.0	11.8	10.3
Montana	27.5	22.7	25.0	28.0	18.0	21.5	24.8	23.9	23.5	32.5
Wyoming	18.5	30.0	27.5	25.0	12.0	18.7	19.6	26.0	24.5	25.0
Colorado	16.5	19.7	20.7	16.0	19.0	13.2	17.9	23.5	17.5	24.0
New Mexico	25.3	19.1	27.2	16.0	27.0	16.8	18.0	20.4	21.0	24.0
Arizona	17.8	18.6	26.0	......	......	17.5	17.0	20.5	23.0	18.0
Utah	21.5	24.4	20.3	25.0	22.0	13.8	22.0	22.4	23.5	21.0
Nevada	......	......	......	......	......	14.7	20.0	21.7	30.0	24.3
Idaho	19.5	28.6	30.7	......	......	19.3	20.6	17.8	24.5	22.0
Washington	21.3	20.8	17.1	14.0	18.0	20.3	16.6	15.5	18.0	23.5
Oregon	24.7	25.4	26.4	22.0	25.0	17.5	17.7	20.0	17.0	17.0
California	31.7	19.3	34.5	37.0	31.5	13.3	11.3	13.0	14.6	10.0
Oklahoma	......	......	......	......	......	......	11.3	11.4	13.0	19.0
Indian Territory	......	......	......	......	......	......	......	......	......	......
General average	22.5	19.4	26.2	28.2	23.8	11.4	13.2	13.7	12.4	13.4

States and Territories.	Oats.					Barley.				
	1893.	1894.	1895.	1896.	1897.	1893.	1894.	1895.	1896.	1897.
	Bush.	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*
Maine	36.3	33.5	40.1	40.0	31.0	26.1	26.1	32.4	30.6	25.0
New Hampshire	34.2	31.1	36.9	38.0	35.0	25.3	24.4	25.6	29.3	22.5
Vermont	36.4	32.9	43.8	40.5	33.0	27.5	27.9	33.2	33.0	28.5
Massachusetts	34.3	31.9	36.0	36.0	32.0	25.3	21.7	22.5	30.0	34.5
Rhode Island	28.2	30.0	32.4	30.0	32.0	25.2	36.0	23.5	29.0	28.0
Connecticut	25.0	25.8	31.9	29.0	20.0	......	......	......	......	......
New York	24.0	22.1	31.7	33.0	31.0	20.3	17.5	22.9	23.2	25.0
New Jersey	23.9	28.4	35.5	34.0	25.0	......	......	......	......	......
Pennsylvania	26.8	22.3	31.7	31.0	28.2	19.0	16.6	20.2	17.2	24.5
Delaware	25.4	19.0	19.1	29.0	22.0	......	......	......	......	......
Maryland	21.2	21.4	26.2	24.0	24.0	......	......	......	......	......
Virginia	17.5	12.0	17.7	18.5	12.0	......	......	......	......	......
North Carolina	14.1	10.9	15.1	12.0	13.0	......	......	......	......	......
South Carolina	11.8	12.0	15.2	11.0	15.5	......	......	......	......	......
Georgia	13.3	13.4	14.5	12.0	14.0	......	......	......	......	......
Florida	11.8	11.8	10.2	12.0	9.0	......	......	......	......	......
Alabama	14.2	13.2	14.9	14.0	13.0	......	......	......	......	......
Mississippi	15.5	13.0	15.7	13.0	14.0	......	......	......	......	......
Louisiana	16.0	22.3	15.0	10.0	18.0	......	......	......	......	......
Texas	25.1	32.7	20.7	20.0	25.0	14.5	15.3	21.6	12.0	25.0
Arkansas	19.3	18.5	25.4	16.0	17.0	......	......	......	......	......
Tennessee	18.4	14.6	22.5	16.5	10.0	15.1	13.8	23.1	14.0	18.0
West Virginia	23.5	18.5	23.4	24.0	20.0	......	......	......	......	......
Kentucky	22.2	21.0	26.2	21.0	18.0	17.0	28.7	33.3	14.8	20.0
Ohio	28.6	30.3	31.7	31.0	32.0	22.7	28.5	28.2	20.2	28.5
Michigan	26.0	26.1	23.9	30.0	26.0	16.4	20.6	18.1	22.3	21.5
Indiana	27.5	32.3	22.9	29.0	30.2	19.9	20.7	15.0	20.3	19.0
Illinois	27.2	26.1	24.4	28.0	32.0	23.2	23.5	20.0	23.7	25.0
Wisconsin	27.6	32.9	33.8	33.4	34.0	24.0	28.6	29.3	27.4	28.0
Minnesota	24.8	28.1	39.9	33.0	26.0	22.1	23.5	36.0	27.2	25.5
Iowa	24.8	25.6	46.2	27.5	30.0	22.6	15.5	28.0	26.3	24.0
Missouri	22.4	23.3	27.7	18.0	22.0	20.0	14.0	15.3	17.5	19.0
Kansas	18.5	17.9	17.9	13.0	24.0	8.1	8.8	14.4	4.6	17.5
Nebraska	15.0	12.6	23.8	19.0	31.0	12.0	5.7	28.4	19.9	22.0
South Dakota	21.5	7.6	25.3	27.5	22.0	15.4	14.7	19.5	28.5	20.0
North Dakota	21.9	25.9	32.1	22.0	23.0	15.2	20.1	30.4	16.1	22.5
Montana	34.0	40.1	35.8	47.0	42.0	30.1	22.5	25.0	25.0	38.0
Wyoming	24.0	30.4	41.0	32.0	35.0	......	......	......	......	......
Colorado	26.7	13.5	24.3	28.0	34.0	28.3	27.8	31.3	20.0	28.0
New Mexico	29.2	35.0	30.9	27.0	35.5	21.6	27.0	28.0	19.0	32.5
Arizona	......	......	......	......	......	27.0	25.0	25.7	......	......
Utah	27.9	33.0	33.3	38.0	35.0	37.6	33.0	30.0	27.1	31.0
Nevada	......	......	......	......	......	35.7	32.5	32.1	......	......
Idaho	33.1	38.5	35.2	42.0	36.3	30.0	32.6	24.5	15.3	35.0
Washington	39.7	36.5	40.3	36.0	48.0	40.1	33.7	37.3	26.0	45.0
Oregon	28.5	26.7	28.8	21.0	32.0	26.1	38.6	22.1	21.8	32.5
California	25.5	35.6	28.1	31.0	18.0	22.5	15.2	20.3	21.6	23.0
Oklahoma	......	......	......	......	......	......	......	......	......	......
Indian Territory	......	......	......	......	......	......	......	......	......	......
General average	23.4	24.5	29.6	25.7	27.2	21.7	19.4	26.4	23.6	24.5

Average yield per acre of the principal farm crops, 1893 to 1897—Continued.

States and Territories.	Hay.					Cotton.				
	1893.	1894.	1895.	1896.	1897.	1893.	1894.	1895.	1896.	1897.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*
Maine	0.92	0.95	1.02	1.00	1.10					
New Hampshire	1.06	.95	.95	.96	1.15					
Vermont	1.11	1.20	1.07	1.25	1.30					
Massachusetts	1.15	1.26	1.11	1.28	1.40					
Rhode Island	.83	.75	.91	1.10	1.15					
Connecticut	.99	.87	.85	1.07	1.20					
New York	1.24	1.17	.73	.81	1.35					
New Jersey	.99	1.16	1.21	1.15	1.75					
Pennsylvania	1.03	1.18	1.01	1.06	1.40					
Delaware	.75	1.30	1.23	1.10	1.35					
Maryland	1.04	1.03	1.25	.87	1.35					
Virginia	1.11	.72	1.13	1.08	1.08		0.21	0.18	0.24	0.24
North Carolina	1.70	1.45	1.63	1.26	1.25	0.34	.35	.38	.42	.42
South Carolina	1.57	1.53	1.00	1.33	1.00	.34	.38	.42	.46	.46
Georgia	1.32	1.16	1.60	1.38	1.35	.33	.33	.35	.37	.37
Florida	2.00	1.23	1.53	1.40	1.00	.33	.24	.20	.18	.18
Alabama	1.52	2.68	1.56	1.40	1.45	.35	.32	.28	.31	.31
Mississippi	1.65	1.84	1.95	1.35	1.48	.37	.41	.41	.42	.42
Louisiana	1.62	1.96	2.02	1.90	1.90	.50	.55	.45	.46	.46
Texas	1.04	1.33	1.48	1.00	1.40	.48	.45	.33	.31	.31
Arkansas	1.17	1.32	1.20	1.18	1.30	.36	.48	.44	.39	.39
Tennessee	1.39	1.18	1.39	1.40	1.45	.34	.33	.24	.26	.26
West Virginia	1.10	1.02	.71	1.22	1.35					
Kentucky	1.33	1.26	1.35	1.20	1.17					.34
Ohio	1.33	1.27	.58	1.26	1.44					
Michigan	1.46	1.20	.58	1.16	1.49					
Indiana	1.36	1.27	.61	1.30	1.43					
Illinois	1.21	1.14	.66	1.38	1.29					
Wisconsin	1.52	1.31	.88	1.25	1.35					
Minnesota	1.62	1.02	1.30	1.69	1.57					
Iowa	1.58	.73	1.08	1.74	1.50					
Missouri	1.24	.85	1.17	1.43	1.15					.31
Kansas	1.31	.77	1.24	1.42	1.30					.41
Nebraska	1.25	.59	.99	1.66	1.60					
South Dakota	1.42	.94	.79	1.28	1.25					
North Dakota	1.29	1.19	1.42	1.65	1.60					
Montana	1.26	1.20	.94	1.38	1.50					
Wyoming	1.35	1.60	1.08	1.55	1.65					
Colorado	1.19	2.27	2.42	2.20	2.25					
New Mexico	2.08	1.88	2.61	3.00	3.50					
Arizona	1.75	1.82	1.85	3.20	3.00					
Utah	1.72	2.52	2.56	2.70	2.95					.79
Nevada	2.66	4.04	3.01	2.55	2.50					
Idaho	2.45	2.53	2.57	2.60	2.30					
Washington	1.58	2.05	1.85	1.95	2.25					
Oregon	1.88	2.00	1.78	1.98	1.90					
California	1.69	1.93	1.66	1.65	1.60					
Oklahoma							.45	.54	.45	.45
Indian Territory							.45	.32	.62	.62
General average	1.33	1.14	1.06	1.37	1.43	.38	.40	.35	.37	.37

Average value per acre of the principal farm crops, 1893 to 1897.

[From Division of Statistics.]

States and Territories.	Corn.					Wheat.				
	1893.	1894.	1895.	1896.	1897.	1893.	1894.	1895.	1896.	1897.
Maine	$18.79	$28.73	$22.68	$17.39	$17.39	$16.32	$16.67	$15.74	$18.48	$17.49
New Hampshire	18.07	26.07	20.50	18.90	15.30	12.75	16.00	14.67	21.00	17.60
Vermont	19.76	28.15	21.89	15.58	15.05	14.28	15.21	20.01	22.79	17.68
Massachusetts	20.77	21.05	22.83	19.78	15.28					
Rhode Island	16.84	23.55	17.50	16.66	16.74					
Connecticut	18.05	21.08	19.33	15.96	15.43					20.00
New York	16.23	17.20	16.02	12.92	12.40	11.02	9.18	12.31	14.08	19.26
New Jersey	13.47	17.87	13.86	11.88	11.97	10.15	9.33	8.80	13.62	17.20
Pennsylvania	12.00	17.60	13.07	13.20	22.24	9.10	8.40	10.79	11.62	17.93
Delaware	9.84	9.90	7.14	5.50	8.70	8.82	7.15	7.42	15.66	20.21
Maryland	10.64	11.45	9.92	10.24	9.90	10.26	8.26	10.88	14.96	17.86
Virginia	8.69	8.98	6.88	6.88	6.84	7.06	5.32	6.05	7.44	11.04
North Carolina	6.15	6.30	5.51	4.44	5.59	5.90	3.25	4.97	6.06	7.52
South Carolina	4.62	7.28	5.11	4.14	4.41	6.17	4.87	5.63	6.05	10.27
Georgia	6.22	6.79	5.33	4.73	5.28	6.48	5.24	5.08	7.12	9.68
Florida	6.60	7.17	5.26	5.30	4.40					
Alabama	6.79	7.26	5.88	5.63	5.52	7.22	6.47	6.00	6.80	10.10

Average value per acre of the principal farm crops, 1893 to 1897—Continued.

States and Territories.	Corn.					Wheat.				
	1893.	1894.	1895.	1896.	1897.	1893.	1894.	1895.	1896.	1897.
Mississippi	$7.20	$8.43	$5.85	$5.94	$6.53	$6.55	$7.35	$4.88	$6.97	$9.90
Louisiana	8.09	10.04	7.24	5.85	7.65	------	------	------	------	------
Texas	9.50	10.64	8.18	3.90	7.58	6.09	8.15	3.76	8.78	14.06
Arkansas	7.29	9.02	6.88	4.99	6.40	5.20	4.84	5.55	5.68	8.82
Tennessee	8.31	8.54	6.75	6.44	7.56	5.24	4.13	5.46	6.29	10.64
West Virginia	11.94	10.55	9.68	10.20	9.80	8.28	7.26	7.31	8.03	11.93
Kentucky	10.11	10.12	8.42	7.00	8.05	6.44	6.25	6.65	6.61	12.10
Ohio	9.52	11.31	8.80	8.61	8.12	8.27	9.31	7.98	7.02	14.87
Michigan	10.66	11.60	10.82	9.12	8.50	7.52	8.22	7.92	10.75	13.57
Indiana	8.89	10.69	7.54	6.65	6.30	7.47	8.46	5.24	7.20	11.57
Illinois	7.97	11.23	8.23	7.29	6.83	5.87	8.19	5.83	10.88	7.03
Wisconsin	10.43	9.32	9.54	8.14	8.25	7.18	8.42	7.91	9.31	10.50
Minnesota	9.62	7.91	6.24	5.79	6.24	4.90	6.62	10.12	9.66	10.01
Iowa	9.15	6.75	6.32	5.46	4.93	5.64	7.40	8.97	9.92	9.75
Missouri	8.37	8.80	7.20	5.40	6.24	4.56	0.58	6.12	8.19	7.65
Kansas	6.60	4.82	4.62	5.04	3.96	3.53	4.58	3.47	6.68	11.47
Nebraska	6.80	3.00	2.90	4.88	5.10	3.48	3.43	4.80	8.12	10.00
South Dakota	5.93	1.93	2.55	4.68	5.04	3.74	3.04	4.56	6.94	5.52
North Dakota	7.87	8.45	5.11	8.75	5.44	4.13	5.07	7.98	7.55	7.62
Montana	19.25	26.81	18.75	15.60	11.70	12.90	13.39	17.45	17.49	22.10
Wyoming	11.66	19.50	15.67	19.50	6.00	12.15	12.35	16.64	15.19	17.50
Colorado	8.42	12.02	8.49	5.76	7.22	6.86	11.64	13.16	10.67	16.80
New Mexico	17.96	14.33	15.23	8.80	15.66	12.60	15.84	14.89	13.86	18.00
Arizona	11.75	18.60	19.50	------	------	11.38	17.00	13.33	18.40	13.32
Utah	12.47	14.15	9.95	12.75	12.10	8.28	11.66	9.86	18.02	14.28
Nevada	------	------	------	------	------	10.73	15.00	10.63	20.70	21.87
Idaho	13.85	16.87	19.03	------	------	11.58	9.48	8.37	15.93	15.40
Washington	13.21	14.35	6.84	7.98	9.90	9.74	6.47	6.35	13.32	15.98
Oregon	11.61	14.22	14.52	12.32	13.25	9.63	7.61	9.40	12.24	12.24
California	15.85	11.00	18.29	19.61	17.64	7.05	6.44	7.80	12.12	8.30
Oklahoma	------	------	------	------	------	------	5.76	5.47	8.84	14.44
Indian Territory	------	------	------	------	------	------	------	------	------	------
General average	8.21	8.86	6.64	6.06	6.26	6.16	6.48	6.99	8.97	10.86

States and Territories.	Oats.					Barley.				
	1893.	1894.	1895.	1896.	1897.	1893.	1894.	1895.	1896.	1897.
Maine	$16.34	$14.74	$13.63	$12.40	$9.92	$17.49	$17.23	$16.85	$13.16	$13.75
New Hampshire	14.71	15.24	12.92	13.30	13.30	17.71	15.37	14.34	15.53	13.50
Vermont	15.29	16.78	14.37	12.56	10.56	16.50	16.74	15.60	13.53	13.11
Massachusetts	14.41	13.72	12.24	12.60	10.56	22.77	13.67	14.63	17.40	22.77
Rhode Island	12.13	14.10	12.64	9.30	10.88	21.92	21.60	17.63	17.40	15.12
Connecticut	10.00	11.09	9.89	8.99	9.86	------	------	------	------	------
New York	7.20	8.62	8.88	8.58	8.37	12.18	9.80	18.55	9.05	10.50
New Jersey	8.37	10.79	10.29	9.52	7.50	------	------	------	------	------
Pennsylvania	9.38	8.47	8.56	7.43	7.61	9.50	7.97	8.28	6.88	9.55
Delaware	9.65	6.65	5.54	6.09	5.06	------	------	------	------	------
Maryland	7.42	8.35	7.07	5.52	6.24	------	------	------	------	------
Virginia	6.13	4.44	5.31	4.81	3.48	------	------	------	------	------
North Carolina	6.20	4.80	5.74	4.20	4.81	------	------	------	------	------
South Carolina	6.25	6.36	7.45	5.28	6.98	------	------	------	------	------
Georgia	6.92	6.83	6.67	4.92	5.88	------	------	------	------	------
Florida	6.49	7.20	6.63	6.36	4.77	------	------	------	------	------
Alabama	7.24	6.73	6.26	5.74	5.59	------	------	------	------	------
Mississippi	7.28	6.11	6.12	5.72	6.16	------	------	------	------	------
Louisiana	7.04	10.48	5.40	3.40	6.84	------	------	------	------	------
Texas	10.54	12.75	5.38	6.80	6.75	8.99	8.41	11.66	6.00	10.75
Arkansas	7.53	7.40	8.13	4.96	5.61	------	------	------	------	------
Tennessee	5.70	5.11	6.08	4.29	2.80	8.31	7.73	11.55	6.30	10.62
West Virginia	8.93	7.21	7.49	6.72	6.00	------	------	------	------	------
Kentucky	7.55	7.56	6.81	5.04	4.86	8.67	13.49	12.65	5.92	8.00
Ohio	8.58	9.39	6.97	5.27	6.40	10.67	13.68	11.56	7.68	11.69
Michigan	8.32	8.87	5.50	5.70	5.98	8.04	10.30	7.78	9.37	8.60
Indiana	7.70	9.69	4.58	4.64	5.74	8.95	9.32	6.00	6.70	8.36
Illinois	7.34	10.47	4.15	4.20	5.76	9.28	11.28	9.00	7.35	9.50
Wisconsin	7.45	9.87	6.08	5.95	6.46	10.32	12.87	9.96	7.40	8.96
Minnesota	6.45	8.43	5.59	4.95	4.94	7.96	9.63	8.64	5.44	6.12
Iowa	5.70	7.17	6.47	3.30	4.80	7.46	6.51	6.44	5.52	5.76
Missouri	5.85	6.76	4.99	3.06	4.18	8.00	7.14	7.34	4.38	7.60
Kansas	5.00	5.55	3.04	2.08	4.32	3.81	4.31	3.31	1.01	4.38
Nebraska	3.30	4.54	3.33	2.09	4.65	3.72	2.45	6.82	3.78	5.28
South Dakota	5.37	2.65	4.35	3.58	3.96	5.08	4.72	3.71	5.42	4.40
North Dakota	6.13	7.51	5.14	3.96	5.98	4.71	7.24	6.08	3.38	6.07
Montana	12.58	12.43	15.75	14.57	13.86	15.05	9.00	14.75	13.75	19.00
Wyoming	9.60	14.59	15.99	16.96	12.25	------	------	------	------	------
Colorado	9.88	6.21	9.60	8.40	10.88	14.15	16.04	18.78	9.20	14.28
New Mexico	14.89	17.50	17.96	10.80	14.56	12.53	18.90	19.04	12.35	17.88
Arizona	------	------	------	------	------	14.04	18.75	17.99	------	------

Average value per acre of the principal farm crops, 1893 to 1897—Continued.

States and Territories.	Oats.					Barley.				
	1893.	1894.	1895.	1896.	1897.	1893.	1894.	1895.	1896.	1897.
Utah	$9.21	$11.22	$10.14	$14.82	$11.55	$16.92	$15.18	$11.70	$11.38	$13.95
Nevada	......	......	......	......	......	21.42	16.57	16.05	......	......
Idaho	13.57	12.32	10.21	12.60	11.62	15.90	15.32	10.29	3.37	14.70
Washington	13.90	11.32	11.28	14.40	16.80	15.64	10.78	14.17	10.40	19.35
Oregon	10.55	7.48	7.78	6.93	11.20	10.44	12.74	8.84	9.81	14.63
California	9.69	15.66	10.96	13.64	8.82	9.45	6.84	8.12	10.37	12.42
Oklahoma	......	......	......	......	......	......	......	......	......	......
Indian Territory	......	......	......	......	......	......	......	......	......	......
General average	6.88	7.95	5.87	4.81	5.75	......	......	......	......	9.25

States and Territories.	Hay.					Cotton.				
	1893.	1894.	1895.	1896.	1897.	1893.	1894.	1895.	1896.	1897.
Maine	$11.16	$9.12	$9.87	$10.25	$10.73	......	......	......	......	......
New Hampshire	16.54	9.97	11.88	12.38	13.23	......	......	......	......	......
Vermont	11.80	11.93	13.11	12.85	12.03	......	......	......	......	......
Massachusetts	19.93	19.53	19.42	20.99	19.46	......	......	......	......	......
Rhode Island	16.27	12.25	15.70	18.26	16.67	......	......	......	......	......
Connecticut	17.32	13.54	13.68	15.74	15.60	......	......	......	......	......
New York	14.05	11.30	10.00	9.75	11.14	......	......	......	......	......
New Jersey	17.26	16.34	15.29	16.50	18.81	......	......	......	......	......
Pennsylvania	14.83	13.35	12.42	12.88	12.81	......	......	......	......	......
Delaware	12.75	19.50	14.96	14.30	13.50	......	......	......	......	......
Maryland	14.82	11.46	14.44	10.31	14.17	......	......	......	......	......
Virginia	14.53	8.56	12.92	11.03	11.07	......	$5.94	$7.31	$8.07	......
North Carolina	18.89	15.85	16.53	13.55	12.19	$12.20	10.00	15.52	14.45	......
South Carolina	15.18	16.45	7.62	15.06	11.50	12.24	10.44	17.26	15.97	......
Georgia	15.92	14.36	17.44	15.25	17.55	11.97	9.10	14.25	12.71	......
Florida	39.50	19.99	20.24	18.20	14.25	12.17	6.67	8.28	7.92	......
Alabama	17.08	25.49	15.93	13.72	13.86	12.24	8.97	11.47	10.65	......
Mississippi	15.86	17.79	18.91	12.77	14.06	12.92	11.07	16.69	14.47	......
Louisiana	14.58	28.85	19.47	16.63	16.62	17.50	15.41	18.42	15.40	......
Texas	9.98	10.13	9.52	7.20	10.15	16.59	12.58	13.40	11.00	......
Arkansas	10.96	11.66	11.12	8.90	11.25	12.36	11.17	17.98	12.71	......
Tennessee	14.96	13.30	15.05	13.54	15.59	11.13	7.61	9.92	8.62	......
West Virginia	14.02	10.87	9.04	11.94	11.95	......	......	......	......	......
Kentucky	13.51	13.19	14.77	11.35	11.70	......	......	......	11.46	......
Ohio	13.37	10.74	7.40	9.99	9.00	......	......	......	......	......
Michigan	13.37	10.85	7.59	9.84	11.55	......	......	......	......	......
Indiana	12.46	9.63	7.34	9.33	8.44	......	......	......	......	......
Illinois	10.72	9.50	6.77	8.82	7.93	......	......	......	......	......
Wisconsin	10.94	10.42	8.47	8.25	8.44	......	......	......	......	......
Minnesota	7.40	5.41	6.66	6.41	7.06	......	......	......	......	......
Iowa	9.73	5.39	6.97	6.94	6.37	......	......	......	......	......
Missouri	8.73	6.65	7.96	6.94	7.07	......	......	10.13	9.96	......
Kansas	6.14	4.04	4.04	3.83	4.42	......	......	15.35	13.69	......
Nebraska	6.09	4.20	3.52	4.05	4.80	......	......	......	......	......
South Dakota	5.21	4.02	2.60	3.99	3.69	......	......	......	......	......
North Dakota	4.80	4.61	4.94	5.59	5.20	......	......	......	......	......
Montana	9.94	8.60	10.72	9.47	11.63	......	......	......	......	......
Wyoming	10.80	16.10	7.02	11.07	9.90	......	......	......	......	......
Colorado	8.31	17.12	14.21	13.68	12.38	......	......	......	......	......
New Mexico	17.68	21.62	20.88	17.10	24.50	......	......	......	......	......
Arizona	14.44	21.84	16.65	28.00	15.00	......	......	......	......	......
Utah	8.89	14.01	13.49	13.50	14.01	......	......	10.55	27.77	......
Nevada	26.60	29.29	20.32	12.29	12.50	......	......	......	......	......
Idaho	13.48	10.98	16.06	12.25	12.08	......	......	......	......	......
Washington	14.49	15.13	12.49	13.83	20.25	......	......	......	......	......
Oregon	15.23	11.72	10.89	13.07	14.73	......	......	......	......	......
California	13.30	18.34	11.72	10.48	14.40	......	......	......	......	......
Oklahoma	......	......	......	......	......	......	......	22.14	15.92	......
Indian Territory	......	......	......	......	......	......	......	13.22	21.16	......
General average	11.51	9.70	8.89	8.97	9.46	13.41	10.94	14.53	12.54	......

Prices of principal agricultural products on the farm December 1, 1893 to 1897.

[From Division of Statistics.]

States and Territories.	Corn (per bushel).					Wheat (per bushel).				
	1893.	1894.	1895.	1896.	1897.	1893.	1894.	1895.	1896.	1897.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*					
Maine	62	72	54	47	47	$1.02	$0.79	$0.82	$0.84	$1.06
New Hampshire	57	76	51	45	45	.85	.80	.76	1.00	1.10
Vermont	61	69	48	38	43	.85	.67	.69	.93	1.04
Massachusetts	62	61	52	46	47	------	------	------	------	------
Rhode Island	69	75	56	49	54	------	------	------	------	------
Connecticut	64	68	51	42	49	------	------	.68	------	1.00
New York	55	61	45	38	40	.76	.62	.68	.88	.90
New Jersey	52	54	42	36	38	.70	.61	.71	.89	.93
Pennsylvania	49	55	39	33	34	.65	.56	.65	.83	.91
Delaware	40	45	34	25	30	.60	.55	.64	.87	.94
Maryland	44	50	37	32	30	.76	.54	.64	.88	.93
Virginia	46	47	37	32	38	.63	.56	.65	.80	.92
North Carolina	50	47	38	37	43	.72	.65	.72	.83	.94
South Carolina	60	65	46	46	49	.98	.87	.88	.89	1.18
Georgia	56	58	41	43	48	.90	.76	.82	.89	1.03
Florida	68	71	47	53	55	------	------	------	------	------
Alabama	59	53	37	45	46	.88	.78	.80	.85	1.01
Mississippi	55	49	37	44	45	.85	.75	.61	.82	.99
Louisiana	57	62	40	45	45	------	------	------	------	------
Texas	54	56	31	41	41	.58	.54	.66	.75	.89
Arkansas	45	47	32	37	40	.65	.55	.59	.71	.81
Tennessee	39	39	27	28	36	.57	.51	.62	.74	.95
West Virginia	55	57	40	34	40	.72	.60	.69	.78	.89
Kentucky	43	44	27	25	35	.57	.50	.61	.76	.89
Ohio	40	43	27	21	25	.57	.49	.60	.78	.88
Michigan	45	50	32	24	27	.57	.52	.60	.84	.87
Indiana	36	37	23	19	21	.53	.46	.57	.80	.89
Illinois	31	39	22	18	21	.51	.45	.53	.74	.89
Wisconsin	35	45	30	22	25	.54	.51	.51	.70	.84
Minnesota	34	43	20	19	24	.51	.49	.44	.68	.77
Iowa	27	45	18	14	17	.49	.50	.46	.62	.75
Missouri	30	40	20	20	24	.48	.43	.51	.70	.85
Kansas	31	43	19	18	22	.42	.44	.45	.63	.74
Nebraska	27	50	18	13	17	.40	.49	.40	.58	.69
South Dakota	25	46	23	18	21	.44	.46	.38	.62	.69
North Dakota	38	44	24	25	32	.43	.43	.38	.64	.74
Montana	70	82	75	60	65	.60	.54	.73	.66	.68
Wyoming	63	65	57	78	50	.65	.63	.64	.62	.70
Colorado	51	61	41	36	38	.52	.65	.56	.61	.70
New Mexico	71	75	56	55	58	.75	.88	.73	.66	.75
Arizona	66	100	75	------	------	.65	1.00	.65	.80	.74
Utah	58	58	49	51	55	.60	.53	.44	.68	.68
Nevada	------	------	------	------	------	.73	.75	.49	.69	.90
Idaho	71	59	62	------	------	.60	.46	.47	.65	.70
Washington	62	69	40	57	55	.48	.39	.41	.74	.68
Oregon	47	56	55	56	53	.55	.43	.47	.72	.72
California	50	57	53	53	56	.53	.57	.60	.83	.83
Oklahoma	------	------	------	------	------	------	.51	.48	.68	.76
Indian Territory	------	------	------	------	------	------	------	------	------	------
General average	36.5	45.7	25.3	21.5	26.3	.538	.491	.509	.726	.808

Prices of principal agricultural products on the farm December 1, 1893 to 1897—Continued.

States and Territories.	Oats (per bushel).					Barley (per bushel).				
	1893.	1894.	1895.	1896.	1897.	1893.	1894.	1895.	1896.	1897.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
Maine	45	44	34	31	32	67	63	52	43	55
New Hampshire	43	49	35	35	38	70	63	56	53	60
Vermont	42	51	33	31	32	60	60	47	41	46
Massachusetts	42	43	34	35	33	90	63	65	58	66
Rhode Island	43	47	39	31	34	87	72	75	60	54
Connecticut	40	43	31	31	34	------	------	------	------	------
New York	30	39	28	26	27	60	56	81	39	42
New Jersey	35	38	29	28	30	------	------	------	------	------
Pennsylvania	35	38	27	24	27	50	48	41	40	39
Delaware	38	35	29	21	23	------	------	------	------	------
Maryland	35	39	27	23	26	55	------	------	------	------
Virginia	35	37	30	26	29	48	------	------	------	------
North Carolina	44	44	38	35	37	52	------	------	------	------
South Carolina	53	53	49	48	45	115	------	------	------	------
Georgia	52	51	46	41	42	115	------	------	------	------
Florida	55	61	65	53	53	------	------	------	------	------
Alabama	51	51	42	41	43	------	------	------	------	------
Mississippi	47	47	39	44	44	------	------	------	------	------
Louisiana	44	47	36	34	38	------	------	------	------	------
Texas	42	39	26	34	27	62	55	54	50	43
Arkansas	39	40	32	31	33	------	------	------	------	------
Tennessee	31	35	27	25	28	55	56	59	45	59
West Virginia	38	39	32	28	30	------	------	38	------	------
Kentucky	34	36	26	24	27	51	47	38	40	40
Ohio	30	31	22	17	20	47	48	41	38	41
Michigan	32	34	23	19	23	49	50	43	42	40
Indiana	28	30	20	16	19	45	45	40	33	44
Illinois	27	29	17	15	18	40	48	45	31	38
Wisconsin	27	30	18	17	19	43	45	34	27	32
Minnesota	26	30	14	15	19	36	41	24	20	24
Iowa	23	28	14	12	16	33	42	23	21	24
Missouri	25	29	18	17	19	40	51	48	25	40
Kansas	27	31	17	16	18	47	49	23	22	25
Nebraska	22	36	14	11	15	31	43	24	19	24
South Dakota	25	35	17	13	18	33	35	19	19	22
North Dakota	28	29	16	18	26	31	36	20	21	27
Montana	37	31	44	31	33	50	40	59	55	50
Wyoming	40	48	39	53	35	73	------	28	------	------
Colorado	37	46	28	30	32	50	58	60	46	51
New Mexico	51	50	45	40	41	58	70	68	65	55
Arizona	------	------	------	------	------	52	75	70	------	------
Utah	33	34	30	39	33	45	46	39	42	45
Nevada	------	------	------	------	------	60	51	50	------	------
Idaho	41	32	29	30	32	53	47	42	22	42
Washington	35	31	28	40	35	39	32	38	40	43
Oregon	37	28	27	33	35	40	33	40	45	45
California	38	44	39	44	49	42	45	40	48	54
Oklahoma	------	------	------	------	------	------	------	------	------	------
Indian Territory	------	------	------	------	------	------	------	------	------	------
General average	29.4	32.4	19.9	18.7	21.2	41.1	44.2	33.7	32.3	37.7

Prices of principal agricultural products on the farm December 1, 1893 to 1897—Continued.

States and Territories.	Hay (per ton).					Cotton (per pound).				
	1893.	1894.	1895.	1896.	1897.	1893.	1894.	1895.	1896.	1897.
						Cents	*Cents.*	*Cents.*	*Cents.*	*Cents.*
Maine	$12.13	$9.60	$9.68	$10.25	$9.75	......	......	......	......	......
New Hampshire	15.60	10.50	12.50	12.90	11.50	......	......	......	......	......
Vermont	10.63	9.94	12.25	10.28	9.25	......	......	......	......	......
Massachusetts	17.33	15.50	17.50	16.40	13.90	......	......	......	......	......
Rhode Island	19.60	16.33	17.25	16.60	14.50	......	......	......	......	......
Connecticut	17.50	15.56	16.10	14.71	13.00	......	......	......	......	......
New York	11.33	9.66	13.70	12.04	8.25	......	......	......	......	......
New Jersey	17.43	14.09	12.61	14.35	10.75	......	......	......	......	......
Pennsylvania	14.40	11.31	12.30	12.15	9.15	......	......	......	......	......
Delaware	17.00	15.00	12.16	13.00	10.00	......	......	......	......	......
Maryland	14.25	11.13	11.55	11.85	10.50	......	......	......	......	......
Virginia	13.09	11.89	11.43	10.21	10.25	7.1	5.0	7.8	7.1	6.9
North Carolina	11.11	10.93	10.14	10.75	9.75	7.2	4.8	8.2	6.7	7.0
South Carolina	9.67	10.75	7.62	11.32	11.50	7.1	5.0	8.8	6.8	6.9
Georgia	12.06	12.38	10.90	11.05	13.00	7.3	4.5	7.0	7.0	6.7
Florida	19.75	16.25	13.23	13.00	14.25	7.3	4.8	11.5	8.7	6.8
Alabama	11.24	9.51	10.21	9.80	10.25	7.0	4.8	7.8	6.5	6.7
Mississippi	9.61	9.67	9.70	9.46	9.50	7.0	4.1	7.5	6.7	6.7
Louisiana	9.00	10.64	9.64	8.75	8.75	7.0	4.3	7.8	6.7	6.7
Texas	9.60	7.62	6.43	7.20	7.25	6.9	4.5	7.3	6.5	6.6
Arkansas	9.37	8.83	9.27	7.54	8.65	6.8	4.8	7.6	6.4	6.5
Tennessee	10.76	11.27	10.83	9.67	10.75	6.5	4.5	7.3	6.2	6.6
West Virginia	12.75	10.66	12.73	9.79	8.85	......	......	......	......	......
Kentucky	10.16	10.47	10.94	9.46	10.00	......	......	......	......	6.6
Ohio	10.05	8.46	12.76	7.93	6.25	......	......	......	......	......
Michigan	9.16	9.04	13.09	8.48	7.75	......	......	......	......	......
Indiana	9.16	7.58	12.03	7.18	5.90	......	......	......	......	......
Illinois	8.86	8.33	10.25	6.39	6.15	......	......	......	......	......
Wisconsin	7.20	7.96	9.63	6.60	6.25	......	......	......	......	......
Minnesota	4.57	5.30	5.12	3.79	4.50	......	......	......	......	......
Iowa	6.16	7.39	6.45	3.99	4.25	......	......	......	......	......
Missouri	7.04	7.82	6.80	4.85	6.15	......	4.6	7.4	6.2	6.4
Kansas	4.69	5.25	3.26	2.70	3.40	......	......	......	......	6.7
Nebraska	4.87	7.12	3.56	2.44	3.00	......	......	......	......	......
South Dakota	3.67	4.28	3.29	3.12	2.95	......	......	......	......	......
North Dakota	3.72	3.87	3.48	3.39	3.25	......	......	......	......	......
Montana	7.89	7.17	1.40	6.86	7.75	......	......	......	......	......
Wyoming	8.00	10.00	6.50	7.14	6.00	......	......	......	......	......
Colorado	6.98	7.54	5.87	6.22	5.50	......	......	......	......	......
New Mexico	8.59	11.50	8.00	5.70	7.60	......	......	......	......	......
Arizona	8.25	12.00	9.00	8.75	5.00	......	......	......	......	......
Utah	5.17	5.56	5.27	5.00	4.75	......	......	......	......	7.0
Nevada	10.00	7.25	6.75	4.82	5.00	......	......	......	......	......
Idaho	5.50	4.34	6.25	4.71	5.25	......	......	......	......	......
Washington	9.17	7.38	6.75	7.09	9.00	......	......	......	......	......
Oregon	8.10	5.86	6.12	6.60	7.75	......	......	......	......	......
California	7.87	9.50	7.06	6.35	9.00	......	......	......	......	......
Oklahoma	......	......	......	......	......	......	4.6	7.5	6.2	6.7
Indian Territory	......	......	......	......	......	......	......	7.3	......	6.4
General average	8.68	8.54	8.35	6.55	6.62	6.99	4.6	7.59	6.6	6.65

Wholesale prices of principal agricultural products in leading cities of the United States, 1892 to 1896.

[From Division of Statistics.]

CORN (PER BUSHEL).

Date.	Boston.		New York.		Richmond.		New Orleans.		Cincinnati.		Chicago.		Kansas City.		St. Paul.		St. Louis.		San Francisco (per cental).	
1892.	*Steamer mixed.*		*No. 2.*		*No. 2.*		*No. 2.*		*No. 2.*		*No. 2.*		*No. 2.*		*No. 3 yellow.*		*No. 2.*		*No. 1 white.*	
August 1	$0.59 to	$0.59½	$0.59 to	$0.60	$0.57 to	$0.58	$0.63 to	$0.64	$0.53 to	$0.53½	$0.49⅛ to	$0.49⅛		$0.43½	$0.45 to	$0.47	$0.45½ to	$0.45¾	$1.40 to	$1.42½
September 1		.61		.58½	.57	.58		.60	.50	.51	.48½	.48¾		.42½	.47	.48	.44	.44¼	1.37½	1.40
October 1		.55½	.51⅞	.52¼	.55	.56	.59	.60	.46½	.47	.43⅝	.43½		.37½	.44	.45	.40⅝	.41	1.35	1.36¼
November 1	.52½	.53	.50⅝	.51⅝	Nominal.		.52	.53		.43	.41⅝	.41⅞		.33	.40	.41		.38¼	1.15	1.17½
December 1	.54	.55	.51½	.51⅞	.49	.50		.51		.43	.42	.42½		.38½	.39	.40	.38⅛	.38⅞	1.12½	1.15
1893.																				
August 1		.49	.46⅛	.46¼	.47	.48		.51		.41	.38	.38⅝		.28¼	.35	.36	.34¼	.34¾	1.00	1.02½
September 1		.50	.45	.45¼		.47		.50		.41½	.37½	.37¾		.30½	.35	.36	.34	.34¼	.90	.95
October 2		.51		.49	.50	.51		.53	.42½	.43	.39¾	.40⅛		.34	.37	.38	.35⅝	.36	.92½	.95
November 1		.50	.45⅝	.46½		.47	.51	.52		.39	.38¼	.38½	$0.31½ to	.32	.37	.38		.35⅝	.85	.87½
December 1		.46½	.44¾	.45¼	.43	.44		.49		.40	.34⅞	.35⅛	.30	.30¼	.33	.34		.34	.90	.92½
1894.																				
August 1		.57	.53½	.54	.52	.53	.56	.57		.50	.46½	.46¾	.41	.42	.45⅛	.46¼	.44½	.45	1.35	1.37½
September 1		.65½	.63	.64	.61	.62		.70		.56	.53¾	.57¾		.52½	.57	.58	.53½	.54	1.25	1.27½
October 1		.60	.55⅛	.55½		.59		.71	.54½	.54¾	.49⅜	.49⅞		.46	.54	.54½	.49¾	.50¼	1.30	1.32½
November 1		.61½		.60		.55		.57		.52½	.52	.52⅝	.42⅛	.43	.54½	.55	.48⅝	.48½	1.30	1.32½
December 1		.54		.58	.43	.44	.53	.54		.46	.46¾	.47	.41⅛	.41⅞	.51	.52	.45⅛	.45¼	1.27½	1.30
1895.															*No. 2.*					
August 1		.54	.48⅛	.49½		.49	.53	.54		.43¼	.43	.44½	.38	.38½	.42½	.43		.39	1.07½	1.10
September 3	.45	.46	.40⅝	.41¾		.41		.45	.37	.37½	.35¾	.36⅞		.30	.35½	.36½	.33	.33½	1.10	1.12½
October 1	.41⅓	.42	.37	.37⅞		.39		.38		.33½	.30¼	.31¼	.26½	.26¾	.31⅓	.32		.26¼	1.10	1.12½
November 1	.39	.39½		.37⅛		.36		.39		.32	.29⅜	.29⅝		.23½	.30	.30		.26⅛	.87½	.90
December 1		.38		.35		.36		.37		.30	.26¼	.26⅝	.22⅛	.23	.24	.24½		.24¼	.85	.87½
1896.																				
August 1		.33½	.30⅝	.31	.31	.31½	.32	.33		.26½	.24⅛	.24⅞	.21¾	.22	.23½	.24		.22¼	.80	.82½
September 1	.29½	.30	.25⅞	.26⅛		.28	.28	.29	.24½	.25	.20¼	.20¾	.18	.18½	.19	.20	.18½	.18⅞	.77½	.80
October 1		.31	.28	.29¼	.28	.29	.28	.29		.25½	.22⅝	.23⅜	.20¼	.20¼	.20	.21		.21⅛	.77½	.80
November 2		.34	.31	.31¼	.31	.31⅛	.35	.36		.26	.24	.24⅛	.19	.21	.23	.23¾		.22¾		.87½
December 1		.30	.28⅞	.29⅛	.27⅛	.28	.34	.35	.22	.22⅛	.23	.23⅛	.18⅛	.19	.24⅛	.25		.21⅛	.85	.87½

1897.	*Steamer yellow*																			
August 2	.35¼	.36½	.33¼	.33¾	.32½	.33	.36½	.38	.28½	.29	.28	.28½	.24	.25	.23½	.24		.25½	.95	1.00
September 1	.40½	.41	.35¾	.37½	.37½	.38	.41	.42		.31	.30	.31½	.25½	.26	.26	.28		.27½	1.05	1.10
October 1		.38½	.32¼	.32½		.35	.41	.42		.30½	.27¾	.28½	.24	.25	.26	.26½	.23½	.26½	1.07½	1.10
November 1	.36½	.37	.31	.31½	.30	.30½	.39	.40		.25½	.26¼	.27	.22	.22½	.24	.25½	.24½	.24½	1.10	1.12½
December 1	.36½	.36¾	.32	.32½		.32½	.38	.39	.27½	.27½	.25½	.26½		.24		.24	.21½	.25½	.87½	.92½

WHEAT (PER BUSHEL).

1892.			*No. 2 red.*		*No. 2 red.*				*No. 2 red.*		*No. 2 red winter.*		*No. 2 hard.*		*No. 2 northern.*		*No. 2 red winter.*		*No. 1 white.*	
August 1	....	....	$0.83½ to	$0.84½	$0.82½ to	$0.83	....	....		$0.75	$0.77½ to	$0.77¾		$0.65	$0.73 to	$0.75	$0.73½ to	$0.73¾	$1.37½ to	$1.38½
September 1	....	....	.78¼	.79¾	.77	.78	....	....		.73		.73¾		.65	.68	.70	.68½	.69	1.28½	1.30
October 1	....	....	.79½	.79½	.78	.79	....	....	$0.72½ to	.73	.72½	.73½		.61½	.66	.68		.69	1.28½	1.30
November 1	....	....	.74¾	.75¾	.72	.73	....	....		.66	.70¾	.71		.60	.63	.65	.65½	.65¾	1.27½	1.30
December 1	....	....	.76¾	.78½	.76	.77	....	....		.76	.71½	.71½		.65	.62	.65		.68½	1.26½	1.27½
1893.																				
August 1	....	....	.66¾	.68½	.64	.64½	....	....	.52½	.53	.57¾	.59½		.46½	.54	.55	.54½	.54½	1.07½	1.10
September 1	....	....	.69	.69¾	.63½	.64	....	....	.57	.58	.62¾	.63½		.51½	.56	.57		.59½	1.01½	1.02½
October 2	....	....	.72½	.72½	.70	.71	....	....		.64	.66	.66¾		.55	.58	.59		.62½	1.04	1.05
November 1	....	....	.67¾	.68½		.69	....	....		.59½	.62½	.62¾	$0.50½ to	.51	.58	.59		.58½	1.02½	1.05
December 1	....	....	.68½	.69½		.64	....	....	.59	.60	.63	.63½	.53	.53½	.57	.58		.59½	1.02½	1.03½
1894.																				
August 1	....	....	.55½	.56½		.54	....	....	.48	.48½	.52	.53	.44	.45	.56½	.57		.47½	.87½	.90
September 1	....	....	.57¾	.58½	.57	.57½	....	....		.51	.53	.53¼	.53	.53½	.52	.54½	.49¾	.50½	.85	.86½
October 1	....	....	.56	.57½		.55	....	....	.51⅝	.51½	.51¾	.52		.51½	.53	.54	.48½	.48½	.77½	.78½
November 1	....	....	.56½	.57	.56	.56½	....	....		.51	.52½	.53½	.47½	.48	.54½	.55	.48½	.48½	.85	.86½
December 1	....	....	.60¾	.61½		.60	....	....		.53	.55½	.56	.53	.54	.57½	.58½	.52½	.52½	.92½	.93½
1895.																				
August 1	....	....	.75	.75½		.72	....	....		.71	.67¾	.69½		.68½	.67	.67½		.68½	.96	.97½
September 3	....	....	.65½	.67		.67	....	....		.64	.60	.61¾		.60	.55½	.56	.61½	.61½	.92½	.93½
October 1	....	....	.66¾	.69½		.72	....	....		.70	.61½	.61½		.64	.55	.55½		.64½	.96½	.97½
November 1	....	....	.70½	.71⅝	.72	.73	....	....		.66½	.58½	.62⅝		.58	.53½	.54		.61½	.97½	.98½
December 1	....	....	.70¾	.71½		.71	....	....		.67½	.59½	.61½	.57½	.58	.53	.54		.63	.97½	1.00
1896.																			*Milling.*	
August 1	....	....	.68½	.68¾		.64½	....	....		.62	.61½	.62		.53	.55	.56	.59	.59½	1.00	1.02½
September 1	....	....	.66¾	.67½	.64	.64½	....	....		.61	.60	.60½		.51	.53	.53½	.58½	.58½	1.00	1.02½
October 1	....	....	.79¾	.80½	.72	.72½	....	....	.71	.75	.70½	.72		.65	.64½	.65	.68½	.69	1.12	1.15
November 2	....	....	.86¾	.88½	.79	.80	....	....	.81½	.82	.77½	.78		.65	.69	.70	.76	.77	1.37½	1.42½
December 1	....	....	1.01	1.02½	.95	.96	....	....		.97	.90½	.92½	.82	.83	.80½	.81½	.91	.92	1.57½	1.60

Wholesale prices of principal agricultural products in leading cities of the United States, 1893 to 1897—Continued.

WHEAT (PER BUSHEL)—Continued.

Date.	Boston.	New York.	Richmond.	New Orleans.	Cincinnati.	Chicago.	Kansas City.	St. Paul.	St. Louis.	San Francisco (per cental).
1897.		*No. 2 red winter.*	*No. 2 red.*		*No. 2 red winter.*	*No. 2 red winter.*	*No. 2 red winter.*	*No. 1 northern.*	*No. 2 red winter.*	*No. 1 white.*
August 2	....	$0.82 to $0.84	$0.77	....	$0.75	$0.77 to $0.77⅝	$0.73 to $0.74	$0.80⅛	$0.79	$1.47½ to $1.52½
September 1	....	.96¼ 1.00⅝	.96	....	.95½	.94⅝ .96⅜	.89 .91	1.01¼	$0.94½ to .95	1.52½ 1.57½
October 1	....	.93¾ .95	.95	....	$0.91 to .92	.94⅛ .95⅝	.91	.87¾	.96¼ .97½	1.47½ 1.50
November 1	....	1.03 1.04	1.00	....	.96	.96 .99¼	.94	.94	1.00	1.52½ 1.55
December 1	....	.98 .99¼	.98	....	.94	.96¼	.89	.90¼	.97½	1.47½ 1.50

OATS (PER BUSHEL).

Date.	Boston.	New York.	Richmond.	New Orleans.	Cincinnati.	Chicago.	Kansas City.	St. Paul.	St. Louis.	San Francisco (per cental).
1892.	*No. 2 white.*	*No. 2 mixed.*	*No. 2 mixed.*	*No. 2.*	*No. 2 mixed.*	*No. 2.*	*No. 2 mixed.*	*No. 2 white.*	*No. 2.*	*No. 1.*
August 1	$0.41 to $0.41½	$0.35½ to $0.36	$0.38 to $0.38½	$0.40	$0.33 to $0.33½	$0.30½ to $0.30¾	$0.26	$0.31½ to $0.32	$0.30	$1.37½ to $1.40
September 1	.42	.37 .38	.37 .38	$0.40 to .41	.34 .34¼	.33⅝ .33¾	.27¼	.32 .32½	.29¼	1.32½ 1.35
October 1	.40½ .41	.36	.37 .38	.40	.33¼ .33½	.31 .31¼	.26½	.32 .33	$0.29½ to .29⅝	1.25 1.27½
November 1	.41½	.35¾	.35½ .36	.38	.32 .32½	.30	....	.29½ .30½	.28⅝ .29	1.25 1.27½
December 1	.43	.36½	.39 .40	.41	.35½ .36	.31½	.32	.31½ .32	.31	1.27½ 1.30
1893.										
August 1	.39	.35½ .36	.32 .33	.38 .38½	.21 .22	.23 .23⅝	.23	.29½ .30½	.22½	1.05 1.10
September 1	.35 .35½	.30⅛ .30¼	.31 .32	.34	.26¼ .26½	.23¾ .24	$0.27 to .29	.26½ .27½	.23¼ .23½	1.07½ 1.10
October 2	.37 .37½	.34½ .34⅞	.34 .35	.36	.31 .32	.27¾ .28	.28½	.26½ .27½	.27¼	1.10 1.12½
November 1	.37½	.34½ .34¾	.34½ .35	.38	.29½	.28	.26½ .27½	.27½ .28	.26¼	1.05 1.10
December 1	.38	.34⅝ .34½	.34½ .35	.38	.31½ .32	.28¼	.27 .27½	.27 .27½	.27⅝	1.05 1.07½
1894.										
August 1	.44 .45	.40	.34½	.38 .39	.39½ .31	.28¾ .29	.27½ .28	.32 .33	.28¾	1.12½ 1.15
September 1	.38 .38½	.33⅞ .34	.34 .34½	.38½ .39	.31	.29½ .30¼	.31	.32 .32½	.30¼	1.02½ 1.05
October 1	.37 .37½	.32½ .32¾	.33 .34	.38	.31¼	.28¼ .28½	.28½ .29¼	.31½ .32	.28⅝ .29¼	1.00 1.02½
November 1	.37½ .38	.32½ .32¾	.32½ .33	.38	.30½	.28¾ .29	.29 .30	.30½ .31	.29½	.95 .97½
December 1	.40	.33⅝ .33¾	.34 .35	.38 .38½	.31½ .32½	.29¼ .29½	.30½ .31	.31 .31½	.30	.95 .97½
1895.								*No. 3 white.*		*No. 1 feed.*
August 1	.33 .33½	.28	.28½ .29	.32	.25 .27	.22½ .22⅝	.19	.24 .24½	.24	.87½ .90
September 3	.27½ .28	.24	.24 .24½	.28	.21¾ .22	.19 .20¼	.17½	.18½ .19	.18 .21	.82½ .85
October 1	.27½ .28	.24 .24½	.24½ .25	.27½ .28	.21 .21½	.18⅝ .18¾	.18 .19	.18½ .19	.19	.70 .72½

November 1	.26	.27		.24	.23	.23½		.27	.20	.20		.18	.15	.16	.17	.17½		.17¾	.65	.67½
December 1		.25½	.22½	.22½	.23	.23½		.26	.21½	.21½		.17¾		.18¼	.16½	.16½		.18	.65	.67½
1896.																				
August 1		.27		.23	.23	.23½		.25½		.21½		.18½		.20	.17½	.17½		.19	.80	.85
September 1		.26		.20	.20½	.21		.26		.17½	.15½	.16		.17	.17	.17½		.17	.87½	.90
October 1		.25½		.22	.19	.19½		.25		.18	.18	.18¾		.15	.18½	.19		.16	.92½	.95
November 2	.26	.26½	.22½	.23	.20	.20½	.25	.26	.19	.19½	.18½	.18½		.16	.17	.17½	.16½	.17	1.12½	1.20
December 1		.26½	.23½	.23½	.21½	.22	.25	.25½	.19½	.20		.18½	.17½	.18	.18	.18½		.19	1.17½	1.30
1897.																			*White.*	
August		.27½		.21¾	.21½	.23	.25½	.26	.20½	.21	.17½	.17¾	.15	.16½	.18	.19½		.18½	1.10	1.17½
September	.28½	.28½	.23½	.21	.23	.23½	.26	.26½	.20	.21½	.19	.19½	.18½	.19	.19	.21		.19½	1.10	1.35
October		.29	.23½	.23½	.21½	.24½	.25	.26½	.20	.21½	.19	.19½	.18	.19	.19½	.20½		.20	1.20	1.30
November		.29½		.24½	.22	.23½	.26	.26½	.20½	.21		.19½	.18	.18½		.20½	.18	.18½	1.12½	1.17½
December		.30½	.26½	.26½		.27	.29	.29½	.23½	.23½	.21½	.21½		.22½		.21½		.20½	1.10	1.17½

BARLEY (PER BUSHEL).

1892.	*Six-rowed State.*		*Two-rowed State.*						*No. 2 spring.*		*Fair to choice.*				*No. 2.*		*Choice.*		*No. 1. Chevalier.*	
August 1	$0.75 to	$0.80							$0.64 to	$0.68	$0.45 to	$0.63			$0.50 to	$0.55				
September 1	.75	.80								.65	.48	.65			.50	.55				
October 1	.75	.80		$0.65					.65	.68	.58	.68			.48	.50		$0.65	$1.15½ to	$1.17½
November 1	.75	.80	$0.63 to	.68					.65	.67	.48	.55			.48	.50		.60	1.12½	1.15
December 1	.75	.80	.65	.68					.65	.67	.50	.58			.50	.55	$0.62 to	.63	1.12	1.15
1893.																				
August 1	.70	.75							.60	.65	.30	.35			.50	.55			1.17½	1.20
															Sample.					
September 1	.70	.75							.50	.52	.45	.52			.30	.45			1.17½	1.20
October 2	.70	.75	.55	.60					.56	.58	.46	.58			.35	.48	.55	.58	1.15	1.17½
November 1	.70	.75	.60	.65					.58	.60	.40	.54			.35	.48		.57	1.15	1.17½
December 1	.70	.75	.63	.64					.58	.60	.46	.52			.35	.48		.57	1.15	1.17½
1894.	*Six-rowed western.*		*No. 2 Milwaukee.*												*No. 2 round.*				*Brewing.*	
August 1	.68	.73							*a* .57	*a* .60		*a* .44			.52	.55			.95	.97½
September 1	.68	.73							.55	.60	.55	.57½			.45	.50		.60	.90	.92½
October 1	.68	.73	.61	.62					.62	.63	.52	.54½			.45	.50	.55	.57	.90	.92½
November 1	.65	.70	.61	.62					.60	.62	.53	.56			.45	.50	.55	.56	.90	.92½
December 1	Nominal.		.63	.64					.60	.62	.52	.54½			.46	.50		.55		

a Extra No. 3.

Wholesale prices of principal agricultural products in leading cities of the United States, 1892 to 1897—Continued.

BARLEY (PER BUSHEL)—Continued.

Date.	Boston.	New York.	Richmond.	New Orleans.	Cincinnati.	Chicago.	Kansas City.	St. Paul.	St. Louis.	San Francisco (per cental).
1895.	*Western.*	*No. 2 Milwaukee.*			*No. 2 spring.*	*No. 3.*		*No. 3.*	*Choice.*	*Brewing.*
August 1	Nominal.	....	....	....	$0.60 to $0.62	$0.37	....	$0.40 to $0.45	....	$0.72½ to $0.75
September 3	Nominal.	$0.50	....	....	.54 *a*.58	$0.36 .42	....	.32 .33	....	.70 .72½
October 1	$0.45 to $0.55	.50	....	....	.44 *a*.45	.25 .37	....	.32 .34	$0.40	.67½
November 1	.45 .55	.50	....	....	.40 .45	.28 .40	....	.32 .35	$0.35 .37	.70 .72½
December 1	.45 .50	.48	....	....	.39 .44	.28 .40	....	.28 .30	.34 .36	.75 .80
1896.	*Malting.*							*No. 4.*		
August 1	.45 .50	....	....	....	.45	.28 .30	....	.21 .24	Out of season.	.80 .82½
September 1	.40	....	....	....	.45	.25 .32	....	.21 .24	Out of season.	.75 .77½
October 1	.42 .43	.48	....	....	.45	.32 .36	....	.24 .26	.35	.77½ .82½
November 2	.40 .42	.48	....	....	.40 .42	.24 .38	....	.22 .23	.37	.87½ .92½
December 1	.40 .42	.47	....	....	*a*.30 *a*.33½	.25 .37	....	.21 .26	.36	1.00 1.05
1897.		*Western.*			*No. 2 fall.*	*Choice.*				
August 2	.40 .42	$0.57 .59	....	....	.35 .36	.31 .33	....	.27	Out of season.	1.00 1.08¾
September 1	.40 .42	.57 .59	....	....	.35 .36	.40 .42	....	.28	Out of season.	1.02½ 1.12½
October 1	.40 .42	.47 .57	....	....	.45 .46	.35 .38	....	.29	.49 .51	1.02½ 1.12½
	Six-rowed State.									
November 1	.50 .53	.46 .56	....	....	.45 .46	.36 .38	....	.30	.47 .50	1.02½ 1.12½
December 1	.50 .56	.44 .55	....	....	.45 .46	.35 .38	....	.30	.35 .41	.95 1.07½

HAY (PER TON).

Date.	Boston.	New York.	Richmond.	New Orleans.	Cincinnati.	Chicago.	Kansas City.	St. Paul.	St. Louis.	San Francisco.
1892.	*Fair to good.*	*Prime timothy.*	*No. 1 timothy.*	*Choice.*	*No. 1 timothy.*	*No. 1 timothy.*	*Choice prairie.*	*Timothy.*	*Timothy (fancy).*	*No. 1 barley.*
August 1	$17.00 to $18.00	$19.00	$15.00	$16.50 to $17.50	$11.50 to $12.00	$12.00 to $12.50	$6.00	$9.00 to $10.00	$13.00	$9.00 to $10.00
September 1	17.00 18.00	17.00	$15.00 to 15.25	16.50 17.50	10.00 10.50	10.50 11.50	6.50	9.00 10.00	12.00	7.50 8.50
October 1	16.50 17.00	$17.00 to 18.00	14.00 14.50	16.50 17.50	11.00 11.50	10.50 11.00	7.00	9.00 10.00	13.00	7.50
November 1	16.00 17.00	17.00	13.50 14.00	15.50 16.00	10.00 10.50	10.50 11.00	8.00	8.00 9.50	11.50	8.00 9.00
December 1	16.00 17.00	18.00	15.50 16.00	15.50 16.00	10.50 11.00	11.00 12.00	7.50	8.00 9.50	12.50	8.00 9.00

a Extra No. 3.

1893.																				
August 1	17.00	18.00		20.00	17.00	17.50	18.00	18.50		13.50	9.50	10.50		7.00	6.00	8.00		15.00	7.00	9.00
September 1	17.00	18.00	17.00	18.00	15.00	15.50	16.50	17.50	12.00	13.00	10.00	10.50		7.00	7.50	9.00		11.50	8.50	9.00
October 2	16.00	17.00	17.00	18.00	15.00	15.50	16.00	16.50		12.50	10.00	11.00		6.50	7.00	8.50		12.50	8.50	9.00
November 1	15.00	16.00	17.00	18.00	14.50	15.50	17.00	18.00	11.50	12.00	10.50	11.00		7.00	7.50	8.50		12.00	10.00	11.00
December 1	15.00	16.50		17.00	14.00	14.50	16.50	17.00	11.00	12.00	10.00	10.50		7.00	7.50	8.50		12.50	10.00	11.00
1894.																				
August 1	15.00	15.50		18.00	13.00	13.50		17.00	11.00	11.50	11.00	12.00		6.75	9.00	10.00		12.00	9.00	10.00
September 1	15.00	15.50	15.00	16.00	13.50	14.00	15.50	16.50	10.00	10.50	9.50	10.00		8.00	9.00	10.00		12.00	8.00	9.00
October 1	13.00	13.50		15.00	12.00	12.50	16.00	16.50	9.50	10.00	10.00	10.50		8.50	9.50	10.50		11.50	9.00	10.00
November 1	13.00	13.50		15.00	12.50	13.00	16.00	16.50	9.00	9.50	10.00	10.50		8.50	9.50	10.50		12.00	9.00	10.00
December 1	13.00	13.50		15.00	12.50	13.00	16.00	17.00	10.00	10.50	10.00	11.00		8.50	10.00	11.00		12.00	9.00	10.00
1895.															*Wild.*					
August 1	16.00	17.00		21.00	16.00	17.00	20.00	21.00	16.50	17.00	12.00	13.00		7.00	7.00	8.50		16.00	6.00	7.00
September 3	16.00	17.00		19.00	14.00	16.00	20.00	21.00	13.50	14.00	11.50	12.50		6.50	6.00	8.00		14.00	6.00	7.00
October 1	16.00	17.00		17.00	15.50	16.50	19.00	20.00	13.50	14.00	11.50	12.50		6.50	7.00	8.50		13.00	7.00	7.50
November 1	16.00	17.00		18.00	16.50	17.00	19.00	20.00	13.75	14.75	11.50	12.00		6.50	7.50	8.75		13.00	8.00	9.00
December 1	17.00	18.00		18.00	16.50	17.00		22.00	14.00	14.75	12.00	13.00		7.00	6.50	8.25		15.00	8.00	9.00
1896.			*Per cwt.*																	
August 1	16.00	17.00	.95	1.00	14.00	15.00	16.50	17.00	13.00	13.50	8.00	8.50		6.00	5.00	6.50	$12.50 to	13.00	7.00	8.00
September 1	16.00	17.00	.90	.92½	11.50	12.50	16.00		9.00	9.50	7.58	8.00		5.00	6.00	6.50	9.00		7.00	8.00
October 1	14.00	15.00	.77½	.80	10.00	12.00	15.00		10.00	10.50	8.00	8.50		5.00	6.00	6.50		11.25	5.00	7.00
November 2		15.00	.85		11.00	12.50	16.00	16.50	9.50	10.00	8.50	9.00		5.50	5.50	6.50	10.00	10.50	5.00	8.00
December 1	15.00		.80	.82½	11.00	13.00	15.50	16.50	10.00	10.50	9.00	9.50		6.00	6.00	6.75		11.50	6.00	8.50
1897.	*Prime.*		*Per ton.*								*Choice timothy.*				*Fancy timothy.*		*Per ton.*			
August 2	15.00	16.50	15.50	16.00	13.00		15.00	16.00	10.50	11.00	8.50	10.50		5.50	8.00	8.50	9.75	10.00	9.00	11.00
September 1	15.00	16.50	15.00	16.00	12.00	12.50	15.00	16.00	8.50	8.75	8.50	9.00		5.50	7.75	8.50	9.00	9.50	9.00	11.00
October 1	14.50	15.50	15.00	15.50	12.50	13.00	14.50	15.50	8.50	9.00	9.00	9.50		5.75	8.00	8.50	9.50	10.00	9.50	11.00
November 1	13.50	15.00	14.50	15.00	12.50	13.00	15.00	15.50	8.75	9.00	9.00	9.50		6.75	7.50	8.00	9.50	10.00	9.50	11.00
December 1	13.50	15.00	15.00	15.50	12.50	13.00	16.50	17.00	8.50	9.00	9.00	9.50		7.00	6.75		9.75	10.50	9.00	12.00

COTTON (PER POUND).

1892.	*Middling.*	*Middling.*	*Middling.*	*Middling.*	*Middling.*	*Middling.*	*Middling.*	*Middling.*	*Middling.*	*Middling.*
August 1	$0.07\frac{3}{16}$	$0.07\frac{1}{4}$	$0.07\frac{3}{16}$	$0.07\frac{3}{16}$	$0.07\frac{5}{8}$	$0.07\frac{1}{2}$	$0.07\frac{1}{8}$	$0.07\frac{3}{16}$	$0.07\frac{3}{16}$	$0.06\frac{7}{8}$
September 1	.07	$.07\frac{1}{2}$	$.06\frac{3}{4}$	.07	$.07\frac{3}{8}$	.07	$.06\frac{3}{4}$	.07	.07	$.06\frac{7}{8}$
October 1	$.07\frac{5}{16}$	$.07\frac{13}{16}$	$.07\frac{1}{4}$	$.07\frac{7}{16}$	$.07\frac{5}{8}$	$.07\frac{7}{16}$	$.07\frac{1}{4}$	$.07\frac{7}{16}$	$.07\frac{1}{4}$	$.07\frac{3}{16}$
November 1	$.07\frac{9}{16}$	$.08\frac{5}{16}$	$.07\frac{1}{2}$	$.07\frac{13}{16}$	.08	$.07\frac{13}{16}$	$0.07\frac{3}{4}$ to $.07\frac{13}{16}$	$.07\frac{1}{2}$	$.07\frac{3}{4}$	$.07\frac{7}{16}$
December 1	$.09\frac{1}{8}$	$.09\frac{3}{4}$	$.09\frac{1}{8}$	$.09\frac{9}{16}$	.10	$.09\frac{5}{8}$	$.09\frac{1}{8}$	$.09\frac{3}{8}$	.10	$.09\frac{7}{16}$

Wholesale prices of principal agricultural products in leading cities of the United States, 1892 to 1897—Continued.

COTTON (PER POUND)—Continued.

Date.	Boston.	New York.	Richmond.	New Orleans.	Cincinnati.	Chicago.	Kansas City.	St. Paul.	St. Louis.	San Francisco (per cental).
1893.	*Middling.*	*Middling.*	*Middling.*	*Middling.*	*Middling.*	*Middling.*	*Middling.*	*Middling.*	*Middling.*	*Middling.*
August 1	$0.07⅝	$0.08	$0.07⅝	$0.07⅞	$0.08½	$0.07⅞	$0.07⅝	$0.07¾	$0.07 9/16	$0.07½
September 1	.07½	.07 13/16	.07 1/16	.07 5/16	.07½	.07 5/16	.06⅞	.07¼	.07¼	.07 3/16
October 2	.07½	.08 1/16	.07 7/16	.07¾	.08¼	.07 11/16	$0.07 9/16 to .07⅝	.07½	.07 13/16	.07
November 1	.07½	.08 3/16	.07½	.07½	.08	.07⅝	.07⅝	.07¾	.07 11/16	.07½
December 1	.07½	.08 1/16	.07 7/16	.07 9/16	.07⅝	.07⅝	.07½	.07 9/16	.07 9/16	.07 7/16
1894.										
August 1	.06 9/16	.06 15/16	.06⅝	.06½	.07¼	.06¾	.06½	.06¾	.06⅞	.06½
September 1	.06 7/16	.06⅝	.06 5/16	.06 7/16	.07	.06½	.06¼	.06 11/16	.06⅜	.06 3/16
October 1	.05 11/16	.06¼	.05 9/16	.05 9/16	.06¼	.05⅝	.05½ to .05⅝	.05⅞	.05¾	.05 5/16
November 1	.05 1/16	.05¾	.05 3/16	.05 3/16	.05½	.05 3/16	.05½	.05¼	.05¼	.04 15/16
December 1	.05¼	.05 13/16	.05 3/16	.05 5/16	.05⅝	.05 5/16	.05½	.05¼	.05⅝	.05 1/16
1895.										
August 1	.06⅞	.07⅛	.06 11/16	.06 9/16	.07	.06¾	.06½	.07	.06 13/16	.06⅝
September 3	.07⅞	.08¼	.07½	.07 9/16	.07⅞	.07 11/16	.07½	.07⅝	.07⅝	.07 5/16
October 1	.08⅝	.09 1/16	.08½	.08¼	.08⅞	.08¾	.08⅜ to .08 7/16	.08½	.08¾	.08½
November 1	.08⅜	.09	.08 7/16	.08½	.09	.08½	.08⅜	.08½	.08⅝	.08⅝
December 1	.08⅛	.08 9/16	.08⅛	.08 3/16	.08⅜	.08¼	.08⅛	.08¼	.08 5/16	.08 1/16
1896.										
August 1	.06 9/16	.07 7/16	.06⅝	.06 13/16	.07	.06 13/16	.06½	.06¾	.06¾	.06 9/16
September 1	.07⅛	.08 3/16	.07¼	.07½	.07¾	.07½	.07 1/16 to .07⅝	.07½	.07⅝	.07 [illegible]
October 1	.07½	.08⅜	.07½	.07⅝	.08	.07½	.07⅜	.07½	.07¾	.07⅝
November 2	.07 3/16	.08 3/16	.07 3/16	.07⅜	.07⅝	.07 5/16	.07⅛	.07⅜	.07 5/16	.07 [illegible]
December 1	.07⅛	.07 11/16	.07	.07⅝	.07⅛	.07 3/16	.07	.07¼	.07¼	.07⅛
1897.										
August 2	.07⅛	.08	$0.07½ to .07¾	.07 11/16	.08⅛	.07 13/16	.07½	.08⅛	.07 13/16	.07 7/16
September 1	.07	.07 13/16	.07	.07 1/16	.08⅛	.07 7/16	.06¾ to .06⅞	$0.07 to .08	.07⅝	.07⅛
October 1	.05⅞	.06½	.05 13/16	.06	.06⅜	.06	.06 3/16	.06 3/16	.06⅛	.05¾
November 1	.05⅝	.06	.05 5/16	.05½	.05⅞	.05 7/16	.05 5/16	.05 9/16	.05 9/16	.05 5/16
December 1	.05 3/16	.05 13/16	.05⅛	.05¼	.05½	.05¼	.05 3/16	.05½	.05¼	.05 1/16

Number and value of farm animals in the United States, 1879 to 1898.

[From Division of Statistics.]

January 1	Horses.		Mules.		Milch cows.	
	Number.	Value.	Number.	Value.	Number.	Value.
1879	10,938,700	$573,254,808	1,713,100	$96,033,971	11,826,400	$256,953,928
1880	11,201,800	613,296,611	1,729,500	105,948,319	12,027,000	279,899,420
1881	11,429,626	667,954,325	1,720,731	120,096,164	12,368,653	296,277,060
1882	10,521,554	615,824,914	1,835,166	130,945,378	12,611,632	326,480,310
1883	10,838,111	765,041,308	1,871,079	148,732,390	13,125,685	396,575,405
1884	11,169,683	833,734,400	1,914,126	161,214,976	13,501,206	423,486,649
1885	11,564,572	852,282,947	1,972,569	162,497,097	13,904,722	412,903,093
1886	12,077,657	860,823,208	2,052,593	163,381,096	14,235,388	389,985,523
1887	12,496,744	901,685,755	2,117,141	167,057,538	14,522,083	378,789,589
1888	13,172,936	946,096,154	2,191,727	174,853,563	14,856,414	366,252,173
1889	13,663,294	982,194,827	2,257,574	179,444,481	15,298,625	366,226,376
1890	14,213,837	978,516,562	2,331,027	182,394,099	15,952,883	352,152,133
1891	14,056,750	941,823,222	2,296,532	178,847,370	16,019,591	346,397,900
1892	15,498,140	1,007,593,636	2,314,699	174,882,070	16,416,351	351,378,132
1893	16,206,802	992,225,185	2,331,128	164,763,751	16,424,087	357,299,785
1894	16,081,139	769,224,799	2,352,231	146,232,811	16,487,400	358,998,661
1895	15,893,318	576,730,580	2,333,108	110,927,834	16,504,629	362,601,729
1896	15,124,057	500,140,186	2,278,946	103,204,457	16,137,586	363,955,545
1897	14,364,667	452,649,396	2,215,654	92,302,090	15,941,727	369,239,993
1898	13,960,911	478,362,407	2,257,665	99,032,062	15,840,886	434,813,826

	Cattle, other than milch cows.		Sheep.		Swine.		Total value of farm animals.
	Number.	Value.	Number.	Value.	Number.	Value.	
1879	21,408,100	$329,543,327	38,123,800	$79,023,984	34,766,100	$110,613,044	$1,445,423,062
1880	21,231,000	341,761,154	40,765,900	90,230,537	34,034,100	145,781,515	1,576,917,556
1881	20,937,702	362,861,509	43,576,899	104,070,759	36,247,603	170,535,435	1,721,795,252
1882	23,280,238	463,069,499	45,016,224	106,594,954	44,122,200	263,543,195	1,906,459,250
1883	28,046,077	611,549,109	49,237,291	124,365,835	43,270,086	291,951,221	2,338,215,268
1884	29,046,101	683,229,054	50,626,626	119,902,706	44,200,893	246,301,139	2,467,868,924
1885	29,866,573	694,382,913	50,360,243	107,960,650	45,142,657	226,401,683	2,456,428,380
1886	31,275,242	661,956,274	48,322,331	92,443,867	46,092,043	196,569,894	2,365,159,862
1887	33,511,750	663,137,926	44,759,314	89,872,839	44,612,836	200,043,291	2,400,586,938
1888	34,378,363	611,750,520	43,544,755	89,279,926	44,346,525	220,811,082	2,409,043,418
1889	35,032,417	597,236,812	42,599,079	90,640,369	50,301,592	291,307,193	2,507,050,058
1890	36,849,024	560,625,137	44,336,072	100,659,761	51,602,780	243,418,336	2,418,766,028
1891	36,875,648	544,127,908	43,431,136	108,397,447	50,625,106	210,193,923	2,329,787,770
1892	37,651,239	570,749,155	44,938,365	116,121,290	52,398,019	241,031,415	2,461,755,698
1893	35,954,196	547,882,204	47,273,553	125,909,264	46,094,807	295,426,492	2,483,506,681
1894	36,608,168	536,789,747	45,048,017	89,186,110	45,206,498	270,384,626	2,170,816,754
1895	34,364,216	482,999,129	42,294,064	66,685,767	44,165,716	219,501,267	1,819,446,306
1896	32,085,409	508,928,416	38,298,783	65,167,735	42,842,759	186,529,745	1,727,926,084
1897	30,508,408	507,929,421	36,818,643	67,020,942	40,600,276	166,272,770	1,655,414,612
1898	29,264,197	612,296,634	37,656,960	92,721,133	39,759,993	174,351,409	1,891,577,471

Average value of farm animals in the United States on January 1, 1879 to 1898.

[From Division of Statistics.]

Years.	Horses.	Mules.	Milch cows.	Cattle, other than milch cows.	Sheep.	Swine.
1879	$52.41	$56.06	$21.73	$15.39	$2.07	$3.18
1880	54.75	61.26	23.27	16.10	2.21	4.28
1881	58.44	69.79	23.95	17.33	2.39	4.70
1882	58.53	71.35	25.89	19.89	2.37	5.97
1883	70.59	79.49	30.21	21.81	2.53	6.75
1884	74.64	84.22	31.37	23.52	2.37	5.57
1885	73.70	82.38	29.70	23.25	2.14	5.02
1886	71.27	79.60	27.40	21.17	1.91	4.26
1887	72.15	78.91	26.08	19.79	2.01	4.48
1888	71.82	79.78	24.65	17.79	2.05	4.98
1889	71.89	79.49	23.94	17.05	2.13	5.79
1890	68.84	78.25	22.14	15.21	2.27	4.72
1891	67.00	77.88	21.62	14.76	2.50	4.15
1892	65.01	75.55	21.40	15.16	2.58	4.60
1893	61.22	70.68	21.75	15.24	2.66	6.41
1894	47.83	62.17	21.77	14.66	1.98	5.98
1895	36.29	47.55	21.97	14.06	1.58	4.97
1896	33.07	45.29	22.55	15.86	1.70	4.35
1897	31.51	41.66	23.16	16.65	1.82	4.10
1898	34.26	43.88	27.45	20.92	2.46	4.39

Number, average price, and total value of farm animals in the United States on January 1, 1898, by States.

[From Division of Statistics.]

States and Territories.	Horses.			Mules.		
	Number.	Average price.	Value.	Number.	Average price.	Value.
Maine	114,272	$50.50	$5,770,895			
New Hampshire	54,483	47.59	2,592,999			
Vermont	85,669	44.14	3,781,669			
Massachusetts	63,162	63.35	4,001,549			
Rhode Island	10,230	76.54	782,976			
Connecticut	43,465	70.19	3,050,873			
New York	608,916	55.48	33,781,467	4,511	$58.25	$262,746
New Jersey	79,980	64.24	5,137,961	7,342	80.74	592,786
Pennsylvania	565,719	49.25	27,862,207	36,686	63.32	2,322,825
Delaware	30,577	52.95	1,619,177	5,243	68.91	361,270
Maryland	130,972	47.91	6,274,811	12,625	70.95	895,684
Virginia	238,714	37.25	8,891,021	36,733	51.54	1,893,283
North Carolina	146,991	47.16	6,931,728	112,523	53.64	6,036,220
South Carolina	67,113	51.36	3,446,710	98,340	61.27	6,024,889
Georgia	111,380	45.59	5,077,374	165,202	64.72	10,691,811
Florida	37,300	38.95	1,452,853	8,438	63.55	536,274
Alabama	130,915	40.52	5,304,161	131,036	50.15	6,571,322
Mississippi	199,482	35.40	7,061,779	162,432	49.45	8,029,440
Louisiana	142,879	29.54	4,220,299	90,004	56.28	5,065,747
Texas	1,148,500	17.30	19,866,178	265,349	30.96	8,214,550
Arkansas	237,927	28.40	6,756,888	146,974	36.52	5,367,264
Tennessee	327,424	35.17	11,516,319	160,920	37.67	6,061,550
West Virginia	153,381	35.25	5,406,535	7,487	43.37	324,727
Kentucky	380,835	32.46	12,363,042	113,348	35.89	4,067,779
Ohio	666,836	41.37	27,590,332	17,761	43.16	766,482
Michigan	418,786	46.44	19,446,741	2,756	46.43	127,969
Indiana	613,542	36.13	22,166,072	44,309	40.54	1,796,173
Illinois	1,040,767	36.05	37,519,129	86,553	40.09	3,470,267
Wisconsin	412,296	43.07	17,757,998	4,802	45.42	218,092
Minnesota	464,410	39.35	18,276,398	8,588	44.97	386,231
Iowa	1,022,242	34.01	34,770,027	32,861	39.94	1,312,466
Missouri	802,878	25.28	20,292,746	199,306	31.98	6,373,297
Kansas	749,879	26.12	19,589,832	80,212	34.48	2,765,356
Nebraska	592,985	30.53	18,102,648	42,590	37.23	1,585,625
South Dakota	287,867	28.97	8,339,207	6,627	39.59	262,394
North Dakota	170,036	37.94	6,451,838	7,008	56.04	392,712
Montana	171,795	18.23	3,131,388	915	32.77	29,984
Wyoming	73,733	14.93	1,100,948	1,511	46.08	69,620
Colorado	151,721	22.86	3,469,095	8,755	43.14	377,687
New Mexico	83,854	18.18	1,524,176	3,507	32.50	113,978
Arizona	51,973	25.28	1,313,620	1,031	24.67	25,434
Utah	67,619	17.21	1,163,489	1,615	26.14	42,218
Nevada	50,347	12.82	645,200	1,408	21.91	30,843
Idaho	130,691	13.69	1,788,895	936	23.72	22,202
Washington	173,157	24.05	4,163,817	1,427	44.09	62,910
Oregon	193,588	20.61	3,989,854	5,782	28.64	165,606
California	417,396	28.96	12,085,909	56,898	38.33	2,180,836
Oklahoma	42,227	17.34	732,177	7,931	26.60	210,967
Total	13,960,911	34.26	478,362,407	2,190,282	43.88	96,109,516

States and Territories.	Milch cows.			Cattle, other than milch cows.		
	Number.	Average price.	Value.	Number.	Average price.	Value.
Maine	195,919	$27.55	$5,397,568	107,294	$22.03	$2,363,309
New Hampshire	132,840	29.65	3,938,706	76,327	24.59	1,876,685
Vermont	266,276	27.25	7,256,021	135,139	22.07	2,982,522
Massachusetts	174,554	32.80	5,725,371	74,134	25.82	1,914,319
Rhode Island	25,258	34.00	858,772	10,676	30.18	322,233
Connecticut	138,930	32.75	4,549,958	65,282	30.08	1,963,673
New York	1,402,164	32.00	44,869,248	544,735	26.17	14,256,261
New Jersey	208,421	36.10	7,523,998	42,406	25.14	1,066,254
Pennsylvania	928,905	29.60	27,495,588	550,981	23.64	13,025,756
Delaware	35,554	26.00	924,404	23,953	22.90	548,545
Maryland	151,982	25.60	3,890,739	109,175	22.63	2,470,249
Virginia	252,512	20.55	5,189,122	356,360	19.07	6,795,970
North Carolina	258,607	14.70	3,801,523	321,228	9.92	3,188,029
South Carolina	130,682	16.25	2,123,582	152,160	9.55	1,453,811
Georgia	303,392	21.85	6,629,115	503,593	8.92	4,492,300
Florida	117,785	19.50	2,296,808	350,295	7.50	2,625,811
Alabama	296,194	12.50	3,702,425	442,736	7.02	3,109,998
Mississippi	267,657	14.85	3,974,706	370,876	8.31	3,082,348
Louisiana	138,184	16.70	2,307,673	220,108	9.61	2,115,346
Texas	722,476	20.00	14,449,520	4,823,295	15.27	73,639,656
Arkansas	223,645	16.10	3,600,684	305,522	12.03	3,675,886
Tennessee	279,863	18.50	5,177,466	379,168	13.41	5,086,344
West Virginia	167,240	25.05	4,189,362	253,604	20.79	5,273,085
Kentucky	264,051	22.15	5,848,730	392,162	20.65	8,097,948

Number, average price, and total value of farm animals, etc.—Continued.

States and Territories.	Milch cows.			Cattle, other than milch cows.		
	Number.	Average price.	Value	Number.	Average price.	Value.
Ohio	720,441	$29.35	$21,409,063	606,127	$27.16	$16,463,012
Michigan	451,561	30.85	14,023,207	348,505	23.13	8,062,319
Indiana	605,916	29.20	17,692,747	675,698	25.25	17,060,685
Illinois	1,003,218	32.85	32,955,711	1,304,192	27.72	36,150,911
Wisconsin	814,384	28.70	23,372,821	607,541	22.76	13,830,060
Minnesota	633,993	27.50	17,434,808	593,922	20.99	12,465,824
Iowa	1,214,345	31.95	38,798,323	2,207,739	28.71	63,395,211
Missouri	666,530	26.75	17,829,678	1,537,523	24.80	38,129,028
Kansas	654,286	29.15	19,072,437	2,035,774	26.38	53,705,755
Nebraska	571,591	30.65	17,519,264	1,213,764	26.82	32,518,295
South Dakota	341,579	28.10	9,598,370	432,079	25.08	10,836,978
North Dakota	167,719	27.35	4,587,115	245,282	23.08	5,660,008
Montana	42,713	31.30	1,336,917	1,082,498	22.00	23,814,965
Wyoming	17,960	31.85	572,026	688,002	23.82	16,390,696
Colorado	85,669	32.50	2,784,242	935,826	26.07	24,392,775
New Mexico	19,126	26.55	507,795	731,216	16.86	12,329,397
Arizona	18,222	26.25	478,328	509,082	15.34	7,807,026
Utah	55,564	23.95	1,330,758	322,464	17.75	5,725,345
Nevada	18,105	27.85	504,224	241,201	17.04	4,109,350
Idaho	29,167	25.50	743,758	349,142	18.61	6,498,582
Washington	120,297	25.85	3,109,677	294,862	18.44	5,436,952
Oregon	115,427	23.30	2,689,449	667,030	17.93	11,957,183
California	342,392	28.65	9,809,531	810,615	18.91	15,328,334
Oklahoma	35,590	26.20	932,458	212,814	22.42	4,771,600
Total	15,840,886	27.45	434,813,826	29,264,197	20.92	612,296,634

States and Territories.	Sheep.			Swine.		
	Number.	Average price.	Value.	Number.	Average price.	Value.
Maine	232,668	$2.84	$660,196	76,067	$7.71	$586,474
New Hampshire	76,754	2.96	227,959	55,825	8.15	454,972
Vermont	161,107	3.38	543,897	75,453	7.88	594,194
Massachusetts	41,262	3.56	146,997	57,131	8.54	488,010
Rhode Island	10,769	3.23	34,731	14,146	7.86	111,187
Connecticut	30,820	3.52	108,363	54,274	9.83	533,514
New York	825,446	4.04	3,332,739	638,849	7.24	4,626,544
New Jersey	41,067	3.78	155,193	150,368	7.25	1,090,545
Pennsylvania	782,776	3.41	2,669,266	1,033,001	6.78	6,999,613
Delaware	12,852	3.59	46,112	50,055	7.16	358,394
Maryland	132,170	3.28	433,452	328,567	5.69	1,870,366
Virginia	380,956	2.57	980,581	955,781	3.45	3,297,444
North Carolina	290,445	1.47	425,502	1,426,774	3.03	4,318,844
South Carolina	70,787	1.58	112,197	1,031,150	3.94	4,062,731
Georgia	341,233	1.67	568,494	2,073,254	3.66	7,592,255
Florida	89,890	1.77	158,925	456,519	2.13	972,386
Alabama	219,356	1.28	279,898	1,848,158	2.51	4,648,117
Mississippi	266,356	1.40	372,898	1,919,019	2.83	5,432,741
Louisiana	126,769	1.41	178,808	751,413	2.91	2,186,611
Texas	2,649,914	1.67	4,409,457	2,826,202	3.14	8,874,588
Arkansas	136,060	1.40	190,688	1,293,051	2.17	2,805,920
Tennessee	328,868	1.75	575,907	1,688,338	3.23	5,449,956
West Virginia	448,994	2.88	1,292,204	352,727	3.93	1,386,217
Kentucky	649,612	2.46	1,599,995	1,475,831	3.36	4,963,219
Ohio	2,416,346	3.42	8,274,777	2,330,355	5.47	12,737,720
Michigan	1,355,391	3.46	4,695,075	727,757	5.70	4,148,943
Indiana	667,853	3.54	2,361,863	1,326,961	5.17	6,857,735
Illinois	601,168	3.44	2,065,914	2,159,425	5.57	12,019,360
Wisconsin	715,809	3.20	2,287,725	920,557	6.18	5,689,042
Minnesota	406,929	2.86	1,164,631	433,003	5.39	2,331,722
Iowa	573,218	3.56	2,044,095	3,625,831	5.99	21,704,225
Missouri	655,428	2.63	1,727,708	3,105,072	3.98	12,358,188
Kansas	226,659	2.78	631,586	1,692,916	5.10	8,641,489
Nebraska	266,163	2.85	759,362	1,327,128	5.38	7,146,582
South Dakota	349,709	2.65	926,029	142,617	5.55	791,524
North Dakota	352,668	2.48	876,028	119,105	5.32	633,045
Montana	3,247,641	2.40	7,804,081	46,961	7.26	340,935
Wyoming	1,940,021	2.95	5,714,332	22,345	5.84	130,572
Colorado	1,625,089	2.38	3,869,445	22,035	5.10	112,379
New Mexico	2,844,265	1.89	5,364,284	29,905	6.07	181,524
Arizona	845,239	2.10	1,773,734	24,772	8.40	208,181
Utah	1,978,457	2.10	4,144,868	47,335	6.31	298,471
Nevada	549,518	2.20	1,206,467	11,349	3.94	44,716
Idaho	1,651,343	2.19	3,612,313	71,432	4.61	329,553
Washington	744,925	2.18	1,622,446	168,546	4.96	835,989
Oregon	2,682,779	1.66	4,451,150	220,847	3.63	801,896
California	2,589,965	2.23	5,785,915	467,676	4.08	1,906,247
Oklahoma	25,536	2.07	52,846	84,010	4.72	396,529
Total	37,656,960	2.46	92,721,133	39,759,993	4.39	174,351,409

IMPORTS AND EXPORTS OF AGRICULTURAL PRODUCTS.

Agricultural imports of the United States during the five years ended June 30, 1897.

[From Section of Foreign Markets.]

Articles imported.	1893.		1894.		1895.		1896.		1897	
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.
ANIMAL MATTER.										
Animals, live:										
Cattle ....number..	3,293	$45,682	1,592	$18,704	149,781	$765,853	217,826	$1,509,856	328,977	$2,589,857
Horses ....do....	15,451	2,388,267	6,166	1,319,572	13,098	1,055,191	9,991	662,591	6,998	464,808
Sheep ....do....	459,484	1,682,977	242,568	788,181	291,461	682,618	322,692	853,530	405,633	1,019,668
All other, including fowls	....	525,269	....	274,789	....	233,416	....	226,500	....	211,122
Total........	....	4,642,195	....	2,401,246	....	2,737,078	....	3,252,477	....	4,285,455
Animal products:										
Beeswax ....pounds..	248,000	62,024	318,660	80,024	288,001	78,776	273,464	75,970	174,017	43,339
Bones, crude or not manufactured	....	360,573	....	207,033	....	305,049	....	157,946	....	224,039
Bristles—										
Crude, not sorted, bunched, or prepared ....pounds..	1,598,818	1,508,258	892,520	929,231	4,741	1,892	726	1,620	630	385
Sorted, bunched, or prepared, pounds........					1,296,753	1,242,259	1,571,804	1,433,728	1,347,270	1,216,794
Total........pounds..	1,598,818	1,508,258	892,520	929,231	1,301,494	1,244,151	1,572,530	1,435,348	1,347,900	1,217,179
Dairy products—										
Butter ....do....	73,423	13,479	144,346	23,356	72,148	12,930	52,067	8,533	37,963	6,077
Cheese ....do....	10,195,924	1,425,927	8,742,851	1,247,198	10,276,293	1,450,657	10,728,397	1,491,338	12,319,122	1,668,796
Milk	....	110,186	....	102,336	....	80,491	....	62,622	....	58,467
Total........	....	1,549,592	....	1,372,890	....	1,544,078	....	1,562,493	....	1,733,340
Eggs ....dozen..	3,318,011	392,973	1,791,430	199,536	2,705,502	324,136	947,132	88,682	580,681	47,760
Feathers and downs, crude........	....	654,337	....	263,849	....	1,746,967	....	2,386,804	....	2,232,908
Fibers, animal—										
Silk—										
Cocoon............pounds..	186,929	111,037	181,824	112,385	320,621	139,042	279,067	112,900	....	....
Raw, or as reeled from the cocoon ....pounds..	7,422,430	29,055,557	4,956,875	15,627,822	7,974,810	22,029,068	8,000,621	26,246,902	6,513,612	18,496,944
Waste ....do....	888,118	670,392	763,786	493,975	1,021,029	457,946	1,084,299	403,626	1,479,832	421,339
Total ....do....	8,497,477	29,836,986	5,902,485	16,234,182	9,316,460	22,626,056	9,363,987	26,763,428	7,993,444	18,918,283

Wools, hair of the camel, goat, alpaca, and other like animals, unmanufactured—										
Class 1, clothing—										
In the grease.......lbs..	43,311,565	7,876,676	10,685,496	1,748,359	87,151,522	13,335,602	117,233,440	19,448,471	176,350,510	27,824,507
Scoured...........do...									24,408,569	6,457,149
Total..................do....	43,311,565	7,876,676	10,685,496	1,748,359	87,151,522	13,335,602	117,233,440	19,448,471	200,759,079	34,281,656
Class 2, combing—										
In the grease.....do....	6,736,201	1,466,641	1,518,505	399,875	13,476,735	2,637,581	15,756,318	3,509,736	37,627,967	7,119,201
Scoured..........do....									323,523	68,419
Total..................do....	6,736,201	1,466,641	1,518,505	399,875	13,476,735	2,637,581	15,756,318	3,509,736	37,951,490	7,187,620
Class 3, carpet—										
In the grease.....do....	122,386,072	11,720,863	42,918,581	3,959,204	105,405,649	9,583,2 38	97,921,715	9,493,035	110,665,432	11,599,886
Scoured..........do...									1,476,025	174,029
Total..................do....	122,386,072	11,720,863	42,918,581	3,959,204	105,405,649	9,583,238	97,921,715	9,493,035	112,141,457	11,773,915
Total wools............do....	172,433,838	21,064,180	55,152,585	6,107,438	206,033,906	25,556,421	230,911,473	32,451,242	350,852,026	53,243,191
Gelatin....................	....	(a)	....	(a)	....	(a)	....	15,386	....	5,748
Glue.....................pounds..	6,170,162	567,756	4,132,524	400,240	4,751,048	416,394	6,276,926	555,979	4,926,620	472,312
Grease—										
Grease and oils commonly used in soap making, wire drawing, or dressing leather, etc., pounds....................	4,887,288	190,896	3,833,616	128,032	724,304	27,625	....	41,698	....	8,026
Other grease, including tallow	....	501,885	....	292,027	....	1,308,763	....	1,190,303	....	976,306
Total....................	....	692,781	....	420,059	....	1,336,388	....	1,232,001	....	984,332
Gut, unmanufactured..........	....	229,261	....	188,111	....	212,645	....	195,392	....	180,721
Hair, unmanufactured..........	....	2,005,796	....	839,972	....	1,165,944	....	1,244,077	....	1,330,652
Hide cuttings, raw, and other glue stock....................	....	365,525	....	280,062	....	263,175	....	279,692	....	289,686
Hides and skins, other than furs—										
Goatskins..............pounds..	....	12,844,245	....	8,583,166	54,240,492	10,954,827	46,747,029	10,304,395	49,868,020	11,328,162
All other..................do....	....	15,503,651	....	8,202,986	172,335,253	15,168,115	163,650,982	20,215,782	156,232,824	16,534,864
Total...................do....	....	28,347,896	....	16,786,152	226,575,745	26,122,942	210,398,011	30,520,177	206,100,844	27,863,026
Honey....................gallons..	176,147	79,396	152,643	56,156	67,444	22,993	79,985	30,609	66,432	27,599
Hoofs, horns, etc., unmanufactured, and horn strips and tips..	....	554,902	....	235,232	....	268,800	....	568,445	....	150,134

a Not separately stated.

Agricultural imports of the United States during the five years ended June 30, 1897—Continued.

Articles imported.	1893.		1894.		1895.		1896.		1897.	
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.
ANIMAL MATTER—continued.										
Animal products—Continued.										
Meat products—										
Meat and meat extracts		$558,284		$412,666		$179,336		$493,393		$601,808
All other		16,717		12,291		5,244		39,129		49,484
Total		575,001		424,957		484,580		532,522		651,292
Oils, animal, not elsewhere specified, except whale and fish, gallons	55,619	21,327	3,597	1,232	1,464	469	37,330	12,213	38,334	6,066
Oleostearin ... pounds							523,341	37,020		
Rennets, raw or prepared		109,358		76,063		84,415		51,073		61,026
Sausage, bologna ... pounds		98,659		102,610		93,188	359,260	80,887	328,080	76,303
Sausage skins		583,217		495,118		419,345		588,657		542,817
Total animal products		89,659,798		45,800,147		84,317,912		100,866,013		110,300,733
Total animal matter		94,301,993		48,201,393		87,054,990		104,118,490		114,586,188
VEGETABLE MATTER.										
Argal, argol, or crude tartar . pounds	28,770,810	2,341,575	22,373,180	1,504,200	27,911,122	1,893,730	28,481,665	2,724,709	23,457,576	1,967,042
Breadstuffs:										
Barley ... bushels	1,970,129	921,605	791,061	358,744	2,116,816	867,743	837,384	317,209	1,271,787	394,749
Corn (maize) ... do	1,881	1,265	2,199	1,508	16,575	7,552	4,338	1,877	6,284	2,070
Oats ... do	21,309	8,897	8,345	3,928	308,308	80,901	47,506	13,039	46,459	12,071
Oatmeal ... pounds	506,232	25,642	421,459	24,483	396,176	21,993	343,732	19,689	1,525,409	32,742
Rye ... bushels	8,598	7,055	50	37	12,918	6,272	154	291	72	170
Wheat ... do	966,280	707,053	1,181,060	769,177	1,429,993	868,965	2,110,030	1,386,161	1,534,117	1,176,337
Wheat flour ... barrels	410	2,223	401	1,946	1,868	8,295	1,394	6,848	2,250	9,914
All other, and preparations of, used as food		1,266,835		1,042,064		998,092		1,035,700		1,146,710
Total		2,940,575		2,201,887		2,859,813		2,780,814		2,774,763
Chocolate, other than confectionery, and sweetened chocolate .. pounds	543,266	118,479	969,855	198,425	897,637	174,805	1,145,467	198,417	1,467,977	239,819

Cocoa or cacao:										
Crude, and leaves and shells of, pounds	24,460,325	4,017,801	17,634,779	2,402,382	29,307,048	3,195,811	23,276,597	2,387,078	31,466,612	2,997,866
Prepared or manufactured..lbs..	1,456,289	499,974	1,294,759	454,730	1,433,576	482,532	1,244,309	410,249	1,495,459	443,604
Total..........do...	25,916,614	4,517,775	18,929,538	2,857,112	30,740,624	3,678,343	24,520,906	2,797,327	32,962,071	3,441,470
Coffee..........do....	563,469,068	80,485,558	550,934,337	90,314,676	652,208,975	96,130,717	580,597,915	84,793,124	737,645,670	81,544,384
Coffee substitutes:										
Chicory root—										
Raw, unground..........do....	6,689,332	134,070	7,951,042	168,892	9,544,186	158,142	15,841,955	210,228	16,969,162	232,494
Roasted, ground, or otherwise prepared..........pounds.	2,007,738	74,814	1,906,300	74,516	445,458	14,816	475,933	15,849	360,008	13,892
Total..........do....	8,697,070	208,884	9,857,342	243,408	9,989,644	172,958	16,317,888	226,077	17,329,170	246,386
All other..........do....	1,729,124	64,298	1,389,672	55,554	2,776,117	106,886	2,366,962	90,532	2,373,245	87,686
Total..........do....	10,426,194	273,182	11,247,014	298,962	12,765,761	279,844	18,684,850	316,609	19,702,415	334,072
Fibers, vegetable:										
Cotton, unmanufactured. pounds..	43,367,952	4,688,799	27,705,949	3,003,888	49,332,022	4,714,375	55,350,520	6,578,212	51,5[illegible],926	5,884,262
Flax, and tow of..........tons..	6,696	1,879,152	4,352	1,336,845	5,008	1,008,743	6,538	1,171,663	7,480	1,256,717
Flax, hackled, etc..........do....					2,225	1,050,548	1,295	632,765	1,710	641,259
Hemp, and tow of..........do....	4,817	685,485	1,635	239,918	6,177	754,975	8,356	1,046,656	5,096	633,288
Hemp, hackled, etc..........do....					777	127,786	94	22,847	24	6,509
Istle or Tampico fiber..........do....	4,987	321,869	4,789	257,089	9,827	458,404	12,207	717,585	6,313	355,841
Jute and jute butts..........do....	82,231	2,467,828	50,037	1,716,298	110,671	2,752,966	88,992	2,001,206	68,530	1,630,484
Manila..........do....	59,439	8,376,370	35,233	4,013,255	50,278	4,060,517	47,244	3,604,585	46,290	3,498,322
Sisal grass..........do....	54,431	6,005,484	48,468	3,742,073	47,596	2,743,396	52,130	3,412,760	65,266	3,834,772
All other..........do....	16,303	1,635,367	10,207	858,003	6,152	324,746	6,336	260,627	8,734	579,206
Total..........	....	26,060,354	....	15,167,369	....	17,996,456	....	19,448,906	....	18,220,680
Flowers, natural, dressed or undressed	....	55,046	....	41,445	....	10,014	....	10,386	....	10,334
Fruit juices:										
Prune juice or prune wine..galls..	22,365	19,481	31,792	27,406	39,011	28,826	34,422	28,566	34,546	24,222
Other, including cherry juice......	....	36,601	....	17,452	....	26,470	....	47,285	....	56,767
Total..........	....	56,082	....	44,858	....	55,296	....	75,851	....	80,989
Fruits and nuts:										
Fruits—										
Bananas..........	....	5,361,187	....	5,122,503	....	4,674,861	....	4,502,746	....	4,086,320
Currants..........pounds..	33,166,546	1,185,537	52,664,843	774,802	16,450,706	258,659	33,040,846	551,072	29,265,761	396,084
Dates..........do....	16,211,906	493,910	12,408,192	387,586	15,186,789	316,592	13,680,302	273,456	11,847,279	284,056
Figs..........do....	10,503,928	548,995	7,985,959	392,040	11,855,890	587,420	11,900,710	639,512	8,940,762	535,380
Lemons..........	....	4,994,328	....	4,285,278	....	3,917,326	....	5,040,344	....	4,043,822
Oranges..........	....	1,695,469	....	1,127,005	....	1,997,266	....	2,694,131	....	2,324,907
Plums and prunes....pounds..	26,414,112	1,162,318	9,908,122	416,342	14,352,057	527,625	483,658	68,862	710,028	73,316
Raisins..........do....	27,543,563	1,266,342	13,751,050	554,081	15,921,278	651,420	10,826,094	460,200	12,650,598	567,039

Agricultural imports of the United States during the five years ended June 30, 1897—Continued.

Articles imported.	1893.		1894.		1895.		1896.		1897.	
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.
VEGETABLE MATTER—continued.										
Fruits and nuts—Continued.										
Fruits—Continued.										
Prepared or preserved fruits		$864,166		$526,561		$570,568		$598,928		$605,053
All other fruits *a*		3,372,666		2,980,584		1,725,342		2,128,056		1,810,807
Total fruits		20,944,918		16,566,782		15,227,079		16,957,307		14,926,771
Nuts—										
Almonds .... pounds	6,679,147	938,054	7,436,784	769,453	7,903,375	810,439	7,789,681	763,594	9,644,338	880,263
Cocoanuts		852,509		786,777		471,994		442,739		471,387
All other nuts		951,941		631,759		730,411		868,799		848,511
Total nuts		2,742,504		2,187,989		2,012,844		2,075,132		2,200,161
Total fruits and nuts		23,687,422		18,754,771		17,239,923		19,032,439		17,126,932
Ginger, preserved or pickled		13,282		14,387		15,395		23,547		7,123
Hay .... tons	104,257	964,755	86,784	761,940	201,900	1,433,716	302,652	2,773,535	119,942	1,030,497
Hops .... pounds	2,691,244	1,085,407	828,022	484,415	3,133,664	599,744	2,772,045	600,419	3,017,821	629,987
Indigo .... do	3,226,312	3,137,511	1,718,534	1,218,576	3,956,986	2,015,975	3,340,001	1,673,170	3,522,016	1,696,641
Malt, barley .... bushels	3,559	4,411	5,010	5,676	11,069	7,495	5,579	4,774	11,084	9,384
Malt, extract, fluid and solid		50,618		28,253		51,501		23,889		11,485
Malt liquors:										
In bottles or jugs .... gallons	1,296,586	1,256,539	931,172	885,537	943,939	900,037	1,038,641	1,007,146	1,048,994	1,025,867
In other receptacles .... do	2,068,803	683,831	1,979,368	625,230	2,027,737	614,808	2,244,763	657,870	1,915,650	534,426
Total .... do	3,365,389	1,940,370	2,910,540	1,510,767	2,971,676	1,514,845	3,283,404	1,665,016	2,964,644	1,560,293
Oil cake .... pounds	7,302,527	82,916	7,600,871	37,588	6,794,531	47,774	7,473,016	45,725	3,098,364	20,313
Oils, vegetable:										
Fixed or expressed—										
Olive, salad .... gallons	686,852	891,424	757,478	909,897	775,046	952,405	942,598	1,107,049	928,567	1,134,077
Other		2,754,372		1,730,797		2,570,035		2,557,026		2,353,084
Volatile or essential .... pounds	4,022,117	1,654,036	2,861,875	1,102,108		1,398,956		1,554,289		1,885,523
Total		5,299,832		3,742,802		4,921,396		5,218,364		5,372,684
Opium:										
Crude or unmanufactured .... lbs	615,957	1,186,824	716,881	1,691,914	358,455	730,669	365,514	683,347	1,072,914	2,184,727
Prepared .... do	63,222	446,422	50,102	310,771	139,765	920,006	98,745	735,134	157,061	1,152,861
Total .... do	679,179	1,633,246	766,983	2,002,685	498,220	1,650,675	464,259	1,418,481	1,229,975	3,317,588

Plants, trees, shrubs, vines, etc.	....	137,503	....	121,143	....	632,523	....	955,307	....	963,977
Rice and rice meal:										
Rice.......pounds	81,031,944	1,598,625	86,810,536	1,510,992	141,301,411	2,353,974	78,190,334	1,274,574	133,939,960	2,555,970
Rice flour, rice meal, and broken rice.......pounds	66,451,884	1,191,526	55,351,281	833,843	78,262,909	1,091,538	68,534,273	911,005	63,876,204	961,200
Total.......do	147,483,828	2,790,151	142,161,817	2,374,835	219,564,320	3,445,512	146,724,607	2,185,579	197,816,134	3,517,160
Sauerkraut	....	39,153	....	16,652	....	25,898	....	7,895	....	1,831
Seeds:										
Linseed or flaxseed.......bushels	112,015	146,818	592,820	701,866	4,166,222	4,554,484	754,507	812,940	105,222	108,871
All other	....	2,610,192	....	1,693,737	....	1,981,096	....	1,870,214	....	1,315,055
Total	....	2,757,010	....	2,395,603	....	6,535,580	....	2,683,154	....	1,423,926
Spices:										
Unground—										
Nutmegs.......pounds	1,419,636	613,743	1,140,878	395,977	1,652,613	513,801	1,355,420	433,436	1,069,740	451,614
Pepper, black and white.......do	21,467,275	1,278,062	12,764,215	665,576	20,501,837	791,343	16,644,763	650,861	15,063,452	711,453
Other.......do	16,862,214	1,110,197	11,857,688	943,155	17,879,564	1,062,868	19,193,589	999,226	20,411,490	1,076,963
All other, ground, etc.......do	2,488,466	298,008	1,664,246	257,845	2,058,782	272,223	3,618,214	294,996	3,000,031	336,686
Total.......do	42,237,591	3,300,010	30,427,027	2,262,553	42,092,796	2,640,235	39,811,986	2,378,519	40,144,713	2,576,716
Spirits, distilled:										
Of domestic manufacture, returned.......proof gallons	915,688	1,001,792	1,060,627	910,526	770,124	670,292	1,029,653	940,030	956,760	863,558
Brandy.......do	326,303	918,165	201,433	568,458	313,327	813,882	259,704	690,761	337,595	911,721
All other.......do	1,024,751	1,082,154	893,131	931,146	1,139,710	1,246,567	1,249,895	1,446,873	1,727,110	2,074,835
Total.......do	2,266,742	3,002,111	2,155,191	2,410,130	2,223,161	2,730,741	2,539,252	3,077,694	3,021,465	3,850,114
Starch.......pounds	3,855,437	90,483	2,045,216	42,606	4,265,650	82,150	3,467,399	62,756	2,941,253	51,812
Straw.......tons	8,892	30,681	8,313	27,300	7,745	24,544	7,879	31,140	9,386	31,768
Sugar and molasses:										
Molasses.......gallons	15,490,679	1,992,334	19,670,663	1,984,778	15,075,879	1,295,146	4,687,664	737,265	3,702,471	586,513
Sugar—										
Not above No. 16 Dutch standard—										
Beet sugar.......pounds	436,333,843	12,846,509	510,350,276	15,793,041	347,376,732	6,993,282	604,686,985	14,048,914	1,865,577,435	33,689,158
Other.......do	3,296,706,423	102,108,587	3,775,878,029	108,842,016	3,168,781,436	67,836,512	3,104,187,781	69,817,286	2,854,192,069	60,448,873
Above No. 16 Dutch standard.......pounds	33,405,081	1,300,688	58,965,576	2,236,832	58,352,286	1,633,042	187,463,791	5,353,573	199,136,169	4,928,150
Total sugar.......do	3,766,445,347	116,255,784	4,345,193,881	126,871,889	3,574,510,454	76,462,836	3,896,338,557	89,219,773	4,918,905,733	99,066,181
Total sugar and molasses	....	118,248,118	....	128,856,667	....	77,757,982	....	89,957,038	....	99,652,694

a Including nuts free of duty.

Agricultural imports of the United States during the five years ended June 30, 1897—Continued.

Articles imported.	1893.		1894.		1895.		1896.		1897.	
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.
VEGETABLE MATTER—continued.										
Tea........pounds..	89,061,287	$13,857,482	93,518,717	$14,144,243	97,253,458	$13,171,379	93,998,372	$12,704,440	113,347,175	$14,835,862
Tobacco, leaf:										
Suitable for cigar wrappers..do....	5,919,203	5,620,357	4,447,308	5,098,461	5,679,252	7,219,877	5,211,852	5,596,778	6,057,268	5,663,214
Other........do....	22,191,175	9,082,083	15,215,951	5,886,925	20,989,009	7,525,843	27,713,114	10,906,352	7,747,959	3,920,941
Total........do....	28,110,378	14,702,440	19,663,259	10,985,386	26,668,261	14,745,720	32,924,966	16,503,130	13,805,227	9,584,155
Vanilla beans........do....	238,733	763,935	171,556	727,853	137,296	495,273	235,763	1,013,608	165,001	884,865
Vegetables:										
Beans and peas........bushels..	1,754,943	1,734,228	1,184,081	1,117,969	1,535,960	1,548,767	613,801	658,320	482,984	489,274
Cabbages........number..	....	(*a*)	....	(*a*)	....	(*a*)	1,261,696	55,644	711,033	38,905
Onions........bushels..	....	(*a*)	....	(*a*)	....	(*a*)	....	(*a*)	560,138	627,273
Potatoes........do....	4,317,021	2,066,589	3,002,578	1,277,194	1,341,533	603,554	175,240	127,595	246,178	145,584
Pickles and sauces........	....	454,099	....	341,135	....	321,632	....	324,377	....	332,243
All other—										
In their natural state........	....	691,968	....	653,259	....	679,894	....	683,117	....	256,752
Prepared or preserved........	....	639,805	....	505,510	....	817,689	....	727,797	....	720,822
Total vegetables........	....	5,586,689	....	3,895,067	....	3,971,536	....	2,576,850	....	2,610,854
Vinegar........gallons..	66,834	19,295	68,542	18,501	75,108	19,823	81,075	24,552	76,123	20,519
Wafers, unmedicated........	....	11,647	....	20,423	....	21,105	....	16,748	....	20,082
Wines:										
Champagne and other sparkling, dozen bottles........	374,124	5,579,054	237,360	3,498,522	257,757	3,807,961	246,393	3,628,319	228,628	3,348,004
Still wines—										
In bottles........dozen..	413,860	2,121,275	296,097	1,423,143	296,779	1,430,229	314,190	1,527,916	309,281	1,475,211
In casks........gallons..	3,525,625	2,505,024	2,599,693	1,817,813	2,789,153	1,945,347	2,834,898	1,950,770	2,997,952	2,039,250
Total........	....	10,205,353	....	6,739,478	....	7,183,537	....	7,107,005	....	6,862,465
Total vegetable matter........	....	330,290,457	....	316,232,234	....	286,060,995	....	286,910,917	....	286,285,280
Total agricultural imports..	....	424,592,450	....	364,433,627	....	373,115,985	....	391,029,407	....	400,871,468

a Not separately stated.

Agricultural exports (domestic) of the United States during the five years ended June 30, 1897.

[From Section of Foreign Markets.]

Articles exported.	1893.		1894.		1895.		1896.		1897.	
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.
ANIMAL MATTER.										
Animals, live:										
Cattle ....number	287,094	$26,032,428	359,278	$33,461,922	331,722	$30,603,796	372,461	$34,560,672	392,190	$36,357,451
Hogs ....do	27,375	397,162	1,553	14,753	7,130	72,424	21,049	227,297	28,751	235,968
Horses ....do	2,967	718,607	5,246	1,108,995	13,984	2,209,298	25,126	3,530,703	39,532	4,769,265
Mules ....do	1,634	210,278	2,063	240,961	2,515	186,452	5,918	406,161	7,473	545,331
Sheep ....do	37,260	126,394	132,370	832,763	405,748	2,630,686	491,565	3,076,384	244,120	1,531,645
All other, including fowls	....	43,116	....	53,247	....	51,389	....	39,752	....	68,771
Total	....	27,527,985	....	35,712,641	....	35,754,045	....	41,840,969	....	43,568,461
Animal products:										
Beeswax ....pounds	77,434	22,018	469,763	118,093	309,212	90,875	222,612	65,844	135,048	30,462
Bones, hoofs, horns and horn tips, strips, and waste	....	319,848	....	260,675	....	288,084	....	321,680	....	280,140
Bristles	....	....	....	1,844	....	3,901	....	....	....	415
Dairy products—										
Butter ....pounds	8,920,107	1,672,690	11,812,092	2,077,608	5,598,812	915,533	19,373,913	2,937,236	31,345,224	4,493,364
Cheese ....do	81,350,923	7,624,648	73,852,134	7,180,331	60,448,421	5,497,539	36,777,291	3,091,914	50,944,617	4,636,163
Milk	....	274,155	....	322,288	....	219,785	....	270,453	....	524,968
Total	....	9,571,493	....	9,580,227	....	6,632,857	....	6,299,570	....	9,654,495
Eggs ....dozen	143,489	33,207	163,061	27,497	151,007	25,317	328,485	48,359	1,390,183	180,954
Egg yolks	....	1,700	....	2,928	....	2,255	....	556	....	....
Feathers—										
Ostrich	....	1,500	....	6,500	....	9	....	250	....	5,679
Other, crude and prepared, except egret ....pounds	467,362	46,987	1,012,173	155,795	1,284,895	215,681	1,165,658	193,046	1,142,632	112,714
Total	....	48,487	....	162,295	....	215,690	....	193,296	....	118,393
Glue ....pounds	736,446	74,722	999,052	101,372	1,178,328	114,493	1,760,470	166,930	1,400,863	132,581
Grease, grease scraps, and all soap stock	....	1,067,723	....	1,380,299	....	904,071	....	1,516,763	....	2,070,111
Hair, and manufactures of	....	459,648	....	353,729	....	505,029	....	455,880	....	517,409
Hides and skins, other than furs, pounds	....	1,497,003	....	3,972,494	36,002,859	2,310,323	39,545,324	3,858,946	31,119,166	2,388,530
Honey	....	15,115	....	127,282	....	118,873	....	90,969	....	22,368

Agricultural exports (domestic) of the United States during the five years ended June 30, 1897—Continued.

Articles exported.	1893.		1894.		1895.		1896.		1897.	
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.
ANIMAL MATTER—continued.										
Animal products—Continued.										
Meat products—										
Beef products—										
Beef, canned ......pounds..	79,089,493	$7,222,824	55,974,910	$5,120,851	64,102,263	$5,720,933	63,698,180	$5,636,953	54,019,772	$4,656,308
Beef, fresh ....do....	206,294,724	17,754,041	193,891,824	16,700,163	191,338,487	16,832,860	224,783,225	18,974,107	290,395,930	22,653,742
Beef, salted or pickled, pounds..................	58,423,963	3,185,321	62,682,667	3,572,054	62,473,325	3,558,230	70,709,209	3,975,113	67,712,940	3,514,126
Beef, other cured, pounds..	898,920	87,776	1,218,334	100,631	821,673	73,569	514,303	59,371	939,448	83,701
Tallow ....do....	61,819,153	3,129,059	54,661,524	2,766,164	25,864,300	1,293,059	52,759,212	2,323,764	75,108,834	2,782,595
Total....................		31,379,021		28,259,863		27,478,651		30,969,308		33,690,472
Hog products—										
Bacon ....pounds..	391,758,175	35,781,470	416,657,577	38,338,843	452,549,976	37,776,293	425,352,187	33,442,847	500,399,448	34,187,147
Hams.................do....	82,178,154	9,933,096	86,970,571	9,845,062	105,494,123	10,960,567	129,036,351	12,669,763	165,247,302	15,970,021
Pork, fresh ....do....	912,644	79,317	1,168,647	92,095	818,581	60,660	744,656	43,739	1,306,424	94,816
Pork, pickled ....do....	52,459,722	4,116,946	63,575,881	5,067,773	58,266,893	4,138,400	69,498,373	3,973,461	66,768,920	3,297,214
Lard ....do....	365,693,501	34,643,993	447,566,867	40,089,809	474,895,274	36,821,508	509,534,256	33,589,851	568,315,640	29,126,485
Total....................		84,554,822		93,433,582		89,757,428		83,719,661		82,675,683
Mutton ....pounds..	108,214	9,175	2,197,900	174,404	591,449	47,832	422,950	31,793	361,955	28,341
Oleo and oleomargarin—										
Oleo, the oil ......pounds..	113,939,363	11,207,250	123,295,895	11,942,842	78,098,878	7,107,018	103,276,756	8,087,905	113,506,152	6,742,061
Oleomargarin, or imitation butter ....pounds..	3,479,322	416,386	3,898,950	475,003	10,100,897	992,464	6,063,699	587,269	4,864,351	472,856
Total ....do....	117,418,685	11,623,636	127,194,845	12,417,845	88,199,775	8,099,482	109,340,455	8,675,174	118,370,503	7,214,917
Poultry and game............		17,978		18,633		17,898		40,647		72,082
All other meat products.......		1,245,466		1,386,089		1,600,231		1,767,437		2,944,486
Total meat products....		128,830,098		135,690,416		127,001,522		125,204,020		126,625,981
Oils, animal, not elsewhere specified—										
Lard oil..............gallons..	486,812	336,613	681,081	449,571	553,421	304,093	833,935	426,401	961,407	419,803
Other, except whale and fish, gallons.....................	212,266	106,275	270,835	149,801	144,556	75,585	100,934	50,839	112,555	47,836
Total ....gallons..	699,078	442,888	951,916	599,372	697,977	379,678	934,869	477,240	1,073,962	467,639

Quills		12,450		15,440		13,653		27,930		19,264
Rennets, prepared		780		1,320		1,801		815		735
Sausage skins		1,409,280		1,280,514		1,581,891		1,771,680		1,514,651
Silk noils		3,140						1,958		
Silk waste .... pounds	161,519	55,081	97,787	28,813	65,673	23,391	102,624	31,163	54,060	13,181
Silkworm eggs		6,500		683		2,850		25		25
Stearin .... pounds	293,423	14,669	321,898	17,938	36,429	2,157	668,585	34,289	1,388,555	70,534
Wool, raw .... do	91,858	14,808	520,247	90,676	4,279,109	484,463	6,945,981	855,950	5,271,535	619,992
Total animal products		143,900,688		153,813,907		140,703,174		141,423,843		144,753,760
Total animal matter		171,428,673		189,526,548		176,457,219		183,264,812		188,322,221
VEGETABLE MATTER.										
Breadstuffs:										
Barley .... bushels	3,035,267	1,468,843	5,219,405	2,379,714	1,563,754	767,228	7,680,331	3,100,311	20,030,301	7,646,384
Bread and biscuit .... pounds	14,583,967	752,353	15,185,175	723,873	14,206,314	634,600	15,426,601	694,325	15,214,619	697,695
Buckwheat .... bushels		(a)		(a)		(a)		(a)	1,677,102	678,959
Corn (maize) .... do	46,037,274	24,587,511	65,324,841	30,211,154	27,691,137	14,650,767	99,992,835	37,836,862	176,916,365	54,087,152
Corn meal .... barrels	271,155	793,081	291,172	770,526	223,567	648,844	276,885	654,121	475,293	912,061
Oats .... bushels	2,380,643	951,920	5,750,266	2,027,934	569,977	200,793	13,012,590	3,497,611	35,096,736	8,756,267
Oatmeal .... pounds	5,762,701	160,660	9,719,337	238,528	20,499,253	566,321	38,592,504	939,592	47,310,251	1,071,340
Rye .... bushels	1,477,058	1,002,796	230,822	126,532	9,437	5,340	988,466	445,075	8,560,271	3,067,505
Rye flour .... barrels	2,811	10,290	3,055	9,273	3,768	12,002	3,777	11,163	2,596	7,396
Wheat .... bushels	117,121,109	93,534,970	88,415,230	59,407,041	76,102,704	43,805,663	60,650,080	39,709,868	79,562,020	59,920,178
Wheat flour .... barrels	16,620,339	75,494,347	16,859,533	69,271,770	15,268,892	51,651,928	14,629,864	52,025,217	14,569,545	55,914,347
All other breadstuffs, and preparations of, used as food		1,555,883		1,610,884		1,661,234		2,442,940		4,578,025
Total		200,312,654		166,777,229		114,604,780		141,356,993		197,857,219
Broom corn		163,105		210,742		169,503		181,853		136,007
Cider .... gallons	752,607	97,352	460,690	65,686	669,745	85,675	372,986	47,670	637,672	77,695
Coffee and cocoa, ground or prepared, and chocolate		93,292		137,777		104,317		107,740		128,078
Cotton, unmanufactured:										
Sea island .... bales	20,696	1,758,756	37,191	2,904,905	39,333	2,782,639	49,651	3,816,216	55,347	4,078,044
pounds	7,983,415		14,255,439		15,261,322		19,159,469		21,585,300	
Other .... bales	4,410,524	187,012,689	5,360,318	207,964,384	6,926,025	202,118,351	4,610,114	186,240,244	6,121,018	226,812,927
pounds	2,204,131,711		2,669,026,886		3,502,171,787		2,316,066,916		3,082,169,589	
Total .... bales	4,431,220	188,771,445	5,397,509	210,869,289	6,965,358	204,900,990	4,659,765	190,056,460	6,176,365	230,890,971
pounds	2,212,115,126		2,683,282,325		3,517,433,109		2,335,226,385		3,103,754,949	
Cotton-seed hulls				1,747		235				
Cotton-seed meats										37,970
Flax, raw				900		906				
Flowers, cut		623		1,588		2,521		798		1,429

a Not separately stated.

Agricultural exports (domestic) of the United States during the five years ended June 30, 1897—Continued.

Articles exported.	1893.		1894.		1895.		1896.		1897.	
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.
VEGETABLE MATTER—continued.										
Fruits and nuts:										
Apples, dried ....pounds..	7,966,819	$482,085	2,846,645	$168,054	7,085,946	$461,214	26,691,963	$1,340,507	30,775,401	$1,340,159
Apples, green or ripe.....barrels..	408,014	1,097,967	78,580	242,617	818,711	1,954,318	360,002	930,289	1,503,981	2,371,148
Fruits, preserved—										
Canned	....	1,137,660	....	660,723	....	871,465	....	1,376,281	....	1,686,725
Other	....	224,381	....	211,215	....	47,420	....	70,353	....	43,276
All other green, ripe, or dried fruits	....	881,804	....	1,016,397	....	1,522,100	....	1,868,353	....	2,172,199
Total fruits	....	3,823,897	....	2,299,006	....	4,856,517	....	5,585,783	....	7,613,500
Nuts	....	94,902	....	125,233	....	115,274	....	93,283	....	125,805
Total fruits and nuts	....	3,918,799	....	2,424,239	....	4,971,791	....	5,679,066	....	7,739,305
Ginseng ....pounds..	251,205	792,928	194,564	619,114	233,236	826,713	199,436	770,673	179,573	840,686
Glucose or grape sugar ....do....	101,546,814	2,204,216	124,796,288	2,328,707	133,808,329	2,567,784	171,231,650	2,772,335	194,419,250	2,736,674
Grasses, dried	....	33,381	....	36,205	....	19,781	....	44,583	....	17,766
Hay ....tons..	33,084	519,640	54,446	890,654	47,117	699,029	59,052	874,048	61,658	845,590
Hops ....pounds..	11,367,030	2,695,867	17,472,975	3,844,232	17,523,388	1,872,597	16,765,254	1,478,919	11,426,241	1,304,183
Lard substitutes, not elsewhere specified (cottolene, lardine, etc.), pounds	911,767	72,871	1,022,046	77,984	503,859	38,122	1,709,923	102,279	16,261,991	857,708
Malt ....do....	3,893,686	85,630	3,056,485	61,186	5,508,187	110,323	6,801,417	126,942	9,844,451	177,292
Malt liquors:										
In bottles ....dozen..	417,704	600,319	351,625	471,589	426,777	492,448	492,055	590,116	549,910	636,837
In other receptacles.......gallons..	245,497	65,219	307,077	77,390	258,620	66,322	290,383	69,759	390,048	87,112
Total	....	665,538	....	548,979	....	558,770	....	659,875	....	723,949
Must	....	32,870	....	51,308	....	16,000	....	18,500	....	....
Oil cake and oil-cake meal:										
Cotton-seed ....pounds..	802,416,067	9,688,773	744,603,229	8,807,256	489,716,053	4,310,128	404,937,291	3,740,232	623,386,638	5,515,800
Flaxseed or linseed..........do....					243,936,442	2,855,459	393,429,432	4,209,415	433,106,448	4,095,244
Total ....do....	802,416,067	9,688,773	744,603,229	8,807,256	733,652,495	7,165,587	798,366,723	7,949,647	1,056,493,086	9,611,044
Oils, vegetable:										
Cotton-seed ....gallons..	9,462,074	3,927,556	14,958,309	6,008,405	21,187,728	6,813,313	19,445,848	5,476,510	27,198,882	6,897,361
Linseed ....do....	103,936	54,356	92,861	48,550	62,718	37,363	67,159	33,260	111,262	42,700

Volatile or essential—										
Peppermint .... pounds	99,629	267,422	80,225	209,722	87,633	194,616	85,290	174,810	162,492	257,484
Other		79,920		64,907		190,798		102,487		146,509
All other		236,101		129,011		106,022		300,955		1,167,564
Total		4,565,355		6,460,625		7,342,112		6,097,022		8,511,658
Plants, trees, and shrubs		74,663		140,415		129,551		133,755		135,047
Rice .... pounds	756,992	25,126	763,425	19,884	124,296	4,087	1,346,876	14,117	387,288	14,017
Rice, bran, meal, and polish ....do	12,954,806	128,208	10,002,824	92,255	1,499,040	11,767	13,684,678	79,057	3,518,406	29,113
Roots, herbs, and barks, n. e. s		194,715		244,438		232,095		153,896		154,547
Seeds:										
Clover .... pounds	8,189,553	988,029	45,418,663	4,540,851	22,900,672	2,124,997	5,539,787	437,493	13,042,994	1,093,157
Cotton ....do	4,519,327	35,809	5,419,056	41,866	11,051,812	86,695	26,980,110	179,621	26,566,024	170,694
Flaxseed or linseed ...... bushels	1,837,370	2,195,374	2,047,836	2,426,284	1,224	1,433	80,453	73,207	4,713,747	3,859,855
Timothy .... pounds	7,077,131	501,937	10,155,867	449,207	4,939,237	277,160	11,894,536	518,755	16,786,993	574,457
All other		269,580		484,013		358,860		382,941		429,379
Total		3,993,729		7,942,221		2,849,145		1,592,017		6,028,432
Spices		1,415		1,205		871		1,367		772
Spirits, distilled:										
Alcohol, including pure, neutral, or cologne spirits ...proof galls	162,181	52,328	173,527	62,166	676,832	181,393	331,407	85,252	416,725	140,036
Brandy ....do	123,518	90,731	361,653	291,022	100,719	94,924	89,259	87,294	11,815	12,640
Rum ....do	647,415	778,006	977,994	1,081,716	879,153	1,134,965	865,648	1,174,096	808,396	1,102,267
Whisky—										
Bourbon ....do	1,550,452	1,461,013	4,105,639	3,720,562	1,442,685	1,485,525	139,866	157,396	509,413	422,451
Rye ....do	142,646	179,534	256,816	266,293	17,672	34,755	26,630	45,268	21,282	38,402
All other ....do	296,708	162,445	592,387	255,177	154,703	60,124	336,424	151,521	500,338	225,897
Total ....do	2,922,920	2,724,057	6,468,016	5,676,936	3,271,764	2,991,686	1,789,229	1,730,804	2,327,996	1,941,716
Starch .... pounds	21,938,456	707,093	22,888,016	727,011	11,788,990	366,800	31,829,435	885,198	79,088,876	1,065,926
Straw				121		3,639		5,293		5,659
Sugar and molasses:										
Molasses and sirup ....gallons	8,373,286	992,471	9,385,359	1,038,680	9,148,711	850,400	6,953,307	737,870	8,913,830	788,323
Sugar—										
Brown .... pounds	359,455	13,175	690,080	25,931	695,486	22,052	296,265	10,389	1,107,864	35,367
Refined ....do	20,386,872	963,123	14,778,416	653,052	8,833,522	406,924	9,106,259	450,753	7,197,335	341,641
Total ....do	20,746,327	976,298	15,468,496	678,983	9,529,008	428,976	9,402,524	461,142	8,305,219	377,008
Total sugar and molasses		1,968,769		1,717,663		1,279,376		1,199,012		1,165,331
Sugar meal .... pounds							3,830,412	66,935		
Teazels		1,353		3,487		1,281		6,287		3,396

Agricultural exports (domestic) of the United States during the five years ended June 30, 1897—Continued.

Articles exported.	1893.		1894.		1895.		1896.		1897.	
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.
VEGETABLE MATTER—continued.										
Tobacco, unmanufactured:										
Leaf .... pounds..	248,367,258	$22,292,704	268,791,312	$22,939,356	293,805,855	$25,622,776	287,700,301	$24,405,245	305,978,292	$24,513,567
Stems and trimmings .... do....	17,715,825	599,195	21,893,680	1,145,878	7,186,075	176,192	7,839,011	166,117	8,953,399	197,879
Total .... do....	266,083,083	22,891,899	290,684,992	24,085,234	300,991,930	25,798,968	295,539,312	24,571,362	314,931,691	24,711,446
Vegetables:										
Beans and peas .... bushels..	389,913	745,636	326,748	576,657	242,680	429,002	473,975	632,073	900,219	1,110,387
Onions .... do....	57,610	60,878	68,865	69,823	53,335	46,703	82,916	61,181	73,511	60,088
Potatoes .... do....	845,720	700,032	803,111	651,877	572,957	418,221	680,049	371,485	926,646	515,067
Vegetables, canned	....	242,284	....	255,857	....	441,388	....	407,506	....	408,840
All other, including pickles and sauces	....	149,167	....	190,248	....	208,144	....	182,805	....	243,542
Total	....	1,897,997	....	1,744,462	....	1,543,458	....	1,655,050	....	2,337,924
Vinegar .... gallons..	86,936	12,177	68,282	9,537	80,234	11,273	123,163	16,975	93,969	11,572
Wine:										
In bottles .... dozen..	11,128	51,654	13,813	63,860	13,919	56,202	17,147	69,460	16,794	69,444
In other receptacles .... gallons..	708,558	369,893	802,192	380,588	1,125,297	545,708	1,339,090	581,827	1,389,375	629,270
Total	....	421,547	....	444,448	....	601,910	....	651,287	....	698,714
Yeast	....	15,911	....	42,435	....	44,599	....	45,077	....	42,849
Total vegetable matter	....	449,772,998	....	447,107,199	....	381,928,642	....	391,133,452	....	501,432,972
Total agricultural exports..	....	621,201,671	....	636,633,747	....	558,385,861	....	574,398,264	....	689,755,193

AVERAGE PRICES FOR IMPORTS AND EXPORTS.

[From Section of Foreign Markets.]

Average import price of agricultural products imported into the United States during each of the five fiscal years 1893–1897, and also during the six months ended December 31, 1897.

[The import prices of merchandise here given represent "the actual market value or wholesale price of such merchandise as bought and sold in usual wholesale quantities, at the time of exportation to the United States, in the principal markets of the country from whence imported, and in the condition in which such merchandise is there bought and sold for exportation to the United States, or consigned to the United States for sale, including the value of all cartons, cases, crates, boxes, sacks, and coverings of any kind, and all costs, charges, and expenses incident to placing the merchandise in condition, packed ready for shipment to the United States." (Act of June 10, 1890.)

The export prices are the actual market values in the port of shipment.]

Articles imported.	Years ended June 30—					Six months ended Dec. 31, 1897.
	1893.	1894.	1895.	1896.	1897.	
ANIMAL MATTER.						
Cattle, free of duty ....head	$120.83	$17.14	$6.63	$20.56	$119.41	$119.51
Cattle, dutiable ....do	7.91	10.43	4.95	6.89	7.80	10.41
Total cattle ....do	13.87	11.75	5.11	6.93	7.87	10.61
Horses, free of duty ....do	384.40	551.55	330.17	196.34	138.85	187.29
Horses, dutiable ....do	105.18	103.96	53.88	50.72	58.38	112.14
Total horses ....do	154.57	214.01	80.56	66.32	66.42	129.10
Sheep, free of duty ....do	22.55	24.84	15.90	10.85	13.70	13.81
Sheep, dutiable ....do	3.46	3.02	2.25	2.54	2.45	2.79
Total sheep ....do	3.66	3.25	2.34	2.65	2.51	2.87
Beeswax ....pound	.250	.251	.274	.278	.249	....
Bristles, crude, not sorted, bunched or prepared ....pound	....	....	.399	2.231	.611	.319
Bristles, sorted, bunched or prepared, pound	....	....	.958	.912	.903	.853
Total bristles ....pound	.943	1.041	.956	.913	.903	.853
Butter ....do	.184	.162	.179	.164	.160	.168
Cheese ....do	.140	.143	.141	.139	.135	.131
Eggs ....dozen	.118	.111	.120	.094	.082	.050
Silk:						
Cocoons ....pound	.594	.618	.434	.405	....	.264
Raw, or as reeled from the cocoon, pound	3.91	3.15	2.76	3.28	2.84	2.94
Waste ....pound	.755	.647	.449	.372	.285	.364
Total silk ....do	3.51	2.75	2.43	2.86	2.37	2.57
Wool, class 1, clothing:						
In the grease ....do	....	....	....	....	.158	.166
Scoured ....do	....	....	....	....	.265	.281
Total wool, class 1 ....do	.182	.164	.153	.166	.171	.180
Wool, class 2, combing:						
In the grease ....do	....	....	....	....	.189	.197
Scoured ....do	....	....	....	....	.211	.210
Total wool, class 2 ....do	.218	.258	.196	.223	.189	.197
Wool, class 3, carpet:						
In the grease ....do	....	....	....	....	.105	.099
Scoured ....do	....	....	....	....	.118	.087
Total wool, class 3 ....do	.086	.092	.091	.097	.105	.099
Total wools ....do	.122	.111	.124	.141	.152	.130
Glue ....do	.092	.097	.088	.089	.096	.105
Grease and oils commonly used in soap making, etc ....pound	.069	.083	.083	....	....	....
Goatskins ....do	....	....	.202	.220	.227	.237
Hides and skins, other than goatskins, pound	....	....	.088	.124	.106	.111
Total hides and skins ....pound	....	....	.115	.145	.135	.146
Honey ....gallon	.451	.368	.341	.383	.415	....
Oils, animal, n. e. s., except whale and fish ....gallon	.383	.343	.320	.327	.158	.232
Oleostearin ....pound	....	....	....	.071	....	....
Sausage, bologna ....do	....	....	....	.225	.233	....
VEGETABLE MATTER.						
Argal, argol, or crude tartar ....pound	.081	.067	.068	.066	.084	.061
Barley ....bushel	.468	.453	.410	.379	.310	.354
Corn (maize) ....do	.673	.486	.456	.433	.329	.395
Oats ....do	.418	.471	.262	.274	.260	.352
Oatmeal ....pound	.051	.058	.056	.057	.021	.055
Rye ....bushel	.821	.740	.486	1.89	2.36	.397
Wheat ....do	.732	.651	.608	.657	.767	.931

Average import price of agricultural products, 1893-1897, etc.—Continued.

Articles imported.	Years ended June 30—					Six months ended Dec. 31, 1897.
	1893.	1894.	1895.	1896.	1897.	
VEGETABLE MATTER—continued.						
Wheat flour ....barrel..	$5.42	$4.85	$4.44	$4.91	$4.41	$4.34
Chocolate, other than confectionery and sweetened chocolate ....pound..	.218	.205	.195	.173	.163	.149
Cocoa, or cacao, crude, and leaves and shells of ....pound..	.164	.136	.109	.103	.095	.124
Cocoa, or cacao, prepared or manufactured ....pound..	.343	.351	.337	.330	.297	.313
Total cocoa or cacao ....do...	.174	.151	.120	.114	.105	.128
Coffee ....do....	.143	.164	.147	.146	.111	.080
Chicory root, raw, unground ....do...	.020	.021	.017	.013	.014	.012
Chicory root, roasted, ground, or otherwise prepared ....pound..	.037	.039	.033	.033	.035	.024
Total chicory root ....do...	.024	.025	.017	.014	.014	.017
Coffee substitutes, n. e. s ....do....	.037	.040	.039	.038	.037	....
Total coffee substitutes ....do...	.026	.027	.022	.017	.017	....
Cotton, unmanufactured ....do....	.108	.108	.096	.119	.113	.100
Flax, and tow of ....ton..	280.64	307.18	201.43	179.21	168.01	137.72
Flax, hackled, etc ....do....			472.16	488.62	375.01	291.60
Hemp, and tow of ....do...	142.31	116.74	122.22	125.26	124.27	146.25
Hemp, hackled, etc ....do....			164.46	243.05	273.71	136.18
Istle or Tampico fiber ....do....	64.54	53.68	46.65	58.78	53.20	50.35
Jute and jute butts ....do....	30.01	34.30	24.88	22.09	23.93	22.90
Manila ....do....	140.92	113.91	80.76	76.30	73.68	63.11
Sisal grass ....do....	110.33	77.21	57.64	65.47	60.61	58.82
Fibers, n. e. s ....do....	100.31	84.06	52.79	41.13	66.32	66.84
Prune juice, or prune wine ....gallon..	.871	.862	.739	.830	.701	....
Currants ....pound..	.036	.015	.016	.017	.020	.031
Dates ....do....	.030	.031	.021	.020	.024	.029
Figs ....do....	.052	.049	.050	.054	.060	.055
Plums and prunes ....do....	.044	.042	.037	.142	.103	.183
Raisins ....do....	.046	.040	.041	.043	.045	.059
Almonds ....do....	.140	.103	.103	.098	.091	.118
Hay ....ton..	9.25	8.78	7.10	9.16	8.59	8.55
Hops ....pound..	.403	.585	.191	.217	.209	.253
Indigo ....do....	.972	.709	.509	.501	.482	.627
Malt, barley ....bushel..	1.24	1.13	.677	.856	.847	.950
Malt liquors in bottles or jugs ....gallon..	.969	.951	.953	.970	.978	.933
Malt liquors in other receptacles ....do....	.331	.316	.303	.293	.279	.273
Total malt liquors ....do....	.577	.519	.510	.507	.526	.466
Oil cake ....pound..	.011	.005	.007	.006	.007	....
Olive oil ....gallon..	1.30	1.20	1.23	1.17	1.22	1.20
Volatile or essential oil ....pound..	.411	.385	....	....	....	....
Opium, crude or unmanufactured, pound	1.93	2.36	2.04	1.87	2.04	2.05
Opium, prepared ....pound..	7.06	6.20	6.58	7.44	7.21	6.69
Total opium ....do....	2.40	2.61	3.31	3.06	2.70	4.32
Rice ....pound..	.020	.018	.017	.016	.019	.022
Rice flour, rice meal, and broken rice, pound	.018	.015	.014	.013	.015	.016
Total rice and rice meal ....pound..	.019	.017	.016	.015	.018	.019
Linseed or flaxseed ....bushel..	1.31	1.18	1.09	1.08	1.03	1.09
Spices, unground:						
Nutmegs ....pound..	.432	.347	.311	.320	.270	.282
Pepper, black and white ....do....	.060	.052	.039	.039	.047	.055
Other ....do....	.066	.063	.059	.052	.053	.066
Spices, ground, etc ....do....	.120	.155	.132	.113	.111	.096
Total spices ....do....	.078	.074	.063	.060	.064	.072
Spirits, distilled:						
Of domestic manufacture, returned, proof gallon	1.09	.858	.870	.913	.903	.869
Brandy ....proof gallon..	2.81	2.82	2.60	2.66	2.70	2.87
All other ....do....	1.06	1.04	1.09	1.16	1.20	1.27
Total ....do....	1.32	1.12	1.23	1.21	1.27	1.16
Starch ....pound..	.023	.021	.019	.018	.018	....
Straw ....ton..	3.45	3.28	3.17	3.95	3.38	....
Molasses ....gallon..	.129	.101	.086	.157	.158	.128
Beet sugar, not above No. 16 Dutch standard ....pound..	.029	.031	.020	.023	.018	.019
Sugar, other than beet, not above No. 16 Dutch standard ....pound..	.031	.029	.021	.022	.021	.022
Sugar, above No. 16 Dutch standard, pound	.039	.038	.028	.029	.025	.024
Total sugar ....pound..	.031	.029	.021	.023	.020	.022
Tea ....do....	.156	.151	.135	.135	.131	.137
Tobacco, leaf:						
Suitable for cigar wrappers ....do....	.950	1.15	1.27	1.07	.935	.922
Other ....do....	.409	.387	.359	.394	.506	.512

Average import price of agricultural products, 1893–1897, etc.—Continued.

Articles imported.	Years ending June 30—					Six months ended Dec. 31, 1897.
	1893.	1894.	1895.	1896.	1897.	
VEGETABLE MATTER—continued.						
Total leaf tobacco .... pound	$0.523	$0.559	$0.553	$0.501	$0.694	$0.603
Vanilla beans .... do	3.20	4.24	3.61	4.30	5.36	4.60
Beans and peas .... bushel	.988	.944	1.01	1.07	1.01	1.01
Cabbages .... number	......	......	......	.044	.055	......
Onions .... bushel	......	......	......	......	1.12	.493
Potatoes .... do	.479	.425	.450	.728	.591	.314
Vinegar .... gallon	.289	.270	.264	.303	.270	......
Champagne and other sparkling wines, dozen bottles	14.91	14.74	14.77	14.73	14.64	14.73
Still wines:						
In bottles .... dozen	5.13	4.81	4.82	4.86	4.77	4.97
In casks .... gallon	.711	.699	.697	.688	.680	.724

Average export price of agricultural products exported from the United States, 1893–1897.

Articles exported.	Years ended June 30—					Six months ended Dec. 31, 1897.
	1893.	1894.	1895.	1896.	1897.	
ANIMAL MATTER.						
Cattle .... head	$90.68	$93.14	$92.26	$92.79	$92.70	$84.40
Hogs .... do	14.51	9.50	10.16	10.80	10.30	8.57
Horses .... do	242.20	211.40	157.99	140.52	120.64	122.92
Mules .... do	128.69	116.80	74.14	68.63	72.97	90.76
Sheep .... do	3.39	6.29	6.48	6.26	6.27	4.99
Beeswax .... pound	.285	.251	.294	.296	.289	.279
Butter .... do	.188	.176	.164	.152	.143	.147
Cheese .... do	.094	.097	.091	.084	.091	.087
Eggs .... dozen	.231	.169	.168	.147	.139	.171
Feathers, crude and prepared, other than ostrich and egret .... pound	.101	.154	.168	.166	.099	......
Glue .... do	.101	.101	.097	.095	.095	.087
Hides and skins, other than furs .... do	......	......	.064	.098	.077	.088
Beef, canned .... do	.091	.091	.089	.088	.086	.087
Beef, fresh .... do	.086	.086	.088	.084	.078	.082
Beef, salted or pickled .... do	.055	.057	.057	.056	.052	.050
Beef, other cured .... do	.098	.083	.090	.115	.089	.095
Tallow .... do	.051	.051	.050	.044	.037	.036
Bacon .... do	.091	.092	.083	.079	.068	.070
Hams .... do	.121	.113	.104	.098	.097	.096
Pork, fresh .... do	.087	.079	.074	.059	.073	.067
Pork, pickled .... do	.078	.080	.071	.057	.049	.052
Lard .... do	.095	.090	.078	.066	.051	.053
Mutton .... do	.085	.079	.081	.075	.078	.087
Oleo-oil .... do	.098	.097	.091	.078	.059	.060
Oleomargarin (imitation butter) .... do	.120	.122	.098	.097	.097	.092
Lard oil .... gallon	.691	.660	.549	.511	.437	.387
Other animal oils .... do	.501	.553	.523	.504	.425	.412
Total animal oils .... do	.634	.630	.544	.510	.435	.390
Silk waste .... pound	.341	.295	.356	.301	.244	......
Stearin .... do	.050	.056	.059	.051	.051	......
Wool, raw .... do	.161	.174	.113	.123	.118	.157
VEGETABLE MATTER.						
Barley .... bushel	.484	.456	.491	.404	.382	.499
Bread and biscuit .... pound	.052	.048	.045	.045	.046	.047
Buckwheat .... bushel	......	......	......	......	.405	.423
Corn (maize) .... do	.534	.462	.529	.378	.306	.336
Corn meal .... barrel	2.92	2.65	2.90	2.36	1.90	2.05
Oats .... bushel	.400	.353	.352	.269	.249	.272
Oatmeal .... pound	.028	.025	.028	.024	.023	.029
Rye .... bushel	.679	.548	.566	.450	.428	.511
Rye flour .... barrel	3.66	3.04	3.20	2.96	2.87	3.03
Wheat .... bushel	.799	.672	.576	.655	.753	.928
Wheat flour .... barrel	4.54	4.11	3.38	3.56	3.84	4.39
Cider .... gallon	.133	.143	.128	.128	.122	.123
Cotton, sea-island .... pound	.220	.204	.182	.199	.189	.161
Cotton, other .... do	.085	.078	.058	.080	.074	.069

Average export price of agricultural products exported from the United States, 1893–1897—Continued.

Articles exported.	Years ended June 30—					Six months ended Dec. 31, 1897.
	1893.	1894.	1895.	1896.	1897.	
VEGETABLE MATTER—continued.						
Total cotton .... pound..	$0.085	$0.079	$0.058	$0.081	$0.074	$0.061
Apples, dried .... do....	.061	.059	.065	.050	.044	.059
Apples, green or ripe .... barrel..	2.69	3.09	2.39	2.58	1.58	2.62
Ginseng .... pound..	3.16	3.18	3.54	3.86	4.68	3.81
Glucose .... do....	.022	.019	.019	.016	.014	.014
Hay .... ton..	15.71	16.36	14.84	14.80	13.71	14.07
Hops .... pound..	.237	.220	.107	.038	.114	.153
Lard substitutes, n. e. s .... do....	.080	.076	.076	.060	.053	.052
Malt .... do....	.022	.020	.020	.019	.018	.020
Malt liquors in bottles .... dozen..	1.44	1.34	1.15	1.20	1.16	1.21
Malt liquors in other receptacles..gal..	.266	.252	.256	.240	.223	.224
Oil cake and oil-cake meal, cotton-seed, pound	....	....	.009	.009	.009	.009
Oil cake and oil-cake meal, flaxseed.lb..	....	....	.012	.011	.009	.010
Total oil cake and oil-cake meal..do....	.012	.012	.010	.010	.009	.009
Cotton-seed oil .... gallon..	.415	.402	.322	.282	.254	.256
Linseed oil .... do....	.523	.523	.596	.495	.384	.401
Peppermint oil .... pound..	2.68	2.61	2.22	2.05	1.58	1.40
Rice .... do....	.033	.026	.038	.010	.038	.044
Rice bran, meal, and polish .... do....	.010	.009	.008	.005	.006	.006
Clover seed .... do....	.121	.100	.093	.079	.077	.064
Cotton seed .... do....	.008	.008	.008	.007	.006	.006
Flaxseed .... bushel..	1.19	1.18	1.17	.910	.820	.899
Timothy seed .... pound..	.071	.044	.056	.044	.034	.031
Alcohol, including pure, neutral, etc., proof gallon	.323	.358	.268	.257	.336	.481
Brandy .... proof gallon..	.735	.805	.942	.978	1.07	1.46
Rum .... do....	1.20	1.11	1.29	1.36	1.36	1.37
Bourbon whisky .... do....	.942	.906	1.03	1.34	.742	.827
Rye whisky .... do....	1.26	1.04	1.97	1.70	1.80	2.01
Distilled spirits, n. e. s .... do....	.547	.431	.389	.450	.451	.903
Total distilled spirits .... do....	.932	.878	.914	.967	.834	.893
Starch .... pound..	.032	.032	.031	.028	.021	.017
Molasses .... gallon..	.119	.111	.093	.106	.088	.074
Sugar, brown .... pound..	.037	.038	.032	.035	.032	.039
Sugar, refined .... do....	.047	.044	.046	.049	.047	.051
Total sugar .... do....	.047	.044	.045	.049	.045	.050
Sugar meal .... do....	....	....	....	.017	....	....
Tobacco, leaf .... do....	.090	.085	.087	.085	.080	.087
Tobacco, stems and trimmings...do....	.034	.052	.025	.021	.022	.018
Total tobacco, unmanufactured ..do....	.086	.083	.086	.083	.078	.085
Beans and peas .... bushel..	1.91	1.76	1.77	1.33	1.23	1.25
Onions .... do....	1.06	1.01	.876	.738	.817	.824
Potatoes .... do....	.828	.812	.730	.546	.556	.772
Vinegar .... gallon..	.140	.140	.141	.138	.123	.123
Wine, in bottles .... dozen..	4.64	4.62	4.04	4.05	4.14	4.22
Wine, in other receptacles .... gallon..	.522	.474	.485	.434	.453	.426

SUGAR STATISTICS.

Value of sugar imported into the United States from the principal countries of supply during each fiscal year from 1893 to 1897, inclusive.

[From Section of Foreign Markets.]

Countries from which imported.	Years ended June 30—					Annual average, 1893–1897.	
	1893.	1894.	1895.	1896.	1897.		
	Dollars.	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Per ct.*
Cuba	60,637,670	63,147,745	40,100,204	24,102,835	11,982,473	39,994,186	39.37
Germany	9,526,959	11,198,222	6,332,916	12,528,755	29,844,019	13,886,174	13.67
Hawaii	8,502,226	9,461,857	7,403,658	11,336,796	13,165,084	9,973,924	9.82
Dutch East Indies	4,783,268	7,808,871	5,759,436	11,388,487	13,090,323	8,566,077	8.43
British West Indies	9,487,479	6,890,949	3,989,614	4,700,527	5,893,877	6,192,489	6.10
British Guiana	5,017,661	4,216,414	2,517,726	3,414,368	3,657,025	3,764,639	3.71
Brazil	2,921,946	5,688,714	2,701,287	3,776,486	2,136,989	3,445,084	3.39
Philippine Islands	2,865,966	3,655,627	1,111,006	2,270,902	1,199,202	2,220,541	2.19
Santo Domingo	2,054,243	2,875,810	1,188,951	2,459,302	2,059,169	2,127,495	2.09
Puerto Rico	3,228,933	2,394,051	994,084	1,707,308	1,577,911	1,980,457	1.95
Belgium	2,122,316	2,357,754	458,779	1,771,980	2,311,309	1,804,428	1.78
United Kingdom	1,024,189	1,824,072	976,266	1,402,694	1,452,004	1,335,845	1.32
Egypt	194,186	....	596,277	2,657,425	2,616,423	1,212,862	1.19
Austria-Hungary	1,098,793	1,423,083	178,472	958,402	1,957,027	1,123,155	1.11
Netherlands	79,354	789,668	296,761	1,182,605	1,916,933	853,064	.84
China	386,486	800,218	668,287	920,301	313,803	617,819	.61
France	8,059	428,506	1,412	859,359	1,421,317	543,731	.54
Dutch Guiana	397,068	426,541	195,589	289,243	380,959	337,880	.33
Danish West Indies	431,217	473,153	205,333	261,728	316,781	337,642	.33
Canada	870,939	193,476	289,060	92,692	74,191	304,072	.30
Hongkong	283,448	435,738	236,292	353,610	87,465	279,311	.27
British Africa	....	134,514	49,725	461,054	417,850	212,629	.21
Other countries	333,378	246,906	211,701	322,914	1,194,047	461,789	.45
Total	116,255,784	126,871,889	76,462,836	89,219,773	99,066,181	101,575,293	100.00

Quantity of sugar imported into the United States from the principal countries of supply during each fiscal year from 1893 to 1897, inclusive.

[From Section of Foreign Markets.]

Countries from which imported.	Years ended June 30—					Annual average, 1893–1897.	
	1893.	1894.	1895.	1896.	1897.		
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Per ct.*
Cuba	1,843,652,253	2,127,502,319	1,845,763,398	1,093,171,312	577,790,173	1,497,575,891	36.52
Germany	326,827,509	358,649,535	311,182,968	525,991,657	1,604,233,071	625,376,948	15.25
Dutch East Indies	183,492,832	288,013,620	280,464,270	567,670,780	634,171,629	390,762,626	9.53
Hawaii	289,553,529	326,574,584	274,385,228	352,175,269	431,217,116	334,781,145	8.17
British West Indies	332,968,755	256,821,752	193,498,237	217,421,118	322,103,866	264,562,745	6.45
Brazil	114,598,997	258,447,122	180,262,039	191,457,878	140,773,692	177,107,945	4.32
British Guiana	159,061,559	134,455,359	110,848,960	146,433,256	175,639,179	145,287,663	3.54
Philippine Islands	122,413,780	124,052,343	68,770,492	145,075,344	72,463,577	106,555,107	2.60
Santo Domingo	64,036,960	89,421,821	66,492,169	116,972,841	131,279,582	93,640,675	2.28
Puerto Rico	99,617,911	75,546,030	56,352,954	81,582,810	86,607,317	79,941,404	1.95
Belgium	71,322,733	80,479,170	24,338,139	72,721,186	130,423,987	75,857,043	1.85
Egypt	9,715,060	....	23,250,815	100,335,317	124,055,211	51,471,281	1.26
United Kingdom	31,964,310	58,241,416	40,610,295	56,992,162	68,250,019	51,211,640	1.25
Austria-Hungary	34,391,679	44,536,822	7,411,234	40,703,929	105,138,128	46,436,358	1.13
Netherlands	2,717,110	23,829,548	12,600,203	40,965,863	82,248,664	32,472,278	.79
France	157,204	13,909,622	35,832	34,810,370	92,169,241	28,216,454	.69
China	10,575,216	21,189,075	23,696,923	31,827,859	11,437,760	19,745,367	.48
Danish West Indies	13,894,070	15,558,546	9,131,589	12,292,619	16,909,347	13,557,234	.33
Dutch Guiana	14,798,065	12,787,452	8,794,544	12,299,609	18,043,833	13,344,705	.33
British Africa	....	8,595,345	3,776,030	26,564,115	25,895,460	12,966,190	.32
Hongkong	7,847,396	11,203,629	8,351,495	12,046,973	3,243,630	8,538,625	.21
Canada	20,480,193	3,846,249	8,329,961	1,304,887	1,098,350	7,011,924	.17
Other countries	12,358,226	11,532,522	16,162,679	15,611,403	63,622,921	23,857,550	.58
Total	3,766,445,347	4,345,193,881	3,574,510,454	3,896,338,557	4,918,905,733	4,100,278,794	100.00

Average price per pound of "Standard A" sugar in the New York market and average consumption of sugar of all grades, per capita of population, in the United States from 1878 to 1897.

[From Division of Statistics.]

Calendar year—	Average price per pound.	Consumption per capita of population.	Calendar year—	Average price per pound.	Consumption per capita of population.
	Cents.	*Pounds.*		*Cents.*	*Pounds.*
1878	8.94	34.3	1888	6.69	56.7
1879	8.53	40.7	1889	7.59	51.8
1880	9.48	42.9	1890	6.00	52.8
1881	9.84	44.2	1891	4.47	66.1
1882	8.87	48.4	1892	4.21	63.5
1883	8.14	51.1	1893	4.72	63.9
1884	6.37	53.4	1894	4.00	66.0
1885	6.06	51.8	1895	4.00	62.6
1886	5.81	56.9	1896	4.41	61.6
1887	5.66	52.7	1897	4.38	64.5

TEA, COFFEE, AND LIQUORS.

Consumption of tea, coffee, wines, distilled spirits, and malt liquors in the United States, per capita of population, 1870 to 1897.

[From Division of Statistics.]

Year ending June 30—	Tea.	Coffee.	Wines.	Distilled spirits.	Malt liquors.
	Pounds.	*Pounds.*	*Gallons.*	*Proof gals.*	*Gallons.*
1870	1.10	6.00	0.32	2.07	5.31
1871	1.14	7.91	.40	1.62	6.10
1872	1.46	7.28	.41	1.68	6.66
1873	1.53	6.87	.45	1.63	7.21
1874	1.27	6.59	.48	1.51	7.00
1875	1.44	7.08	.45	1.50	6.71
1876	1.35	7.33	.45	1.33	6.83
1877	1.23	6.94	.47	1.28	6.58
1878	1.33	6.24	.47	1.09	6.68
1879	1.21	7.42	.50	1.11	7.05
1880	1.39	8.78	.56	1.27	8.26
1881	1.54	8.25	.47	1.38	8.65
1882	1.47	8.30	.49	1.40	10.03
1883	1.30	8.91	.48	1.46	10.27
1884	1.09	9.26	.37	1.48	10.74
1885	1.18	9.60	.39	1.26	10.62
1886	1.37	9.36	.45	1.26	11.20
1887	1.49	8.53	.55	1.21	11.23
1888	1.40	6.81	.61	1.26	12.80
1889	1.29	9.16	.56	1.32	12.72
1890	1.33	7.83	.46	1.40	13.67
1891	1.29	7.99	.45	1.42	15.28
1892	1.37	9.61	.44	1.50	15.10
1893	1.32	8.24	.48	1.51	16.08
1894	1.34	8.01	.31	1.33	15.18
1895	1.38	9.22	.28	1.12	14.95
1896	1.31	8.04	.26	1.00	15.16
1897	1.55	9.95	.53	1.01	14.69

TRANSPORTATION RATES.

Grain in sacks by steamers.

[Rates, in cents, per 100 pounds.]

[Compiled for Bulletin No. 14 of the Division of Statistics, from reports of the St. Louis Merchants' Exchange.]

Year.	From St. Louis, Mo., to—								
	Memphis, Tenn.			Vicksburg, Miss.			New Orleans, La.		
	Highest.	Lowest.	Longest in effect.	Highest.	Lowest.	Longest in effect.	Highest.	Lowest.	Longest in effect.
1877	24	11.9	14.3	33	19	19	33	14	19
1878	50	7.4	7.4	50	10	10	35	10	10
1879	20	10	12.5	35	15	17.5	30	10	12.5
1880	51	12.5	20	30	20	20	35	15	20
1881	22.5	15	15	30	20	30	25	15	22.5
1882	17.5	12.5	12.5	30	20	20	25	20	20
1883	17.5	12.5	17.5	25	20	25	22.5	12.5	20
1884	15	13	15	22.5	20	20	17.5	12.5	12.5
1885	15	15	15	22.5	22.5	22.5	17.5	15	17.5
1886	15	10	10	20	17.5	17.5	17.5	15	17.5
1887	20	10	10	20	17.5	20	20	15	17.5
1888	15	10	10	20	17.5	17.5	17.5	12.5	12.5
1889	17.5	10	11	25	17.5	17.5	20	17.5	17.5
1890	12.5	10	10	17.5	15	17.5	17.5	15	15
1891	20	10	10	25	17.5	17.5	20	15	15
1892	20	10	10	25.5	17.5	17.5	20	15	17.5
1893	12	12	12	17.5	17.5	17.5	17.5	15	17.5
1894	15	12	12	20	17.5	17.5	20	12.5	20
1895	15	10	10	20	12.5	15	20	10	10
1896	12.5	10	10	17.5	15	15	15	10	15
1897	8	8	8	15	15	15	15	15	15

Miscellaneous commodities, New York to Chicago by rail.

AVERAGE RATES FOR LESS THAN CARLOAD QUANTITIES, IN CENTS, PER 100 POUNDS.

[From Bulletin No. 14, Miscellaneous Series, of the Division of Statistics.]

Year.	Furniture.	Agricultural implements.	Lead.	Bagging.	Crockery and earthenware.	Coffee.	Starch.	Sugar.	Molasses.	Rice.	Soap.	
											Castile and fancy.	Common.
1867	137	137	60	117	117	117	117	60	60	60	117	93
1868	122	122	56	103	103	......	87	......	....	56	103	56
1869	99	99	54	92	....	......	75	......	....	54	92	54
1870	113	113	61	98	....	......	78	......	....	......	98	69
1871	81	81	39	71	49	36	58	36	46	46	71	46
1872	105	105	43	93	81	43	72	43	55	51	93	55
1873	69	....	31	62	31	31	50	31	40	31	62	40
1874	81	....	37	74	37	37	62	37	49	37	74	49
1875	53	....	25	48	29	24	40	24	41	25	48	33
1876	39	....	20	37	20	20	32	20	23	20	37	23
1877	72	....	33	56	33	33	50	33	40	33	65	40
1878	77	....	41	41	41	41	41	41	41	41	62	41
1879	75	....	40	40	40	40	40	40	40	40	60	40
1880	75	....	40	40	40	40	40	40	40	40	60	40
1881	65	....	33	33	33	33	33	33	33	33	51	33
1882	56	....	26	26	26	26	26	24	24	26	44	25
1883	75	....	35	35	35	35	35	30	30	35	60	35
1884	75	....	35	35	35	35	35	25	25	35	60	35
1885	56	....	27	27	27	27	27	20	20	27	45	27
1886	75	....	35	35	35	35	35	25	25	35	60	35
1887	75	....	35	46	35	35	35	33	33	35	64	35
1888	73	49	35	49	35	35	35	35	35	35	63	35
1889	75	50	35	50	35	35	35	35	35	35	65	35
1890	75	50	35	50	35	35	35	35	35	35	65	35
1891	75	50	35	50	35	35	35	35	35	35	49	35
1892	75	50	35	50	35	35	35	35	35	35	35	35
1893	75	50	35	50	35	35	35	35	35	35	35	35
1894	75	50	35	50	35	35	35	35	35	35	35	35
1895	75	50	35	50	35	35	35	35	35	35	35	35
1896	75	50	35	50	35	35	35	35	35	35	35	35
1897	75	50	35	50	35	35	35	35	35	35	35	35

AVERAGE RATES FOR CARLOADS, IN CENTS, PER 100 POUNDS.

[From Bulletin No. 14, Miscellaneous Series, of the Division of Statistics.]

Year.	Furniture.	Agricultural implements.	Lead.	Bagging.	Crockery and earthenware.	Coffee.	Starch.	Sugar.	Molasses.	Rice.	Soap.	
											Castile and fancy	Common.
1867	137	137	60	117	117	117	117	60	60	60	117	93
1868	122	122	56	103	103	......	87	......	....	56	103	56
1869	99	99	54	92	....	......	75	......	....	54	92	54
1870	113	113	61	98	....	......	78	......	....	......	98	60
1871	81	81	39	71	49	36	58	36	46	46	71	46
1872	105	105	93	93	81	43	72	43	55	51	93	55
1873	69	54	31	62	31	31	50	31	40	31	62	40
1874	81	49	37	74	37	37	62	37	49	37	74	49
1875	53	33	25	48	29	24	40	24	41	25	48	33
1876	39	23	20	37	20	20	32	20	23	20	37	23
1877	72	39	33	56	33	33	50	33	40	33	65	40
1878	77	41	41	41	41	41	41	41	41	41	62	41
1879	75	40	40	40	40	40	40	40	40	40	60	40
1880	75	40	40	40	40	40	40	40	40	40	60	40
1881	65	33	33	33	33	33	33	33	33	33	51	33
1882	56	26	26	26	26	26	26	24	24	26	44	26
1883	75	36	35	35	35	35	35	30	30	35	60	35
1884	75	36	35	35	35	35	35	25	25	35	60	35
1885	56	27	27	27	27	27	27	20	20	27	45	27
1886	75	35	35	35	35	35	35	25	25	35	60	35
1887	67	31	27	35	31	27	27	25	29	35	64	31
1888	63	30	25	35	30	25	25	25	30	25	63	30
1889	65	30	25	35	30	25	25	25	30	25	65	30
1890	65	30	25	35	30	25	25	25	30	25	65	30
1891	65	30	25	35	30	25	25	25	30	25	44	26
1892	65	30	25	35	30	25	25	24	30	25	25	25
1893	65	30	25	35	30	25	25	24	30	25	25	25
1894	65	30	25	35	30	25	25	24	30	25	25	25
1895	65	30	25	35	30	25	25	24	30	25	25	25
1896	65	30	25	35	30	25	25	24	30	25	25	25
1897	65	30	25	35	30	25	25	24	30	25	25	25

AVERAGE RATES, REGARDLESS OF QUANTITY SHIPPED, IN CENTS, PER 100 POUNDS.

[From Bulletin No. 14, Miscellaneous Series, of the Division of Statistics.]

Year.	Dry goods.	Cotton piece goods.	Boots and shoes.	Tea.	Drugs.
1867	137	137	137	137	137
1868	122	122	122	122	122
1869	99	99	99	99	99
1870	113	113	113	113	113
1871	81	81	81	81	81
1872	105	105	105	105	105
1873	69	69	69	69	69
1874	81	81	81	81	81
1875	53	53	53	53	53
1876	39	39	39	39	39
1877	72	72	72	72	72
1878	77	77	77	77	77
1879	75	75	75	75	75
1880	75	75	75	75	75
1881	65	65	65	65	65
1882	56	56	56	56	56
1883	75	75	75	75	75
1884	75	75	75	75	75
1885	56	56	56	56	56
1886	75	66	75	75	75
1887	75	50	75	75	75
1888	73	49	73	73	73
1889	75	50	75	75	75
1890	75	50	75	75	75
1891	75	50	75	75	75
1892	75	50	75	75	75
1893	75	50	75	75	75
1894	75	50	75	75	75
1895	75	50	75	75	75
1896	75	50	75	75	75
1897	75	50	75	75	75

Live stock and dressed meats, Chicago to New York.

AVERAGE RATES, IN CENTS, PER 100 POUNDS.

[From Bulletin No. 14, Miscellaneous Series of the Division of Statistics.

Year.	Cattle.	Hogs.	Sheep.	Horses and mules.	Dressed beef.	Dressed hogs.	
						Refrigerator cars.	Common cars.
1872	....	....	....	....	81	....	....
1873	....	....	....	....	83	....	....
1874	....	....	....	....	85	....	....
1875	....	....	....	....	72	....	....
1876	....	....	....	....	62	....	....
1877	....	....	....	....	72	....	....
1878	....	....	....	....	79	....	....
1879	47	45	61	60	82	....	....
1880	55	43	65	60	88	....	....
1881	35	31	61	60	56	....	....
1882	36	29	53	60	57	....	....
1883	40	32	50	60	64	....	....
1884	31	28	44	60	51	....	....
1885	31	26	43	60	54	....	....
1886	33	30	42	60	61	53	48
1887	33	32	40	60	62	59	54
1888	22	26	31	60	46	46	44
1889	25	30	30	60	47	47	45
1890	23	28	30	60	39	39	39
1891	27	30	30	60	45	45	45
1892	28	28	30	60	45	45	45
1893	28	20	30	60	45	45	45
1894	28	30	30	60	45	45	45
1895	28	30	30	60	45	45	45
1896	28	30	30	60	45	45	45
1897	28	30	30	60	45	45	45

Grain, Chicago to New York.

AVERAGE RATES, IN CENTS, PER BUSHEL.

[From Bulletin No. 14, Miscellaneous Series of the Division of Statistics.]

Year.	Wheat.				Corn.	
	Via lake and rail.		Via all rail.		Via lake and rail.	Via all rail.
	As reported by New York Produce Exchange.	As reported by Chicago Board of Trade.	As reported by New York Produce Exchange.	As reported by Chicago Board of Trade.	As reported by Chicago Board of Trade.	As reported by Chicago Board of Trade.
1858	....	....	....	38.61	....	36.19
1859	....	....	....	34.80	....	32.48
1860	....	....	....	34.80	....	32.48
1861	....	....	....	41.58	....	38.81
1862	....	....	....	42.37	....	39.54
1863	....	....	....	33.88	....	31.63
1864	....	....	....	29.51	....	27.55
1865	....	....	....	28.53	....	26.62
1866	....	....	....	32.79	....	30.60
1867	....	....	....	32.38	....	30.22
1868	20.76	....	30.49	27.09	....	25.28
1869	18.80	18.80	26.39	26.74	17.71	24.96
1870	19.15	19.58	28.98	26.11	19.32	24.37
1871	22.38	22.76	27.75	28.47	21.24	26.57
1872	24.91	26.25	29.80	31.13	23.67	29.06
1873	23.64	21.63	29.17	27.26	20.19	25.42
1874	15.20	15.37	25.81	23.61	12.48	22.03
1875	12.71	12.09	20.97	20.89	11.34	19.50
1876	10.58	10.19	14.80	15.12	9.68	14.12
1877	15.08	14.75	19.37	19.56	13.42	18.03
1878	11.31	11.99	17.56	17.56	10.45	16.39
1879	13.30	13.13	17.30	17.74	12.20	14.56
1880	15.70	15.80	19.90	19.80	14.43	17.48
1881	10.40	10.49	14.40	14.40	9.42	13.40
1882	10.90	10.91	14.60	14.47	10.28	13.50

Grain, Chicago to New York—Continued.

AVERAGE RATES, IN CENTS, PER BUSHEL.

Year.	Wheat. Via lake and rail. As reported by New York Produce Exchange.	Wheat. Via lake and rail. As reported by Chicago Board of Trade.	Wheat. Via all rail. As reported by New York Produce Exchange.	Wheat. Via all rail. As reported by Chicago Board of Trade.	Corn. Via lake and rail. As reported by Chicago Board of Trade.	Corn. Via all rail. As reported by Chicago Board of Trade.
1883	11.5	11.63	16.5	16.20	11	15.12
1884	9.55	10	13.12	13.20	8.50	12.32
1885	9.02	9.02	14	13.20	8.01	12.32
1886	12	12	16.50	15	11.20	14
1887	12	12	16.33	15.75	11.20	14.70
1888	11	11.14	14.50	14.50	10.26	13.54
1889	8.70	8.97	15	15	8.19	12.6
1890	8.50	8.52	14.31	14.30	7.32	11.36
1891	8.53	8.57	15	15	7.53	14
1892	7.55	7.59	14.23	13.80	7.21	12.96
1893	8.44	8.48	14.70	14.63	7.97	13.65
1894	7	7	12.88	13.20	6.50	12.32
1895	6.95	6.96	12.17	11.89	6.40	10.29
1896	7.32	6.61	12	12	6.15	10.50
1897	7.37	7.42	12.32	12.50	6.92	11.43

Average freight rates, in cents, per ton per mile.

[From Bulletin No. 14, Miscellaneous Series of the Division of Statistics.]

Year.	Fitchburg R. R.	Boston and Albany R. R.	New York Central and Hudson River R. R.	Erie R. R.	Lake Shore and Michigan Southern Rwy.	Pennsylvania R. R.	Pittsburg, Fort Wayne and Chicago Rwy.	Chesapeake and Ohio Rwy.	Illinois Central R. R.	Chicago, Rock Island and Pacific Rwy.	Chicago, Milwaukee and St. Paul Rwy.	Chicago and Alton R. R.	Union Pacific Rwy.	Louisville and Nashville R. R.	All railways in the United States.
1867	3.023	2.201	1.980	1.465	1.745	1.497	1.403	3.753	2.085	2.185	2.834	2.055	......	3.007	1.925
1868	2.905	1.999	1.951	1.287	1.661	1.322	1.211	3.179	1.751	2.385	2.528	2.101	......	2.949	1.810
1869	3.212	1.798	1.763	1.137	1.266	1.229	1.198	3.752	1.840	2.202	2.298	1.856	......	2.450	1.709
1870	3.635	1.851	1.590	1.125	1.269	1.268	1.229	4.101	1.953	2.316	2.380	1.963	3.596	2.513	1.889
1871	......	1.869	1.457	1.282	1.244	1.211	1.276	4.445	2.077	2.369	2.289	1.968	2.419	2.298	1.789
1872	3.504	1.800	1.422	1.362	1.227	1.304	1.264	3.643	1.923	2.229	2.177	1.789	2.390	2.053	1.846
1873	3.289	1.707	1.371	1.267	1.164	1.258	1.220	1.909	1.916	2.002	2.173	1.864	2.153	1.930	1.613
1874	3.903	1.641	1.319	1.184	1.065	1.164	1.134	1.354	1.881	1.871	2.137	1.916	1.949	1.940	1.520
1875	3.624	1.346	1.119	1.061	.887	.989	.970	1.299	1.692	1.688	1.833	1.649	2.164	1.687	1.421
1876	2.218	1.139	.929	.972	.722	.841	.827	1.061	1.587	1.693	1.798	1.438	2.211	1.638	1.217
1877	1.955	1.136	.954	.898	.813	.954	1.024	1.035	1.719	1.563	1.949	1.361	2.135	1.382	1.286
1878	1.582	1.113	.919	.960	.724	.914	.867	.985	1.616	1.539	1.762	1.354	2.236	1.635	1.296
1879	1.299	1.100	.793	.779	.641	.823	.754	.860	1.523	1.429	1.704	1.054	1.991	1.528	1.153
1880	1.36	1.207	.879	.836	.750	.918	......	.866	1.543	1.209	1.749	1.206	......	1.594	1.232
1881	1.26	1.038	.783	.805	.617	.857	.745	.892	1.522	1.220	1.702	1.241	2.178	1.503	1.188
1882	1.17	1.064	.738	.749	.628	.874	.752	.753	1.417	1.281	1.481	1.253	2.102	1.349	1.102
1883	1.19	1.197	.915	.786	.728	.881	.787	.722	1.433	1.170	1.391	1.128	1.913	1.323	1.205
1884	1.09	1.093	.834	.719	.652	.804	.673	.672	1.368	1.097	1.293	1.008	1.557	1.344	1.136
1885	1.06	.944	.688	.656	.553	.695	.577	.550	1.307	1.043	1.278	1.009	1.420	1.159	1.011
1886	1.07	1.101	.765	.659	.639	.755	.692	.541	1.157	1.071	1.168	.961	1.266	1.079	.999
1887	1.13	1.107	.782	.687	.670	.730	.717	.537	1.087	1.012	1.089	.946	1.213	1.075	.984
1888	1.116	1.099	.753	.716	.861	.723	.660	.541	1.068	.964	1.020	.973	1.170	1.049	1.001
1889	1.015	1.030	.712	.644	.632	.685	.69	.538	.839	.971	1.067	.525	1.166	.998	.922
1890	.995	1.105	.730	.665	.644	.661	.69	.561	.942	.995	.995	.898	1.138	.972	.941
1891	.991	1.089	.740	.636	.630	.656	.70	.525	.934	1.039	1.003	.980	1.131	.968	.895
1892	.925	1.057	.699	.614	.602	.647	.67	.518	.908	1.055	1.026	.973	1.080	.948	.898
1893	.923	1.006	.701	.631	.599	.620	.68	.511	.845	1.039	1.026	.949	1.033	.917	.878
1894	.895	.944	.733	.621	.587	.606	.65	.478	.839	.989	1.037	.974	.970	.876	.860
1895	.878	.969	.726	.604	.567	.565	.64	.425	.808	1.084	1.075	.994	.971	.831	.839
1896	.864	.942	.668	.606	.551	.563	.66	.425	.745	1.017	1.003	.925	.957	.806	.806

Average rates, in cents, per passenger per mile.

[From Bulletin No. 14, Miscellaneous Series of the Division of Statistics.]

Year.	Fitchburg R. R.	Boston and Albany R. R.	New York Central and Hudson River R. R.	Erie R. R.	Lake Shore and Michigan Southern Rwy.	Pennsylvania R. R.	Pittsburg, Fort Wayne and Chicago Rwy.	Chesapeake and Ohio Rwy.	Illinois Central R. R.	Chicago, Rock Island and Pacific Rwy.	Chicago, Milwaukee and St. Paul Rwy.	Chicago and Alton R. R.	Union Pacific Rwy.	Louisville and Nashville R. R.	All railways in the United States.
1867	1.603	1.955	......	1.641	......	2.074	2.129	......	2.798	3.132	......	......	......	2.733	1.994
1868	......	1.940	......	2.021	......	1.926	2.017	......	2.791	2.982	......	......	......	2.845	2.164
1869	1.696	1.974	......	2.324	......	1.872	1.970	......	2.914	3.047	2.897	......	......	2.894	2.144
1870	1.945	2.343	1.770	2.470	2.204	2.167	2.282	3.979	3.290	3.426	3.273	......	4.301	3.194	2.392
1871	2.010	2.517	1.920	2.396	2.503	2.322	......	4.037	3.358	3.435	3.322	......	3.775	3.340	2.632
1872	1.923	2.275	1.863	1.904	2.321	2.379	......	3.992	3.034	3.229	3.404	......	3.730	3.240	2.521
1873	1.820	2.176	1.799	1.927	2.221	2.317	......	3.686	3.097	3.131	3.099	......	3.541	3.102	2.486
1874	1.984	2.229	1.929	2.088	2.214	2.349	2.301	3.542	2.966	3.063	2.995	2.949	3.394	3.412	2.544
1875	1.910	2.180	1.885	1.955	2.088	2.259	2.107	3.231	2.882	2.687	2.690	2.755	2.878	3.219	2.378
1876	1.864	2.099	1.693	1.859	1.846	1.819	1.830	3.322	2.804	2.626	2.805	2.614	2.974	3.018	2.183
1877	1.947	2.174	1.953	1.772	2.182	2.185	2.192	3.786	2.942	2.772	2.994	2.798	3.140	3.167	2.458
1878	1.969	2.217	1.978	2.158	2.255	2.277	2.258	3.738	3.122	2.933	3.029	2.795	3.226	3.345	2.573
1879	1.888	2.137	2.044	2.090	2.221	2.253	2.228	3.630	3.066	2.971	2.908	2.417	......	3.444	2.484
1880	1.885	2.096	1.999	2.041	2.135	2.222	2.156	2.959	2.514	2.806	2.868	2.076	......	3.476	2.442
1881	1.820	1.970	1.862	2.016	1.988	2.152	1.895	2.989	2.164	2.666	2.856	1.828	3.341	3.168	2.446
1882	1.715	1.993	1.808	1.948	2.156	2.249	2.024	2.605	2.388	2.505	2.579	1.951	3.300	2.706	2.391
1883	1.790	2.088	1.986	1.673	2.196	2.297	2.193	2.373	2.424	2.504	2.516	2.141	3.128	2.614	2.402
1884	1.651	1.908	1.942	2.189	2.170	3.258	2.222	2.379	2.225	2.572	2.553	1.900	2.952	2.342	2.323
1885	1.833	1.838	1.419	1.756	2.058	1.950	1.569	2.270	2.211	2.466	2.563	2.026	2.749	2.103	2.216
1886	1.756	1.853	1.845	1.890	2.098	2.114	2.130	2.131	2.208	2.420	2.415	2.023	2.135	2.436	2.142
1887	1.89	1.880	1.989	2.039	2.260	2.125	2.255	2.074	2.268	2.328	2.538	2.062	2.301	2.594	2.245
1888	1.978	1.976	1.967	1.851	2.280	2.111	2.10	2.025	2.197	2.312	2.445	2.123	2.248	2.429	2.349
1889	1.957	1.869	1.932	1.722	2.286	2.076	2.18	1.709	1.927	2.285	2.415	2.128	2.135	2.370	2.165
1890	1.915	1.858	1.910	1.584	2.254	2.094	2.25	2.056	2.022	2.149	2.359	2.004	2.045	2.403	2.167
1891	1.869	1.818	1.905	1.601	2.105	2.070	2.23	2.155	2.073	2.322	2.408	2.205	2.059	2.483	2.142
1892	1.916	1.828	1.887	1.589	2.183	2.028	2.00	2.181	2.101	2.308	2.464	2.043	2.104	2.448	2.126
1893	1.869	1.835	1.832	1.551	2.195	1.968	1.98	1.989	1.999	2.095	2.414	1.981	1.987	2.432	2.108
1894	1.851	1.794	1.857	1.509	2.069	1.993	2.00	1.905	1.925	1.891	2.191	1.776	1.758	2.365	1.986
1895	1.819	1.770	1.837	1.560	2.215	1.971	2.06	1.980	1.995	2.146	2.411	2.119	1.962	2.318	2.040
1896	1.769	1.752	1.838	1.641	2.148	1.950	1.88	1.952	1.979	2.108	2.375	2.117	2.075	2.187	2.019

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