John Adams

Horſe-Hoeing Husbandry:

OR,

An ESSAY on the PRINCIPLES

OF

Vegetation *and* Tillage.

Deſigned to introduce

A NEW METHOD of CULTURE;

WHEREBY

The Produce of Land will be increaſed, and the uſual Expence leſſened.

Together with

Accurate DESCRIPTIONS and CUTS of the Inſtruments employed in it.

By JETHRO TULL, *Eſq*;
Of Shalborne *in* Berkſhire.

The FOURTH EDITION, very carefully Corrected.

To which is prefixed,

A New PREFACE by the EDITORS, addreſſed to all concerned in AGRICULTURE.

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M.DCC.LXII.

THE PREFACE.

AS Mr. *Tull*'s Eſſay on *Horſe-hoeing Huſbandry* has been publiſhed ſome Years, it may be preſumed that the World hath by this time formed ſome Judgment of his Performance; which renders it the leſs neceſſary for the Editors of this Impreſſion to ſay much concerning it. For every Man who has attended to the Subject, and duly conſidered the Principles upon which our Author's Method of Culture is founded, is an equal Judge how far his Theory is agreeable to Nature: Though it is but too true, that few have made ſufficient Experiments to be fully informed of its Worth.

How it has happened, that a Method of Culture, which propoſes ſuch Advantages to thoſe who ſhall duly proſecute it, hath been ſo long neglected in this Country, may be matter of Surprize to ſuch as are not acquainted with the Characters of the Men on whom the Practice thereof depends; but to thoſe who know them thoroughly it can be none. For it is certain that very few of them can be prevailed on to alter their uſual Methods upon any Conſideration; though they are convinced that their continuing therein diſables them from paying their Rents, and maintaining their Families.

And, what is ſtill more to be lamented, theſe People are ſo much attached to their old Cuſtoms, that they are not only averſe to alter them themſelves, but are moreover induſtrious to prevent others from ſucceeding, who attempt to introduce any thing new; and indeed have it too generally in their Power, to defeat any Scheme which is not agreeable to their own Notions; ſeeing it muſt be executed by the ſame Sort of Hands.

This naturally accounts for Mr. *Tull*'s Huſbandry having been ſo little practiſed. But as the Methods commonly uſed, together with the mean Price of Grain for ſome Years paſt, have brought the Farmers every-where ſo low, that they pay their Rents very ill, and in many Places have thrown up their Farms; the Cure of theſe Evils is certainly an Object worthy of the public Attention: For if the Proprietor muſt be reduced to cultivate his own Lands, which cannot be done but by the Hands of theſe indocile People, it is eaſy to gueſs on which Side his Balance of Profit and Loſs will turn.

This Conſideration, together with many others which might be enumerated, hath induced the Editors to recommend this Treatiſe once more to the ſerious Attention of every one who wiſhes well to his Country; in hopes that
ſome

ſome may be prevailed upon, by regard either to the public Good or their own private Intereſt, to give the Method here propoſed a fair and impartial Trial: For could it be introduced into ſeveral Parts of this Country by Men of generous Principles, their Example might, in time, eſtabliſh the Practice thereof, and bring it into general Uſe; which is not to be expected by any other means.

It is therefore to ſuch only, as are qualified to judge of a Theory from the Principles on which it is founded, that the Editors addreſs themſelves, deſiring they will give this Eſſay another Reading with due Attention: and at the ſame time they beg leave to remind them how unfit the common Practiſers of Huſbandry are to paſs Judgment, either on the Theory or Practice of this Method; for which Reaſon it is hoped that none will be influenced by ſuch, but try the Experiment themſelves with proper Care.

As a Motive to this, it is to be obſerved that, although the Method of Culture here propoſed has made little Progreſs in *England*, it is not like to meet with the ſame Neglect abroad, eſpecially in *France*; where a Tranſlation of Mr. *Tull*'s Book was undertaken, at one and the ſame time, by three different Perſons of Conſideration, without the Privity of each other: But afterwards, Two of them put their Papers into the Hands of the Third, Mr. *Du Hamel du Manceau*, of the *Royal Academy of Sciences* at *Paris*, and of the *Royal Society* at *London*; who has publiſhed a Book, intituled, *A Treatiſe of Tillage on the Principles of Mr.* Tull. The ingenious Author has indeed altered the Method obſerved by Mr. *Tull* in his Book; yet has very exactly given his Principles and Rules: But as he had only ſeen the Firſt Edition of the *Horſe-hoeing Huſbandry*, ſo he is very defective in his Deſcriptions of the Ploughs and Drills, which in that were very imperfect, and were afterwards amended by Mr. *Tull* in his Additions to that Eſſay.

One of our principal Reaſons for taking Notice of this Book is, to ſhew the Compariſon this Author has made between the Old Method of Huſbandry and the New. By his Calculation the Profits ariſing from the New, are conſiderably more than double thoſe of the Old. For, according to him, the Profits of Twenty Acres of Land for Ten Years, amount, at 10*d.* ½ *per* Livre,

	l.	*s.*	*d.*	
By the Old Method, to 3000 Livres, or	131	5	0	*Sterling.*
By the New Method, to 7650 Livres, or	334	13	9	

which makes a prodigious Difference in favour of the latter. As this Computation was made by one who cannot be ſuppoſed to have any Prejudice in favour of Mr. *Tull*'s Scheme, it will naturally find more Credit with the Public than any Compariſon made by Mr. *Tull* himſelf, or by ſuch as may have an Attachment to his Principles.

It

It may probably be expected, that the Editors should take Notice of such Objections as have been made, either to Mr. *Tull*'s Theory or Practice; but we do not know any that in the least affect his Principles: They stand uncontroverted: Nor are there any to the Practice, which may not be equally urged against every Sort of Improvement. One of the principal which have come to our Knowlege is, its being impracticable in common Fields, which make a great Part of this Country, without the Concurrence of every one who occupies Land in the same Field. But doth not this equally affect the Old Husbandry? For every such Person is obliged to keep the Turns of plowing, fallowing, *&c.* with the other Occupiers; so that if any of them were inclinable to improve their Lands, by sowing Grass-seeds, or any other Method of Culture, they are now under the same Difficulties as they would be, were they to practise Mr. *Tull*'s Method. Therefore this is rather to be lamented as a public Misfortune, than to be brought as an Objection to the Practicableness of that Method. Others object, that the introducing this Sort of Husbandry is unnecessary, seeing the Improvements which are made by Grass-seeds are so considerable; besides, that the Returns made by the Fold and the Dairy, being much quicker than those of Grain, engage the Farmer to mix Plowing and Grazing together. But when this is duly considered it can have no ſort of Weight: for is it not well known that, in thoſe Farms where the greateſt Improvements have been made by Graſs-ſeeds, the Quantity of Dreſſing required for the Arable Land often runs away with moſt of the Profit of the whole Farm? eſpecially when the Price of Grain is low. And if this be the Situation of the moſt improved Farms, what muſt be the Caſe of thoſe which chiefly conſiſt of Arable Land; where moſt of the Dreſſing muſt be purchaſed at a great Price, and often fetched from a conſiderable Diſtance? Add to this the great Expence of Servants and Horſes, unavoidable in Arable Farms; and it will appear how great the Advantages are which the Graſier hath over the plowing Farmer. So that it is much to be wiſhed, the Practice of mixing the Two Sorts of Huſbandry were more generally uſed in every Part of the Kingdom; which would be far from rendering Mr. *Tull*'s Method of Culture uſeleſs; ſeeing that, when it is well underſtood, it will be found the ſureſt Method to improve both.

For although Mr. *Tull* chiefly confined the Practice of his Method to the Production of Grain (which is a great Pity), yet it may be extended to every Vegetable which is the Object of Culture in the Fields, Gardens, Woods, &c. and perhaps may be applied to many other Crops, to equal, if not greater Advantage, than to Corn.

In the Vineyard it has been long practiſed with Succeſs; and may be uſed in the Hop-Ground with no leſs Advantage. For the Culture of Beans, Peas, Woad, Madder, and other large-growing Vegetables; as alſo for Lucern, Saintfoin, and the larger Graſſes; we dare venture to pronounce it the only Method of Culture for Profit to the Farmer; ſeeing that, in all theſe Crops, one Sixth Part of the Seeds now commonly ſown will be ſufficient for the ſame Quantity of Land, and the Crop in Return will be much greater; which, when the Expence of Seeds is duly conſidered, will be found no ſmall Saving to the Farmer.

Nor ſhould this Method of Culture be confined to *Europe*: for it may be practiſed to as great Advantage in the *Britiſh* Colonies in *America*, where, in the Culture of the Sugar-Cane, Indigo, Cotton, Rice, and almoſt all the Crops of that Country, it will certainly ſave a great Expence of Labour, and improve the Growth of every Plant, more than can be imagined by ſuch as are ignorant of the Benefit ariſing from this Culture. And ſhould the Subjects of *Great Britain* neglect to introduce this Method into her Colonies, it may be preſumed our Neighbours will take care not to *be blameable on this Head*; for they ſeem to be as intent upon extending every Branch of Trade, and making the greateſt Improvements of their Land, as we are indifferent to both: So that, unleſs a contrary Spirit be ſoon exerted, the Balance of

Trade,

Trade, Power, and every other Advantage, muſt be againſt us.

There have been Objections made by ſome to Mr. *Tull*'s Method, as if it were practicable only on ſuch Lands as are ſoft and light, and not at all on ſtiff and ſtony Ground. That it hath not been practiſed on either of theſe Lands in *England* we are willing to grant; but we muſt not from thence infer that it is impoſſible to apply it to them. For the Hoe-Plough has been very long uſed in the Vineyards in many Countries, where the Soil is ſtronger, and abounds with Stones full as much as any Part of this Country. However, though the Uſe of this Plough may be attended with ſome Difficulties upon ſuch Land, for Wheat, or Plants of low Growth, whoſe Roots may be in Danger of being turned out of the Ground, or their Tops buried by the Clods or Stones; yet none of the larger-growing Plants are ſubject to the ſame Inconveniencies. Beſides, the ſtronger the Soil is, the more Benefit will it receive from this Method of Culture, if the Land be thereby more pulverized; which will certainly be the Conſequence, where the Method laid down by Mr. *Tull* is duly obſerved.

But as moſt Inſtruments, in their Firſt Uſe, are attended with ſome Difficulty, eſpecially in the Hands of ſuch as are indocile, the Hoe-plough has been complained of, as cumberſome and unwieldy to the Horſe and Ploughman. But perhaps this ariſes chiefly from the Unwillingneſs of

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the Workmen to introduce any new Inſtrument: Indeed, ſeeing little is to be expected from thoſe who have been long attached to different Methods, the ſureſt Way to promote the Uſe of it, is to engage young Perſons, who may probably be better diſpoſed, to make the Trial at their firſt entering into Buſineſs; and then a little Uſe will make it eaſy. It is proper to obſerve here, that the Swing-plough, which is commonly uſed in the deep Land about *London*, will do the Buſineſs of the Hoe-plough in all Ground that is not very ſtrong, or very ſtony; and that where it is ſo, the Foot-plough, made proportionably ſtrong, will completely anſwer all Purpoſes. But it muſt be remembered, that when theſe are uſed to hoe Corn, the Board on the Left Hand of the Plough, anſwering the Mould-Board, muſt be taken off; otherwiſe ſo much Earth will run to the Left Side, as to injure the Crop when it is low.

The *Drills* are excellent Inſtruments; yet we imagine them capable of ſome farther Improvement. Parallel Grooves, at about an Inch aſunder, round the Inſide of the Hopper, would ſhew the Man who follows the Drill, whether or no both Boxes vent the Seed equally. By an Hitch from the Plank to the Harrow, the latter may be lifted to a proper Height, ſo as not to be in the Way when the Ploughman turns at the Headland. Two light Handles on the Plank, like thoſe of the common Plough, would

 enable

enable the Perſon who follows the Drill to keep it from falling off the Middle of the Ridge. It may alſo be uſeful, in wet Weather, to double the Drills; by which means Two Ridges may be ſown at the ſame time, the Horſe going between them: For the Planks of Two Drills, each Plank having one of the Shafts fixed to it, may be joined End for End by Two flat Bars of Iron, one on each Side, well ſecured by Iron Pins and Screws; and, by correſponding Holes in the Planks and Bars, the Diſtance between the Drills may be altered, according to the different Spaces between the Ridges.

The Alterations made by the Editors of this Impreſſion are little more than omitting the controverſial Parts of the Book, which were judged of no Service to the Reader, as they no-ways affected the Merits of Mr. *Tull*'s Principles.

But as he endeavoured to recommend his Theory by drawing a Compariſon between the Old Method of Culture and the New, ſo we beg leave to annex a Computation of the Expence and Profit of each; for which we are obliged to a Gentleman, who for ſome Years practiſed both in a Country where the Soil was of the ſame Nature with that from whence Mr. *Tull* drew his Obſervations, *viz.* light and chalky. And we chuſe to give this the rather, as it comes from one who has no Attachment to Mr. *Tull*'s Method, farther than that he found it anſwer in his Trials. We appeal to

Experience,

Experience, whether every Article in this Calculation is not eſtimated in favour of the Common Huſbandry; whether the Expence be not rated lower than moſt Farmers find it, and the Crop ſuch as they would rejoice to ſee, but ſeldom do, in the Country where this Computation was made.

In the New Huſbandry every Article is put at its full Value, and the Crop of each Year is Four Buſhels ſhort of the other; tho', in ſeveral Years Experience, it has equalled, and generally exceeded, thoſe of the Neighbourhood in the Old Way.

An Eſtimate of the Expence and Profit of Ten Acres of Land in Twenty Years.

I. *In the Old Way.*

First Year, for Wheat, coſts 33 *l.* 5 *s.* *viz.*	*l.*	*s.*	*d.*	*l.*	*s.*	*d.*
Firſt Plowing, at 6 *s.* *per* Acre - - - -	3	0	0			
Second and Third Ditto, at 8 *s.* *per* Acre - -	4	0	0			
Manure, 30 *s.* *per* Acre	15	0	0			
				22	0	0
Two Harrowings, and Sowing, at 2 *s.* 6 *d.* *per* Acre - - -	1	5	0			
Seed, three Buſhels *per* Acre, at 4 *s.* *per* Buſh.	6	0	0			
Weeding, at 2 *s.* *per* Acre	1	0	0			
Reaping, Binding, and Carrying, at 6 *s.* *per* Acre - - - -	3	0	0	11	5	0
				33	5	0

				l.	s.	d.
Brought over - - - - -				33	5	0
Second Year, for Barley, coſts 11 *l.* 6 *s.* 8 *d.* *viz.*						
	l.	*s.*	*d.*			
Once Plowing, at 6 *s.* *per* Acre - - - - -	3	0	0			
Harrowing and Sowing, at 1 *s.* 6 *d.* *per* Acre,	0	15	0			
Weeding, at 1 *s.* *per* Acre	0	10	0			
Seed, 4 Buſhels *per* Acre, at 2 *s.* *per* Buſhel -	4	0	0			
Cutting, Raking, and Carrying, at 3 *s.* 2 *d.* *per* Acre - - -	1	11	8			
Graſs-Seeds, at 3 *s.* *per* Acre - - - - -	1	10	0			
				11	6	8
				44	11	8
Third and Fourth Years, lying in Graſs, coſt nothing: So that the Expence of Ten Acres in Four Years comes to 44 *l.* 11 *s.* 8 *d.* and in Twenty Years to - -				222	18	4
Firſt Year's Produce is half a Load of Wheat *per* Acre, at 7 *l.* - -	35	0	0			
Second Years Produce is Two Quarters of Barley *per* Acre, at 1 *l.*	20	0	0			
Third and Fourth Years Graſs is valued at 1 *l.* 10 *s.* *per* Acre - -	15	0	0			
So that the Produce of Ten Acres in Four Years is - - - -	70	0	0			

And in Twenty Years it will be -				350	0	0
Deduct the Expence, and there remains clear Profit on Ten Acres in 20 Years by the Old Way -				127	1	8

II. *In the New Way.*

First Year's extraordinary Expence is, for plowing and manuring the Land, the same as in Old Way - - - - - - -				22	0	0
Plowing once more, at 4 *s. per* Acre -	2	0	0			
Seed, 9 Gallons *per* Acre, at 4 *s. per* Bushel -	2	5	0			
Drilling, at 7 *d. per* Acre	0	5	10			
Hand-hoeing and Weeding, at 2 *s.* 6 *d. per* Acre	1	5	0			
Horse-hoeing Six times, at 10 *s. per* Acre -	5	0	0			
Reaping, Binding, and Carrying, at 6 *s. per* Acre - - - - -	3	0	0			
The standing annual Charge on Ten Acres is -	13	15	10			
Therefore the Expence on Ten Acres in Twenty Years is - -				275	16	8
Add the Extraordinaries of the First Year, and the Sum is - -				297	16	8
The yearly Produce is at least Two Quarters of Wheat *per* Acre, at 1 *l.* 8 *s. per* Quarter; which, on Ten Acres in Twenty Years, amounts to - - - - - -				560	00	
Therefore, all things paid, there remains clear Profit on Ten Acres in Twenty Years by the New Way				262	3	4

So that the Profit on Ten Acres of Land in Twenty Years, in the New Way, exceeds that in the Old by 135*l.* 1*s.* 8*d.* and consequently is considerably more than double thereof: an ample Encouragement to practise a Scheme, whereby so great Advantage will arise from so small a Quantity of Land, in the Compass of a Twenty-one Years Lease; One Year being allowed, both in the Old and New Way, for preparing the Ground.

It ought withal to be observed, that Mr. *Tull*'s Husbandry requires no Manure at all, tho' we have here, to prevent Objections, allowed the Charge thereof for the first Year; and moreover, that tho' the Crop of Wheat from the *Drill-plough* is here put only at Two Quarters on an Acre, yet Mr. *Tull* himself, by actual Experiment and Measure, found the Produce of his drilled Wheat-crop amounted to almost Four Quarters on an Acre: And, as he has delivered this Fact upon his own Knowlege, so there is no Reason to doubt of his Veracity, which has never yet been called in question. But that we might not be supposed to have any Prejudice in favour of his Scheme, we have chosen to take the Calculations of others rather than his, having no other View in what we have said, than to promote the Cause of Truth, and the public Welfare.

The Wheat and Turnep Drill-Boxes, or the Drill Plough complete, mentioned in this Treatise, may be had at Mr. *Mulford*'s in *Cursitor-street, Chancery-lane, London.*

CHAP.

CHAP. I.

Of Roots *and* Leaves.

SINCE the moſt immediate Uſe of *Agriculture*, in feeding Plants, relates to their *Roots*, they ought to be treated of in the firſt Place.

Roots are very different in different Plants: But 'tis not neceſſary here to take notice of all the nice Diſtinctions of them; therefore I ſhall only divide them in general into two Sorts, *viz. Horizontal-Roots*, and *Tap-Roots*, which may include them all.

All have Branchings and Fibres going all manner of ways, ready to fill the Earth that is open.

But ſuch *Roots* as I call Horizontal (except of Trees) have ſeldom any of their Branchings deeper than the Surface or Staple of the Earth, that is commonly mov'd by the Plough or Spade.

The Tap-Root commonly runs down Single and Perpendicular *(a)*, reaching ſometimes many Fathoms below.

This (tho' it goes never ſo deep) has horizontal ones paſſing out all round the Sides; and extend to ſeveral Yards Diſtance from it, after they are by their

(a) In this manner deſcends the firſt Root of every Seed; but of Corn very little, if at all, deeper than the Earth is tilled.

Theſe firſt Seed-Roots of Corn die as ſoon as the other Roots come out near the Surface, above the Grain: and therefore this firſt is not called a Tap-Root; but yet ſome of the next Roots that come out near the Surface of the Ground, always reach down to the Bottom of the pulveriz'd Staple; as may be ſeen, if you carefully examine it in the Spring time; but this firſt Root in Saint-foin becomes a Tap-Root.

Minuteneſs, and earthly Tincture, become inviſible to the naked Eye.

A Method how to find the Diſtance to which Roots *extend Horizontally.*

Pl. 6. *Fig.* 7. Is a Piece or Plot dug and made fine in whole hard Ground, the End *A* 2 Feet, the End *B* 12 Feet, the Length of the Piece 20 Yards; the Figures in the middle of it are 20 *Turneps*, ſown early, and well ho'd.

The manner of this Hoing muſt be at firſt near the Plants, with a Spade, and each time afterwards, a Foot farther Diſtance, till all the Earth be once well dug; and if Weeds appear where it has been ſo dug, hoe them out ſhallow with the Hand-Hoe. But dig all the Piece next the out Lines deep every time, that it may be the finer for the *Roots* to enter, when they are permitted to come thither.

If theſe *Turneps* are all gradually bigger, as they ſtand nearer to the End *B*, 'tis a Proof they all extend to the Outſide of the Piece; and the *Turnep* 20 will appear to draw Nouriſhment from ſix Feet Diſtance from its Centre.

But if the *Turneps* 16, 17, 18, 19, 20, acquire no greater Bulk than the *Turnep* 15, it will be clear, that their *Roots* extend no farther than thoſe of the *Turnep* 15 does; which is but about 4 Feet.

By this Method the Diſtance of the Extent of *Roots* of any Plant may be diſcover'd.

What put me upon this Method was an Obſervation of two Lands (or Ridges) drill'd with *Turneps* in Rows, a Foot aſunder, and very even in them; the Ground, at both Ends, and one Side, was hard and unplow'd; the *Turneps* not being ho'd, were very poor, ſmall, and yellow, except the Three outſide Rows, *B*, *C*, *D*, which ſtood next to the Land (or Ridge) *E*, which Land being plow'd and harrow'd, at the time the Land *A* ought to have been ho'd, gave

gave a dark flouriſhing Colour to theſe three Rows; and the *Turneps* in the Row *D*, which ſtood fartheſt off from the new-plow'd Land *E*, received ſo much Benefit from it, as to grow twice as big as any of the more diſtant Rows. The Row *C*, being a Foot nearer to the new-plow'd Land, became twice as large as thoſe in *D*; but the Row *B*, which was next to the Land *E*, grew much larger yet *(a)*.

F Plate 6. is a Piece of hard whole Ground, of about two Perch in Length, and about two or three Feet broad, lying betwixt thoſe two Lands, which had not been plow'd that Year; 'twas remarkable, that during the Length of this interjacent hard Ground, the Rows *B*, *C*, *D*, were as ſmall and yellow as any in the Land.

The *Turneps* in the Row *D*, about three Feet diſtant from the Land *E*, receiving a double Increaſe, proves they had as much Nouriſhment from the Land *E*, as from the Land *A*, wherein they ſtood; which Nouriſhment was brought by leſs than half the Number of *Roots* of each of theſe *Turneps*.

In their own Land they muſt have extended a Yard all round, elſe they could not have reach'd the Land *E*, wherein 'tis probable theſe few Roots went

(a) A like Obſervation to this on the Land E, has been made in ſeveral Turnep-Fields of divers Farmers, where Lands adjoining to the Turneps have been well tilled; all the Turneps of the contiguous Lands that were within three or four Feet, or more, of the newly pulveriz'd Earth, received as great, or greater Increaſe, in the Manner as my Rows B C D did; and what is yet a greater Proof of the Length of Roots, and of the Benefit of deep Hoing, all theſe Turneps have been well Hand-ho'd; which is a good Reaſon why the Benefit of the deep Pulveration ſhould be perceivable at a greater Diſtance from it than mine, becauſe my Turneps, not being hoed at all, had not Strength to ſend out their Roots through ſo many Feet of unpulveriz'd Earth, as theſe can through their Earth pulveriz'd by the Hoe, tho' but ſhallowly.

This Obſervation, as 'tis related to me (I being unable to go far enough to ſee it myſelf) ſufficiently demonſtrates the mighty Difference there is between Hand-hoing and Horſe-hoing.

B 2 more

more than another Yard, to give each *Turnep* as much Increaſe as all the Roots had done in their own Land.

Except that it will hereafter appear, that the new Nouriſhment taken at the Extremities of the Roots in the Land *E*, might enable the Plants to ſend out more new Roots in their own Land, and receive ſomething more from thence.

The Row *C* being twice as big as the Row *D*, muſt be ſuppos'd to extend twice as far; and the Row *B*, four times as far, in proportion as it was of a Bulk quadruple to the Row *D*.

A *Turnep* has a Tap-Root, from whence all theſe Horizontal Roots are deriv'd.

And 'tis obſervable; that betwixt theſe two Lands there was a Trench, or Furrow, of about the Depth of nine or ten Inches, where theſe Roots muſt deſcend firſt, and then aſcend into the Land *E*: But it muſt be noted, that ſome ſmall Quantity of Earth was, by the Harrowing, fall'n into this Furrow, elſe the Roots could not have paſs'd thro' it.

Roots will follow the open Mould *(a)*, by deſcending

(a) A Chalk-Pit, contiguous to a Barn, the Area of which being about 40 Perch of Ground, was made clean and ſwept; ſo that there was not the Appearance of any Part of a Vegetable, more than in the Barn's Floor: Straw was thrown from thence into the Pit, for Cattle to lie on; the Dung made thereby was haled away about three Years after the Pit had been cleanſed; when, at the Bottom of it, and upon the Top of the Chalk, the Pit was cover'd all over with Roots, which came from a Witch-Elm, not more than Five or Six Yards in Length, from Top to Bottom, and which was about Five Yards above, and Eleven Yards from the Area of the Pit; ſo that in three Years the Roots of this Tree extended themſelves Eight times the Length of the Tree, beyond the Extremities of the old Roots, at Eleven Yards Diſtance from the Body: The annual-increaſed Length of the Roots was near Three times as much as the Height of the Tree.

I'm told an Objection hath been made from hence againſt the Growth of a Plant's being in proportion to the Length of its Roots; but when the Caſe is fully ſtated, the Objection may vaniſh. This Witching perpendicularly, and mounting again in the ſame manner: As I have obſerv'd the Roots of a Hedge to do, that have paſs'd a ſteep Ditch two Feet deep, and reach'd the Mould on the other ſide, and there fill it; and digging Five Feet diſtant from the Ditch, found the Roots large, tho' this Mould was very ſhallow, and no Roots below the good Mould.

So in an Orchard, where the Trees are planted too deep, below the Staple or good Mould, the Roots, at a little Diſtance from the Stem, are all as near the upper Superficies of the Ground, as of thoſe Trees, which are planted higher than the Level of the Earth's Surface.

But the Damage of planting a Tree too low in moiſt Ground is, that in paſſing thro' this low Part, ſtanding in Water, the Sap is chill'd, and its Circulation thereby retarded.

One Cauſe of Peoples not ſuſpecting Roots to extend to the Twentieth Part of the Diſtance which in reality they do, was from obſerving theſe Horizontal-Roots, near the Plant, to be pretty taper; and if they did diminiſh on, in proportion to what they do

Witch-Elm is a very old decay'd Stump, which is here called a *Staggar*, appearing by its Crookedneſs to have been formerly a *Plaſher* in an old White-thorn Hedge wherein it ſtands: It had been lopped many Years before that accidental Increaſe of Roots happened; it was ſtunted, and ſent out poor Shoots; but in the third Year of theſe Roots, its Boughs being moſt of them horizontally inclined, were obſerved to grow vigorouſly, and the Leaves were broad, and of a flouriſhing Colour; at the End of the third Year all theſe Roots were taken away, and the *Area* being a Chalk-Rock lying uncovered, round the Place where the Single Root, that produced all theſe, came out of the Bank, no more Roots could run out on the bare Chalk, and the Growth of the Boughs has been but little ſince.

Wheat, drill'd in double Rows in *November*, in a Field well till'd before Planting, look'd yellow, when about Eighteen Inches high; at Two Feet Diſtance from the Plants, the Earth was Ho-plow'd, which gave ſuch Nouriſhment to 'em, that they recover'd their Health, and changed their ſickly Yellow, to a lively Green Colour.

there, they muſt ſoon come to an End. But the Truth is, that after a few Inches, they are not diſcernibly taper, but paſs on to their Ends very nearly of the ſame Bigneſs; this may be ſeen in *Roots* growing in Water, and in ſome other, tho' with much Care and Difficulty.

In pulling up the aforemention'd *Turneps*, their Roots ſeem'd to end at few Inches Diſtance from the Plants, they being, farther off, too fine to be perceiv'd by ordinary Obſervation.

I found an extreme ſmall Fibre on the Side of a *Carrot*, much leſs than a Hair; but thro' a Microſcope it appear'd a large Root, not taper, but broken off ſhort at the End, which it is probable might have (before broken off) extended near as far as the *Turnep* Roots did. It had many Fibres going out of it, and I have ſeen that a *Carrot* will draw Nouriſhment from a great Diſtance, tho' the Roots are almoſt inviſible, where they come out of the *Carrot* itſelf.

By the Piece *F* Plate 6. may be ſeen, that thoſe Roots cannot penetrate, unleſs the Land be open'd by Tillage, *&c.*

As Animals of different Species have their Guts bearing different Proportions to the Length of their Bodies; ſo 'tis probable, different Species of Plants may have their Roots as different. But if thoſe which have ſhorter Roots have more in Number, and having ſet down the means how to know the Length of them in the Earth, I leave the different Lengths of different Species to be examin'd by thoſe who will take the Pains of more Trials. This is enough for me, that there is no Plant commonly propagated, but what will ſend out its Roots far enough, to have the Benefit of all the ho'd Spaces or Intervals I in the following Chapters allot them, even tho' they ſhould not have Roots ſo long as their Stalks or Stems.

And this great Length of Roots will appear very reaſonable, if we compare the Largeneſs of the Leaves (which are the Parts ordain'd for Excretion) with the Smalneſs of the Capillary Roots, which muſt make up in Length or Number what they want in Bigneſs, being deſtin'd to range far in the Earth, to find out a Supply of Matter to maintain the whole Plant; whereas the chief Office of the Stalks and Leaves is only to receive the ſame, and to diſcharge into the Atmoſphere ſuch Part thereof as is found unfit for Nutrition; a much eaſier Taſk than the other, and conſequently fewer Paſſages ſuffice, theſe ending in an obtuſe Form; for otherwiſe the Air would not be able to ſuſtain the Stalks and Leaves in their upright Poſture: but the Roots, tho' very weak and ſlender, are eaſily ſupported by the Earth, notwithſtanding their Length, Smalneſs, and Flexibility.

Plants have no Stomach, nor *Oeſophagus*, which are neceſſary to convey the Maſs of Food to an Animal: Which Maſs, being exhauſted by the Lacteals, is eliminated by way of Execrements, but the Earth itſelf being that Maſs to the Guts (or Roots) of Plants, they have only fine Recrements, which are thrown off by the Leaves.

In this, Animal and Vegetable Bodies agree, that Guts and Roots are both injured by the open Air; and Nature has taken an equal Care, that both may be ſupply'd with Nouriſhment, without being expos'd to it. Guts are ſupply'd from their Inſides, and Roots from their Outſides.

All the Nutriment (or *Pabulum*) which Guts receive for the Uſe of an Animal, is brought to them; but Roots muſt ſearch out and fetch themſelves all the *Pabulum* of a Plant; therefore a greater Quantity of Roots, in Length or Number, is neceſſary to a Plant, than of Guts to an Animal.

All *Roots* are as the Inteſtines of Animals, and have their Mouths or Lacteal Veſſels opening on their outer ſpongy Superficies, as the Guts of Animals have theirs opening in their inner ſpongy Superficies.

The Animal Lacteals take in their Food by the Preſſure that is made from the Periſtaltic Motion, and that Motion caus'd by the Action of Reſpiration, both which Motions preſs the Mouths of the Lacteals againſt the Maſs or Soil which is within the Guts, and bring them into cloſer Contact with it.

Both theſe Motions are ſupply'd in Roots by the Preſſure occaſion'd by the Increaſe of their Diameters in the Earth, which preſſes their Lacteal Mouths againſt the Soil without. But in ſuch Roots as live in Water, a Preſſure is conſtantly made againſt the Roots by the Weight and Fluidity of the Water; this preſſes ſuch fine Particles of Earth it contains, and which come into Contact with their Mouths, the cloſer to them.

And when *Roots* are in a till'd Soil, a great Preſſure is made againſt them by the Earth, which conſtantly ſubſides, and preſſes their Food cloſer and cloſer, even into their Mouths; until itſelf becomes ſo hard and cloſe, that the weak Sorts of Roots can penetrate no farther into it, unleſs re-open'd by new Tillage, which is call'd Hoing.

When a good Number of Single-Mint Stalks had ſtood in Water, until they were well ſtock'd with Roots from their two lower Joints, and ſome of them from three Joints, I ſet one in a Mint-Glaſs full of Salt Water; this Mint became perfectly dead within three Days.

Another Mint I put into a Glaſs of fair Water; but I immers'd one String of its Roots (being brought over the Top of that Glaſs into another Glaſs of Salt-water, contiguous to the Top of the other Glaſs: This *Mint* dy'd alſo very ſoon.

Of another (ſtanding in a Glaſs of Water and Earth till it grew vigorouſly) I ty'd one ſingle Root into a Bag, which held a Spoonful of dry Salt, adjoining to the

the Top of the Glaſs, which kill'd this ſtrong Mint alſo. I found that this Salt was ſoon diſſolv'd, tho' on the Outſide of the Glaſs; and tho' no Water reach'd ſo high, as to be within Two Inches of the Joint which produc'd this Root: The Leaves of all theſe were ſalt as Brine to the Taſte.

Of another, I put an upper Root into a ſmall Glaſs of Ink, inſtead of a Bag of Salt, in the Manner above-mention'd; this Plant was alſo kill'd by ſome of the Ink Ingredients. The Blackneſs was not communicated to the Stalk, or Leaves, which inclin'd rather to a yellowiſh Colour as they died, which ſeem'd owing to the *Copperas*.

I made a very ſtrong Liquor with Water, and bruiſed Seeds of *Wild-Garlick*, and, filling a Glaſs therewith, plac'd the Top of it cloſe to the Top of another Glaſs, having in it a Mint, two or three of whoſe upper Roots, put into this ſtinking Liquor, full of the bruiſed Seeds, and there remaining, it kill'd the Mint in ſome time; but it was much longer in dying than the others were with Salt and Ink. It might be, becauſe theſe Roots in the *Garlick* were very ſmall, and did not bear ſo great a Proportion to their whole Syſtem of Roots, as the Roots, by which the other Mints were poiſon'd, did to theirs.

When the Edges of the Leaves began to change Colour, I chew'd many of them in my Mouth, and found at firſt the ſtrong aromatic Flavour of Mint, but that was ſoon over; and then the nauſeous Taſte of *Garlick* was very perceptible to my Palate.

I obſerv'd, that when the *Mint* had ſtood in a Glaſs of Water, until it ſeem'd to have finiſh'd its Growth, the Roots being about a Foot long, and of an earthy Colour, after putting in ſome fine Earth, which ſunk down to the Bottom, there came from the upper Joint a new Set of white Roots, taking their Courſe on the Outſide of the Heap of old Roots downwards, until they reach'd the Earth at the Bottom; and then, after ſome

ſome time, came to be of the ſame earthy Colour with the old ones.

Another *Mint* being well rooted from Two Joints, about Four Inches aſunder; I plac'd the Roots of the lower Joint in a deep Mint-Glaſs, having Water at the Bottom, and the Roots of the upper Joint into a ſquare Box, contriv'd for the Purpoſe, ſtanding over the Glaſs, and having a Bottom, that open'd in the Middle, with a Hole, that ſhut together cloſe to the Stalk, juſt below the upper Joint; then laying all theſe upper Roots to one Corner of the Box, I fill'd it with Sand, dry'd in a Fire-ſhovel, and found, that in one Night's time, the Roots of the lower Joint, which reach'd the Water at the Bottom of the Glaſs, had drawn it up, and imparted ſo much thereof to thoſe Roots in the Box above, that the Sand, at that Corner where they lay, was very wet, and the other three Corners dry. This Experiment I repeated very often, and it always ſucceeded as that did.

And for the ſame Purpoſe I prepar'd a ſmall Trough, about two Foot long, and plac'd a Mint-Glaſs under each End of the Trough; over each Glaſs I plac'd a Mint, with half its Roots in the Glaſs, the other half in the Trough: The Mints ſtood juſt upon the Ends of the Trough. Then I cover'd theſe Roots with pulveriz'd Earth, and kept the Glaſſes ſupply'd with Water; and as oft as the white fibrous Roots ſhot thro' the Earth, I threw on more Earth, till the Trough would hold no more; and ſtill the white Fibres came thro', and appear'd above it; but all ſeem'd (as I ſaw by the Help of a coarſe Microſcope) to turn, and when they came above-ground, their Ends enter'd into it again. Theſe two *Mints* grew thrice as large as any other *Mint* I had, which were many, that ſtood in Water, and much larger than thoſe which ſtood in Water with Earth in it: They being all of an equal Bigneſs when ſet in, and ſet at the ſame time. Tho' theſe two, ſtanding in my Chamber, never had any Water in their Earth, but what those Roots, which reach'd the Water in the Glasses, sent up to the Roots, which grew in the Trough. The vast Quantity of Water these Roots sent up, being sufficient to keep all the Earth in the Troughs moist, tho' of a thousand times greater Quantity than the Roots which water'd it, makes it probable, that the Water pass'd out of the Roots into the Earth, without mixing at all with the Sap, or being alter'd to any Degree. The Earth kept always moist, and in the hot Weather there would not remain a Drop of Water in the Glasses, when they had not been fresh supply'd in two Days and one Night; and yet these Roots in the Glasses were not dry'd, tho' they stood sometimes a whole Day and Night thus in the empty Glasses. These two Mints have thus liv'd all one Summer.

Remarks on the Mints, *&c.*

Tho' the Vessels of Marine Plants be some ways fortify'd against the Acrimony of Salt, as Sea-fish are, yet the Mints all shew, that Salt is poison to other Plants.

The Reason why the Salts in Dung, Brine, or Urine, do not kill Plants in the Field or Garden, is, that their Force is spent in acting upon, and dividing the Parts of Earth; neither do these Salts, or at least any considerable Quantity of them, reach the Roots.

I try'd Salt to many Potatoes in the Ground being undermin'd, and a few of their Roots put into a Dish of Salt-water, they all died sooner or later, according to their Bigness, and to the Proportions the Quantity of Salt apply'd did bear to them.

By the Mints it appears, that Roots make no Distinctions in the Liquor they imbibe, whether it be for their Nourishment or Destruction; and that they do not insume what is disagreeable, or Poison to them, for lack of other Sustenance; since they were very vigorous, and well fed in the Glasses, at the time when the most inconsiderable Part of their Num-

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ber had the Salt, Garlick, and Ink offer'd to them.

The ſixth *Mint* ſhews, that when new Earth is apply'd to the old Roots, a Plant ſends out new Roots on Purpoſe to feed on it: And that the more Earth is given it, the more Roots will be form'd, by the new Vigour the Plant takes from the Addition of Earth. This correſponds with the Action of Hoing; for every time the Earth is mov'd about Roots, they have a Change of Earth, which is new to them.

The ſeventh *Mint* proves, that there is ſuch a Communication betwixt all the Roots, that when any of them have Water, they do impart a Share thereof to all the reſt: And that the Root of the lower Joint of this Mint had Paſſages (or Veſſels) leading from them, through the Stalk, to the Roots of the upper Joint; tho' the clear Stalk (through which it muſt have paſs'd) that was betwixt theſe two Joints, was ſeveral Inches in Length.

This accounts for the great Produce of long tap-rooted Plants, ſuch as *Luſern* and *St. Foin*, in very dry Weather: for the Earth at a great Depth is always moiſt. It accounts alſo for the good Crops we have in dry Summers, upon Land that has a Clay Bottom; for there the Water is retain'd a long time, and the lower Roots of Plants which reach it, do, like thoſe of this Mint, ſend up a Share to all the higher Roots.

If thoſe Roots of a Plant, which lie at the Surface of the Ground, did not receive Moiſture from other Roots, which lie deeper, they could be of no Uſe in dry Weather. But 'tis certain, that if this dry Surface be mov'd or dung'd, the Plant will be found to grow the faſter, tho' no Rain falls; which ſeems to prove, both that the deep Roots communicate to the ſhallow a Share of their Water, and receive in Return from them a Share of Food, in common with all the reſt of the Plant, as in the Mints they did.

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The two laſt *Mints* ſhew, that when the upper Roots have Moiſture (as they had in the Earth in the Trough, carried thither firſt by the lower Roots) they impart ſome of it to the lower, elſe theſe could not have continu'd plump and freſh, as they did for 24 Hours in the empty Glaſs. And I have ſince obſerved them to do ſo, in the cooler Seaſon of the Year, for ſeveral Weeks together, without any other Water, than what the upper Roots convey'd to them, from the moiſt Earth above in the Trough *(a)*. I know not what Time theſe Roots might continue to be ſupply'd thus in the hot Weather, becauſe I did not try any longer, for fear of killing them.

But it muſt be noted, that the Depth of the Glaſs protected the Roots therein from the Injury of the Motion of the free Air, which would have dry'd them, if they had been out of the Glaſs.

In this Trough is ſhewn moſt of the Hoing Effects; *viz.* That Roots, by being broken off near the Ends, increaſe their Number, and ſend out ſeveral where one is broken off.

That the Roots increaſe their Fibres every time the Earth is ſtirr'd about them.

That the ſtirring the Earth makes the Plants grow the faſter.

LEAVES are the Parts or Bowels of a Plant, which perform the ſame Office to Sap, as the Lungs of an Animal do to Blood; that is, they purify or cleanſe it of the Recrements, or fuliginous Steams, received in the Circulation, being the unfit Parts of the Food; and perhaps ſome decay'd Particles, which fly off the

(a) 'Tis certain, that Roots and other Chyle-Veſſels of a Plant have a free Communication throughout all their Cavities, and the Liquor in them will run towards that Part where there is leaſt Reſiſtance; and ſuch is that which is the moſt empty, whether it be above or below; for there are no *Valves* that can hinder the Deſcent or Aſcent of Liquor in theſe Veſſels, as appears by the growing of a Plant in an inverted Poſture.

Veſſels,

Veſſels, through which Blood and Sap do paſs reſpectively.

Beſides which Uſe, the Nitro-aerous Particles may there enter, to keep up the vital Ferment or Flame.

Mr. *Papin* ſhews, that Air will paſs in at the Leaves, and out thro' the Plant at the Roots, but Water will not paſs in at the Leaves; and that if the Leaves have no Air, a Plant will die; but if the Leaves have Air, tho' the Root remain in Water *in vacuo*, the Plant will live and grow.

Dr. *Grew*, in his Anatomy of Plants, mentions Veſſels, which he calls, Net-work, Cobweb, Skeins of Silk, *&c.* but above all, the Multitude of Air-Bladders in them, which I take to be of the ſame Uſe in Leaves, as the Veſiculæ are in Lungs. Leaves being as Lungs inverted, and of a broad and thin Form; their Veſiculæ are in Contact with the free open Air, and therefore have no need of Trachea, or Bronchia, nor of Reſpiration.

CHAP. II.

Of FOOD *of* PLANTS.

THE chief Art of an Huſbandman is to feed Plants to the beſt Advantage; but how ſhall he do that, unleſs he knows what is their Food? By Food is meant that Matter, which, being added and united to the firſt *Stamina* of Plants, or *Plantulæ*, which were made in little at the Creation, gives them, or rather is their Increaſe.

'Tis agreed, that all the following Materials contribute, in ſome manner, to the Increaſe of Plants; but 'tis diſputed which of them is that very Increaſe or Food. 1. *Nitre.* 2. *Water.* 3. *Air.* 4. *Fire.* 5. *Earth.*

I will not mention, as a Food, that acid Spirit of the Air, so much talk'd of; since by its eating asunder Iron Bars it appears too much of the Nature of *Aqua Fortis*, to be a welcome Guest alone to the tender Vessels of the Roots of Plants.

Nitre is useful to divide and prepare the Food, and may be said to nourish Vegetables in much the same Manner as my Knife nourishes me, by cutting and dividing my Meat: But when *Nitre* is apply'd to the Root of a Plant, it will kill it as certainly as a Knife misapply'd will kill a Man: Which proves, that *Nitre* is, in respect of Nourishment, just as much the Food of Plants, as *White Arsenick* is the Food of Rats. And the same may be said of Salts.

Water, from *Van-Helmont*'s Experiment, was by some great Philosophers thought to be it. But these were deceived, in not observing, that Water has always in its Intervals a Charge of Earth, from which no Art can free it. This Hypothesis having been fully confuted by Dr. *Woodward*, no body has, that I know of, maintain'd it since: And to the Doctor's Arguments I shall add more in the Article of Air.

Air, because its Spring, *&c.* is as necessary to the Life of Vegetables, as the Vehicle of Water is; some modern Virtuosi have affirm'd, from the same and worse Arguments than those of the Water-Philosophers, that Air is the Food of Plants. Mr. *Bradley* being the chief, if not only Author, who has publish'd this Phantasy, which at present seems to get Ground, 'tis fit he should be answer'd: And this will be easily done, if I can shew, that he has answer'd this his own Opinion, by some or all of his own Arguments.

His first is, that of *Helmont*, and is thus related in Mr. *Bradley*'s general Treatise of *Husbandry and Gardening*, Vol. I. *p.* 36. „Who dry'd Two hun-
‘ dred Pounds of Earth, and planted a Willow of
‘ Five Pounds Weight in it, which he water'd with
‘ Rain,

'Rain, or diſtill'd Water; and to ſecure it from any 'other Earth getting in, he covered it with a perfo-'rated Tin Cover. Five Years after, weighing the 'Tree, with all the Leaves it had borne in that Time, 'he found it to weigh One hundred Sixty-nine 'Pounds Three Ounces; but the Earth was only di-'miniſh'd about two Ounces in its Weight.'

On this Experiment Mr. *Bradley* grounds his Airy Hypotheſis. But let it be but examined fairly, and ſee what may be thence inferr'd.

The Tin Cover was to prevent any other Earth from getting in. This muſt alſo prevent any Earth from getting out, except what enter'd the Roots, and by them paſs'd into the Tree.

A Willow is a very thirſty Tree, and muſt have drank in Five Years time ſeveral Tuns of Water, which muſt neceſſarily carry in its Interſtices a great Quantity of Earth (probably many times more than the Tree's (*a*) Weight, which could not get out, but by the Roots of the Willow.

Therefore the Two hundred Pounds of Earth not being increaſed, proves that ſo much Earth as was poured in with the Water, did enter the Tree.

Whether the Earth did enter to nouriſh the Tree, or whether only in order to paſs through it (by way of Vehicle to the Air), and leave the Air behind for the Augment of the Willow, may appear by examining the Matter of which the Tree did conſiſt.

If the Matter remaining after the Corruption or Putrefaction of the Tree be Earth, will it not be a Proof, that the Earth remained in it, to nouriſh and augment it? for it could not leave what it did not firſt take, nor be augmented by what paſs'd through it. According to *Ariſtotle*'s Doctrine, and Mr. *Bradley*'s

(*a*) The Body of an Animal receives a much leſs Increaſe in Weight than its Perſpirations amount to, as *Sanctorius*'s *Static-Chair* demonſtrates.

too,

too, in Vol. I. *pag.* 72. " Putrefaction resolves it " again into Earth, its first Principle."

The Weight of the Tree, even when green, must consist of Earth and Water. Air could be no Part of it, because Air being of no greater specific Gravity than the incumbent Atmosphere, could not be of any Weight in it; therefore was no Part of the One hundred Sixty-nine Pounds Three Ounces.

Nature has directed Animals and Vegetables to seek what is most necessary to them. At the Time when the *Fœtus* has a Necessity of Respiration, 'tis brought forth into the open Air, and then the Lungs are filled with Air. As soon as a Calf, Lamb, *&c.* is able to stand, it applies to the Teat for Food, without any Teaching. In like manner Mr. *Bradley* remarks, in his Vol. I. *pag.* 10. ' That almost every ' Stem and every Root are formed in a bending manner under Ground; and yet all these Stems become ' strait and upright when they come above-ground, ' and meet the Air; and most Roots run as directly ' downwards, and shun the Air as much as possible.'

Can any thing more plainly shew the Intent of Nature, than this his Remark does? *viz.* That the Air is most necessary to the Tree above ground, to purify the Sap by the Leaves, as the Blood of Animals is depurated by their Lungs: And that Roots seek the Earth for their Food, and shun the Air, which would dry up and destroy them.

No one Truth can possibly contradict or interfere with any other Truth; but one Error may contradict and interfere with another Error, *viz.*

Mr. *Bradley*, and all Authors, I think, are of Opinion, that Plants of different Natures are fed by a different Sort of Nourishment; from whence they aver, that a Crop of Wheat takes up all that is peculiar to that Grain; then a Crop of Barley all that is proper to it; next a Crop of Pease, and so on, 'till each has drawn off all those Particles which are proper to it; and then no more of theſe Grains will grow in that Land, till by Fallow, Dung, and Influences of the Heavens, the Earth will be again repleniſh'd with new Nouriſhment, to ſupply the ſame Sorts of Corn over again. This, if true (as they all affirm it to be), would prove, that the Air is not the Food of Vegetables. For the Air being in itſelf ſo homogeneous as it is, could never afford ſuch different Matter as they imagine; neither is it probable, that the Air ſhould afford the Wheat Nouriſhment more one Year, than the enſuing Year; or that the ſame Year it ſhould nouriſh Barley in one Field, Wheat in another, Peaſe in a Third; but that if Barley were ſown in the Third, Wheat in the Firſt, Peaſe in the Second, all would fail: Therefore this Hypotheſis of Air for Food interferes with, and contradicts this Doctrine of Neceſſity of changing Sorts.

I ſuppoſe, by Air, they do not mean dry Particles of Earth, and the Effluvia which float in the Air: The Quantity of theſe is too ſmall to augment Vegetables to that Bulk they arrive at. By that way of ſpeaking they might more truly affirm this of Water, becauſe it muſt be like to carry a greater Quantity of Earth than Air doth, in proportion to the Difference of their different ſpecific Weight; Water, being about 800 times heavier than Air, is likely to have 800 times more of that terreſtrial Matter in it; and we ſee this is ſufficient to maintain ſome Sort of Vegetables, as Aquatics; but the Air, by its Charge of Effluvia, *&c.* is never able to maintain or nouriſh any Plant; for as to the Sedums, Aloes, and all others, that are ſuppoſed to grow ſuſpended in the Air, 'tis a mere Fallacy; they ſeem to grow, but do not; ſince they conſtantly grow lighter; and tho' their Veſſels may be ſomewhat diſtended by the Ferment of their own Juices which they received in the Earth, yet ſuſpended in Air, they continually diminiſh in Weight (which is the true Argument of a Plant) until they grow to nothing.

nothing. So that this Inſtance of Sedums, *&c.* which they pretend to bring for Proof of this their Hypotheſis, is alone a full Confutation of it.

Yet if granted, that Air could nouriſh ſome Vegetables by the earthy Effluvia, *&c.* which it carry'd with it *(a)*, even that would be againſt them, not for them.

They might as well believe, that *Martins* and *Swallows* are nouriſh'd by the Air, becauſe they live on Flies and Gnats, which they catch therein; this being the ſame Food, which is found in the Stomach of the Chameleon.

If, as they ſay, the Earth is of little other Uſe to Plants, but to keep them fix'd and ſteady, there would be little or no Difference in the Value of rich and poor Land, dung'd or undung'd; for one would ſerve to keep Plants fix'd and ſteady, very near, if not quite as well as the other.

If Water or Air was the Food of Plants, I cannot ſee what Neceſſity there ſhould be of Dung or Tillage.

4. *Fire.* No Plant can live without Heat, tho' different Degrees of it be neceſſary to different Sorts of Plants. Some are almoſt able to keep Company with the *Salamander*, and do live in the hotteſt Expoſures of the hot Countries. Others have their Abode with Fiſhes under Water, in cold Climates: for the Sun has his Influence, tho' weaker, upon the Earth cover'd with Water, at a conſiderable Depth; which appears by the Effect the Viciſſitudes of Winter and Summer have upon ſubterraqueous Vegetables.

Tho' every Heat is ſaid to be a different Degree of Fire; yet we may diſtinguiſh the Degrees by their different Effects. Heat warms; but Fire burns: The firſt helps to cheriſh, the latter deſtroys Plants.

(a) This is meant of dry Earth, by its Lightneſs (when pulveriz'd extremely fine) carried in the Air without Vapour: For the Atmoſphere, conſiſting of all the Elements, has Earth in it in conſiderable Quantity, mix'd with Water; but a very little Earth is ſo minutely divided, as to fly therein pure from Water, which is its Vehicle there for the moſt Part.

5. *Earth.* That which nouriſhes and augments a Plant is the true Food of it.

Every Plant is Earth, and the Growth and true Increaſe of a Plant is the Addition of more Earth.

Nitre (or other Salts) prepares the Earth, Water and Air move it, by conveying and fermenting it in the Juices; and this Motion is called Heat.

When this additional Earth is aſſimilated to the Plant, it becomes an abſolute Part of it.

Suppoſe Water, Air, and Heat, could be taken away, would it not remain to be a Plant, tho' a dead one?

But ſuppoſe the Earth of it taken away, what would then become of the Plant? Mr. *Bradley* might look long enough after it, before he found it in the Air among his ſpecific or certain Qualities.

Beſides, too much *Nitre* (or other Salts) corrodes a Plant; too much Water drowns it; too much Air dries the Roots of it; too much Heat (or Fire) burns it; but too much Earth a Plant never can have, unleſs it be therein wholly buried; and in that Caſe it would be equally miſapply'd to the Body, as Air or Nitre would be to the Roots.

Too much Earth, or too fine, can never poſſibly be given to Roots; for they never receive ſo much of it as to ſurfeit the Plants, unleſs it be depriv'd of Leaves, which, as Lungs, ſhould purify it.

And Earth is ſo ſurely the Food of all Plants, that with the proper Share of the other Elements, which each Species of Plants requires, I do not find but that any common Earth will nouriſh any Plant.

The only Difference of Soil *(a)* (except the Richneſs) ſeems to be the different Heat and Moiſture it has;

(a) As I have ſaid in my *Eſſay*, That *a Soil being once proper to a Species of Vegetables, it will always continue to be ſo*; it muſt be ſuppoſed, that there be no Alteration of the *Heat* and *Moiſture* of it; and that this Difference I mean, is of its Quality of

has; for if thofe be rightly adjufted, any Soil will nourifh any Sort of Plant; for let *Thyme* and *Rufhes* change Places, and both will die; but let them change their Soil, by removing the Earth wherein the *Thyme* grew, from the dry Hill down into the watry Bottom, and plant *Rufhes* therein; and carry the moift Earth, wherein the *Rufhes* grew, up to the Hill; and there *Thyme* will grow in the Earth that was taken from the *Rufhes*; and fo will the *Rufhes* grow in the Earth that was taken from the *Thyme*; fo that 'tis only more or lefs Water that makes the fame Earth fit either for the Growth of *Thyme* or *Rufhes*.

So for Heat; our Earth, when it has in the Stove the juft Degree of Heat that each Sort of Plants requires, will maintain Plants brought from both the *Indies*.

Plants differ as much from one another in the Degrees of Heat and Moifture they require, as a Fifh differs from a Salamander.

Indeed *Mifletoe*, and fome other Plants, will not live upon Earth, until it be firft alter'd by the Veffels of another Plant or Tree, upon which they grow, and therein are as nice in Food as an Animal.

There is no need to have Recourfe to Tranfmutation; for whether Air or Water, or both, are transform'd into Earth or not, the thing is the fame, if it be Earth when the Roots take it; and we are convinced that neither Air nor Water alone, as fuch, will maintain Plants.

Thefe kind of Metamorphofes may properly enough be confider'd in Differtations purely concerning Matter, and to difcover what the component Particles of Earth are; but not at all neceffary to be known, in relation to the maintaining of Vegetables.

of nourifhing different Species of Vegetables, not of the Quantity of it; which Quantity may be alter'd by Diminution or Superinduction.

CHAP. III.

Of PASTURE *of* PLANTS.

CATTLE feed on Vegetables that grow upon the Earth's external Surface; but Vegetables themſelves firſt receive, from within the Earth, the Nouriſhment they give to Animals.

The Paſture of Cattle has been known and underſtood in all Ages of the World, it being liable to Inſpection; but the Paſture of Plants, being out of the Obſervation of the Senſes, is only to be known by Diſquiſitions of Reaſon; and has (for ought I can find) paſs'd undiſcover'd by the Writers of Huſbandry *(a)*.

The Ignorance of this ſeems to be one principal Cauſe, that Agriculture, the moſt neceſſary of all Arts, has been treated of by Authors more ſuperficially than any other Art whatever. The Food or *Pabulum* of Plants being prov'd to be Earth, where and whence *(b)* they take that, may properly be called their Paſture.

This Paſture I ſhall endeavour to deſcribe.

(a) When Writers of Huſbandry, in diſcourſing of Earth and Vegetation, come neareſt to the Thing, that is, the *Paſture* of *Plants*, they are loſt in the Shadow of it, and wander in a Wilderneſs of obſcure Expreſſions, ſuch as *Magnetiſm*, *Virtue*, *Power*, *Specific Quality*, *Certain Quality*, and the like; wherein there is no manner of Light for diſcovering the real Subſtance, but we are left by them more in the Dark to find it, than Roots are when they feed on it: And when a Man, no leſs ſagacious than Mr. *Evelyn*, has trac'd it thro' all the *Mazes* of the *Occult Qualities*, and even up to the *Metaphyſics*, he declares he cannot determine, whether the Thing he purſues be *Corporeal* or *Spiritual*.

(b) By the *Paſture* is not meant the *Pabulum* itſelf; but the *Superficies* from whence the *Pabulum* is taken by Roots.

'Tis

'Tis the inner or (internal) Superficies *(a)* of the Earth; or which is the ſame thing, 'tis the Superficies of the Pores, Cavities, or Interſtices of the divided Parts of the Earth, which are of two Sorts, viz. *Natural* and *Artificial*.

By Nature, the whole Earth (or Soil) is compoſed of Parts; and, if theſe had been in every Place abſolutely joined, it would have been without Interſtices or Pores, and would have had no internal Superficies, or Paſture for Plants: but ſince it is not ſo ſtrictly denſe *(b)*, there muſt be Interſtices at all thoſe Places where the Parts remain ſeparate and divided.

Theſe Interſtices, by their Number and Largeneſs, determine the ſpecific Gravity (or true Quantity) of every Soil: The larger they are, the lighter is the Soil; and the inner Superficies is commonly the leſs.

The Mouths, or Lacteals, being ſituate, and opening, in the convex Superficies of Roots, they take their *Pabulum*, being fine Particles of Earth, from the Superficies of the Pores, or Cavities, wherein the Roots are included.

(a) This Paſture of Plants never having been mentioned or deſcribed by any Author that I know of, I am at a loſs to find any other Term to deſcribe it by, that may be ſynonymous, or equipollent to it: Therefore, for want of a better, I call it the inner, or internal Superficies of the Earth, to diſtinguiſh it from the outer or external Superficies, or Surface, whereon we tread.

Inner or internal Superficies may be thought an abſurd Expreſſion, the Adjective expreſſing ſomething within, and the Subſtantive ſeeming to expreſs only what is without it; and indeed the Senſe of the Expreſſion is ſo; for the Vegetable Paſture is within the Earth, but without (or on the Outſides of) the divided Parts of the Earth.

And, beſides, Superficies muſt be joined with the Adjective Inner (or Internal) when 'tis uſed to deſcribe the Inſide of a thing that is hollow, as the Pores and Interſtices of the Earth are.

The Superficies, which is the Paſture of Plants, is not a bare Mathematical Superficies; for that is only imaginary.

(*b*) For were the Soil as denſe as Glaſs, the Roots or Vegetables (ſuch as our Earth produces) would never be able to enter its Pores.

And 'tis certain, that the Earth is not divested or robb'd of this *Pabulum*, by any other Means, than by actual Fire, or the Roots of Plants.

For, when no Vegetables are suffer'd to grow in a Soil, it will always grow richer. Plow it, harrow it, as often as you please, expose it to the Sun in Horse-Paths all the Summer, and to the Frost of the Winter; let it be cover'd by Water at the Bottom of Ponds, or Ditches; or if you grind dry Earth to Powder, the longer 'tis kept exposed, or treated by these or any other Method possible (except actual Burning by Fire); instead of losing, it will gain the more Fertility.

These Particles, which are the *Pabulum* of Plants, are so very minute *(a)* and light, as not to be singly attracted to the Earth, if separated from those Parts to which they adhere *(b)*, or with which they are in Contact (like Dust to a Looking-Glass, turn it upwards, or downwards, it will remain affixt to it), as these Particles do to those Parts, until from thence remov'd by some Agent.

(a) As to the Fineness of the *Pabulum* of Plants, 'tis not unlikely, that Roots may insume no grosser Particles, than those on which the Colours of Bodies depend; but to discover the greatest of those Corpuscles, Sir *Isaac Newton* think, it will require a Microscope, that with sufficient Distinctness can represent Objects Five or Six hundred times bigger, than at a Foot Distance they appear to the naked Eye.

My Microscope indeed is but a very ordinary one, and when I view with it the Liquor newly imbibed by a fibrous Root of a Mint, it seems more limpid than the clearest common Water, not ing at all appearing in it.

(b) Either Roots must insume the Earth, that is their *Pabulum*, as they find it in whole Pieces, having intire Superficies of their own, or else such Particles as have not intire Superficies of their own, but want some Part of it, which adheres to, or is Part of the Superficies of larger Particles, before they are separated by Roots. The former they cannot insume (unless contained in Water); because they would fly away at the first Pores that were open: *Ergo* they must insume the latter.

A Plant cannot ſeparate theſe Particles from the Parts to which they adhere, without the Aſſiſtance of Water, which helps to looſen them.

And 'tis alſo probable, that the Nitre of the Air may be neceſſary to relax this Superficies, to render the prolific Particles capable of being thence disjoin'd; and this Action of the Nitre ſeems to be what is call'd, Impregnating the Earth.

Since the groſſer Vegetable Particles, when they have paſs'd thro' a Plant, together with their moiſt Vehicle, do fly up into the Air inviſibly; 'tis not likely they ſhould, in the Earth, fall off from the Superficies of the Pores, by their own Gravity: And if they did fall off, they might fly away as eaſily before they enter'd Plants, as they do after they have paſs'd thro' them; and then a Soil might become the poorer *(a)* for all the Culture and Stirring we beſtow upon it; tho' no Plants were in it; contrary to Experience.

It muſt be own'd, that Water does ever carry, in its Interſtices, Particles of Earth fine enough to enter Roots; becauſe I have ſeen, that a great Quantity of Earth (in my Experiments) will paſs out of Roots ſet in Rain-water; and tis found that Water can never be, by any Art, wholly freed from its earthy Charge; therefore it muſt have carry'd in ſome Particles of Earth along with it: But yet I cannot hence conclude, that the Water did firſt take theſe fine Particles from the aforeſaid Superficies: I rather think, that they are exhal'd, together with very ſmall Pieces to which they adhere, and in the Vapour divided by the Aereal Nitre; and, when the Vapour is condens'd, they deſcend with it to repleniſh

(a) But we ſee it is always the richer by being frequently turned and expoſed to the Atmoſphere: Therefore Plants muſt take all their *Pabulum* from a Superficies of Parts of Earth; except what may perhaps be contained in Water fine enough to enter Roots intire with the Water.

the

the Paſture of Plants; and that theſe do not enter intire into Roots, neither does any other of the earthy Charge that any Water contains; except ſuch fine Particles which have already paſs'd thro' the Vegetable Veſſels, and been thence exhal'd.

This Conjecture is the more probable, for that Rain-Water is as nouriſhing to Plants ſet therein as Spring-Water, tho' the latter have more Earth in it; and tho' Spring-water have ſome Particles in it that will enter intire into Roots, yet we muſt conſider, that even that Water may have been many times exhal'd into the Air, and may have ſtill retain'd a great Quantity of Vegetable Particles, which it received from Vegetable Exhalations in the Atmoſphere; tho' not ſo great a Quantity as Rain-water, that comes immediately thence.

Theſe, I have to do with, are the Particles which Plants have from the Earth, or Soil; but they have alſo fine Particles of Earth from Water, which may impart ſome of its fineſt Charge to the Superficies of Roots, as well as to the Superficies of the Parts of the Earth *(a)* which makes the Paſture of Plants.

Yet it ſeems, that much of the Earth, contain'd in the cleareſt Water, is there in too large Parts to enter a Root; ſince we ſee, that in a ſhort time the Root's Superficies will, in the pureſt Water, be cover'd with Earth, which is then form'd into a terrene Paſture, which may nouriſh Roots; but very few Plants will live long in ſo thin a Paſture, as any Water affords them. I cannot find one as yet that has liv'd a Year, without ſome Earth have been added to it.

And all Aquatics, that I know, have their Roots in the Earth, tho' cover'd with Water.

The Pores, Cavities, or Interſtices of the Earth, being of two Sorts, *viz. Natural* and *Artificial*; the

(a) If Water does ſeparate, and take any of the mere *Pabulum* of Plants from the Soil, it gives much more to it.

one

one affords the Natural, the other the Artificial Pasture of Plants.

The natural Pasture alone will suffice, to furnish a Country with Vegetables, for the Maintenance of a few Inhabitants; but if Agriculture were taken out of the World, 'tis much to be fear'd, that those of all populous Countries, especially towards the Confines of the frigid Zones (for there the Trees often fail of producing Fruit), would be oblig'd to turn *Anthropophagi*, as in many uncultivated Regions they do, very probably for that Reason.

The artificial Pasture of Plants is that inner Superficies which is made from dividing the Soil by Art.

This does, on all Parts of the Globe, where used, maintain many more People than the natural Pasture (*a*); and in the colder Climates, I believe, it will not be

(*a*) The extraordinary Increase of St. Foin, Clover, and natural Grass, when their Roots reach into pulveriz'd Earth, exceeding the Increase of all those other Plants of the same Species (that stand out of the Reach of it) above One hundred Times, shew how vastly the artificial Pasture of Plants exceeds the natural. A full Proof of this Difference, (besides very many I have had before) was seen by two Intervals in the middle of a poor Field of worn-out St. Foin, pulveriz'd in the precedent Summer, in the manner describ'd in a Note on the latter Part of Chap. XII. relating to *St. Foin*. Here not only the *St. Foin* adjoining to these Intervals recover'd its Strength, blossom'd, and seeded well, but also the natural Grass amongst it was as strong, and had as flourishing a Colour, as if a Dung-heap had been laid in the Intervals; also many other Weeds came out from the Edges of the unplow'd Ground, which must have lain dormant a great many Years, grew higher and larger than ever were seen before in that Field; but above all, there was a Weed amongst the St. *Foin*, which generally accompanies it, bearing a white Flower; some call it *White Weed*, others *Lady's Bedstraw:* Some Plants of this that stood near the Intervals, were, in the Opinion of all that saw them, increased to a thousand Times the Bulk of those of the same Species, that stood in the Field three Feet distant from such pulveriz'd Earth.

Note, These Intervals were each an Hundred Perch long, and had each in them a treble Row of Barley very good. The Reason I take to be this, That the Land had lain still several Years after be extravagant to ſay, ten times as many: Or that, in Caſe Agriculture were a little improved (as I hope to ſhew is not difficult to be done), it might maintain twice as many more yet, or the ſame Number, better.

The natural Paſture is not only leſs than the artificial, in an equal Quantity of Earth; but alſo, that little conſiſting in the Superficies of Pores, or Cavities, not having a free Communication (*a*) with one another, being leſs pervious to the Roots of all Vegetables, and requiring a greater Force to break thro' their Partitions; by that Means, Roots, eſpecially of weak Plants, are excluded from many of thoſe Cavities, and ſo loſe the Benefit of them.

But the artificial Paſture conſiſts in Superficies of Cavities, that are pervious to all Manner of Roots, and that afford them free Paſſage and Entertainment in and thro' all their Receſſes. Roots may here extend to the utmoſt, without meeting with any Barricadoes in their Way.

The internal Superficies, which is the natural Paſture of Plants, is like the external Superficies or

after its artificial Paſture was loſt; whereby all the Plants in it having only the natural Paſture to ſubſiſt on, became ſo extremely *ſmall* and *weak*, that they were not able to exhauſt the Land of ſo great a Quantity of the (vegetable) nouriſhing Particles as the Atmoſphere brought down to it.

And when by Pulveration the artificial Paſture came to be added to this natural Paſture (not much exhauſted), and nothing at all ſuffered to grow out of it for above Three Quarters of a Year, it became rich enough, without any Manure, to produce this extraordinary Effect upon the Vegetables, whoſe Roots reached into it. How long this Effect may continue, is uncertain: but I may venture to ſay, it will continue until the Exhauſtion by Vegetables doth over-balance the Deſcent of the Atmoſphere, and the Pulveration.

And what I have ſaid of any one Species of Plants in this Reſpect may be generally apply'd to the reſt.

(*a*) None of the natural Vegetable Paſture is loſt or injured by the artificial: but on the contrary, 'tis mended by being mix'd with it, and by having a greater Communication betwixt Pore and Pore.

Surface

Surface of the Earth, whereon is the Paſture of Cattle; in that it cannot be inlarg'd without Addition of more Surface taken from Land adjoining to it, by inlarging its Bounds or Limits.

But the artificial Paſture of Plants may be inlarg'd, without any Addition of more Land, or inlarging of Bounds, and this by Diviſion only of the ſame Earth.

And this artificial Paſture may be increas'd in proportion to the Diviſion of the Parts of Earth, whereof it is the Superficies, which Diviſion may be mathematically infinite; for an Atom is nothing; neither is there a more plain Impoſſibility in Nature, than to reduce Matter to nothing, by Diviſion or Separation of its Parts.

A Cube of Earth of One Foot has but Six Feet of Superficies. Divide this Cube into Cubical Inches, and then its Superficies will be increas'd Twelve times, *viz.* to Seventy-two Superficial Feet. Divide theſe again in like Manner and Proportion; that is, Divide them into Parts that bear the ſame Proportion to the Inches, as the Inches do to the Feet, and then the ſame Earth, which had at firſt no more than Six Superficial Feet, will have Eight hundred Sixty-four Superficial Feet of artificial Paſture; and ſo is the Soil diviſible, and this Paſture increaſable *ad Infinitum.*

The common Methods of dividing the Soil are theſe; *viz.* by *Dung*, by *Tillage*, or by both *(a)*.

CHAP. IV.

Of DUNG.

ALL Sorts of Dung and Compoſt contain ſome Matter, which, when mixt with the Soil, ferments therein; and by ſuch Ferment diſſolves, crum-

(a) For *Vis Unita Fortior.*

bles, and divides the Earth very much: This is the chief, and almoſt only Uſe of Dung: For, as to the pure earthy Part, the Quantity is ſo very ſmall, that, after a perfect Putrefaction, it appears to bear a moſt inconſiderable Proportion to the Soil it is deſign'd to manure: and therefore, in that reſpect, is next to nothing.

Its fermenting Quality is chiefly owing to the Salts wherewith it abounds; but a very little of this Salt applied alone to a few Roots of almoſt any Plant, will (as, in my Mint Experiments, it is evident common Salt does) kill it.

This proves, that its Uſe is not to nouriſh, but to diſſolve; *i. e.* Divide the terreſtrial Matter, which affords Nutriment to the Mouths of Vegetable Roots.

It is, I ſuppoſe, upon the Account of the acrimonious fiery Nature of theſe Salts, that the Floriſts have baniſh'd Dung from their Flower-Gardens.

And there is, I'm ſure, much more Reaſon to prohibit the Uſe of Dung in the Kitchen-Garden, on Account of the ill Taſte it gives to eſculent Roots and Plants, eſpecially ſuch Dung as is made in great Towns.

'Tis a Wonder how delicate Palates can diſpenſe with eating their own and their Beaſts Ordure, but a little more putrefied and evaporated; together with all Sorts of Filth and Naſtineſs, a Tincture of which thoſe Roots muſt unavoidably receive, that grow amongſt it.

Indeed I do not admire, that learned Palates, accuſtom'd to the *Goût* of *Silphium*, *Garlick*, *la Chair venee*, and mortify'd Veniſon, equalling the Stench and Rankneſs of this Sort of City-Muck, ſhould reliſh and approve of Plants that are fed and fatted by its immediate Contact.

People who are ſo vulgarly nice, as to nauſeate theſe modiſh Dainties, and whoſe ſqueamiſh Stomachs even

even abhor to receive the Food of Nobles, ſo little different from that wherewith they regale their richeſt Gardens, ſay that even the very Water, wherein a rich Garden Cabbage is boil'd, ſtinks; but that the Water, wherein a Cabbage from a poor undung'd Field is boil'd, has no Manner of unpleaſant Savour; and that a Carrot, bred in a Dunghill, has none of that ſweet Reliſh, which a Field-Carrot affords.

There is a like Difference in all Roots, nouriſh'd with ſuch different Diet.

Dung not only ſpoils the fine Flavour of theſe our Eatables, but inquinates good Liquor. The dung'd Vineyards in *Languedoc* produce nauſeous Wine; from whence there is a Proverb in that Country, That poor People's Wine is beſt, becauſe they carry no Dung to their Vineyards.

Dung is obſerv'd to give great Encouragement to the Production of Worms; and Carrots in the Garden are much worm-eaten, when thoſe in the Field are free from Worms.

Dung is the Putrefaction of Earth, after it has been alter'd by Vegetable or Animal Veſſels. But if Dung be thoroughly ventilated and putrefy'd before it be ſpread on the Field (as I think all the Authors I have read direct) ſo much of its Salts will be ſpent in fermenting the Dung itſelf, that little of them will remain to ferment the Soil; and the Farmer who might dung One Acre in Twenty, by laying on his Dung whilſt fully replete with vigorous Salts, may (if he follows theſe Writers Advice to a Nicety) be forced to content himſelf with dunging one Acre in an Hundred.

This indeed is good Advice for Gardeners, for making their Stuff more palatable and wholeſome; but would ruin the Farmer who could have no more Dung than what he could make upon his Arable Farm.

For every Sort of Dung, the longer Time it ferments without the Ground, the leſſer Time it has to ferment in it, and the weaker its Ferment will be.

The Reaſon given for this great Diminution of Dung is, that the Seeds of Weeds may be rotted, and loſe their vegetating Faculty; but this I am certain of by Demonſtration, that let a Dunghil remain Three Years unmov'd, though its Bulk be vaſtly diminiſh'd in that Time, and its beſt Quality loſt, Charlock-ſeed will remain ſound in it, and ſtock the Land whereon it is laid: For that Ferment which is ſufficient to conſume the Virtue of the ſtercoreous Salts, is not ſufficient to deſtroy the vegative Virtue of Charlock-ſeeds, nor (I believe) of many other Sorts of Weeds.

The very Effluvia of animal Bodies, ſent off by Perſpiration, are ſo noxious as to kill the Animal that emits them, if confin'd to receive them back in great Quantity, by breathing in an Air replete with them; which appears from the ſoon dying of an Animal ſhut up in a Receiver full of Air. Yet this ſeems to be the moſt harmleſs of all ſorts of animal Excrements the Air can be infected with. How noxious then muſt be the more fetid Steams of Ordure!

If a Catalogue were publiſh'd of all Inſtances from Charnel-houſes (or Cœmeteries) and of the peſtiferous Effects, which have happen'd from the Putrefaction of dead Bodies, after great Battles, even in the open Air, no body, I believe, would have a good Opinion of the Wholſomeneſs of Animal Dung; for if a great Quantity do ſo infect the Air, 'tis likely a leſs may infect it in proportion to that leſs Quantity.

In great Cities the Air is full of theſe Effluvia, which in hot Climes often produce the Peſtilence; and in cold Climes People are generally obſerv'd to live a leſs time, and leſs healthfully, in Cities, than in the Country; to which Difference, 'tis likely, that the eating unwholſome Gardenage may contribute.

This

This Dung is a fitter Food for venomous Creatures *(a)* than for edible Plants; and 'tis (no doubt) upon Account of this, that dung'd Gardens are ſo much frequented by Toads, which are ſeldom or never ſeen in the open undung'd Fields.

What can we ſay then to the Salubrity of thoſe Roots themſelves, bred up and fatten'd among theſe Toads and Corruption? The Leaves indeed are only diſcharging ſome of the Filth, when we eat them; but the Roots have that unſavoury infected Food in their very Mouths, when we take them for our Nouriſhment.

But tho' *Dung* be, upon theſe and other Accounts, injurious to the Garden, yet a conſiderable Quantity of it is ſo neceſſary to moſt Corn-fields, that without it little Good can be done by the old Huſbandry.

Dung is not injurious to the Fields *(b)* being there in leſs Proportion: And the Produce of Corn is the Grain. When the Leaves have done their utmoſt to purify the Sap, the moſt refin'd Part is ſecern'd to be yet further elaborated by peculiar Organs; then, by the Veſſels of the Bloſſoms, 'tis become double-refin'd, for the Nouriſhment of the Grain; which is therefore more pure from Dung, and more wholſome, than any other Part of the Plant that bears it.

And common Tillage alone is not ſufficient for many Sorts of Corn, eſpecially Wheat, which is the King of Grains.

Very few Fields can have the Conveniency of a ſufficient Supply of Dung, to enable them to produce half the Wheat thoſe will do near Cities, where they have Plenty of it.

(a) Mr. *Evelyn* ſays, that Dung is the Nurſe of Vermin.

(b) Such Plants as *Cabbages*, *Turneps*, *Carrots*, and *Potatoes*, when they are deſigned only for fatting of Cattle, will not be injured by Dung, Tillage, and Hoeing all together, which will make the Crops the greater, and the Cattle will like them never the worſe.

The Crop of 20 Acres will ſcarce make Dung ſufficient for one Acre, in the common Way of laying it on.

The Action of the Dung's Ferment affords a Warmth *(a)* to the Infant-plants, in their moſt tender State, and the moſt rigorous Seaſon.

But 'tis hard to know how long the Warmth of this Ferment laſteth, by reaſon of the great Difficulty to diſtinguiſh the very leaſt Degree of Heat from the very leaſt Degree of Cold.

Under the Name of Dung we may alſo underſtand whatever ferments with the Earth (except Fire); ſuch as green Vegetables cover'd in the Ground, *&c.*

As to the Difference of the Quantity of artificial Paſture made by *Dung* without Tillage, and that made by Tillage without *Dung*; the latter is many Times greater, of which I had the following Proof. An unplow'd Land, wherein a Dunghil had lain for two or three Years, and being taken away, was planted with *Turneps*; at the ſame time a till'd Land, contiguous thereto, was drill'd with *Turneps*, and Horſe-ho'd; the other, being Hand-ho'd, proſpered beſt at the firſt; but at laſt did not amount to the Fifth Part of the Till'd and Horſe-ho'd, in Bigneſs, nor in Crop. The Benefit of the Dung and Hand-hoe was ſo inconſiderable, in compariſon of the Plough and Hoe-plough; the little Quantity of artificial Paſture raiſed to the other, was only near the Surface, and did not reach deep enough to maintain the *Turneps*, till they arrived at the Fifth Part of the Growth of

(a) But though Dung in fermenting may have a little Warmth, yet it may ſometimes, by letting more Water enter its Hollowneſs, be in a Froſt much colder than undung'd pulveriz'd Earth; for I have ſeen Wheat-plants in the Winter die in the very Spits of Dung, when undung'd drill'd Wheat, adjoining to it, planted at the ſame Time, has flouriſh'd all the ſame Winter; and I could not find any other Reaſon for this, but the Hollowneſs of the Dung; and yet it ſeemed to be well rotted.

thoſe, whoſe artificial Paſture reach'd to the Bottom of the Staple of the Land.

A like Proof is; that ſeveral Lands of *Turneps*, drill'd on the Level, at three Foot Rows, plow'd, and doubly dung'd, and alſo Horſe-ho'd, did not produce near ſo good a Crop of *Turneps*, as Six Foot Ridges adjoining, Horſe-ho'd, tho' no Dung had been laid thereon for many Years: There was no other Difference, than that the three Foot Rows did not admit the Hoe-plough to raiſe half the artificial Paſture, as the Six Foot Rows did. The Dung plow'd into the narrow Intervals, before drilling, could operate no further, with any great Effect, than the Hoe-plough could turn it up, and help in its Pulveration.

Dung, without Tillage, can do very little; with ſome Tillage doth ſomething; with much Tillage pulverizes the Soil in leſs Time, than Tillage alone can do; but the Tillage alone, with more Time, can pulverize as well: This the Experiments of *artificially* pulverizing of the pooreſt Land, as they are related by Mr. *Evelyn*, fully prove.

And theſe Experiments are the more to be depended on, as they are made both in *England* and *Holland* by Perſons of known Integrity.

This Truth is alſo further confirmed by thoſe Authors who have found, that High-way Duſt alone is a Manure preferable to Dung: And all theſe Pulverations being made by Attrition or Contuſion, why ſhould not our Inſtruments of Pulveration, in Time, reduce a ſufficient Part of the Staple of a dry friable Soil, to a Duſt equal to that of a Highway?

The common Proportion of Dung uſed in the Field pulverizes only a ſmall Part of the Staple: but how long a time may be required for our Inſtruments to pulverize an equal Part, it depending much upon the Weather, and the Degree of Friability of the Soil, is uncertain.

I have ſeen ſurpriſing Effects from Ground, after being kept unexhauſted, by plowing with common Ploughs for Two whole Years running: And I am confident, that the Expence of this extraordinary Tillage and Fallow will not, in many Places, amount to above half the Expence of a dreſſing with Dung; and if the Land be all the Time kept in our Sort of little Ridges of the Size moſt proper for that Purpoſe, the Expence of plowing will be diminiſhed one half; beſides the Advantage the Earth of ſuch Ridges hath, of being friable in Weather which is too moiſt for plowing the ſame Land on the Level.

I have made many Trials of fine *Dung* on the Rows; and, notwithſtanding the Benefit of it, I have, for theſe ſeveral Years laſt paſt, left it off, finding that a little more Hoeing will ſupply it at a much leſs Expence, than that of ſo ſmall a Quantity of Manure, and of the Hands neceſſary to lay it on, and of the Carriage.

CHAP. V.

Of Tillage.

Tillage is breaking and dividing the Ground by Spade, Plough, Hoe, or other Inſtruments, which divide by a Sort of Attrition (or Contuſion) as Dung does by Fermentation *(a)*.

(*a*) *Neque enim aliud eſt Colere quam Reſolvere, & Fermentare Terram.* Columella.

And ſince the artificial Paſture of Plants is made and increas'd by Pulveration, 'tis no Matter whether it be by the Ferment of *Dung*, the Attrition of the *Plough*, the Contuſion of the *Roller*, or by any other Inſtrument or Means whatſoever, except by Fire, which carries away all the Cement of that which is burnt.

By

By Dung we are limited to the Quantity of it we can procure, which in moſt Places is too ſcanty: But by Tillage, we can inlarge our Field of ſubterranean Paſture without Limitation, tho' the external Surface of it be confin'd within narrow Bounds: Tillage may extend the Earth's internal Superficies, in proportion to the Diviſion of its Parts; and as Diviſion is infinite, ſo may that Superficies be.

Every Time the Earth is broken by any Sort of Tillage, or Diviſion, there muſt ariſe ſome new Superficies of the broken Parts, which never has been open before. For when the Parts of Earth are once united and incorporated together, 'tis morally impoſſible, that they, or any of them, ſhould be broken again, only in the ſame Places; for to do that, ſuch Parts muſt have again the ſame numerical Figures and Dimenſions they had before ſuch Breaking, which even by an infinite Diviſion could never be likely to happen: As the Letters of a Diſtichon, cut out and mixt, if they ſhould be thrown up never ſo often, would never be likely to fall into the ſame Order and Poſition with one another, ſo as to recompoſe the ſame Diſtich.

Although the internal Superficies may have been drain'd by a preceding Crop, and the next Plowing may move many of the before divided Parts, without new-breaking them; yet ſuch as are new-broken, have, at ſuch Places where they are ſo broken, a new Superficies, which never was, or did exiſt before; becauſe we cannot reaſonably ſuppoſe, that any of thoſe Parts can have in all places (if in any Places) the ſame Figure and Dimenſions twice.

For as Matter is diviſible *ad infinitum*, the Places or Lines whereat 'tis ſo diviſible, muſt be, in relation to Number, infinite, that is to ſay, without Number; and muſt have at every Diviſion Superficies of Parts of infinite Variety *(b)* in Figure and Dimenfions.

And becaufe 'tis morally impoffible, the fame Figure and Dimenfions fhould happen twice to any one Part, we need not wonder, how the Earth, every time of Tilling, fhould afford a new internal Superficies (or artificial Pafture); and that the till'd Soil has in it an inexhauftible Fund, which by a fufficient Divifion (being capable of an infinite one) may be produc'd.

Tillage (as well as Dung) is beneficial to all Sorts of Land *(c)*. Light Land, being naturally hollow, has larger Pores, which are the Caufe of its Lightnefs: This, when it is by any Means fufficiently divided,

(b) Their Variety is fuch, that 'tis next to impoffible, any two Pieces, or Clods, in a Thoufand Acres of till'd Ground, fhould have the fame Figure, and equal Dimenfions, or that any Piece fhould exactly tally with any other, except with that from whence it was broken off.

(c) 'Tis of late fully prov'd, by the Experience of many Farmers, that two or three additional Plowings will fupply the Place of Dung, even in the old Hufbandry, if they be perform'd at proper Seafons: and the hiring Price of three Plowings, after Land has been thrice plow'd before, is but Twelve Shillings, whereas a Dunging will coft three Pounds: This was accidentally difcovered in my Neighbourhood, by the Practice of a poor Farmer, who, when he had prepar'd his Land for Barley, and could not procure Seed to fow it, plow'd it on till Wheat Seed-Time, and (by means of fuch additional Plowing) without Dung, had fo good a Crop of Wheat, that it was judg'd to be more than the Inheritance of the Land it grew on.

The fame Effect follows when they prepare Land for Turneps, fince they are come in Fafhion, and fow them feveral Times upon feveral Plowings, the Fly as often taking them off; they have from fuch extraordinary Tillage a good Crop of Wheat, inftead of the loft Turneps, without the Help of Dung; hence double-plowing is now become frequent in this Country.

The Reafon why Land is enrich'd by lying long unplow'd, is that fo very few Vegetables are carried off it, very little being produc'd; the Exhauftion is lefs than what is added by the Atmofphere, Cattle, *&c.* But when 'tis plow'd, a vaftly greater Quantity of Vegetables is produc'd, and carried off, more than by the old Hufbandry is return'd to it.

the Parts being brought nearer together, becomes, for a time, Bulk for Bulk, heavier; *i. e.* The ſame Quantity will be contain'd in leſs Room, and ſo is made to partake of the Nature and Benefits of ſtrong Land, *viz.* to keep out too much Heat and Cold, and the like.

But ſtrong Land, being naturally leſs porous, is made for a Time lighter (as well as richer) by a good Diviſion; the Separation of its Parts makes it more porous, and cauſes it to take up more Room than it does in its natural State; and then it partakes of all the Benefits of lighter Land.

When ſtrong Land is plow'd, and not ſufficiently, ſo that the Parts remain groſs, 'tis ſaid to be rough, and it has not the Benefit of Tillage; becauſe moſt of the artificial Pores (or Interſtices) are too large; and then it partakes of the Inconveniences of the hollow Land untill'd.

For when the light Land is plow'd but once, that is not ſufficient to diminiſh its natural Hollowneſs (or Pores;) and, for Want of more Tillage, the Parts into which 'tis divided by that once (or perhaps twice) Plowing, remain too large; and conſequently the artificial Pores are large alſo, and, in that reſpect, are like the ill-till'd ſtrong Land.

Light-land, having naturally leſs internal Superficies, ſeems to require the more Tillage *(d)* or Dung to

(d) As for puffy Land, which naturally ſwells up, inſtead of ſubſiding, tho' its Hollowneſs is much abated by Tillage, yet it is thought little better than barren Land, and unprofitable for Corn: But what we uſually call Light-land, is only comparatively ſo, in Reſpect of that which is heavier and ſtronger. And this Sort of Light land becomes much lighter by being ill-till'd; the unbroken Pieces of Turf underneath undiſſolved, forming large Cavities, increaſe its Hollowneſs, and conſequently its Lightneſs: I have often known this Sort of Land deſpis'd by its Owners, who fear'd to give it due Tillage, which they thought would make it ſo light, that the Wind would blow it away; but whenever ſuch has been thoroughly till'd, it never fail'd to become much

to enrich it; as when the poor, hollow, thin Downs have their upper Part (which is the beſt) burnt, whereby all (except a *Caput Mortuum*) is carried away; yet the Salts of this ſpread upon that barren Part of the Staple, which is unburnt, divide it into ſo very minute Particles, that their Paſture will nouriſh two or three good Crops of Corn: But then the Plough, even with a conſiderable Quantity of Dung, is never able afterwards to make a Diviſion equal to what thoſe Salts have done; and therefore ſuch burnt Land remains barren.

Artificial Pores cannot be too ſmall, becauſe Roots may the more eaſily enter the Soil that has them, quite contrary to natural Pores; for theſe may be, and generally are, too ſmall, and too hard for the Entrance of all weak Roots, and for the free Entrance of ſtrong Roots.

Inſufficient Tillage leaves ſtrong Land with its natural Pores too ſmall, and its artificial ones too large. It leaves Light-land, with its natural and artificial Pores both too large.

Pores that are too ſmall in hard Ground, will not eaſily permit Roots to enter them.

Pores that are too large in any Sort of Land, can be of little other Uſe to Roots, but only to give them Paſſage to other Cavities more proper for them; and if in any Place they lie open to the Air, they are dry'd up, and ſpoil'd, before they reach them.

much ſtronger than before; and conſidering that 'tis till'd with leſs Expence than very ſtrong Land, it is, for ſeveral Sorts of Corn, found to be more profitable than Land of greater Strength and Richneſs, that is more difficult to be till'd.

And I am apt to think, that this Sort of Light-land acquires more Cement, by having its *external* Superficies often changed, and expoſed to the Dews, and other Benefits of the Atmoſphere, as well as by the Increaſe of (its *internal* Superficies, which is the Surfaces of all the divided Parts of Earth, or) the Paſture of Plants; the one being augmented by the other; *i. e*, that into the more Parts the Earth is broken, the more Cement will it attain, from the Sulphur, which is brought by the Dews.

For

For fibrous Roots (which alone maintain the Plant; the other Roots ſerve for receiving the Chyle from them, and convey it to the Stem) can take in no Nouriſhment from any Cavity, unleſs they come into Contact with *(e)*, and preſs againſt, all the Superficies of that Cavity, which includes them; for it diſpenſes the Food to their Lacteals by ſuch Preſſure only: But a fibrous Root is not ſo preſs'd by the Superficies of a Cavity whoſe Diameter is greater than that of the Root.

The Surfaces of great Clods form Declivities on every Side of them, and large Cavities, which are as Sinks to convey, what Rain and Dew bring, too quickly downwards to below the plow'd Part.

The firſt and ſecond Plowings with common Ploughs ſcarce deſerve the Name of Tillage; they rather ſerve to prepare the Land for Tillage.

The third, fourth, and every ſubſequent Plowing, may be of more Benefit, and leſs Expence, than any of the preceding ones.

(e) Roots cannot have any Nouriſhment from Cavities of the Earth that are too large to preſs againſt them, except what Water, when 'tis in great Quantity, brings to them, which is imbibed by the gentle Preſſure of the Water; but when the Water is gone, thoſe large Cavities being empty, the Preſſure ceaſes; and this is the Reaſon, that when Land has few other but ſuch large Cavities, the Plants in it always ſuffer more by dry Weather, than in Land which by Dung or Tillage has more minute and fewer large Cavities.

There may be ſome Moiſture on the Superficies of large Cavities; but without Preſſure the fibrous Roots cannot reach it; and very little or no Preſſure can be made to one Part of the Root's Superficies, unleſs the Whole that is included be preſſed.

If it be objected that a Charlock-Plant, when pulled up, and thrown upon the Ground, will grow thereon; this proves nothing againſt the Neceſſity of Preſſure, *&c.* for the Weight of that Plant preſſes ſome of its Roots ſo cloſely againſt the Ground, that they ſend out (unleſs the Weather be very dry) new Fibres into the Earth; and there they are preſſed in all their Superficies; without which Fibres the Plant doth not grow.

But

But the laſt Plowings will be more advantageouſly perform'd by Way of Hoeing, as in the following Chapters will appear.

For the finer Land is made by Tillage, the richer will it become, and the more Plants it will maintain.

It has been often obſerv'd, that when Part of a Ground has been better till'd than the reſt, and the whole Ground conſtantly manag'd alike afterwards for ſix or ſeven Years ſucceſſively; this Part that was but once better till'd, always produc'd a better Crop than the reſt, and the Difference remain'd very viſible every Harveſt.

One Part being once made finer, the Dews did more enrich it; for they penetrate within and beyond the Superficies, whereto the Roots are able to enter: The fine Parts of the Earth are impregnate, throughout their whole Subſtance, with ſome of the Riches carried in by the Dews, and there repoſited; until, by new Tillage, the Inſides of thoſe fine Parts become Superficies; and as the Corn drains them, they are again ſupply'd as before; but the rough large Parts cannot have that Benefit; the Dews not penetrating to their Centres, they remain poorer.

I think nothing can be ſaid more ſtrongly to confirm the Truth of this, than what is related by the Authors quoted by Mr. *Evelyn* (*f*), to this Effect, *viz.*

'Take of the moſt barren Earth you can find, 'pulverize it well, and expoſe it abroad for a Year, 'inceſſantly agitated (*g*); it will become ſo fertile as 'to receive an exotic Plant from the furtheſt *Indies*; 'and to cauſe all Vegetables to proſper in the moſt 'exalted Degree, and to bear their Fruit as kindly 'with us as in their natural Climates.'

(*f*) In Pag. 17, 18, and 19, of his *Phil. Diſcourſe of Earth.*
(*g*) *i. e.* Stirr'd often.

This artificial Duft (*h*), he fays, will entertain Plants which refufe Dung, and other violent Applications; and that it has a more nutritive Power than any artificial Dungs or Compoft whatfoever: And further, that by this Toil of pulverizing, "'tis found, that "Soil may be fo ftrangely alter'd from its former "Nature, as to render the harfh and moft uncivil "Clay (*i*) obfequious to the Hufbandmen, and to "bring forth Roots and Plants, which otherwife re-"quire the lighteft and holloweft Mould (*k*)."

'Tis to be fuppos'd, that the *Indian* Plants had their due Degrees of Heat and Moifture given them; and I fhould not chufe to beftow this Toil upon the pooreft of Earth in a Field or Garden, tho' that be the moft fure wherein to make the Experiment (*l*).

I never myfelf try'd this way of pounding or grinding, becaufe impracticable in the Fields.

But I have had the Experience of a Multitude of Inftances, which confirm it fo far, that I am in no

(*h*) Tho' it may be impoffible for the Plough to reduce the whole Staple into fo fine Powder, yet the more internal Superficies it makes, the more Duft will be made by the Atmofphere in Proportion; and great Clods perhaps are of no Ufe to Plants, but by that Duft they let fall, being thence extricated by the infenfible Ferment of the nitrous Air; and the Surfaces of this artificial Duft muft receive fuch Operations from the Air, before the utmoft Fertility be obtain'd.

(*i*) But I take harfh uncivil Clay to be the leaft profitable of any to keep in Tillage.

(*k*) To this Duft, *Namque hoc imitamur arando* ought to be apply'd, and not to *Putre Solum*, which itfelf needs Tillage, as well as ftrong Land: But it feems the Antients did not obferve the Difference between natural Pores (or Hollownefs) and artificial ones, tho' it is very great; as is fhewn in Chap. of *Pafture of Plants*: Tis eafier indeed to imitate this artificial Duft in *hollow* than in *ftrong* Land.

(*l*) This is the moft proper Trial of the Effect of Pulveration by *pounding* and *grinding*; but Land may be fo barren, that Plough or Spade may not be fufficient to pulverize it to that Degree, which is neceffary to give it the fame Fertility, that Pounding in a Mortar, or grinding betwixt Marbles (as Colours are ground), can.

Doubt,

Doubt, that any Soil (*m*) (be it rich or poor) can ever be made too fine by Tillage *(n)*.

For 'tis without Dispute, that one cubical Foot of this minute Powder may have more internal Superficies, than a thousand cubical Feet of the same, or any other Earth till'd in the common Manner; and, I believe no two arable Earths in the World do exceed one another in their natural Richness Twenty Times; that is, one cubical Foot of the richest is not able to produce an equal Quantity of Vegetables, *cæteris paribus*, to Twenty cubical Feet of the poorest;

(m) Land that is too hollow and light, having no Cement to join its Parts together, tho' in Nature they are capable of infinite Division, yet in Practice the Plough cannot divide them to any Purpose, unless they were first join'd, but glides through without breaking them; being more like to the primary Particles of Water against the Plough, which are broken by no Force, than to Earth; it may be moved, but not broken by Tillage, and therefore ought not to be reputed arable; nor does it indeed deserve the Name of Land, but as the desart Sands of *Lybia*, to distinguish it from Sea.

(n) According to some, this Rule is only general, and not universal; for, say they, there's a Sort of binding Gravel, that, when it is made *fine*, will, by a sudden Dash of Rain, run together like a Metal; and I have seen the same Accident in a particular Sort of *white* Land; but this very rarely happens to the latter: I never knew it above once, and that was after Barley was sown on it; the Hardness was only like a very thin Ice upon the Surface, which was some Hindrance to the coming up of the Barley, until the Harrow's going over it once or twice broke that Ice or Crust, and then it came up very well.

I never had any other Sort of Land liable to this Misfortune: therefore can say nothing to the Gravel in that Case, nor how deep the *Constipation* may reach in it, nor what Remedy is most proper to prevent the ill Consequence of it: But if there should be two or three Exceptions out of *One thousand Seventy-nine Millions One thousand and Sixty different Sorts of* Earth *(see Mr. Evelyn's Terra*, p. 2), 'twill be no great Matter.

But I think these are no real Exceptions against any Degree of *Pulverizing*; for it only shews, that some Sorts of Land, tho' very few, are subject by Accident to lose too soon their Pulveration: And if the Fineness were no Benefit to that Land, such Loss of it would be no Injury to it.

therefore

therefore 'tis not ſtrange, that the pooreſt, when by pulverizing it has obtain'd One hundred Times the internal Superficies of the rich untill'd Land, it ſhould exceed it in Fertility; or, if a Foot of the pooreſt was made to have Twenty Times the Superficies of a Foot of ſuch rich Land, the pooreſt might produce an equal Quantity of Vegetables with the rich (*o*). Beſides, there is another extraordinary Advantage, when a Soil has a larger internal Superficies in a very little Compaſs; for then the Roots of Plants in it are better ſupply'd with Nouriſhment, being nearer to them on all Sides within Reach, than it can be when the Soil is leſs fine, as in common Tillage; and the Roots in the one muſt extend much further than in the other, to reach an equal Quantity of Nouriſhment: They muſt range and fill perhaps above twenty Times more Space to collect the ſame Quantity of Food.

But in this fine Soil, the moſt weak and tender Roots have free Paſſage to the utmoſt of their Extent, and have alſo an eaſy, due, and equal Preſſure everywhere, as in Water.

(*o*) And very poor Land, well pulveriz'd, will produce better Corn than very rich will do, without Manure or Tillage. The Experiment may be made by paring off the Turf, and ſetting Corn in the whole Ground that is very rich; and that will ſhew how much the natural Paſture of the rich is inferior to the artificial Paſture of the poor Land; but then the *poor* muſt have this Proportion of Exceſs of internal Superficies continued to it, during the whole Time of their Growth, which cannot be done without frequently repeated Diviſions of the Soil by Hoeing or Manure; elſe it might require forty Times the internal Superficies at the Time of Sowing, to keep twenty Times the internal Superficies of the *rich* till Harveſt: For although the rich is continually loſing ſome of its artificial Paſture, as well as the *poor*, yet by loſing this equally, they ſtill draw nearer and nearer to the firſt Inequality of their natural Paſture.

But *poor* Land, being lighter, has this Advantage, that it being more *friable* than the ſtrong, requires leſs Labour to pulverize it; and therefore the Expence of it is much leſs, than in proportion to the Exceſs of Poorneſs of its internal Superficies.

Hard

Hard Ground makes a too great Reſiſtance, as Air makes a too little Reſiſtance, to the Superficies of Roots.

Farmers, juſt when they have brought their Land into a Condition fit to be further till'd to much greater Advantage, leave off, ſuppoſing the Soil to be fine enough, when, with the Help of Harrows, they can cover the Seed; and afterwards with a Roller they break the Clods; to the End that, if a Crop ſucceed, they may be able to mow it, without being hinder'd by thoſe Clods: By what I could ever find, this Inſtrument, call'd a Roller, is ſeldom beneficial to good Huſbands; it rather untills the Land, and anticipates the ſubſiding of the Ground, which in ſtrong Land happens too ſoon of itſelf *(p)*.

But more to blame are they, who neglect to give their Land due Plowing, truſting to the Harrow to make it fine; and when they have thrown in their Seed, go over it twenty Times with the Harrows *(q)* till the Horſes have trodden it almoſt as hard as a Highway, which in moiſt Weather ſpoils the Crop; but on the contrary, the very Horſes, when the Earth is moiſt, ought all to tread in the Furrows only, as in plowing with a Hoe-Plough they always do, when they uſe it inſtead of a common Plough.

(p) This Injury the Roller does, is only when tis uſed to preſs down the Earth after the Seed is ſown; and is the greater, if Land be moiſt; but the Rolling of it in dry Weather, when 'tis to be immediately plow'd up again, is the moſt ſpeedy Way to pulverize the Soil; and the Harrow is then very uſeful in pulling up the Clods, to the End that the Roller may the better come at them to cruſh them.

(q) Nam veteres Romani dixerunt male ſubactum Agrum, qui ſatis Frugibus occandus ſit.

Sed ut compluribus Iterationibus ſic reſolvatur vervactum in Pulverem, ut nullam vel exiguam deſideret Occationem, cum ſeminaverimus. Col. Lib. 2. Cap. 4.

CHAP.

CHAP. VI.

Of HOEING.

HOEING is the breaking or dividing the Soil by Tillage, whilſt the Corn or other Plants are growing thereon.

It differs from common Tillage (which is always perform'd before the Corn or Plants are ſown or planted) in the Times of performing it; 'tis much more beneficial; and 'tis perform'd by different Inſtruments.

Land that is before Sowing tilled never ſo much (tho' the more 'tis till'd the more it will produce) will have ſome Weeds, and they will come in along with the Crop for a Share of the Benefit of the Tillage, greater or leſs, according to their Number, and what Species they are of.

But what is moſt to be regarded is, that as ſoon as the Ploughman has done his Work of plowing and harrowing, the Soil begins to undo it, inclining towards, and endeavouring to regain, its natural ſpecific Gravity; the broken Parts by little and little coaleſce, unite, and loſe ſome of their Surfaces; many of their Pores and Interſtices cloſe up during the Seed's Incubation and Hatching in the Ground; and, as the Plants grow up, they require an Increaſe of Food proportionable to their increaſing Bulk; but on the contrary, inſtead thereof, that internal Superficies, which is their artificial Paſture, gradually decreaſes.

The Earth is ſo unjuſt to Plants, her own Off-ſpring, as to ſhut up her Stores in proportion to their Wants; that is, to give them leſs Nouriſhment when they have need of more: Therefore Man, for whoſe Uſe they are chiefly deſign'd, ought to bring in his reaſonable

ſonable Aid for their Relief, and force open her Magazines with the Hoe, which will thence procure them at all times Proviſions in Abundance, and alſo free them from Intruders; I mean, their ſpurious Kindred, the Weeds, that robb'd them of their too ſcanty Allowance.

There's no Doubt, but that one third Part of the Nouriſhment raiſed by Dung and Tillage, given to Plants or Corn at many proper Seaſons, and apportion'd to the different Times of their Exigencies, will be of more Benefit to a Crop, than the Whole apply'd, as it commonly is, only at the time of Sowing. This old Method is almoſt as unreaſonable as if Treble the full Stock of Leaves, neceſſary to maintain Silk-worms till they had finiſhed their Spinning, ſhould be given them before they are hatched, and no more afterwards.

Next to Hoeing, and ſomething like it, is Tranſplanting, but much inferior; both becauſe it requires a ſo much greater Number of Hands, that by no Contrivance can it ever become general, nor does it ſucceed, if often repeated; but Hoeing will maintain any Plant in the greateſt Vigour 'tis capable of, even unto the utmoſt Period of Age. Beſides, there is Danger in removing a whole Plant, and Loſs of Time before the Plant can take Root again, all the former Roots being broken off at the Ends in taking up (for 'tis impoſſible to do it without), and ſo muſt wait until by the Strength and Virtue of its own Sap (which by a continual Perſpiration is daily enfeebled) new Roots are form'd, which, unleſs the Earth continue moiſt *(a)*, are ſo long in forming, that they not only

(*a*) But when the Earth doth continue moiſt, many tranſplanted Vegetables thrive better than the ſame Species planted in Seeds, becauſe the former, ſtriking Root ſooner, have a greater Advantage of the freſh-pulveriz'd Mould, which loſes ſome of its artificial Paſture before the Seeds have Roots to reach it. The ſame Advantage alſo have Seeds by ſoaking till ready to ſprout before they are planted. To both theſe the Moiſture of the Earth is neceſſary.

find

find a more difficult Reception into the clofing Pores; but many Times the Plant languifhes and dies of an Atrophy, being ftarv'd in the midft of Plenty; but whilft this is thus decaying, the hoed Plant obtains a more flourifhing State than ever, without removing from the fame Soil that produc'd it.

'Tis obferv'd that fome Plants are the worfe for Tranfplanting (*a*). *Fenochia* removed is never fo good and tender as that which is not, it receives fuch a Check in Tranfplanting in its Infancy; which, like the Rickets, leaves Knots that indurate the Parts of the Fennel, and fpoil it from being a Dainty.

Hoeing has moft of the Benefits without any Inconveniences of Tranfplanting; becaufe it removes the Roots by little and little, and at different Times; fome of the Roots remaining undifturb'd, always fupply the moved Roots with Moifture, and the whole Plant with Nourifhment fufficient to keep it from fainting, until the moved Roots can enjoy the Benefit of their new Pafture, which is very foon.

Another extraordinary Benefit of the new Hoeing (*b*) Hufbandry is, that it keeps Plants moift in dry Weather, and this upon a double Account.

(*a*) As moft long Tap-rooted Plants are; for I have often try'd the Tranfplanting of Plants, of *St. Foin* and *Luferne*; and could never find, that any ever came near to the Perfection that thofe will do which are not removed, being equally fingle.

Tap-rooted Graffes and Turneps are always injur'd by Tranfplanting; their long Root once broken off never arrives at the Depth it would have arriv'd unbroken; as for this Reafon they cut off the Tap-root of an Apple-tree, to prevent its running downward, by which it would have too much Moifture.

(*b*) Hoeing may be divided into Deep, which is our Horfe-hoeing, and Shallow, which is the Englifh Hand-hoeing; and alfo the Shallow Horfe-hoeing, ufed in fome Places betwixt Rows, where the Intervals are very narrow, as fixteen or eighteen Inches; this is but an Imitation of the Hand-hoe, or a *Succedaneum* to it; and can neither fupply the Ufe of Dung, nor of Fallow, and may be properly called Scratch-hoeing.

First, as they are better nourished by Hoeing, they require less Moisture, as appears by Dr. *Woodward*'s Experiment, that those Plants which receive the greatest Increase, having most terrestrial Nourishment, carry off the least Water in Proportion to their Augment: So Barley or Oats, being sown on a Part of a Ground very well divided by Dung and Tillage, will come up and grow vigorously without Rain, when the same Grains, sown at the same Time, on the other Part, not thus enriched, will scarce come up; or, if they do, will not thrive till Rain comes.

Secondly, The Hoe, I mean the Horse-hoe (the other goes not deep enough), procures Moisture to the Roots from the Dews, which fall most in dry Weather; and those Dews (by what Mr. *Thomas Henshaw* has observ'd) seem to be the richest Present the Atmosphere gives to the Earth; having, when putrefy'd in a Vessel, a black Sediment like Mud at the Bottom. This seems to cause the darkish Colour to the upper Part of the Ground. And the Sulphur, which is found in the Sediment of the Dew, may be the chief Ingredient of the Cement of the Earth; Sulphur being very glutinous, as Nitre is dissolvent. Dew has both these.

These enter in proportion to the Fineness and Freshness of the Soil, and to the Quantity that is so made fine and fresh by the Hoe. How this comes to pass, and the Reason of it, are shewn in the Chapter of Tillage.

To demonstrate that Dews moisten the Land when fine, dig a Hole in the hard dry Ground, in the driest Weather, as deep as the Plough ought to reach: Beat the Earth very fine, and fill the Hole therewith; and, after a few Nights Dews, you'll find this fine Earth become moist at the Bottom, and the hard Ground all round will continue dry.

Till

Till a Field in Lands; make one Land very fin by frequent deep Plowings; and let another be rough by insufficient Tillage, alternately; then plow the whole Field cross-ways in the driest Weather, which has continued long; and you will perceive, by the Colour of the Earth, that every fine Land will be turn'd up moist; but every rough Land will be dry as Powder, from Top to Bottom.

Altho' hard Ground, when thoroughly soak'd with Rain, will continue wet longer than fine till'd Land adjoining to it; yet this Water serves rather to chill, than nourish the Plants standing therein, and to keep out the other Benefits of the Atmosphere, leaving the Ground still harder when 'tis thence exhaled; and being at last once become dry, it can admit no more Moisture, unless from a long-continued Deluge of Rain, which seldom falls till Winter, which is not the Season for Vegetation.

As fine hoed Ground is not so long soaked by Rain, so the Dews never suffer it to become perfectly dry: This appears by the Plants, which flourish and grow fat in this, whilst those in the hard Ground are starved, except such of them, which stand near enough to the hoed *(a)* Earth, for the Roots to borrow Moisture and Nourishment from it.

And

(*a*) As when Wheat is drill'd late in very poor Land, so that in the Spring the young Plants look all very yellow; let your Hoe-plough, making a crooked Line, like an Indenture, on one Side of a strait Row of this poor Wheat in the Spring, turn a Furrow from it; and in a short time you will see all those yellow Plants, that are contiguous to this Furrow, change their yellow Colour to a deep Green; whilst those Plants of the same Row, which stand farthest off from this indented Furrow, change not their Colour till afterwards; and all the Plants change or retain their Colour sooner or later gradually, as they stand nearer to, or farther from it; and the other Rows, which have no Furrow near them, continue their yellow, after all this Row is become green and flourishing: But this Experiment is best to be made in poor sandy Ground, when the Mould is friable; else perhaps the differ-

 ent

And I have been informed by ſome Perſons, that they have often made the like Obſervations; that, in the drieſt of Weather, good Hoeing *(a)* procures Moiſture to Roots; tho' the Ignorant and Incurious fanſy, it lets in the Drought; and therefore are afraid to hoe their Plants at ſuch Times, when, unleſs they water them, they are ſpoil'd for Want of it.

There is yet one more Benefit Hoeing gives to Plants, which by no Art can poſſibly be given to Animals: For all that can be done in feeding an Animal is, what has been here already ſaid of Hoeing; that is, to give it ſufficient Food, Meat and Drink, at the times it has occaſion for them; if you give an Animal any more, 'tis to no manner of Purpoſe, unleſs you could give it more Mouths, which is impoſſible;

ent Colour may not appear until the Furrow be turn'd back to the Row, having lain ſome time to be ſomewhat pulveriz'd (or impregnated) by the Weather, *&c.*

This Experiment I often made on Wheat drill'd on the Level before I drill'd any on Ridges.

The plowing one Furrow in ſandy or mellow Ground makes a Pulveration, which is enjoy'd firſt by theſe Plants that are the neareſt to it; and alſo delivers them from the Weeds, which, though there may be very few, yet there is a vaſt difference between their robbing the Wheat of its Paſture in the Row, and the Wheat's enjoying both that and the whole Paſture of the Furrow alſo.

I never remember to have ſeen a Plant poor, that was contiguous to a well-hoed Interval, unleſs overpower'd by a too great Multitude of other Plants; and the ſame Exception muſt be made, if it were a Plant that required more or leſs Heat or Moiſture, than the Soil or Climate afforded.

(a) When Land is become hard by lying too long unho'd, the Plough in turning a deep Furrow from each Side of a ſingle Row of young Plants (ſuppoſe of Turneps) may crack the Earth quite through the Row, and expoſe the Roots to the open Air and Sun in very dry Weather; but if the Earth wherein the Plants ſtand be fine, there will be no Cracks in it: 'Tis therefore the delaying the Hoeing too long that occaſions the Injury. But to hoe with Advantage againſt dry Weather, the Ground muſt have been well tilled or hoed before, that the Hoe may go deep, elſe the Dews, that fall in the Night, will be exhal'd back in the Heat of the Day.

ble; but in hoeing a Plant the additional Nourifh-ment thereby given, enables it to fend out innumerable additional Fibres and Roots, as in one of the Glaffes with a Mint in it, is feen; which fully demonftrates, that a Plant increafeth its Mouths, in fome Proportion to the Increafe of Food given to it: So that Hoeing, by the new Pafture it raifes, furnifhes both Food and Mouths to Plants; and 'tis for Want of Hoeing, that fo few are brought to their Growth and Perfection *(a)*

In what Manner the Sarrition of the Antients was performed in their Corn, is not very clear: This feems to have been their Method; *viz.* When the Plants were fome time come up, they harrowed the Ground, and pull'd out the Weeds by Hand. The Procefs of this appears in *Columella*, where he directs the Planting of *Medica* to be but a Sort of Harrowing or Raking amongft the young Plants, that the Weeds might come out the more eafily: *Ligneis Raftris ftatim jacta Semina obruantur. Poft Sationem Ligneis Raftris Jarriendus, & identidem runcandus eft Ager, ne alterius generis Herba invalidam Medicam perimat.*

(a) A Ground was drill'd with Ray-grafs and Barley, in Rows at Five Inches Diftance from each other; it produced a pretty good Crop of Ray-grafs the fecond Year as is ufual; there was adjoining to it a Ground of Turneps, that were in Rows, with wide Intervals Horfe-ho'd; they ftood for Seed; and amongft them there was, in Room of a Turnep, a fingle Plant of Ray-grafs, which, being hoed as the Turneps were, had (in every one's Opinion that faw it) acquired a Bulk at leaft equal to a Thoufand Plants of the fame Species in the other Ground; tho' that vaft Plant had no other Advantage above the other, except its Singlenefs, and the deep Hoeing.

I have feen a Chickweed, by the fame means, as much increas'd beyond its common Size; and a Plant of Muftard-feed, whofe collateral Branches were much bigger than ever I faw a whole Plant of that Sort; it was higher than I could reach its Top, and indeed more like a Tree than an Herb; many other forts of Plants have I feen thus increas'd beyond what I had ever obferv'd before, but none fo much as thofe.

They harrowed and hoed *Raſtris*; ſo that their *Occatio* and *Sarritio* were performed with much the ſame Sort of Inſtrument, and differed chiefly in the Time: The firſt was at Seed-time, to cover the Seed, or level the Ground; the other was to move the Ground after the Plants were up.

One Sort of their Sarrition was, *Segetes permota Terra debere adobrui, ut fruticare poſſint*. Another Sort was thus: *In Locis autem frigidis ſarriri nec adobrui, ſed Plana Sarritione Terram permoveri.*

For the better Underſtanding of theſe two Sorts of Sarrition, we muſt conſider, that the Antients ſowed their Corn under Furrow; that is, when they had harrowed the Ground, to break the Clods, and make it level, they ſowed the Seed, and then plowed it in: This left the Ground very uneven, and the Corn came up (as we ſee it does here in the ſame Caſe) moſtly in the loweſt Places betwixt the Furrows, which always lay higher: This appears by *Virgil*'s *Cum Sulcos æquant Sata*. Now, when they uſed *Plana Sarritio*, they harrowed Length-ways of the Furrows, which being ſomewhat harden'd, there could be little Earth thrown down thence upon the young Corn.

But the other Sort of Sarrition, whereby the Corn is ſaid *Adobrui*, to be cover'd, ſeems to be perform'd by Harrowing croſs the Furrows; which muſt needs throw down much Earth from the Furrows, which neceſſarily fell upon the Corn.

How this did contribute to make the Corn *fruticare*, is another Queſtion: I am in no doubt to ſay, it was not from covering any Part of it (for I ſee that has a contrary Effect), but from moving much Ground, which gave a new Paſture to the Roots: This appears by the Obſervation of the extraordinary Frutication of Wheat ho'd without being cover'd; and by the Injury it receives by not being uncover'd when any Earth falls on the Rows.

The ſame Author ſaith, *Faba, & cætera Legumina, cum quatuor Digitis à Terra extiterint, recte ſarrientur,* *excepto tamen Lupino, cujus Semini contraria eſt Sarritio; quoniam unam Radicem habet, quæ ſive Ferro ſuccisa ſeu vulnerata eſt, totus Frutex emoritur.*

If they had ho'd it only betwixt Rows, there had been no Danger of killing the Lupine, which is a Plant moſt proper for Hoeing. What he ſays of the Lupine's having no need of Sarrition, becauſe it is able of itſelf to kill Weeds, ſhews the Antients were ignorant of the chief Uſe of Hoeing; *viz.* to raiſe new Nouriſhment by dividing the Earth, and making a new Internal Superficies in it.

Sarrition ſcratched and broke ſo ſmall a Part of the Earth's Surface, amongſt the Corn and Weeds, without Diſtinction, or favouring one any more than the other, that it was a Diſpute, whether the Good it did in facilitating the Runcation (or Hand-weeding) was greater, than the Injury it did by bruiſing and tearing the Corn: And many of the Antients choſe rather to content themſelves with the Uſe of Runcation only, and totally to omit all Sarrition of their Corn.

But Hoeing is an Action very different from that of Sarrition, and is every Way beneficial, no-way injurious to Corn, tho' deſtructive to Weeds. Therefore ſome modern Authors ſhew a profound Ignorance, in tranſlating *Sarritio*, Hoeing: They give an Idea very different from the true one: For the Antients truly hoed their Vineyards, but not their Corn; neither did they plant their Corn in Rows, without which they could not give it the Vineyard-hoeing: Their Sarculation was uſed but amongſt ſmall Quantities of ſown Corn, and is yet in Uſe for Flax; for I have ſeen the *Sarculum* (which is a Sort of a very narrow Hoe) uſed amongſt the Plants of Flax ſtanding irregularly: But this Operation is too tedious and too chargeable, to be apply'd to great Quantities of irregular Corn.

If they ho'd their Crops ſown at Random, one would think they ſhould have made mad Work of

it;

it; ſince they were not at the Pains to plant in Rows, and hoe betwixt them with their Bidens; being the Inſtrument with which they tilled many of their Vineyards, and enters as deep as the Plough, and is much better than the *Engliſh* Hoe, which indeed ſeems, at the firſt Invention of it, to be deſigned rather to ſcrape Chimneys, than to till the Ground.

The higheſt and loweſt Vineyards are ho'd by the Plough; firſt the high Vineyards, where the Vines grow (almoſt like Ivy) upon great Trees, ſuch as Elms, Maples, Cherry-trees, *&c.* Theſe are conſtantly kept in Tillage, and produce good Crops of Corn, beſides what the Trees do yield; and alſo theſe great and conſtant Products of the Vines are owing to this Sort of Hoe-tillage; becauſe neither in Meadow or Paſture Grounds can Vines be made to proſper; tho' the Land be much richer, and yet have a leſs Quantity of Graſs taken off it, than the Arable has Corn carried from that.

The Vines of low Vineyards *(a)*, ho'd by the

(a) From theſe I took my Vineyard Scheme, obſerving that indifferent Land produces an annual Crop of Grapes and Wood without Dung; and though there is annually carried off from an Acre of Vineyard, as much in Subſtance as is carried off in the Crop of an Acre of Corn produced on Land of equal Goodneſs; and yet the Vineyard Soil is never impoveriſhed, unleſs the hoeing Culture be denied it: But a few annual Crops of Wheat, without Dung in the common Management, will impoveriſh and emaciate the Soil.

The Vine indeed has the Advantage of being a large perennial Plant, and of receiving ſome Part of its Nouriſhment below the Staple; but it has alſo Diſadvantages: The Soil of the Vineyard never can have a true Summer Fallow, tho' it has much Summer Hoeing; for the Vines live in it, and all over it all the Year: neither can that Soil have Benefit from Dung, becauſe though by increaſing the Pulveration, it increaſes the Crop, yet it ſpoils the Taſte of the Wine; the Exhauſtion of that Soil is therefore ſupply'd by no artificial Help but Hoeing: And by all the Experience I have had of it, the ſame Cauſe will have the ſame Effect upon a Soil for the Production of Corn, and other Vegetables, as well as upon the Vineyard.

Plough,

Plough, have their Heads juſt above the Ground, ſtanding all in a moſt regular Order, and are conſtantly plowed in the proper Seaſon: Theſe have no other Aſſiſtance, but by Hoeing; becauſe their Head and Roots are ſo near together, that Dung would ſpoil the Taſte of the Wine they produce, in hot Countries.

All Vineyards muſt be ho'd one Way or other (*a*), or elſe they will produce nothing of Value; but Corn-Fields without Hoeing do produce ſomething, tho' nothing in Compariſon to what they would do with it.

Mr. *Evelyn* ſays, that when the Soil, wherein Fruit-Trees are planted, is conſtantly kept in Tillage, they grow up to be an Orchard in half the Time they would do, if the Soil were not till'd; and this keeping an Orchard-Soil in Arable, is Horſe-hoeing it.

In ſome Places in *Berkſhire* they have uſed, for a long time to Hand-hoe moſt Sorts of Corn, with very great Succeſs; and I may ſay this, that I myſelf never knew, or heard, that ever any Crop of Corn was properly ſo ho'd, but what very well anſwer'd the Expence, even of this Hand-work; but be this never ſo profitable, there are not a Number of Hands to uſe it in great Quantities; which poſſibly was one Reaſon the Antients were not able to introduce it into their Corn-Fields to any Purpoſe; tho' they ſhould not have been ignorant of the Effect of it, from what they ſaw it do in their Vineyards and Gardens.

In the next Place I ſhall give ſome general Directions, which by Experience I have found neceſſary to be known, in order to the Practice of this Hoeing-Huſbandry.

I. *Concerning the Depth to plant at.*
II. *The Quantity of Seed to plant.*
III. *And the Diſtance of the Rows.*

(*a*) Vines, that cannot be ho'd by the Ploughs, are ho'd by the Bidens.

I. 'Tis

I. 'Tis neceſſary to know how deep we may plant our Seed, without Danger of burying it; for ſo 'tis ſaid to be, when laid at a Depth below what 'tis able to come up at.

Different Sorts of Seeds come up at different Depths; ſome at ſix Inches, or more; ſome at not more than half an Inch: The Way to know for certain the Depth any Sort will come up at is, to make Gauges in this Manner: Saw off 12 Sticks of about 3 Inches Diameter: Bore a Hole in the End of each Stick, and drive into it a taper Peg; let the firſt Peg be half an Inch long, the next an Inch, and ſo on; every Peg to be half an Inch longer than the former, till the laſt Peg be ſix Inches long; then in that ſort of Ground where you intend to plant, make a Row of Twenty Holes with the half-Inch Gauge; put therein Twenty good Seeds; cover them up, and ſtick the Gauge at the End of that Row; then do the like with all the other Eleven Gauges: This will determine the Depth, at which the moſt Seeds will come up *(a)*.

When the Depth is known, wherein the Seed is ſure to come up, we may eaſily diſcover, whether the Seed be good or not, by obſerving how many will fail: For in ſome Sorts of Seeds the Goodneſs cannot be known by the Eye; and there has been often great Loſs by bad Seed, as well as by burying good Seed; both which Misfortunes might be prevented by this little Trouble; beſides 'tis not convenient to plant ſome ſorts of Seed at the utmoſt Depth they

(a) In the common way of Sowing tis hard to know the proper Depth, becauſe ſome Seeds lying deep, and others ſhallow, it is not eaſy to diſcover the Depth of thoſe that are buried: But I have found in drilling of black Oats, that when the Drill-Plough was ſet a little deeper for Trial, very few came up: Therefore 'tis proper for the Driller to uſe the Gauges for all Sorts of Seeds; for, if he drills them too deep, he may loſe his Crop; or, if too ſhallow, in dry Weather, he may injure it, eſpecially in Summer Seeds; but for thoſe planted againſt Winter, there is the moſt Damage by planting too deep.

will

will come up at; for it may be ſo deep, as that the Wet may rot or chill the firſt Root, as in Wheat in moiſt Land.

The Nature of the Land, the Manner how it is laid, either flat, or in Ridges, and the Seaſon of Planting, with the Experience of the Planter, acquired by ſuch Trials, muſt determine the proper Depths for different Sorts of Seeds.

II. The proper Quantity of Seed to be drill'd on an Acre, is much leſs than muſt be ſown in the common Way; not becauſe Hoeing will not maintain as many Plants as the other; for, on the contrary, Experience ſhews it will, *cæteris paribus*, maintain more; but the Difference is upon many other Accounts: As that 'tis impoſſible to ſow it ſo even by Hand, as the Drill will do; for let the Hand ſpread it never ſo exactly (which is difficult to do ſome Seeds, eſpecially in windy Weather), yet the Unevenneſs of the Ground will alter the Situation of the Seed; the greateſt Part rebounding into the Holes, and loweſt Places; or elſe the Harrows, in Covering, draw it down thither; and tho' theſe low Places may have Ten Times too much, the high Places may have little or none of it: This Inequality leſſens, in Effect, the Quantity of the Seed; becauſe Fifty Seeds, in Room of One, will not produce ſo much as One will do; and where they are too thick, they cannot be well nouriſhed, their Roots not ſpreading to near their natural Extent, for Want of Hoeing to open the Earth. Some Seed is buried (by which is meant the laying them ſo deep, that they are never able to come up, as *Columella* cautions, *Ut abſque ulla Reſurrectionis Spe ſepeliantur*): Some lies naked above the Ground; which, with more uncovered by the firſt Rain, feeds the Birds and Vermin.

Farmers know not the Depth that is enough to bury their Seed, neither do they make much Difference in the Quantity they ſow on a rough, or a

fine

fine Acre; tho' the ſame that is too little for the one, is too much for the other; tis all mere Chance-work, and they put their whole Truſt in good Ground, and much Dung, to cover their Errors.

The greateſt Quantity of Seed I ever heard of to be uſually ſown, is in *Wiltſhire*, where I am informed by the Owners themſelves, that on ſome Sorts of Land they ſow Eight Buſhels of Barley to an Acre; ſo that if it produce four Quarters to an Acre, there are but four Grains for one that is ſown, and is a very poor Increaſe, tho' a good Crop; this is on Land plowed once, and then double-dung'd, the Seed only harrow'd into the ſtale and hard Ground *(a)*, 'tis like not two Buſhels of the eight will enter it to grow; and I have heard, that in a dry Summer an Acre of this ſcarce produces four Buſhels at Harveſt.

But, in Drilling, Seed lies all the ſame juſt Depth, none deeper, nor ſhallower, than the reſt; here's no Danger of the Accidents of burying, or being uncover'd, and therefore no Allowance muſt be made for them; but Allowance muſt be made for other Accidents, where the Sort of Seed is liable to them; ſuch as Grub, Fly, Worm, Froſt, *&c.*

Next, when a Man unexperienc'd in this Method has proved the Goodneſs of his Seed, and Depth to plant at it, he ought to calculate what Number of Seeds a Buſhel, or other Meaſure or Weight, contains: For one Buſhel or one Pound of ſmall Seed, may contain double the Number of Seeds, of a Buſhel, or a Pound, of large Seed of the ſame Species.

This Calculation is made by weighing an Ounce, and counting the Number of Seeds therein; then weighing a Buſhel of it, and multiplying the Number of Seeds of the Ounce, by the Number of Ounces

(a) Stale Ground is that which has lain ſome conſiderable time after Plowing, before it is ſown, contrary to that which is ſown immediately after plow'd; for this laſt is generally not ſo hard as the former,

of

of the Bushel's Weight; the Product will shew the Number of Seeds of a Bushel near enough: Then, by the Rule of Three, apportion them to the Square Feet of an Acre; or else it may be done, by divideing the Seeds of the Bushel by the Square Feet of an Acre; the Quotient will give the Number of Seeds for every Foot: Also consider how near you intend to plant the Rows, and whether Single, Double, Treble, or Quadruple; for the more Rows, the more Seed will be required *(a)*.

Examine what is the Produce of one middle-siz'd Plant of the Annual, but the Produce of the best and largest of the perennial Sort; because that by Hoeing will be brought to its utmost Perfection: Proportion the Seed of both to the reasonable Product; and, when 'tis worth while, adjust the Plants to their competent Number with the Hand-hoe, after they are up; and plant Perennials generally in single Rows: Lastly, Plant some Rows of the Annual thicker than others, which will soon give you Experience (better than any other Rule) to know the exact Quantity of Seed to drill.

III. The Distances of the Rows are one of the most material Points, wherein we shall find many apparent Objections against the Truth; of which, tho' full Experience be the most infallible Proof, yet the World is by false Notions so prejudiced against wide Spaces between Rows, that unless these common (and I wish I could say, only vulgar) Objections be first answer'd, perhaps no-body will venture so far out of the old Road, as is necessary to gain the Experience; without it be such as have seen it.

(a) The narrow Spaces (suppose seven Inches) betwixt Double, Treble, or Quadruple Rows, the Double having One, the Treble Two, and the Quadruple Three of them, are called *Partitions*.

The wide Space (suppose of near five Feet) betwixt any Two of these Double, Treble, or Quadruple Rows, is call'd an *Interval*.

I for-

I formerly was at much Pains, and at ſome Charge, in improving my Drills, for planting the Rows at very near Diſtances; and had brought them to ſuch Perfection, that One Horſe would draw a Drill with Eleven Shares, making the Rows at three Inches and half Diſtance from one another; and at the ſame Time ſow in them Three very different Sorts of Seeds, which did not mix; and theſe too, at different Depths; as the Barley-Rows were ſeven Inches aſunder, the Barley lay four Inches deep; a little more than three Inches above that, in the ſame Chanels, was Clover; betwixt every Two of theſe Rows was a Row of St. Foin, cover'd half an Inch deep.

I had a good Crop of Barley the firſt Year; the next Year, Two Crops of Broad-Clover, where that was ſown; and where Hop-Clover was ſown, a mix'd Crop of That and St. Foin, and every Year afterwards a Crop of St. Foin; but I am ſince, by Experience, ſo fully convinced of the Folly of theſe, or any other ſuch mix'd Crops, and more eſpecially of narrow Spaces, that I have demoliſh'd theſe Inſtruments (in their full Perfection) as a vain Curioſity, the Drift and Uſe of them being contrary to the true Principles and Practice of Horſe-Hoeing.

Altho' I am ſatisfied, that every one, who ſhall have ſeen as much of it as I have, will be of my Mind in this Matter; yet I am aware, that what I am going to advance, will ſeem ſhocking to them, before they have made Trials.

I lay it down as a Rule (to myſelf) that every Row of Vegetables, to be Horſe-ho'd, ought to have an empty Space or Interval of thirty Inches on one Side of it *(a)* at leaſt, and of near five Feet in all Sorts of Corn.

In

(a) Note, We call it one Row, tho' it be a Double, Treble, or Quadruple Row; becauſe when they unite in the Spring, they ſeem to be all ſingle; even the Quadruple then is but as one ſingle Row.

Obſerve

In Hand-hoeing there is always leſs Seed, fewer Plants, and a greater Crop, *cæteris paribus*, than in the common Sowing: Yet there, the Rows muſt be much nearer together, than in Horſe-hoeing; becauſe as the Hand moves many times leſs Earth than the Horſe, the Roots will be ſent out in like Proportion; and if the Spaces or Intervals, where the Hand-hoe only ſcratches a little of the upper Surface of them, ſhould be wide, they would be ſo hard and ſtale underneath, that the Roots of perennial Plants would be long in running thro' them; and the Roots of many annual Plants would never be able to do it.

An Inſtance which ſhews ſomething of the Difference between Hand-hoeing and Deep-hoeing is, That a certain poor Man is obſerv'd to have his Cabbages vaſtly bigger than any-body's elſe, tho' their Ground be richer, and better dung'd: His Neighbours were amaz'd at it, till the Secret at length came out, and was only this: As other People ho'd their Cab-

Obſerve, that as wide Intervals are neceſſary for perfect Horſe-hoeing, ſo the largeſt Vegetables have generally the greateſt Benefit by them; tho' ſmall Plants may have conſiderable Benefit from much narrower Intervals than Five Feet.

The Intervals may be ſomewhat narrower for conſtant annual Crops of Barley, than of Wheat; becauſe Barley does not ſhut out the Hoe-Plough ſo ſoon, nor require ſo much Room for Hoeing, nor ſo much Earth in the Intervals, it being a leſſer Plant, and growing but about a Third-part of the Time on the Ground; but he that drills Barley, muſt reſolve to reap it, and bind it up in Sheaves; for if he mows it, or does not bind it, a great Part will be loſt among the Earth in the Intervals: But 'tis now found, that in a wet Harveſt the beſt Way is not to bind up drill'd Barley or Oats; but inſtead thereof, to make up the Grips into little Heaps by Hands, laying the Ears upon one another inwards, and the Stubble-ones outwards; ſo that with a Fork that hath Two Fingers, and a Thumb, 'tis very eaſy to pitch ſuch Heaps up the Waggons without ſcattering, or waſting any of the Corn.

'Tis alſo ſeen, that when the Reapers take Care to ſet their Grips with the But-ends in the Bottoms of the Intervals, and the Ears properly on the Stubble, they will ſo ſtand up from the Ground, as to eſcape much better from ſprouting, than mow'd Corn.

bages with a Hand-hoe, he inftead thereof dug his with a Spade: And nothing can more nearly equal *(a)* the Ufe of the Horfe-hoe than the Spade does.

And when the Plants have never fo much *Pabulum* near them, their fibrous Roots cannot reach it all, before the Earth naturally excludes them from it; for, to reach it all, they muft fill all the Pores *(b)*, which is impoffible: So far otherwife it is, that we fhall find it probable, that they can only reach the leaft Part of it, unlefs the Roots could remove themfelves from Place to Place, to leave fuch Pores as they had exhaufted, and apply themfelves to fuch as were unexhaufted; but they not being endow'd with Parts neceffary for local Motion (as Animals are), the Hoe-Plough fupplies their Want of Feet; and both conveys them to their Food, and their Food to them, as well as provides it for them; for by tranfplanting the Roots, it gives them Change of the Pafture, which it increafes by the very Act of changing them from one Situation to another, if the Intervals be wide enough for this Hoeing Operation to be properly perform'd.

The Objections moft likely to prepoffefs Peoples Minds, and prevent their making Trials of this Hufbandry, are thefe:

Firft, they will be apt to think, that thefe wide, naked Spaces, not being cover'd by the Plants, will not be fufficient to make a good Crop.

For Anfwer, we muft confider, that tho' Corn, ftanding irregular and *fparfim*, may feem to cover

(*a*) The Hoe-plough exceeds the Spade in this Refpect, that it removes more of the Roots, and cuts off fewer; which is an Advantage when we till near to the Bodies of Plants that are grown large.

(*b*) The Roots of a Mint, fet a whole Summer in a Glafs, kept conftantly replenifhed with Water, will, in Appearance, fill the whole Cavity of the Glafs; but by compreffing the Roots, or by obferving how much Water the Glafs will hold when the Roots are in it, we are convinc'd, that they do not fill a Fourth-part of its Cavity; tho' they are not ftopp'd by Water, as they are by Earth.

the Ground better than when it ſtands regular in Rows; this Appearance *(a)* is a mere *Deceptio viſus*; for Stalks are never ſo thick on any Part of the Ground as where many come out of one Plant, or as when they ſtand in a Row; and a ho'd Plant of Corn will have Twenty or Thirty Stalks *(b)*, in the ſame Quantity of Ground where an unho'd Plant, being equally ſingle, will have only Two or Three Stalks. Theſe tillered ho'd Stalks, if they were planted *ſparſim* all over the Interval, it might ſeem well cover'd, and perhaps thicker than the ſown Crop commonly is; ſo that tho' theſe ho'd Rows ſeem to contain a leſs Crop, they may contain, in reality, a greater Crop than the ſown, that ſeems to exceed it; and 'tis only the different Placing that makes one ſeem greater, and the other leſs, than it really is; and this is only when both Crops are young.

The next Objection is, That the Space or Interval not being *planted*, much of the Benefit of that Ground will be loſt; and therefore the Crop muſt be leſs than if it were planted all over.

I anſwer, It might be ſo, if not Horſe-ho'd; but if well Horſe-ho'd, the Roots can run through the Intervals; and, having more Nouriſhment, make a greater Crop.

The too great Number of Plants, plac'd all over the Ground in common ſowing, have, whilſt it is open, an Opportunity of *waſting*, when they are very young, that Stock of Proviſion, for Want of which the greateſt Part of them are afterwards ſtarv'd; for

(a) For the Eye to make a Compariſon betwixt a ſown Crop and ſuch a ho'd Crop, it ought, when 'tis half grown, to look on the ho'd Crop acroſs the Rows; becauſe in the other it does ſo, in Effect, which way ſoever it looks; but whatever Appearance the ho'd Crop of Vegetables (of as large a Species as Wheat) makes when young, it ſurely, if well managed, appears more beautiful at Harveſt than a ſown Crop.

(b) I have counted Fifty large Ears on one ſingle ho'd Plant of Barley.

their irregular Standing prevents their being relieved with fresh Supplies from the Hoe: Hence it is, that the old Method exhausting the Earth to no Purpose, produces a less Crop; and yet leaves less *Pabulum* behind for a succeeding one, contrary to the Hoeing-Husbandry, wherein Plants are manag'd in all Respects by a quite different Oeconomy.

In a large Ground of Wheat it was prov'd, that the widest ho'd Intervals brought the greatest Crop of all: Dung without Hoeing did not equal Hoeing without Dung. And what was most remarkable, amongst Twelve Differences of wider and narrower Spaces, more and less ho'd, dung'd and undung'd, the Hand-sow'd was considerably the worst of all; tho' all the Winter and Beginning of the Spring, that made infinitely the most promising Appearance; but at Harvest yielded but about One-fifth Part of Wheat of that which was most hoed; there was some of the most hoed, which yielded Eighteen Ounces of clean Wheat in a Yard in Length of a double Row, the Intervals being thirty Inches, and the Partition Six Inches *(a)*.

A Third Objection like the two former is, that so small a Part of the Ground, as that whereon the Row stands, cannot contain Plants or Stalks sufficient for a full Crop.

This some Authors endeavour to support by Arguments taken from the perpendicular Growth of Vegetables, and the Room they require to stand on; both which having answer'd elsewhere, I need not say much of them here; only I may add, that if Plants could be brought to as great Perfection, and so to

(a) The same Harvest, a Yard in Length of a double Row of Barley, having Six Inches Partition, produc'd Eight hundred and Eighty Ears in a Garden; but the Grains happen'd to be eaten by Poultry before 'twas ripe, so that their Produce of Grains could not be known: One like Yard of a ho'd Row of Wheat, in an undung'd Field, produc'd Four hundred Ears of Lammas-Wheat.

ſtand as thick all over the Land, as they do in the ho'd Rows, there might be produc'd, at once, many of the greateſt Crops of Corn that ever grew.

But ſince Plants thrive, and make their Produce, in Proportion to the Nouriſhment they have within the Ground, not to the Room they have to ſtand upon it, one very narrow Row may contain more Plants than a wide Interval can nouriſh, and bring to their full Perfection, by all the Art that can be uſed; and 'tis impoſſible a Crop ſhould be loſt for want of room to ſtand above the Ground, tho' it were leſs than a Tenth-part of the Surface *(a)*.

In wide Intervals there is another Advantage of Hoeing, I mean Horſe-hoeing (the other being more like Scratching and Scraping than Hoeing): There is room for many Hoeings *(b)*, which muſt not come very

(a) Mr. *Houghton* calculates, that a Crop of Wheat of Thirty Quarters to an Acre, each Ear has two Inches and a Half of Surface; by which 'tis evident, that there would be Room for many ſuch prodigious Crops to ſtand on.

And a Quick-hedge, ſtanding between two Arable Grounds, one Foot broad at Bottom, and Eighteen Feet in Length, will, at fourteen Years Growth, produce more of the ſame Sort of Wood, than eighteen Feet ſquare of a Coppice will produce in the ſame Time, the Soil of both being of equal Goodneſs.

This ſeems to be the ſame Caſe with our ho'd Rows; the Coppice, if it were to be cut in the firſt Years, would yield perhaps ten Times as much Wood, as the Hedge; but many of the Shoots of the Coppice conſtantly die every Year, for Want of ſufficient Nouriſhment, until the Coppice is fit to be cut; and then its Product is much leſs than that of the Hedge, whoſe Paſture has not been over-ſtock'd to ſuch a Degree as the Coppice-Paſture has been; and therefore brings its Crop of Wood to greater Perfection than the Coppice-Wood, which has Eighteen Times the Surface of Ground to ſtand on: The Hedge has the Benefit of Hoeing, as oft as the Land on either Side of it is till'd; but the Coppice, like the ſown Corn, wants that Benefit.

(b) Many Hoeings; but if it ſhould be aſked how many, we may take *Columella*'s Rule in hoeing the Vines, *viz. Numerus autem vertendi Soli (bidentibus) definiendus non eſt, cum quanto crebrior*

very near the Bodies of ſome annual Plants, except whilſt they are young; but in narrow Intervals, this cannot be avoided at every Hoeing: 'Tis true, that in the laſt Hoeings, even in the middle of a large Interval, many of the Roots may be broken off by the Hoe-plough, at ſome conſiderable Diſtance from the Bodies; but yet this is no Damage, for they ſend out a greater Number of Roots than before; as in Chap. I. appears.

In wide Intervals, thoſe Roots are broken off only where they are ſmall; for tho' they are capable of running out to more than the Length of the external Parts of a Plant; yet 'tis not neceſſary they ſhould always do ſo; if they can have ſufficient Food nearer to the Bodies (*a*) of the Plants.

And theſe new, young, multiply'd Roots are fuller of Lacteal Mouths than the older ones; which makes it no Wonder, that Plants ſhould thrive faſter by having ſome of their Roots broken off by the Hoe; for as Roots do not enter every Pore of the Earth, but miſs great Part of the Paſture, which is left unexhauſted, ſo when new Roots ſtrike out from the broken Parts of the old, they meet with that Paſture, which their Predeceſſors miſs'd, beſides that new Paſture which the Hoe raiſes for them; and thoſe Roots which the Hoe pulls out without breaking,

brior ſit, plus prodeſſe foſſionem conveniat. Sed imperſurum Ratio modum poſtulat. Lib. 4. Cap. 5.

Neither is it altogether the Number of Hoeings that determines the Degrees of Pulveration: For, Once well done, is Twice done; and the oftener the better, if the Expence be not exceſſive.

Poor Land, be it never ſo light, ſhould have the moſt Hoeings; becauſe Plants, receiving but very little Nouriſhment from the natural Paſture of ſuch Land, require the more artificial Paſture to ſubſiſt on.

(*a*) All the Mould is never ſo near to the Bodies of Plants, as 'tis when the Row ſtands on a high Six-feet Ridge, when the middle of the Interval is left bare of Earth, at the laſt Hoeing; for then all the Mould may be but about a Foot, or a Foot and half, diſtant from the Body of each Plant of a Treble Row.

and covers again, are turn'd into a freſh Paſture; ſome broken, and ſome unbroken: All together invigorate the Plants.

Beſides, the Plants of ſown Corn, being treble in Number to thoſe of the drill'd, and of equal Strength and Bulk, whilſt they are very young, muſt exhauſt the Earth whilſt it is open, thrice as much as the drill'd Plants do; and before the ſown Plants grow large, the Pores of the Earth are ſhut againſt them, and againſt the Benefit of the Atmoſphere; but for the drill'd, the Hoe gives conſtant Admiſſion to that Benefit; and if the Hoe procures them (by dividing the Earth) Four Times the Paſture of the ſown during their Lives, and the Roots devour but one half of that, then tho' the ho'd Crop ſhould be double to the ſown, yet it might leave twice as much *Pabulum* for a ſucceeding Crop. 'Tis impoſſible to bring theſe Calculations to Mathematical Rules; but this is certain in Practice, that a ſown Crop, ſucceeding a large undung'd ho'd Crop, is much better than a ſown Crop, that ſucceeds a ſmall dung'd ſown Crop. And I have the Experience of poor, worn out Heath-ground, that, having produc'd Four ſucceſſive good ho'd Crops of Potatoes (the laſt ſtill beſt), is become tolerable good Ground.

In a very poor Field were planted Potatoes, and, in the very worſt Part of it, ſeveral Lands had them in Squares a Yard aſunder; theſe were plowed four ways at different times: Some other Lands adjoining to them, of the very ſame Ground, were very well dung'd and till'd; but the Potatoes came irregularly, in ſome Places thicker, and in others thinner: Theſe were not ho'd, and yet, at firſt coming up, looked blacker and ſtronger than thoſe in Squares not dung'd, either that Year, or ever, that I know of; yet theſe Lands brought a good Crop of the largeſt Potatoes, and very few ſmall ones amongſt them; but in the dung'd Lands, for Want of Hoeing, the Potatoes were not worth the taking up; which proves, that in thofe Plants that are planted fo as to leave Spaces wide enough for Repetitions of Hoeing, that Inftrument can raife more Nourifhment to them, than a good Coat of Dung with common Tillage.

Another Thing I have more particularly obferv'd, *viz.* That the more fucceffive Crops are planted in wide Intervals, and often ho'd, the better the Ground does maintain them; the laft Crop is ftill the beft, without Dung, or changing the Sort of Plant; and this is vifible in Parts of the fame Field, where fome Part has a firft, fome other Part a fecond, the reft a third Crop growing all together at the fame time; which feems to prove, that as the Earth is made by this Operation to difpenfe or diftribute her Wealth to Plants, in Proportion to the Increafe of her inner Superficies (which is the Pafture of Plants); fo the Atmofphere, by the Riches in Rain and Dews, does annually reimburfe her in Proportion to the fame Superficies, with an Overplus for Intereft: But if that Superficies be not increafed to a competent Degree, and, by frequent Repetitions of Hoeing, kept increafing (which never happens in common Hufbandry) this Advantage is loft; and, without often repeated Stercoration, every Year's Crop grows worfe; and it has been made evident by Trials, which admit of no Difpute, that Hoeing, without Dung or Fallow, can make fuch Plants as ftand in wide Intervals, more vigorous in the fame Ground, than both common Dunging and Fallowing can do without Hoeing.

This Sort of Hoeing has in Truth every Year the Effect of a Summer-fallow; tho' it yearly produce a good Crop.

This is one Reafon of the different Effects Plants have upon the Soil; fome are faid to enrich it, others to burn it, *i. e.* to impoverifh it; but I think it may be obferved, that all thofe Plants, which are ufually ho'd, are reckoned among the Enrichers;

and

and tho' it be certain that ſome Species of Plants are, by the Heat of their Conſtitution, greater Devourers than thoſe of another Species of equal Bulk; yet there is Reaſon to believe, that were the moſt cormorant Plant of them all to be commonly ho'd, it would gain *(a)* the Reputation of an Enricher or

(a) But this muſt be intended of the deep Horſe-hoeing; for Turneps that ſtand for Seed, are ſuch Devourers, and feed ſo long on the Soil, that tho' they are Hand-ho'd, ſuch a ſhallow Operation doth not ſupply the uſual Thickneſs of thoſe Plants with Paſture ſufficient to raiſe their Stems to half their natural Bulk; and they leave ſo little of that Paſture behind them, that the Soil is obſerv'd to be extremely impoveriſhed for a Year or two, and ſometimes three Years after them; but 'tis otherwiſe with my Horſe-ho'd Turnep-Seed; for I never fail'd of a good Crop of Barley after it, ſown on the Level in the following Spring, tho' no Dung hath been uſed on the Land where the Turnep-Seed grew for many Years. And alſo my Barley Crops thus ſown after two ſucceſſive Crops of Turnep-Seed without a Fallow between them, are as good as thoſe ſown after a ſingle Crop of it. For I have ſeveral Times made theſe Turnep-Seed Crops annual, that is, to have Two Crops of it in Two Years, which would in the old Way require three Years, becauſe this Crop ſtands about a Year on the Ground, and is not ripe till Midſummer, which is too late to get that Land into a Tilth proper to plant another Seed Crop on it the ſame Summer; neither can the Soil be able to bear ſuch another Crop immediately after being ſo much exhauſted, and unplowed for a whole Year, except it be extraordinary rich, or much dunged: However, Two Crops of Turnep-Seed immediately ſucceeding one another, is what I never knew, or heard of, except my own that were Horſe-ho'd; and of theſe the ſecond Crop was as good as the firſt; their Stalks grew much higher than they uſually do in the common Way; and tho' the Number of Plants was much leſs, their Produce was ſo valuable, that the *Vicar's Agent* declared, he made Twenty Shillings *per* Acre of his Tythe of a whole Field which he tythed in Kind. The Expence of theſe Crops was judg'd to be anſwered by the Fuel of the threſh'd Stalks. It muſt be noted, that the extraordinary Value of theſe Crops aroſe, not from a greater Quantity of Seed than ſome common Crops; but from their Quality, Experience having brought this Seed into great Eſteem, on account of its being perfectly clean, and produced by large Turneps of a good Sort, and of a proper Shape; for thoſe that are not well cultivated are very apt to degenerate, and then their Seed will produce Turneps of a ſmall Size, and of a long rapy ill Shape.

Improver of the Soil; except it ſhould be ſuch, as might occaſion Trouble, by filling it full of its ſhatter'd Seeds, which might do the Injury of Weeds to the next Crop; and except ſuch Plants, which have a vaſt Bulk to be maintained a long Time, as Turnep-Seed *(a)*.

The wider the Intervals are, the more Earth may be divided; for the Row takes up the ſame Room with a wide, or a narrow Interval; and therefore with the wide, the unho'd Part bears a leſs Proportion to the ho'd Part than in the narrow.

And 'tis no Purpoſe to hoe, where there is not Earth to be ho'd, or Room to hoe it in.

There are many Ways of Hoeing with the Hoe-Plough; but there is not Room to turn Two deep clean Furrows in an Interval that is narrower than Four Feet Eight Inches; for if it want much of this Breadth, one, at leaſt, of theſe Furrows, will reach, and fall upon the next Row, which will be very injurious to the Plants; except of grown St. Foin, and ſuch other Plants, that can bear to have the Earth pull'd off them by Harrows.

Thus much of Hoeing in general may ſuffice: And different Sorts of Plants requiring different Management; that may more properly be deſcribed in the Chapter, where particular Vegetables are treated of.

It may not be amiſs to add, that all Sorts of Land are not equally proper for Hoeing: I take it, that a dry friable Soil is the beſt. Intractable wet Clays, and ſuch Hills as are too ſteep for Cattle to draw a Plough up and down them, are the moſt improper *(b)*.

(a) Turneps run to Seed, not till the ſecond Summer.

(b) For by hoeing croſs the Hill, the Furrow turn'd againſt the Declivity cannot be thrown up near enough to the Row above it; and the Furrow that is turn'd downwards will bury the Row below it.

That

That 'tis not ſo beneficial to hoe in Common-fields, is not in Reſpect of the Soil, but to the old Principles, which have bound the Owners to unreaſonable Cuſtoms of changing the Species of Corn, and make it neceſſary to fallow every Second, Third, or Fourth Year at fartheſt.

CHAP. VII.

Of WEEDS.

PLANTS, that come up in any Land, of a different Kind from the ſown or planted Crop, are Weeds.

That there are in Nature any ſuch things as *inutiles Herbæ*, the Botaniſts deny; and juſtly too, according to their Meaning.

But the Farmer, who expects to make Profit of his Land from what he ſows or plants in it, finds not only *Herbæ inutiles*, but alſo *noxiæ*, unprofitable and hurtful Weeds; which come like *Muſcæ*, or uninvited Gueſts, that always hurt, and often ſpoil his Crop, by devouring what he has, by his Labour in Dunging and Tilling, provided for its Suſtenance.

All Weeds, as ſuch, are pernicious; but ſome much more than others; ſome do more Injury, and are more eaſily deſtroy'd; ſome do leſs Injury, and are harder to kill; others there are, which have both theſe bad Qualities. The hardeſt to kill are ſuch as will grow and propagate by their Seed, and alſo by every Piece of their Roots, as Couch-graſs, Coltsfoot, Melilot, Fern, and ſuch-like. Some are hurtful only by robbing legitimate (or ſown) Plants of their Nouriſhment, as all Weeds do; others both leſſen a legitimate Crop by robbing it, and alſo ſpoil that Crop, which eſcapes their Rapine, when they infect it it with their naufeous Scent and Relifh, as Melilot, wild Garlick, *&c.*

Weeds ftarve the fown Plants, by robbing them of their Provifion of Food *(a)*, not of their Room (as fome Authors vainly imagine); which will appear by the following Experiment.

Let three Beds of the fame Soil, equal, and equally prepared, be fown with the fame Sort of Corn. Let the firft of thefe Beds be kept clean from Weeds: In the Second, let a Quantity of Weeds grow along with the Corn; and in the Third, ftick up a Quantity of dead Sticks, greater in Bulk than the Weeds.

It will be found, that the Produce of the Corn in the Firft will not exceed that of the Third Bed; but in the Second, where the Weeds are, the Corn will be diminifh'd in Proportion to the Quantity of Weeds amongft it.

The Sticks, having done no Injury to the Corn, fhew there was room enough in the Bed for Company to lodge, would they forbear to eat; or elfe (like Travellers in *Spain*) bring their Provifion with them to their Inn, or (which would be the fame thing) if Weeds could find there fome Difh fo difagreeable to the Palate of the Corn, and agreeable to their own, that they might feed on it without robbing; and then they would be as innocent as the Sticks, which take up the fame Room with the Weeds.

The Quantity of Nourifhment Weeds rob the Corn of, is not in Proportion only to their Number and Bulk, but to the Degrees of Heat in their Con-

(a) A Tree of any Sort will fpoil Corn all round it, in a large Circle; half an Acre of Turneps has been fpoil'd by one: Hereby 'tis plain, that Trees rob as Weeds; becaufe 'tis not by their Shadow, there being as much Damage done by them on the South-Side, where their Shadow never comes, as on their North-Side: Nor can it be by their dropping; for 'tis the fame on the Side where a Tree has no Boughs to drop over the Plants, when they are alfo at a very great Diftance from all Parts of the Tree, except its Roots.

ftitution;

ſtitution; as appears by the Inſtance of Charlock and Turneps, mention'd in the Chapter *Of Change of Species.*

'Tis needleſs to go about to compute the Value of the Damage Weeds do, ſince all experienc'd Huſbandmen know it to be very great, and would unanimouſly agree to extirpate their whole Race as intirely, as in *England* they have done the Wolves, tho' much more innocent, and leſs rapacious than Weeds *(a)*.

But alas! they find it impoſſible to be done, or even to be hoped for, by the common Huſbandry; and the Reaſons I take to be theſe.

The Seeds of moſt Sorts of Weeds are ſo hardy, as to lie ſound and uncorrupt for many Years *(b)*, or perhaps Ages in the Earth; and are not kill'd until they begin to grow or ſprout, which very few of them do, unleſs the Land be plow'd; and then enough of them will ripen amongſt the ſown Crop, to propagate and continue their Species, by ſhedding their Off-ſpring in the Ground (for 'tis obſerv'd they are generally ripe before the Corn); and the Seeds of theſe do the ſame in the next ſown Crop; and thus perpetuate their ſavage, wicked *(c)* Brood, from Generation to Generation.

Beſides, their Seeds never all come up in one Year, unleſs the Land be very often plow'd; for they muſt have their exact Depth, and Degrees of Moiſture and

(a) If we conſider the Crops they utterly deſtroy, and thoſe they extremely diminiſh; and that very few Crops eſcape without receiving Injury from them; it may be a Queſtion, whether the Miſchief Weeds do to our Corn, is not as great as the Value of the Rent of all the Arable Lands in *England.*

(b) The Seeds of *Lethean Poppy* (call'd *Red-weed*) have lain dormant 24 Years (the Land being, during that time, in *St. Foin)* and then at firſt Plowing they came up very thick; this I have ſeen, and ſo will many other Sorts of Weeds, when the Ground has lain untill'd for an Age.

(c) The *French* call them, *les Herbes Sauvages, & les mechantes Herbes.*

Heat,

Heat, to make them grow; and ſuch as have not theſe, will lie in the Ground, and retain their vegetative Virtue for Ages; and the common uſual Plowings, not being ſufficient to make them all, or the greateſt Part, grow, almoſt every Crop that ripens increaſes the Stock of Seed, until it make a conſiderable Part of the Staple of ſuch Land as is ſown without good Tillage and Fallowing.

The beſt Defence againſt theſe Enemies, which the Farmer has hitherto found, is to endeavour their Deſtruction by a good Summer-fallow: This indeed, if the Weather be propitious, does make Havock of them; but ſtill ſome will eſcape one Year's Proſecution. Either by being ſometimes ſituate ſo high, that the Sun's Heat dries them, or ſometimes lying ſo deep, that it cannot reach them; either way their Germination, which would have proved their Death, is prevented.

Another Faculty ſecures abundance of them, and that is, their being able to endure the Heat and Moiſture of one Year without growing; as *(a)* wild Oats, and innumerable other Sorts of Weeds, will do; for gather theſe when ripe, ſow them in the richeſt Bed, water them, and do all that is poſſible to make them grow the Firſt Year, it will be vain Labour; they will reſiſt all Enticements till the Second; that is, if you gather them in Autumn, you cannot force them to grow until the next Spring come Twelvemonth; and many of them will remain dormant even to the next Year after that, and ſome of them longer.

By this Means, One Year's Summer-Fallow can have no Effect upon them, but to prepare the Soil

(a) I have not try'd wild Oats by ſowing them in a Bed myſelf, but have been ſo inform'd by others; and my own Experience hath frequently ſhewn me, that they will come up, after lying many Years in the Ground; and that very few Sorts of Weeds will come all up the firſt Year, as Corn doth: If they did, the Tillage of one Year's Summer-fallow might extirpate them.

for their more vigorous Growth and plentiful Increaſe the next Year after; and very rarely will the Farmer fallow his Land Two Years ſucceſſively; and often the Dung, which is made of the Straw of ſown Corn, being full of the Seeds of Weeds, when ſpread on the Fallows, incumbers the Soil with another Stock of Weeds, as ample as that the Fallowing has deſtroy'd; and tho' perhaps many of theſe may not grow the next Year, they will be ſure to come up afterwards.

The other old Remedy is what often proves worſe than the Diſeaſe; that is, what they call Weeding among ſown Corn; for if by the Hook or Hand they cut ſome Sorts (as Thiſtles) while they are young, they will ſprout up again, like *Hydras*, with more Heads than before; and if they are cut when full-grown, after they have done almoſt their utmoſt in robbing the Crop, 'tis like ſhutting the Stable-Door after the Steed is ſtolen.

Hand-weeders often do more Harm to the Corn with their Feet, than they do Good by cutting or pulling out the Weeds with their Hands; and yet I have known this Operation ſometimes coſt the Farmer Twelve Shillings an Acre; beſides the Damage done by treading down his Wheat; and, after all, a ſufficient Quantity of them have eſcaped, to make a too plentiful Increaſe in the next Crop of Corn.

The new Hoeing-Huſbandry in Time will probably make ſuch an utter Riddance (*a*) of all Sorts of Weeds (*b*), except ſuch as come in the Air, that

(*a*) A very pernicious, large, perennial Weed, like *Burrage*, with a blue Flower, infeſted a Piece of Land, for Time out of Mind: Hoeing has deſtroyed it utterly; not one of the Species has been ſeen in the Field theſe Seven Years, tho' conſtantly till'd and ho'd.

(*b*) I have now a Piece of Wheat drill'd early the laſt Autumn upon an Hill, fallowed and well pulveriz'd: Part of it was drill'd with Wheat in double Rows upon the Level Nine Years ago, Horſe-that (*c*) as long as this Management is properly continued, there is no Danger to be apprehended from them; which is enough to confute the old Error

Horse-ho'd, and the Partitions thoroughly Hand-ho'd to cleanse out the Poppies, of which the Land was very full; the other Part of this Piece was never drilled till this Year: The whole Piece hath not been before this Winter Horse-ho'd. Now the Partitions of the Part that was never any Way Ho'd, are so stock'd with Poppies matted together, that unless they are taken out early in the Spring, they will totally devour the Rows of Wheat; but in the other Part that was ho'd so long since, there are now very few Poppies to be seen. Both these Parts have had several sown Crops of Barley together since, and have lain with *St. Foin* these last Five or Six Years.

(*c*) And except also such Weeds, whose Seed is carried by Birds, which is the most common Manner of transporting the Seeds of Vegetables from Field to Field, against the Consent of the Owner: For Birds, whether great or small, do not care to eat their Prey where they take it, but generally chuse some open Place for that Purpose. 'Tis, I am persuaded, by this Means chiefly, that a Vineyard or Field, made ever so clean from Grass, will, in lying untilled a few Years, be replenished with a Turf of that neighbouring Species of Grass, which best suits the Heat and Moisture of the Soil: Yet there are some Species of Seeds that Birds (at least such as frequent this Place) do not affect; else the Burrage-weed (mentioned in *p.* 77.) would have appeared again in my Field in some of the many Years since the Hoeing has extirpated it there; for it grows plentifully in the unplowed Way adjoining thereto.

The Seeds of some Weeds may be suspected to come in the Air; as the Seed of the Grass that grew in the *Cheapside*, in the Time of the Plague; but it might come from Seeds in the Dirt, brought thither by the Feet of People and Cattle, and by the Wheels of Coaches, Carts carrying Hay: Or otherwise continual Treading might keep it from Growing; and when the Treading ceased, 'tis no Wonder the Seeds should furnish the Streets with Grass.

And I have observ'd on the Floors, two Stories high, of a lone, ruinous, uninhabited House, being long uncover'd, a sort of Herb growing very thick; I think it was *Pimpernel*, and believe that its Seeds did not come thither in the Air; but in the Sand which was mix'd with the Mortar that had fallen from the Cielings; and 'tis like there were few Seeds at first: Yet, these, ripening for several Years, shed their Seeds annually, until the Floors became all over very thick planted: Besides, Hay-seeds and Pimpernel are too heavy to be carry'd far by the Air.

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of equivocal Generation, had it not been already ſufficiently exploded, ever ſince that Demonſtration of *Malpighius's* Experiment. For if Weeds were brought forth without their proper Seeds, the Hoeing could not hinder their Production, where the Soil was inclined naturally to produce them. The Belief of that blind Doctrine might probably be one of the Cauſes that made the Antients deſpair of finding ſo great Succeſs in Hoeing, as now appears; or elſe, if they had had true Principles, they might perhaps have invented and improved that Huſbandry, and the Inſtruments neceſſary to put it in Practice.

CHAP. VIII.

Of TURNEPS.

As far as I can be inform'd, 'tis but of late Years that Turneps have been introduc'd as an Improvement in the Field.

All Sorts of Land, when made fine by Tillage, or by Manure and Tillage, will ſerve to produce Turneps, but not equally; for chalky Land is generally too dry (a Turnep being a thirſty Plant); and they are ſo long in ſuch dry poor Land before they get into rough Leaf, that the Fly is very apt to deſtroy them there; yet I have known them ſucceed on ſuch Land, tho' rarely.

Sand and Gravel are the moſt proper Soil for Turneps, becauſe that is moſt eaſily pulveriz'd, and its Warmth cauſeth the Turneps to grow faſter, and ſo they get the ſooner out of the Danger of the Fly; and ſuch a Soil, when well-till'd, and Horſe-ho'd, never wants a ſufficient Moiſture, even in the drieſt Weather; and the Turneps being drill'd will come up without Rain, and proſper very well with the ſole

Moiſture of the Dews, which are admitted as deep as the Pulveration reacheth; and if that be to Five or ſix Inches, the hotteſt Sun cannot exhale the Dews thence in the Climate of *England:* I have known Turneps thrive well in a very dry Summer by repeated Horſe-hoeings, both in Sand and in Land which is neither ſandy nor gravelly.

When I ſow'd Turneps by Hand, and ho'd them with a Hand-hoe, the Expence was great, and the Operation not half perform'd, by the Deceitfulneſs of the Hoers, who left half the Land unho'd, and cover'd it with the Earth from the Part they did hoe, and then the Graſs and Weeds grew the faſter: Beſides, in this Manner a great Quantity of Land could not be managed in the proper Seaſon.

When I drill'd upon the Level *(a)*, at Three Feet Intervals, a Trial was made between thoſe Turneps and a Field of the next Neighbour's, ſown at the ſame Time, whereof the Hand-hoeing coſt Ten Shillings *per* Acre, and had not quite half the Crop of the drill'd, both being meaſur'd by the Buſhel, on Purpoſe to find the Difference *(b)*.

In the new Method they are more certain to come up quickly; becauſe in every Row, half the Seed is planted about Four Inches deep (*c*); and the other Half is planted exactly over that, at the Depth of half an Inch, falling in after the Earth has cover'd

(a) 'Tis impoſſible to hoe-plow them ſo well when planted upon the Level, as when they are planted upon Ridges; for if we plow deep near the Row, the Earth will come over on the Left-Side of the Plough, and bury the younger Turneps; but when they ſtand on Ridges, the Earth will almoſt all fall down on the Right Side into the Furrow in the Middle of the Interval.

(b) And I have ſince found, that Turneps on the ſame Land, planted on Ridges, with Six-feet Intervals, make a Crop double to thoſe that are planted on the Level, or even on Ridges with Three-feet Intervals.

(*c*) Turnep-feed will come up from a greater Depth than moſt other Sorts of Seeds.

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the firſt Half: Thus planted, let the Weather be never ſo dry, the deepeſt Seed will come up; but if it raineth (immediately after planting), the Shallow will come up firſt: We alſo make it come up at Four *(d)* Times, by mixing our Seed, half new and half old (the new coming up a Day quicker than the old): Theſe four Comings up give it ſo many Chances for eſcaping the Fly, it being often ſeen, that the Seed ſown over Night will be deſtroy'd by the Fly, when that ſown the next Morning will eſcape, and *vice verſa* (*e*); or you may hoe-plow them, when you the Fly is like to devour them; this will bury the greateſt Part of thoſe Enemies; or elſe you may drill in another Row, without new-plowing the Land.

This Method has alſo another Advantage of eſcaping the Fly, the moſt certain of any other, and infallible, if the Land be made fine, as it ought to be: This is to roll it with a heavy Roller acroſs the Ridges, after 'tis drill'd, which cloſing up the Cavities of the Earth, prevents the Fly's Entrance and Exit, to lay the Eggs, hatch, or bring forth the young ones to prey upon the Turneps; which they might intirely devour, if the Fly came before they had more than the firſt two Leaves, which, being form'd of the very Seed itſelf, are very ſweet; but the next Leaves are rough and bitter, which the Fly does not love: I have always found the Rolling diſappoint the Fly; but very often it diſappoints the Owner alſo, who ſows at Random; for it makes the Ground ſo hard, that the Turneps cannot thrive, but look yellow, dwindle, and grow to no Perfection, unleſs they have a good Hoeing ſoon after the rough Leaves appear; for

(*d*) I have ſeen drill'd Turnep-ſeed come up daily for a Fortnight together, when it has not been mixt thus, the old with the new.

(*e*) I have had the firſt Turneps that came up all deſtroy'd by the Fly; and about a Fortnight afterwards more have come up, and been ho'd time enough, and made a good Crop.

when they ſtand long without it, they will be ſo poor and ſtinted, that the Hand-hoe does not go deep enough to recover them; and 'tis ſeldom that theſe rolled Turneps can be Hand-ho'd at the critical Time, becauſe the Earth is then become ſo hard, that the Hoe cannot enter it without great Difficulty, unleſs it be very moiſt; and very often the Rain does not come to ſoak it, until it be too late; but the drill'd Turneps being in ſingle Rows with Six-feet Intervals, may be roll'd without Danger: For be the Ground ever ſo hard, the Hand-hoe will eaſily ſingle them out, at the Price of Six-pence per Acre, or leſs (if not in Harveſt); and the Horſe-hoe will, in thoſe wide Intervals, plow at any Time, wet or dry; and, tho' the Turneps ſhould have been neglected till ſtinted, will go deep enough to recover them to a flouriſhing Condition.

Drill'd Turneps, by being no-where but in the Rows *(f)*, may be more eaſily ſeen than thoſe which come up at Random; and may therefore be ſooner *(g)*

(f) Drill'd Turneps coming all up nearly in a *Mathematical Line*, 'tis very nearly that a Charlock, or other like Weed, comes up in the ſame Line amongſt them, unleſs it be drill'd in with the Turnep-ſeed, of which Weeds our Horſe-ho'd Seed never has any; there being no Charlock in the Rows, nor any Turnep in the Intervals: We know, that whatever comes up in the Interval is not a Turnep, though ſo like to it, that, at firſt coming up, if promiſcuouſly, it cannot eaſily be diſtinguiſhed by the Eye, until after the Turneps, *&c.* attain the rough Leaf; and even then, before they are of a conſiderable Bigneſs, they are ſo hard to be diſtinguiſhed by thoſe People, who are not well experienced, that a Company of *Hand-hoers* cut out the Turneps by Miſtake, and left the Charlock for a Crop of a large Field of ſown Turneps. Such a Misfortune can never happen to drill'd Turneps, unleſs wilfully done, be they ſet out ever ſo young.

(g) The ſooner they are made ſingle, the better; but yet, when they are not very thick, they may ſtand till we have the beſt Convenience of ſingling them without much Damage; but, when they come up extraordinary thick, 'twill be much more difficult to make them ſingle, if they are neglected at their very firſt coming into rough Leaf.

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ſingled out by the Hand-hoe; which is another Advantage; becauſe the ſooner they are ſo ſet out, the better they will thrive (*h*).

Three or Four Ounces of Seed is the uſual Quantity to drill; but, at random, Three or Four Pounds are commonly ſown, which, coming thick all over the Ground, muſt exhauſt the Land more than the other, eſpecially ſince the ſown muſt ſtand longer, before the Hoers can ſee to ſet them out.

The Six-feet Ridges, whereon Turneps are drill'd in ſingle Rows, may be left higher than for double-row'd Crops; becauſe there will be more Earth in the Intervals, as the ſingle Row takes up leſs.

There is no prefix'd Time for planting Turneps, becauſe that muſt be according to the Richneſs of the Land; for ſome Land will bring them as forward, and make them as good, when planted the beginning of *Auguſt*, as other Land will, when planted in *May*; but the moſt general Time is, a little before, and a little after *Midſummer*.

Between theſe Rows of Turneps (*i*), I have planted Wheat in this Manner; *viz.* About *Michaelmas*, the Turneps

(*h*) Becauſe ſuch young Turneps will enjoy the more of the Paſture made by the Plowing, and by that little Pulveration of the Hand-hoe, without being robb'd of any Paſture by their own ſupernumerary Plants.

(*i*) As I have formerly drilled Wheat between Rows of Turneps, ſo I have ſince had the Experience of drilling Tnrneps between Rows of Barley and Rows of Oats: I have had them in the Intervals between Six-feet Ridges, and between Four-feet Ridges, and between thoſe of ſeveral intermediate Diſtances; but which of them all is the beſt, I leave at preſent undetermined. I ſhall only add, that the poorer the Land is, the wider the Intervals ought to be; and that, in the narrow, 'tis convenient at the Hoeing, to leave more Earth on that Side of each Interval whereon the Turneps are to be drill'd; and this is done by going round ſeveral Intervals with the Hoe-Plough, without going forwards and backwards in each immediately: But in the wide Intervals the Earth may be equal on both Sides of them.

Turneps being full grown, I plow'd a Ridge in the Middle of each of their Intervals, taking moſt of the Earth

I will propoſe another Method of Drilling, which may be very advantageous to thoſe who ſow their Barley upon the Level, and ſow Turnep-ſeed amongſt it, at Random, as they do Clover; which is, of late, a common Practice in ſome Places. The Barley keeps the Turneps under it, and ſtints them ſo much, that they are uſeful in the Winter or Spring, chiefly by the Food their *Leaves* afford to Sheep, their Roots being exceeding ſmall; and for this ſmall Profit they loſe the Time of tilling the Ground, until after the Turnéps are eaten off; which is a Damage we think greater than the Profit of ſuch Turneps: To prevent which Damage, they may drill them in Rows at competent Diſtances, and Horſe-hoe them, and ſet them out as ſoon as the Barley is off: This will both keep the Ground in Tilth, fit for another Crop of Spring Corn, and cauſe the Turneps to grow great enough (eſpecially if Harveſt be early, and the Winter prove favourable) for feeding of Sheep in a moveable Fold to dung the Ground into the Bargain.

What induces me to propoſe this Improvement is, that a Gentleman plows up his Barley-Stubble, and tranſplants Turneps therein, and Hand-hoes them with Succeſs. By the propoſed Way all the Expence of tranſplanting (which muſt be conſiderable) will be ſaved; and the ſetting out cannot be more than an Eighth of the Labour of *Hand hoeings*; and I conjecture the Horſe-hoed Turneps may be as good; for they (though ſtinted) having their Tap-roots remaining unmoved below the Staple of the Land, their horizontal Roots, being ſupply'd with Moiſture from the Tap-roots, immediately take hold of the freſh-plowed Earth, as ſoon as 'tis turned back to them; whereas the tranſplanted, having their Tap-roots broken off, and their Horizontal Roots crumpled in the Holes wherein they are ſet, muſt loſe Time, and be in Danger of dying with Thirſt, if the Weather proves dry.

Alſo this Way ſeems better than the common Practice of ſowing Turneps upon once plowing after Wheat; becauſe the Wheat-land commonly lies longer unplow'd by Six or Eight Months than Barley-land; and therefore cannot be in ſo good Tilth for Turneps as Barley-land may, unleſs the former be of a more friable Nature, or much more dunged, than the latter. Beſides, theſe Wheat-Turneps are uncertain, in Reſpect of the Fly that often deſtroys them at their firſt coming up; which Misfortune happened the Autumn 1734. to almoſt all that were ſown in that Manner.

I have obſerv'd, that Barley ſown on the Level, and not hoed, overcomes the Turneps that come up amongſt it; but that Tur-

Earth from the Turneps, leaving only juſt enough to keep them alive; and on this Ridge drill'd my Crop of Wheat *(k)*, and towards the Spring pull'd up my Turneps, and carried them off for Cattle.

When Turneps are planted too late, to have Time and Sun for attaining to their full Bulk, ſome drill a double Row on each Six-feet Ridge, with a Partition of Fourteen Inches; but I am told, that in this double Row the Turneps do not, even at that late Seaſon, grow ſo large, as thoſe planted at the ſame time in ſingle Rows; tho' the double Row requires

neps, which come up in the Partitions of Treble Rows of my Ridges of Horſe-hoed Barley, grew ſo vigorouſly as to overcome the Barley. And this was demonſtrated at Harveſt in a long Field, one Side of which had borne Turnep-ſeed, and the drilled Ridges of Barley croſſing the Middle of it; and both Ends of the Field having Barley ſown on the Level, one End of every Ridge croſs'd the Turnep-ſeed Part of the Field for about Ten Perches of their Length.

I obſerved alſo, that the Turneps near the Edges of the Lands of ſown Barley, adjoining to the hoed Intervals, grew large, but not ſo large as thoſe in the Partitions on the Ridges, their Intervals being hoed on each Side of them.

But different from this have I ſeen ſhattered Turnep-ſeed coming up in the like Partitions of drilled Wheat, on the very ſame Sort of Land, ſo miſerably poor and ſtinted, that they ſcarce grew a Hand's Breadth high, when thoſe Turneps which the Hoe left in the Sides of the Intervals, and at the narrow Edges of the unhoed Earth of the Interval Sides of the Rows of Wheat, grew large; and the Wheat was good alſo: But I do not remember how the middle Row of it ſucceeded.

This laſt Experience of the Turneps among the Wheat was got by this Accident: The Wheat was drilled after drilled Turneps on Ridges of a different Size. The Turneps were all pulled up before the Ground was plowed for the Wheat; but as Turnep-ſeed never comes *all* up the firſt Year, enough remained of this to come up (though thinly) in the Wheat, to ſhew exactly where every Row had been drilled; whereupon the Obſervation was made.

(k) This Wheat, being thus drill'd on the new Ridges made in the Intervals, betwixt the Rows of Turneps, being well Horſe-ho'd in the Spring, prov'd a very good Crop; it was drill'd in treble Rows, the Partitions Seven Inches each.

double the Expence in ſetting out; and there will be leſs Earth ho'd by the Breadth of fourteen Inches of the deepeſt Part of the Ridge, and conſequently the Land will be the leſs improv'd for the next Crop. We need not to be very exact, in the Number *(l)* or Diſtance *(m)* we ſet them out at; we contrive to leave the Maſter-turneps (when there is much Difference in them), and ſpare ſuch when near one another, and leave the more Space before and behind them; but if they be Three Maſter-turneps too near together, we take out the middlemoſt.

Turneps that were ſo thick as to touch one another when half-grown, by means of well Hoeing their wide Intervals, have afterwards grown to a good Bigneſs, and by thruſting againſt one another became oval, inſtead of round.

'Tis beneficial to hoe Turneps (eſpecially the firſt Time) alternately; *viz.* to hoe every other Interval, and throw the Earth back again before we hoe the other Intervals; for by this Means the Turneps are kept from being *(n)* ſtinted: 'Tis better to have Nouriſhment given them moderately at twice, than to have it all once, and be twice as long before a Repetition *(o)*.

(l) The leaſt Number will be the largeſt Turneps; yet we ſhould have a competent Stock, which I think is not leſs than Thirty on a ſquare Perch.

(m) The Diſtance need not to be regular; for when a Turnep has Six Inches of Room on one Side, and Eighteen Inches on the other Side, 'tis almoſt as well as if there was one Foot on each Side: tho' then it would be equally diſtant from the Two Turneps betwixt which it ſtood.

(n) Becauſe this alternate Hoeing doth not at all endanger the Roots by being dried by the Sun; for whilſt one half of the Roots have Moiſture, 'tis ſufficient; the other Half will be ſupplied from thoſe; ſo that they will ſoon take hold of the Earth again after being moved by the Hoe.

(o) Sometimes, when Turneps are planted late, this alternate Hoeing ſuffices without any Repetition; but when they are planted early, 'twill be neceſſary to hoe them again; eſpecially if Weeds appear.

Tho'

Tho' the Earth on each Side the Row be left as narrow as poſſible *(p)*; yet 'tis very profitable to hoe that little with a *Bidens (q)*, called here a Prong-hoe *(r)*; for this will be ſure to let out all the Roots into the Intervals; even ſuch as run very nearly parallel to the Rows.

This alternate Way of Hoeing Plants that grow in ſingle Rows, is of ſuch vaſt Advantage, that four of theſe, which are but equal to Two of the *whole* Hoeings in Labour, are near equal to four *whole* Hoeings in Benefit; for when one Side is well nouriſhed, the other Side cannot be ſtarv'd *(s)*.

Beſides, where a great Quantity of Turneps are to be ho'd, the laſt ho'd may be ſtinted, before the firſt are finiſh'd by *whole* Hoeings.

In this alternate Hoeing, the Hoe-plough may go deeper *(t)* and nearer to the Row, without Danger of thruſting it down on the Left Side, whilſt the Plants are very ſmall; becauſe the Earth on the other Side of the Row always bears againſt it for its Support: But in the *whole* Hoeing, there is an open Furrow left the firſt Time on both Sides of the Row, and there is Danger of throwing it into one Furrow in

(p) I do not think that we can go nearer to the Plants with the Hoe-plough, than within Three Inches of their Bodies.

(q) We ought not to uſe the *Bidens* for this Purpoſe, before the perpendicular Roots are as big as one's litle Finger.

(r) Some of theſe Prong-hoes have Three Teeth, and are reckoned better as a *Tridens* than a *Bidens*; but this is only in mellow Ground.

(s) But yet ſometimes the Weeds, or other Circumſtances, may make it proper to give them a *whole* Hoeing at firſt.

(t) This deep Plowing ſo near to the Row is very beneficial at firſt; but afterwards, when the Plants are grown large, and have ſent their Roots far into the Intervals, it would almoſt totally diſroot them; and they, being Annuals, might not live long enough for a new Stock of Roots to extend ſo far as is neceſſary to bring the Turneps to their full Bigneſs.

Note, At the laſt Hoeing we generally leave a broad, deep Trench in the middle of each Interval.

plowing the other; or, if the Row is not thrown down, it may be too much dry'd in hot Weather, by the Two Furrows lying too long open: Yet, when the Turneps are large before Hoeing, we need not fear either of these Dangers in giving them a *whole* Hoeing; as I have found by Experience, even when there has been left on each Side of the Row only about Three Inches Breadth of Earth; tho' it is not best to suffer it to lie long open *(u)*.

Dry Weather does not injure Turneps when Horse-ho'd, as it does sown Turneps; the Hand-hoe does not go deep enough to keep the Earth moist, and secure the Plants against the Drought; and that is the best Season for Horse-hoeing, which always can keep the Roots moist (*x*).

Dung and Tillage together will attain the necessary Degree of Pulveration, in less time than Plowing can do alone: Therefore Dung is more useful for Turneps, because they have commonly less time to grow than other Plants.

Turneps of Nineteen Pounds Weight I have several Times heard of, and of Sixteen Pounds Weight often known; and Twelve Pounds may be reckon'd the middle Size of great Turneps: And I can see no Reason, why every Turnep should not arrive to the full Bigness of its Species, if it did not want Part of its due Nourishment.

(u) But, if the Weather prove wet, we always suffer those Furrows to lie open, until the Earth be dry enough to be turn'd back again to the Row, without smearing or sticking together; unless such Weather continue so long that the Weeds begin to come up, and then we throw back the Furrows to stifle the Weeds, before they grow large, tho' the Earth be wet.

(x) But if some Sorts of Earth have lain so long unmoved as to become very hard before the first Hoeing, the Hoe, going very near to the Rows on each Side, may cause such hard Earth whereon the Rows stand, to crack and open enough to let in the Drought *(i. e.* the Sun and Air) to the Roots in very dry Weather. In this Case 'tis best to *Horse-hoe* alternately, as is directed in *Page* 86.

The greateſt Inconvenience, which has been obſerv'd in the Turnep-huſbandry, is, when they are fed off late in the Spring (which is in many Places the greateſt Uſe of them), there is not time to bring the Land in Tilth for Barley; the Loſs of which Crop is ſometimes more than the Gain of the Turneps: This is intirely remedied by the drilling Method; for, by that, the Land may be almoſt as well till'd before the Turneps are eaten, or taken off, as it can afterwards.

If Turneps be ſown in *June*, or the Beginning of *July*, the moſt experienced Turnep-Farmers will have no more than Thirty to a ſquare Perch left in Hand-hoeing; and find that when more are left, the Crop will be leſs; but, in drilling the Rows at Six Feet Intervals, there may be Sixty to a Perch; and the Horſe-hoe, by breaking ſo much more Earth than the Hand-hoe does, can nouriſh Sixty drill'd, as well as Thirty are by the ſowing Method, which has been made appear upon Trial; but, I think, about Forty or Forty-five better than Sixty on a Perch; and the Number of Plants ſhould always be proportion'd to the natural and artificial Paſture which is to maintain them; and ſixty Turneps on a ſquare Perch, at Five Pounds each (which is but a Third of the Weight of the large Size of Sheep-Turneps), make a Crop of above Eighty Quarters to an Acre (*y*).

When

(*y*) I have had Turneps upon poor undung'd Land, that weigh'd Fourteen Pounds a-piece; but theſe were only ſuch as had more Room than the reſt. I have ſeen a whole Waggon-load of drill'd Turneps ſpread on the Ground, wherein I believe one could not have found one that weighed ſo little as ſix Pounds; or if the Rows had been ſearched before they had been pull'd up, they would have weighed Seven or Eight Pounds apiece one with another; we weighed ſome of them that were Thirteen, ſome Fourteen Pounds each, and yet they ſtood pretty thick: There might be, as I gueſs, about Fifty on a ſquare Perch; but this Crop was on ſandy Land, not poor; and was dung'd the Third or

When Turneps are planted late (eſpecially upon poor Ground), they may be a greater Number than when planted early; becauſe they will not have time enough of Heat to enjoy the full Benefit of Hoeing, which would otherwiſe cauſe them to grow larger.

The greateſt Turnep-Improvement uſed by the Farmer, is for his Cattle in the Winter; one Acre of Turneps will then maintain more than Fifty of Meadow or Paſture-ground.

'Tis now ſo well known, that moſt Cattle will eat them, and how much they breed Milk, *&c.* that I need ſay nothing about it.

Sheep always refuſe them at firſt, and, unleſs they have eaten them whilſt they were Lambs, muſt be ready to ſtarve before they will feed on them; tho', when they have taſted them, they will be fatted by them; and I have ſeen Lambs of Three Weeks old ſcoop them prettily, when thoſe of a Year old (which are called Tegs) have been ready to die with Hunger amongſt them; and for Three or Four Days would not touch them, but at laſt eat them very well.

In ſome Places, the greateſt Uſe of Turneps (except for fatting Oxen and Sheep) is for Ewes and Lambs in the Spring, when natural Graſs is not grown on poor Ground; and if the artificial Graſs be then fed by the common Manner, the Crop will be ſpoil'd, and it will yield the leſs Paſture all the Summer: I have known Farmers, for that Reaſon, oblig'd to keep their Ewes and Lambs upon Turneps (tho' run up to Seed) even until the Middle of *April.*

There are now three Manners of ſpending Turneps with Sheep, amongſt which I do not reckon the Way of putting a Flock of Sheep into a large Ground of Turneps without dividing it; for in that Caſe the

or Fourth Year before; and had every Year a ho'd Crop of Potatoes, or Wheat, until the Year wherein the Turneps were planted.

Flock

Flock will deſtroy as many Turneps in a Fortnight, as ſhould keep them well a whole Winter.

The Firſt Manner now in Uſe is, to divide the Ground of Turneps by Hurdles, giving them leave to come upon no more at a Time than they can eat in one Day, and ſo advance the Hurdles farther into the Ground daily, until all be ſpent; but we muſt obſerve, that they never eat them clean this Way, but leave the Bottoms and Outſides of the Turneps they have ſcoop'd in the Ground. Theſe Bottoms People pull up with Iron Crooks, made for that Purpoſe; but their Cavities being tainted with Urine, Dung, and Dirt from their Feet, tho' the Sheep do eat ſome of the Pieces, they waſte more, and many the Crooks leave behind in the Earth; and even what they do eat of this tainted Food, can't nouriſh them ſo well as that which is freſh and cleanly.

The ſecond Manner is, to move the Hurdles every Day, as in the Firſt; but that the Sheep may not tread upon the Turneps, they pull them up firſt, and then advance the Hurdles as far daily as the Turneps are pull'd up, and no farther: By this Means there is not that Waſte made as in the other Way; the Food is eaten freſh and clean; and the Turneps are pull'd up with leſs Labour than their Pieces can be (*z*).

The Third Manner is, to pull them up, and to carry them into ſome other Ground in a Cart, or Waggon, and there ſpread them every Day on a new

(*z*) I have ſeen Three Labourers work every Day with their Crooks, to pull up theſe Pieces, which was done with much Difficulty, the Ground being trodden very hard by the Sheep; when one Perſon, in Two Hours time, would have pull'd up all the *whole* Turneps daily, and the Sheep would have eaten them clean; but ſo many of thoſe Pieces were dry'd and ſpoil'd, that, after the Land was ſown with Barley, they appear'd very thick upon the Surface, and there could not be much leſs than half the Crop of Turneps waſted, notwithſtanding the Contrivance of theſe Crooks.

Place,

Place, where the Sheep will eat them up clean, both Leaf and Root: This is done when there is Land not far off, which has more Need of Dung, than that where the Turneps grow, which perhaps is alſo too wet for Sheep in the Winter; and then the Turneps will, by the too great Moiſture and Dirt of the Soil, ſpoil the Sheep, and in ſome Soils give them the Rot, yet ſuch Ground will bring forth more and larger Turneps than dry Land; and when they are carry'd off, and eaten on plow'd Ground in dry Weather, and on Green-ſwerd in wet Weather, the Sheep will thrive much better; and that moiſt Soil, not being trodden by the Sheep, will be in much the better Order for a Crop of Corn. And generally the Expence of Hurdles, and removing them, being ſaved, will more than countervail the Labour of carrying off the Turneps.

Theſe Three Ways of ſpending Turneps with Sheep are common to thoſe drill'd, and to thoſe ſown in the random Manner; but they muſt always be carry'd off for Cows and Oxen; both which will be well fatted by them, and ſome Hay in the Winter: The Management of theſe is the Buſineſs of a Grazier.

CHAP. IX.

Of WHEAT.

THO' all Sorts of Vegetables may have great Benefit from the Hoe, becauſe it ſupplies them with Plenty of Food, at the Time of their greateſt Need, yet they do not all equally require Hoeing; but the Plant that is to live the longeſt, ſhould have the largeſt Stock of Suſtenance provided for it: Generally

nerally Wheat lives, or ought to live, longer than other Sorts of Corn; for if it be not ſown before Spring, its Grain will be thin, and have but little Flour in it, which is the only uſeful Part for making Bread. And when ſown late in the Winter, 'tis in great Danger of Death from the Froſt, whilſt weak and tender, being maintain'd (as a *Fœtus*) by the umbilical Veſſels, until the Warmth of the Sun enables it to ſend out ſufficient Roots of its own to ſubſiſt on, without Help of the *Ovum*.

To prevent theſe Inconveniences, Wheat is uſually ſown in Autumn: Hence, having about thrice the Time to be maintain'd that Spring Corn hath, it requires a larger Supply of Nouriſhment, in proportion to that longer Time; not becauſe the Wheat in its Infancy conſumes the Stock of Food, during the Winter, proportionably to what it does afterwards; but becauſe, during that long Interval betwixt Autumn and Spring Seed-times, moſt of the artificial Paſture is naturally loſt, both in light and in ſtrong Land.

For this very Reaſon is that extraordinary Pains of fallowing and dunging the Soil, neceſſary to Wheat; tho', notwithſtanding all that Labour and Expence, the Ground is generally grown ſo ſtale by the Spring, and ſo little of the Benefit of that chargeable Culture remains, that, if Part of the ſame Field be ſown in the Beginning of *April*, upon freſh Plowing, without the Dung, or Year's Fallow, it will be as great or a greater Crop, in all Reſpects, except the Flour, which fails only for want of Time to fill the Grain.

Poor light Land, by the common Huſbandry, muſt be very well cultivated and manur'd, to maintain Wheat for a whole Year, which is the uſual Time it grows thereon; and if it be ſown late, the greateſt Part of it will ſeldom ſurvive the Winter, on ſuch Land; and if it be ſown very early on ſtrong Land, tho' rich, well till'd, and dung'd, the Crop will be worſe than on the poor light Land ſown early. So much

much do the long Winter's Rains cause the Earth to subside, and the divided Parts to coalesce, and lock out the Roots from the Stock of Provision, which, tho' it was laid in abundantly at Autumn, the Wheat has no great Occasion of until the Spring; and then the Soil is become too hard for the Roots to penetrate; and therefore must starve (like *Tantalus*) amidst Dainties, which may tempt the Roots, but cannot be attain'd by them.

But the new Method of Hoeing gives, to strong and to light Land, all the Advantages, and takes away all the Disadvantages, of both; as appears in the Chapters of *Tillage* and *Hoeing*. By this Method the strong Land may be planted with Wheat as early as the light (if plow'd dry); and the Hoe-Plough can, if rightly apply'd, raise a Pasture to it *(a)*, equal to that of Dung in both Sorts of Land.

About the Year 1701, when I had contrived my Drill for planting St. Foin, I made use of it also for Wheat. Drilling many Rows at once, which made the Work much more compendious, and perform'd it much better than Hands could do, making the Channels of a Foot Distance, drilling in the Seed, and covering it, did not in all amount to more than Six-pence *per* Acre Expence, which was above ten Times over-paid by the Seed that was saved; for One Bushel to an Acre was the Quantity drill'd; there remain'd then no need of Hand-work, but for the Hoeing; and this did cost from Half a Crown to Four Shillings *per* Acre. This way turn'd to a very good Account, and in considerable Quantities; it has brought as good a Crop of Wheat on Barley-stubble, as that sown the common Way on Summer-fallow;

(a) Because the Hoe may go in it all the Year, and the Soil being *infinitely divisible*, the Division which the Hoe may make whilst the Crop is growing, added to the common Tillage, may equal, or even exceed, a common Dressing with Dung, as I have often experienced.

and when that ſown the old Way, on the ſame Field, on Barley-ſtubble, intirely fail'd, tho' there was no other Difference but the Drilling and Hoeing: It was alſo ſuch an Improvement to the Land, that when one Part of a ſtrong whitiſh Ground, all of equal Goodneſs, and equally fallow'd and till'd, was dung'd and ſown in the common Manner, and the other Part was thus drill'd and hand-ho'd without Dung, the ho'd Part was not only the beſt Crop, but the whole Piece being fallow'd the next Year, and ſown all alike by a Tenant, the ho'd Part produc'd ſo much a better Crop of Wheat than the dung'd Part, that a Stranger would have believ'd by looking on it, that that Part had been dung'd which was not (*a*), and that Part not to have been dung'd which really was.

Scarce any Land is ſo unfit, and ill prepar'd, for Wheat, as that where the natural Graſs (*b*) abounds. Moſt other ſorts of Weeds may be dealt withal when they come among drill'd Wheat; but 'tis impoſſible to extract Graſs from the Rows: Therefore let that be kill'd before the Wheat be planted.

The Six-feet Ridges being Eleven, on Sixty-ſix Feet, which is an Acre's Breadth, ought to be made Lengthways of the Field, if there be no Impediment againſt it; as if it be an Hill of any conſiderable Steepneſs, then they muſt be made to run up and down, whether that be the Length or Breadth of the Piece; for if the Ridges ſhould go croſs ſuch a Hill, they could not be well Horſe-ho'd; becauſe it would be very difficult to turn a Furrow upwards, cloſe to the Row above it, or to turn a Furrow downwards, without burying the Row below it; and even

(*a*) If the Dung did pulverize as much as the Hoeing, the Cauſe muſt be from the different Exhauſtion.

(*b*) One Bunch of natural Graſs, tranſplanted by the Plough into a treble Row of Wheat, will deſtroy almoſt a whole Yard of it.

when

when a Furrow is turn'd from the lower Row, enough of the Earth to bury that Row will be apt to run over on the Left-ſide of the Plough; unleſs it goes at ſuch a Diſtance from the Row, as to give it no Benefit of Hoeing.

Theſe Ridges ſhould be made ſtrait and equal: And to make them ſtrait (*c*) all good Ploughmen know how; and they will, by ſetting up Marks to look at, plow in a Line like the Path of an Arrow: But to make the Ridges equal, 'tis neceſſary to mark out a Number of them, before you begin to plow, by ſhort Sticks ſet up at each End of the Piece; and then if one Ridge happen to be a little too broad, the next may be made the narrower; for if the Plough comes not out exactly at the ſecond Stick, the Two Ridges may be made equal by the next Plowing, or by the Drilling; but if many contiguous Ridges ſhould be too wide, or too narrow, 'twill be difficult to bring them all to an Equality afterwards, without levelling the whole Piece, and laying out the Ridges all anew.

The exact Height of Ridges, which is beſt, I cannot determine (*d*): A different Soil may require a different Height, according to the Depth, Richneſs, and Pulveration of the Mould. As Wheat covets always to lie dry in the Winter, ſo there is no other way to keep it ſo dry as theſe Ridges; for when they are, after the firſt Hoeing, about Eighteen Inches

(*c*) But if the Piece be of ſuch a crooked or ſerpentine Form, that the Ridges cannot well be plow'd ſtrait the firſt Time, 'tis beſt to drill it upon the Level; and then the marking Wheels may direct for making the Row all parallel and equidiſtant; which will guide the Plough to make all the Ridges for the next and all the ſubſequent Crops, as equal.

(*d*) I find by meaſuring my Wheat Ridges in the Spring, that none of them are quite a Foot high; and ſome of them only Six Inches; but I know not how much they have ſubſided in the Winter; for they were certainly higher when firſt made.

broad,

broad *(a)*, with a Ditch on each Side, of almoſt a Foot deep, the Rain-water runs off ſuch narrow Ridges as faſt it falls, and much ſooner *(b)* than 'tis poſſible for it to do from broad Ridges.

And the deeper the Soil, the more occaſion there commonly is of this high Situation; becauſe ſuch Land is wetter for the moſt Part than ſhallow Land, where we cannot make the Furrows ſo deep, nor the Ridges ſo high *(c)*, as in deep Land; for we muſt never plow below the Staple. I ſee the Wheat on theſe ho'd Ridges flouriſh, and grow vigorouſly, in wet Weather, when other Wheat looks yellow and ſickly.

The ſame wide Interval, which is ho'd betwixt Ridges the Firſt time, with Two Furrows, muſt have had Four Furrows, to hoe it on the Level; or elſe the Furrow, that is turn'd from the Row, would riſe up, and a great Part of it fall over to the Left-hand, and bury the Row; but when turn'd from a Ridge, it will all fall down to the Right-hand.

You muſt not leave the Tops of the Ridges quite ſo narrow and ſharp for Drilling of Wheat, as you may for drilling Turneps; Wheat being in treble Rows, but Turneps generally in ſingle Rows *(d)*. This is our Method of making Ridges for the Firſt Crop of drill'd Wheat.

(*a*) This is the Breadth the Ridges are generally left at, when the Furrows are hoed from them, and thrown into the Intervals.

(*b*) Water, when it runs off very ſoon, is beneficial, as is ſeen in water'd Meadows; but where it remains long on, or very near the Bodies of terreſtrial Plants, it kills them, or at leaſt is very injurious to them.

(*c*) If we ſhould make our Ridges as high on a ſhallow Soil, as we may on a deep Soil, there would be a Deficiency of Mould in the Intervals of equal Breadth with thoſe of a deep Soil.

(*d*) A ſingle Row taking up leſs of the Breadth, may be afforded to have more of the Ridge's Depth; becauſe it leaves the Interval wider.

But the Method of making Ridges for a ſucceeding Crop, after the former is harveſted, is beſt perform'd as follows: In making Ridges for Wheat after Wheat, you muſt raiſe them to their full Height, before you plow the old Partitions, with their Stubble, up to them; for if you go about to make the Ridges higher afterwards, the Stubble will ſo mix with the Mould of their Tops, that it may not only be an Hindrance to the Drill, but alſo to the Firſt Hoeing; becauſe if the Hoe-plough goes ſo near to the Rows as it ought, it would be apt to tear out the Wheat-plants along with the Stubble.

In Reaping, we cut as near as we can to the Ground *(a)*; which is eaſily done, becauſe the Stalks ſtand all cloſe together at Bottom, contrary to thoſe of ſown Wheat.

I find this Stubble, when 'tis only mixt with the Intervals, very beneficial to the Hoeing of my Wheat; but I know not whether it may be ſo in rich miry Land.

As ſoon as conveniently you can, after the Crop of Wheat is carried off (if the Trench in the Middle of each wide Interval be left deep enough by the laſt Hoeing), go as near as you can to the Stubble with a common Plough, and turn Two large Furrows into the Middle of the Intervals, which will *(b)* make a Ridge

(*a*) When Wheat is reap'd very low, the Stubble is no great Impediment; and I do this when I am forc'd to inlarge the Breadth of my Ridges, or to change their Bearing, as I do when I find it convenient for them to point Croſs-ways of the Field inſtead of Length ways; as if one End of it be wetter than the other: For 'tis inconvenient, that one End of a Ridge ſhould be in the wet Part, and the other in the dry; becauſe, in that Caſe, we cannot hoe the dry End without hoeing the wet at the ſame time; and whilſt we attend for the wet Part to become dry, it may happen, that the Seaſon for hoeing the whole (if the Quantity be great) may be loſt.

(*b*) 'Tis the Depth and Fineneſs of this Ridge that the Succeſs of our Crop depends on; the Plants having nothing elſe to maintain them

Ridge over the Place where the Trench was: But if the Trench be not deep enough, go firſt in the Middle of it with one Furrow; which with Two more

them during the Firſt Six Months; and if, for want of Suſtenance, they are weak in the Spring, 'twill be more difficult to make them recover their Strength afterwards ſo fully as to bring them to their due Perfection. But Ploughmen have found a Trick to diſappoint us in this fundamental Part of our Huſbandry, if they are not narrowly watched: They do it in the following Manner; *viz.* They contrive to leave the Trench very ſhallow; and then, in turning the Two Firſt Furrows of the Ridge, they hold the Plough towards the Left, which raiſes up the Fin of the Share, and leaves ſo much of the Earth whereon the Rows are to ſtand whole and unplowed, that after once Harrowing there doth not remain above Two or Three Inches in Depth of fine Earth underneath the Rows when drilled, inſtead of Ten or Twelve Inches.

On a Time, when my Diſeaſes permitted me to go into the Wheat-field, where my Ploughs were at Work, I diſcovered this Trick, and ventured to aſk my chief Ploughman his Reaſon for doing this in my Abſence, contrary to my Direction. He magiſterially anſwer'd, according to his own Theory, which Servants judge ought to be follow'd before that of him they call Maſter, ſaying, That as the Roots of Wheat never reached more than Two or Three Inches deep, there was no need that the fine Mould ſhould be any deeper. But thoſe ſhallow Ridges, which were indeed too many, producing a Crop very much inferior to the contiguous deep Ridges, ſhewed, at my Coſt, the Miſtake of my cunning Ploughman.

'Tis true, that People who examine Wheat-roots when dead, are apt to fall into this miſtake; for then they are ſhrivell'd up, and ſo rotten, that they break off very near to the Stalk in pulling up; but if they are examined in their Vigour at Summer with Care, in a friable Soil, they may be ſeen to deſcend as deep as the fine pulveriz'd Mould reacheth, though that ſhould be a Foot in Thickneſs.

I took up a Wheat-ear in Harveſt that had lain on the Graſs in wet Weather, where the Wind could not come to dry it, which had ſent out white Roots like the Teeth of a Comb, ſome of them Three Inches long: None having reached the Ground, they could not be nouriſhed from any thing but the Grains, which remained faſt to the Ear, and had not as yet ſent out any Blade. 'Tis unreaſonable to imagine, that ſuch a ſingle Root as one of theſe, when in the Earth, from whence it muſt maintain a pretty large Plant all or moſt Part of the Winter, ſhould deſcend no farther than when it was itſelf maintained from the Flour of the Grain only.

 taken

taken from the Ridges, will be three Furrows in each Interval; continue this Plowing as long as the dry Weather lafteth; and then finifh, by turning the Partitions (whereon the laft Wheat grew) up to the new Ridges, which is ufually done at Two great Furrows. You may plow thefe laft Furrows, which complete the Ridges, in wet Weather.

To make a Six-feet Ridge very high, will fometimes require more Furrows; as when the Middle of the Intervals are open very wide and deep, then Six Furrows to the whole Ridge may be neceffary, and they not little ones; and the Seafon makes a Difference, as well as the Size of the Furrows; for when the fine Mould is very dry (which is beft), it will much of it run to the Left-hand before the Plough, and alfo more will run back again to the Left after the Plough is gone paft it.

But when fuch Ridges have been made for Wheat, and the Seafon continues long too dry for planting it, and the Stubble not thrown up, we then plow one deep Furrow on the Middle of each Ridge, and then plow the whole Ridge at Four Furrows more, which will raife it very high. This Way of replowing the Ridges moves all the Earth of them, and yet is done at Five Furrows.

The Furrows, neceffary for raifing up the Ridges, muft be more, or fewer, in regard to the Bignefs of them; becaufe Six fmall Furrows may be lefs than Four great ones. 'Tis not beft to plow the Stubble up to the Ridges, until juft before Planting (efpecially in the early Plowing); becaufe that will hinder the Re-plowing of the Firft Furrows, which, if the Seafon continues dry, may be neceffary: Sometimes we do this by opening One Furrow in the Middle of the Ridge, fometimes Two, and afterwards raife up the Ridges again; and when they are become moift enough at Top (the old Partitions being plow'd up to them), we harrow them

once

once (*a*) (and that only Lengthways); and then drill them.

There is a Neceſſity of plowing the old Partitions up to the new Ridges, to ſupport their other Earth from falling down by the Harrowing and Drilling, which would elſe make them level.

Our Ridges, after the Firſt Time of Plowing, excel common Ridges of the ſame Height; becauſe theſe, tho' as deep in Mould at the Tops, have little of it till'd at the laſt Plowing; but ours, being made upon the open Trenches, conſiſt of new-till'd pulveriz'd Mould, from Top to Bottom.

'Tis a general Rule, that all Sorts of Grain and Seeds proſper beſt, ſown when the Ground is ſo dry, as to be broken into the moſt Parts by the Plough. The Reaſon why Wheat is an Exception to that Rule is, becauſe it muſt endure the Rigours of Winter, which 'tis the better able to do, by the Earth's being

(*a*) But if once be not ſufficient to level the Tops of the Ridges fit for the Drill to paſs thereon, as it always will, unleſs the Two hard Furrows lie ſo high, that all the Three Shares of the Drill cannot reach to make their Channels, in this Caſe you muſt harrow again until they can all reach deep enough. Alſo in ſome Sort of Land, that when drilled late, and very moiſt, will ſtick to the Shares like Pitch or Bird-lime, whereby the Channels are in Part left open by the Drill-harrow, it muſt be harrowed after 'tis drilled, becauſe 'tis neceſſary in ſuch Land to take off the common Drill-harrow, in order for a Man to follow the Drill with a Paddle, or elſe a forked Stick, with which he frees the Sheats of the adhering Dirt; this Harrow being gone, much of the Seed will lie uncovered, and then muſt be covered with common Harrows; unleſs a Drill-harrow, which was not in Uſe when my Plates were made, be placed inſtead of that taken off: This, with its two Iron *Tines*, will cover the Seed in this Caſe much better than common Harrows, and will be no Hindrance to cleanſing of the Sheats, the Legs by which this Harrow is drawn, being remote from them, placed at near the End of the Plank; and *note*, that the moſt proper Drill for this Purpoſe is one that has only Two Shares, ſtanding a Foot or fourteen Inches aſunder: This Harrew ſerves for taking up the Drill to turn it.

prefs'd or trodden harder, and clofer to it *(a)*, as it is when moved wet.

If Wheat were as hardy as Rye, and its Roots as patient of Cold, it might, no doubt, be fown in as dry a Seafon as Rye is, and profper the better for it, as Rye doth. This will appear, if Wheat and Rye be both fown in the fame dry Seafon, after the Winter is over.

But as Wheat requires to have the Earth lie harder on and about it, in the Winter; fo it alfo requires more Dung (or fomewhat elfe) to diffolve the Earth about its Roots, after the cold Winter is paft, than Rye doth, whofe Roots never were fo much confined.

'Tis another general Rule, that all Sorts of Vegetables thrive beft, when fown on frefh till'd Ground, immediately after 'tis plow'd.

Wheat is an Exception to this Rule alfo; for 'tis better to plow the Ground dry, and let it lie till the Weather moiftens it (tho' it be feveral Weeks), and then drill the Wheat: The Harrows and the Drill will move a fufficient Part of the Ground, which will ftick together for Defence of the fmall Roots, during the Winter, the reft of the Mould, lying open, and divided underneath until Spring, to nourifh them.

There is a Sort of binding Sand, that requires not only to be plow'd dry, but fow'd dry alfo; or elfe the Wheat will dwindle in the Spring, and fail of being a tolerable Crop.

But what I mean by dry Plowing is, not that the Land fhould always be fo void of Moifture, as that the Duft fhould fly; but it muft not be fo wet, as to ftick together *(b)*. Neither fhould we drill when the

(a) 'Tis for that Reafon, that Farmers drive their Sheep over very light Land, as foon as 'tis fown with Wheat, to tread the (Top or) Surface of it hard; and then the Cold of the Winter cannot fo eafily penetrate, to kill the Roots of the tender Plants.

(b) But the drier 'tis plow'd the better

the Earth is wet as Pap; it ſuffices that it be moiſt, but moiſter in light Land than in ſtrong Land, when we drill.

If the Two Furrows, whereon the treble Row is to ſtand, be plow'd wet, the Earth of the Partitions may grow ſo hard by the Spring, that the Roots cannot run freely therein, unleſs there be Dung to ferment and keep it open.

So we ſee, that a ſteep Bank, made of wet Earth, will lie faſt for ſeveral Years, when another, made of the ſame Earth dry, will moulder, and run down very ſoon; becauſe its Parts have not the Coheſion that holds the other together, it continues open, and more porous, and crumbles continually down.

I have ſeen Trials of this Difference betwixt plowing Dry, and plowing Wet, for planting of Wheat, both in the Old Way, and in the Drilling Way, but moſt in the latter; and never ſaw an Inſtance where the Dry-Plowing did not outdo the Wet; if the Wheat was not planted thereon before the Earth was become moiſt enough at Top.

And ſtrong Land, plow'd wet in *November*, will be harder in the Spring, than if plow'd dry in *Auguſt*; tho' it would then have Three Months longer to lie.

After Rain, when the Top of the Ground is of a fit Moiſture for Drilling, harrow it with Two light Harrows, drawn by a Horſe going in the Furrow betwixt Two Ridges *(a)*; once will be enough, the Furrow being juſt broken to level, or rather ſmooth it for the Drill.

If the Veerings *(b)* whereon the next Drop is to ſtand, be plow'd dry, we may drill at any Time during

(a) Once Harrowing is generally enough, but not always.

(b) The Word veering is, I believe, taken from the Seamen, and ſignifies to turn: It is the Ploughman's Term for turning Two Furrows toward each other, as they muſt do to begin a Ridge: and

during the common and ufual Wheat-feed time, that is proper for the fort of Wheat to be drill'd, and the fort of Land, whether that be early or late, we may drill earlier, but not later than the fowing Farmers. But I have had good Crops of Wheat drill'd at all Times betwixt Harveft and the Beginning of *November*.

For the Benefit of the middle Rows, 'tis better not to drill Wheat on ftrong Land before the ufual Seafon; becaufe the later 'tis planted, the more open the Partitions will be for the Roots of thofe Rows to run through them in the Spring: and yet, if the Earth of the Partitions be plow'd very wet, tho' late, they may be harder at the Spring, than thofe which are plow'd early and dry.

There is a Sort of Wheat call'd by fome (a) *Smyrna Wheat*: It has a prodigious large Ear, with many lefs (or collateral) Ears, coming all round the Bottom of this Ear; as it is the largeft of all Sorts of Wheat, fo it will difpenfe with the Nourifhment of a Garden, without being over-fed, and requires more Nourifhment than the common Hufban-

and therefore they call the Top of a Ridge a Veering; they call the Two Furrows that are turn'd from each other at the Bottom, between Two Ridges, a Henting, *i. e.* an Ending: becaufe it makes an End of plowing Ridges.

Our Intervals wholly confift of Veerings or Hentings; when Two Furrows are turn'd from the Rows, they make a Veering; when turn'd towards the Rows, they are a Henting, which is the deep wide Trench in the Middle of an Interval.

(*a*) 'Tis faid to grow moftly in fome Iflands of the *Archipelago*, and fome Author defcribes it *Triticum fpica multiplici*: There is another Sort of Wheat that has many little Ears coming out of Two Sides of the main Ear, but this is very late ripe, and doth not fucceed well here, nor is it liked by them who have fown it; yet I have had fome Ears of it by chance among my drill'd Wheat, which have been larger than thofe of any common Sort. I have not as yet been able to procure any of the *Smyrna Wheat*, which I look on as a great Misfortune; but I had fome of it above Forty Years ago.

dry

dry will afford it; for there its Ears grow not much bigger than thofe of common Wheat: This I believe to be, for that Reafon, the very beft Sort for the Hoeing Hufbandry; next to this I efteem the White-cone Wheat, then the Grey-cone. I have had very good Crops from other Sorts; but look upon thefe to be the beft.

When Wheat is planted early, lefs Seed is required than when late; becaufe lefs of it will die in the Winter than of that planted late, and it has more Time to tiller *(a)*.

Poor Land fhould have more Seed than rich Land, becaufe a lefs Number of the Plants will furvive the Winter on poor Land.

The leaft Quantity of Seed may fuffice for rich Land that is planted early; for thereon very few Plants will die; and the Hoe will caufe a fmall Number of Plants to fend out a vaft Number of Stalks, which will have large Ears; and in thefe, more than in the Number of Plants, confifts the Goodnefs of a Crop (*b*).

Another thing muft be confider'd, in order to find the juft Proportion of Seed to plant; and that is, that fome Wheat has its Grains twice as big as other Wheat of the fame Sort; and then a Bufhel (*c*) will contain but half the Number of Grains; and one Bufhel of Small-grain'd Wheat will plant as much Ground as Two Bufhels of the Large-grain'd; for, in Truth, 'tis not the Meafure of the Seed, but the Number of the Grains, to which refpect ought to be had in apportioning the Quantity of it to the Land.

(*a*) To *tiller* is to branch out into many Stalks, and is the Country Word, that fignifies the fame with *fruticare*.

(*b*) A too great Number of Plants do neither tiller, nor produce fo large Ears, nor make half fo good a Crop, as a bare competent Number of Plants will.

(*c*) Our Bufhel contains Seventy Pounds of the beft Wheat.

Some

Some have thought, that a large Grain of Wheat would produce a larger Plant than a ſmall Grain; but I have full Experience to the contrary. The ſmall Grain, indeed, ſends up its firſt ſingle Blade in Proportion to its own Bulk, but afterwards becomes as large a Plant, as the largeſt Grain can produce *(a)*, *cæteris paribus*.

Six Gallons of middle-ſiz'd Seed we moſt commonly drill on an Acre; yet, on rich Land planted early, Four Gallons may ſuffice; becauſe then the Wheat will have Roots at the Top of the Ground before Winter, and tiller very much, without Danger of the Worms, and other Accidents, that late-planted Wheat is liable to.

If it is drill'd too thick, 'twill be in Danger of falling; if too thin, it may happen to tiller ſo late in the Spring, that ſome of the Ears may be blighted; yet a little thicker or thinner does not matter.

As to the Depth, we may plant from half an Inch, to three Inches deep; if planted too deep, there is more Danger of its being eaten off by Worms, betwixt the Grain and the Blade *(b)*; for as that

(a) Farmers in general know this, and chooſe the thinneſt, ſmalleſt-grained Wheat for Seed; and therefore prefer that which is blighted and lodged, and that which grows on new-broken Ground, and is not fit for Bread; not only becauſe this thin Wheat has more Grains in a Buſhel; but alſo becauſe ſuch Seed is leaſt liable to produce a ſmutty Crop, and yet brings Grains as large as any.

I myſelf have had as full Proofs of this as can poſſibly be made in both Reſpects.

'Twas from ſuch ſmall Seed that my drill'd *Lammas* Wheat produced the Ears of that monſtrous Length deſcribed in this Chapter. I never ſaw the like, except in that one Year; and the Grains were large alſo.

And as full Proofs have I ſeen of thin Seed-wheat eſcaping the Smut, when plump large grain'd Seed of the ſame Sort have been ſmutty.

(b) A Wheat-plant, that is not planted early, ſends out no Root above the Grain before the Spring; and is nouriſh'd all the Winter by a ſingle Thread, proceeding from the Grain up to the Surface of the Ground. Thread

Thread is the Thread of Life during the Winter (if not planted early), fo the longer the Thread is, the more Danger will there be of the Worms *(a)*.

'Tis a neceffary Caution to beware of the Rooks *(b)*, juft as the Wheat begins to peep; for before

(a) Becaufe the Worms can more eafily find a Thread, that extends by its Length to five or fix Inches Depth, than one which reaches but One Inch; and befides, the Worms in Winter do not inhabit very near the Surface of the Ground; and therefore alfo mifs the fhort Threads, and meet with the long ones.

(b) 'Tis true, that Wheat which is planted early enough for its Grain to be unfit for the Rooks, before the Corn that is left on the Ground at Harveft is either all eaten by them, or by Swine, or elfe grow'd, plowed in, or otherwife fpoiled, is in no Danger: but as this fometimes happens foon after Harveft, the Time of which is uncertain, a timely Care is neceffary.

Many are the Contrivances to fright the Rooks; *viz.* To dig an Hole in the Ground, and ftick Feathers therein; to tear a Rook to Pieces, and lay them on divers Parts of the Field: This is fometimes effectual; but Kites or other Vermin foon carry away thofe Pieces. Hanging up of dead Rooks is of little Ufe; for the living will dig up the Wheat under the dead ones. A Gun is alfo of great Ufe for the Purpofe; but unlefs the Field in Time of Danger be conftantly attended the Rooks will at one Time or other of the Day do their Work, and you may attend often, and yet to no Purpofe; for they will do great Damage in your Abfence.

The only Remedy that I have found infallible is a Keeper (a Boy may ferve very well) to attend from Morning until Night; when he fees Rooks either flying over the Field, or alighted in it, he halloos, and throws up his Hat, or a dead Rook, into the Air: upon which they immediately go off; and 'tis feldom that any one will alight there: They, finding there is no Reft for them, feek other Places for their Prey, wherein they can feed more undifturbed.

This was the Expedient I made ufe of for preferving my prefent Crop: It fucceeded fo well, that in Sixfcore Acres, I believe there is not Two-pence Damage done by the Rooks; but I had two Boys (one at Four-pence, and the other at Three-pence a Day) to attend them; becaufe my Wheat is on Two Sides of my Farm; the whole Expence was about Twenty Shillings. The Damage I received by Rooks the laft Year in a Field of Seventeen Acres, was more than would have, in this manner, preferved my whole Crops for Twenty Years running. I wifh I could as eafily defend my Wheat againft Sheep, which are to me a more pernicious Vermin than the Rooks.

you can perceive it to be coming up, they will find it, and dig it up to eat the Grain; therefore you muſt keep them off for a Week or Ten Days; and in that time the Blade will become green, and the Grain ſo much exhauſted of its Flour, that the Rooks think it not worth while to dig after it.

But the Rooks do not moleſt Wheat that is planted before or a little after St. *Michael*; for then there remains Corn enough in the Fields, which is left at Harveſt above-ground, that Rooks prefer always before Corn which muſt coſt them the Labour of digging to find it.

Of Partitions.

I have now intirely left out the middle Row for Wheat, and keep only to the double Row, for the following Reaſons.

It makes the cleanſing from Weeds more difficult, than when there is only a double Row.

The Hand-hoe cannot give near ſo much Nouriſhment (*i. e.* pulverize ſo much Earth) in Two Seven-inch Partitions, as it can in One Ten-inch Partition.

There is Four Inches leſs Earth to be pulveriz'd by the Horſe-hoe from the Surface of a Ridge that has Two Seven-inch Partitions, than from a Ridge that hath One Ten-inch Partition.

The Ridge muſt be almoſt twice as deep in Mould for the treble as for the double Row, or elſe the middle Row will be very weak and poor; and then, according to the Principles, the whole Ridge will be more exhauſted, than by an equal Product produced by ſtrong Plants.

As the Ridges may be much lower that have only the one Partition, ſo the Intervals may be narrower, and yet have as much Earth in them to be pulveriz'd, as in wide ones that are betwixt treble Rows; becauſe the Four Inches that are in the two Partitions more than in the ſingle Partition, being on the Top of the

the Ridge, may have more Mould under them than Eight Inches on the Side of a Ridge; and the Four Inches, being in the Partitions, lose the Benefit of Horse-hoeing.

Instead of using the middle Row as an Alloy, 'tis better to plant such Sorts of Wheat as do not require any Alloy to the double Row; and these are the *White-cone*, and above all other Sorts the right *Smyrna*.

The *White-cone* Wheat must not be reaped so green as the *Lammas* Wheat may; for if it is not full-ripe, it will be difficult to thresh it clean out of the Straw.

It happened once that my *White-cone* being planted early, and being very high, the Blade and Stalk were kill'd in the Winter; and yet it grew high again in the Spring, and had then the same Fortune a Second time; it lay on the Ridges like Straw, but sprung out anew from the Root, and made a very good Crop at Harvest: Therefore, if the like Accident should happen, the Owner needs not be frighted at it.

One thing that made Six-feet Ridges seem at first necessary, was the great Breadth of the Two Partitions (which were Eight Inches apiece), which, together with the Earth left on each Side of the treble Row not well cleansed by Hand-work, made Two large whole Furrows, at the first Plowing for the next Crop, that could not be broken by Harrows: These Two strong Furrows, being turned to the Two Furrows that are in the middle of a narrow Interval, for making a new Ridge, would cover almost all the pulveriz'd Earth, not leaving room betwixt the Two whole Furrows for the Drill to go in. But now the single Partition, and the Earth left by the Hoe-Plough, on the Outsides of the double Row, making Two narrow Furrows, and the one Partition being cleansed, and deeper Hand-ho'd than those of the treble Row were, or could be, are easily broken by the Harrows;

Harrows; for, beſides their Narrowneſs, they have no Roots to hold their Mould together, except the Wheat-roots, which, being ſmall and dead, have not Strength enough to hold it; and therefore that Neceſſity of ſuch broad Ridges now ceaſes along with the treble Row.

When the Two narrow fragile Furrows are harrowed, and mixed with the pulveriz'd Earth of the Intervals, the Roots of the Wheat will reach it; and it is no Matter whether the Crop be drill'd after Two Plowings, in which Caſe the Row will ſtand on the very ſame Place whereon the Row ſtood the precedent Year, or whether it be drill'd after One or Three Plowings; and then the Rows will ſtand on the Middle of the laſt Year's Intervals.

I cannot preſcribe preciſely the moſt proper Width of all Intervals; becauſe they ſhould be different in different Circumſtances. In deep rich Land they may be a little narrower than in ſhallow Land.

There muſt be (as has been ſaid) a competent Quantity of Earth in them to be pulveriz'd; and, when the Soil is rich, the leſs will ſuffice.

Never let the Intervals be too wide to be Horſe-hoed at Two Furrows, without leaving any Part unplowed in the Middle of them, when the Furrows are turned towards the Rows.

Some Ploughmen can plow a wider Furrow than others, that do not underſtand the ſetting of the Hoe-Plough ſo well, can.

By making the Plank of the Hoe-plough ſhorter, and the Limbers more crooked, we can now hoe in narrower Intervals than formerly, without doing any Damage to the Wheat.

I now chooſe to have Fourteen Ridges on an Acre, and one only Partition of Ten Inches on each of them. This I find anſwers all the Ends I purpoſe. If the Partitions are narrower, there is not ſufficient room in them for the Hand-hoe tó do its work effectually; if wider, too much Earth will loſe the Benefit of the Horſe-hoe.

The poorer the Soil is, the more Pulveration will be neceſſary to it.

When a great Seaſon of Wheat is drill'd, it cannot be expected that much of it can be plowed dry, tho' it is advantageous when there happens an Opportunity for doing it; but by long Experience I find, that in moſt of my Lands it does very well, when plowed in a moderate Temper of Moiſture.

It may not be amiſs to harrow it once after it is drill'd, which will, in ſome Meaſure, diſappoint the Rooks; beſides covering the Wheat, if, perchance, any ſhould miſs being covered by the Drill-harrow.

But theſe, and all Harrows that go on a Ridge, both before and after it is drill'd, ſhould be very light, and faſtened together in the common Manner; except that the Pole muſt be faſtened to each Harrow in two Places; which keeps them both as level as if they were One ſingle Harrow: Otherwiſe the Ridges would be too ſharp at the Top, and the Partitions would lie higher than the Rows, and ſome of their Earth would be apt to fall on the Rows when it is Hand-hoed.

By Means of this level Harrowing, there is left an open Furrow in the Middle of the Interval, which much facilitates the Firſt Horſe-hoeing.

But when, after a Crop is taken off, the Ridges are plowed twice, as they may be where the one Partition hath been well Hand-ho'd; 'tis better to harrow the firſt-made Ridges in the common Manner; becauſe then ſome of the fine Earth, that is harrow'd down, will reach to the middle of the Intervals whereon the Ridges are to be made for Drilling: Or if there ſhould be time for plowing thrice, the Ridges of the Firſt and Second Plowings are to be harrow'd in the common Manner alſo.

The

The Harrowing of Ridges muſt never be croſs-ways, unleſs they are to be made level for Croſs-plowing, in order to lay out the Ridges of a Breadth different to what they were of before.

When you perceive the Ridges are too high, harrow them lower by the deſcribed manner of Harrowing; firſt with the heavy Harrows for harrowing out the Stubble, and then with light ones, which may be often, for making the Earth on the Ridges the finer for Drilling, without throwing much of it down; frequent Harrowings in this manner, not being injurious like too much Harrowing on level Ground, which is ſometimes trodden as hard as the Highway by the Cattle that draw the Harrows; for in harrowing theſe Ridges, the Beaſt draws the Two Harrows, and always treads in the Furrow between them where there is none or very little Mould to tread on.

The Price of Hand-hoeing of theſe double Rows is a Peny for thirty Perches in Length of Row, which amounts to between Eighteen and Nineteen Pence for an Acre.

I ſhould ſay, that in Hand-hoeing the Earth muſt never be turned towards the Wheat; for, if it were, it might cruſh it when young; neither could the Partition be clean hoed.

The Hand-hoes for hoeing the Ten-inch Partition have their Edges Seven Inches long; they are about Four Inches deep from the Handle; if they were deeper, they would be too weak; for they muſt be thin, and well ſteeled. The Labourers pay for them, and keep them in Order, for their own Uſe.

Theſe Hoes muſt not cut out any Part of the Two Rows, nor be drawn through them, as the Four-inch Hoes ſometimes may through the treble Rows.

If I am taxed with Levity in changing my treble Rows for double ones, it will not appear to be done of a ſudden. In *p.* 132. I adviſed the Trial of both

Sorts:

Sorts: And now, upon fuller Experience, I find the double Rows much preferable to the treble, eſpecially for Wheat.

When Gentlemen ſaw the middle Row on low Ridges ſo much inferior to the outſide Rows, they were convinced of the Effect of deep Hoeing; for they ſaid, there was no other Reaſon for this ſo viſible a Difference, except the outſide Rows ſtanding nearer to the pulveriz'd Intervals than the middle Row did.

And when on high Ridges the middle Row was nearly or quite as good as one of the outſide Rows, I was not convinced, that they were not diminiſhed by the middle Row, as much as the Produce of it amounted to: And this I now find to be the Caſe; for Four Rows of Oats, without a middle Row, produced ſomewhat more than the ſame Number that had a middle Row; Two of which treble Rows were taken on one Side, and Two on the other Side of the double Rows, purpoſely to make an unexceptionable Trial. And it is, as far as I can judge, the ſame in Wheat.

'Tis true, I began my Horſe-hoeing *Scheme* firſt with double Rows; but then they were different to what they are now; for the firſt had their Partition uneven, being the parting Space, whereby it was leſs proper for Hand-hoeing, which I then ſeldom uſed, except for abſolute Neceſſity, as to cleanſe our Poppies, and the like. The Intervals alſo were too narrow for conſtant annual Crops.

By all theſe Three Methods I have had very good Crops; but as this I now deſcribe is the lateſt, and is (as it ought to be) the beſt; I publiſh it as ſuch, without Partiality to my own Opinions; for I think it leſs diſhonourable to expoſe my Errors, when I chance to detect them, than to conceal them: And as I aim at nothing but Truth, I cannot, with any Satisfaction to myſelf, ſuffer any thing of my own

I know-

knowingly to eſcape, that is in the leaſt contrary to it.

I have a Piece of Five or Six Acres of Land which I annually plant with boiling Peaſe, in the very ſame manner as Wheat; except that the Second Horſe-hoeing (which is the laſt) throws the Earth ſo far upon the Peaſe as to make the Two Rows become One. Theſe Peaſe cannot be planted until after the 25th of *March*; elſe Two Horſe-hoeings might not be ſufficient. The ſame Drill that plants Wheat plants Peaſe; only ſometimes we change the Spindle for one that has its Notches a little bigger.

I drill no more Barley, becauſe 'tis not proper to be followed by a Crop of Wheat without a Fallow; for ſome of the ſhattered Barley will live over the Winter, and mix with the Wheat in the Rows, and can ſcarce poſſibly be thence timely taken out, its firſt Stalk and Blade being difficult to diſtinguiſh from the Wheat; and this is a great Damage to the Sale in the Market; and for the ſame Reaſon I plant no more Oats.

The Firſt Hoeing is performed by turning a Furrow from the Row.

We are not ſo exact as to the Weather in the Firſt Hoeing; for if the Earth be wet, the Hoe-plough may go nearer to the Row, without burying the Wheat; and the Froſt of the Winter will pulverize that Part of the *(a)* Furrow, which is to be thrown to the Wheat in the Spring, altho' it was hoed wet.

Neither is it neceſſary to be very exact as to Time; but it muſt never be till the Wheat has more than One Blade; and it may be ſoon enough, when it has Four or Five Leaves, ſo that it is done before *(b)*, or in the Beginning of Winter.

The

(a) The Word Furrow ſignifies the Earth that is thrown out, as well as the Trench from whence it is thrown by the Plough.

(b) But if the Wheat is planted very late, it may not be *hoeable* before the Winter is paſt; nor is there ſuch a Neceſſity of hoeing

The greateſt Fault you can commit in Hoeing, is the Firſt Time, when the Furrow is turned from the Row, not to go near enough to it, nor deep enough. You cannot then go too near it, unleſs you plow it out, or bury it with Mould, and do not uncover it; nor too deep, unleſs you go below the Staple of the Ground.

Servants are apt to hoe too far from the Rows, going backwards and forwards, in the Middle of the Intervals, without coming near the Rows: This loſes moſt of the Benefit of Hoeing, and is very injurious to the preſent Crop, and alſo to the Two ſucceeding Crops; for then there will be a Deficiency of pulverized Earth; and nobody can ſuppoſe, that the hoed Earth can be of any Benefit to the Rows, before the Roots reach into it; and when 'tis far off, few of the Roots reach it at all; and thoſe that do reach, come there too late to bring the Plants to their full Perfection: Therefore, if the Firſt Furrow was not near enough, nor deep enough, plow a Second Furrow at the Bottom of the former, which will go deeper than the Firſt, and break the Earth more; beſides taking away from the Rows ſuch unmoved Ground, which the Firſt Plowing may poſſibly have miſſed. If this can't be conveniently done ſoon after the Firſt Hoeing, do it before the Ridge is turned back in the Spring.

Always leave the Furrows turned up, to make *(a)* Ridges in the Middle of the Intervals during the Winter;

hoeing the late planted before the great Froſts are over, as there is of the early-planted; for the later 'tis planted, the leſs time the Earth has to ſubſide, and grow hard.

Note, By Winter we do not mean only thoſe Months that are properly ſo reckoned, but alſo ſuch other Months as have hard Froſts in them, as *January*, *February*, and ſometimes the Beginning of *March*.

(*a*) Tho' the Ridge in the Middle of the Interval ſhould, for Want of ſufficient Mould, or otherwiſe, be too low to give Shelter, Winter; and then the hollow Furrows, or Trenches next the Rows, being enriched by the Froſt *(b)* and Rains *(c)*, the Wheat will have the Benefit of them earlier in the Spring, than if the Trenches had been left open in the Middle of the Intervals.

The outſide Rows of Wheat, from which the Earth is hoed off before or in the Beginning of Winter,

ter, yet there is generally ſome Earth falls to the Left of the Hoe-plough, and lodges upon that Part which is left on the Outſide of the Row; which, notwithſtanding that Part be very narrow (as ſuppoſe Two or Three Inches), yet a ſmall Quantity of Earth lying thereon, ſo near to the outſide Row, gives an extraordinary Shelter to the young Wheat plants that grow in it.

Shelter is a great Benefit to Wheat; but yet Nouriſhment is more: for in the Winter I ſee the Wheat-plants upon the moſt expoſed Part of the Ridge flouriſh, when ſingle Plants in the Bottom of the Furrow are in a very poor languiſhing Condition, without any Annoyance of Water, they being upon a Chalk Bottom.

(b) Froſt, if it does not kill the Wheat, is of great Benefit to it; Water or Moiſture, when it is frozen in the Earth, takes up more Room than in its natural State; this Swelling of the Ice (which is Water congealed) muſt move and break the Earth wherewith it is mixt; and when it thaws, the Earth is left hollow and open, which is a kind of Hoeing to it. This Benefit is done chiefly to and near the Surface; conſequently the more Surface there is, by the Unevenneſs of the Land, the more Advantage the Soil has from the Froſt.

This is another very great Uſe of the Ridge left in the Middle of the Interval during the Winter; becauſe that Ridge, and its Two Furrows, contain Four Times as much Surface as when level. This thus pulverized Surface, turned in in the Spring hoeing, enriches the Earth, in proportion to its Increaſe of internal Superficies, and likewiſe proportionably nouriſhes the Plants, whoſe Roots enter it; and that Part of it wherein they do not enter, muſt remain more enriched for the next Crop, than if the Soil had remained level all the Winter.

(c) It is a vulgar Error that the Winter Rains do not enrich the Earth; and is only thought ſo, becauſe we do not ſee the Effect of them upon Vegetables, for lack of Heat in that Seaſon. But ſome Farmers have frequently obſerved, that one half of a Ground plowed up juſt before Winter has produced a Crop of Barley as much better than the other Part plowed up at the End of Winter, as is the Difference of a Dunging, even when there has been very little Froſt.

and

and left almoſt bare till the Spring, one would think ſhould ſuffer by the Froſt coming ſo near them *(d)*, or for want of Paſture: But it appears to be quite contrary; for where the Hoe has gone neareſt to a Row, its Plants thrive beſt: The Earth, which the Froſt hath pulverized, being within the Reach of the young ſhort Roots, on that Side of the Row, from the Top to the Bottom of the Trench, nouriſhes them at firſt; and before the Plants have much exhauſted this, as they grow larger in the Spring, the Ridge from the Middle of the Interval is thrown to them, having a perfectly unexhauſted Paſture, to ſupply their increaſing Bulk with more Nouriſhment.

The Row ſtanding as it were on the Brink of this almoſt perpendicular Ditch, the Water runs off quickly, or doth not enter but a very little Way into this ſteep Side; ſo that, the Earth at the Plants being dry, the Froſt doth not reach quite to all their Roots to hurt them, tho' the Diſtance from the Air to the Roots be very ſhort; and dry Earth doth not freeze as wet doth, neither is this Ditch much expoſed to the cold Winds.

The Spring-hoeing is performed after the great Froſts are paſt, and when the Weather will allow it; and then turn *(e)* the Ridge from *(f)* the Middle of the

(d) In very light Land, perhaps, we muſt not hoe quite ſo near to the Rows of Wheat, as in ſtrong Land, for fear the Winter ſhould lay the Roots bare, and expoſe them too much to the Cold; but then we may be ſure, that, in this Caſe, the Roots will reach the Interval at a greater Diſtance than in ſtrong Land; yet ſuch very light Land is not proper for Wheat.

(e) 'Tis an errant Miſtake of the Vulgar, when they imagine that the immediate Benefit of freſh Earth to Plants is from that Part which remains uppermoſt; for 'tis from turning the impregnated pulverized Side downwards, to be fed on by the Roots, that gives the *Pabulum* or Nouriſhment of the freſh Earth to Plants: The other Side, being turned upwards, becomes impregnate alſo in a little time.

(f) But note, that when we ſee Weeds coming up near the Row in the Spring, we plow again from the Rows (and ſome-

the Interval, to the Rows on each Side by Two Furrows as near as can be, without covering the Wheat; in doing which have regard to the Row only, without looking at the Middle of the Interval; for 'tis no matter if a little Earth be left there; the next Hoeing, or the next ſave one *(g)*, will move it.

As to how many times Wheat is to be hoed in the Summer, after this Spring Operation, it depends upon the Circumſtances *(h)* and Condition of the Land *(i)* and Weather *(k)*; but be the Seaſon as it will, never ſuffer the Weeds to grow high, nor let any unmoved Earth lie in the Middle of the Intervals long enough to grow hard; neither plow deep near the Rows in the Summer, when the Plants are large *(l)*, but as deep in the Middle of the Intervals

times can plow within one Inch of the Row) before we turn down the Mould from the Middle of the Interval.

(*g*) If at the next Hoeing we turn another Furrow towards the Row (which is ſeldom done), then 'tis the next that moves the remaining Earth, left in the Middle of the Interval: But if the next Hoeing be from the Row (as it generally is), then that covers the Middle of the Interval; and then 'tis the next Hoeing after that, that turns all the Earth clean out of the Middle of the Interval toward the Rows.

(*h*) If the Land was not ſufficiently tilled or hoed in the precedent Year, it will require the more Hoeings in the following Year.

(*i*) The poorer the Land is, the more Hoeings it ſhould have.

(*k*) A wet Summer may prevent ſome of the Hoeings that we ſhould perform in a dry Summer.

(*l*) Our Hoeing deep near the Plants, when ſmall, breaks off only the Ends of the Roots; but after the Roots are ſpread far in the Interval, the greateſt Part of them, being then on the Right-hand Side of the Hoe plough, might hold faſt on that Side, and not be drawn out; and then the whole Roots would be broken off cloſe to the Bodies of the Plants: Therefore at the Second deep Hoeing, that turns a Furrow from the Row in the Summer, we go about Four or Six Inches farther off from the Roots than the time before; but we go nearer or farther off, according to the Diſtance of Time between thoſe Two Hoeings: Yet we may hoe *ſhallow* near to the Plants at any time, without Injury to their Roots, but, on the contrary, it will be advantageous to them.

as the Staple will allow; turning the Earth towards the Wheat, especially at the last Hoeing, so as to leave a deep, wide Trench in the Middle of each Interval.

We augment our Wheat-crops Four Ways; not in Number of Plants, but in Stalks, Ears, and Grains.

The First is, by increasing the Number of Stalks from One, Two, or Three, to Thirty or Forty to a Plant, in ordinary Field-land.

And we augment the Crop, by bringing up all the Stalks into Ears, which is the Second Way; for, if it be diligently observed, we shall find, that not half *(m)* the Stalks of sown Wheat come into Ear.

I saw an Experiment of this in Rows of Wheat that were equally poor: One of these Rows was increased *(n)* so much, as to produce more Grains than Ten of the other, by bringing up more of its Stalks into Ears, and also by augmenting its Ears to a much greater Bigness; which is the Third Way: For, whatever *Varro* means by saying, that the Ears remain Fifteen Days *in Vaginis*, 'tis pretty plain, that the Ears are formed together with the Stalks, and will be very large, or very small, in proportion to the Nourishment given them *(o)*.

The last and Foureh Way of augmenting the Produce of Wheat-plants, is by causing them to have large and plump Grains in the Ears; and this can no way be so effectually done as by late Hoeing, especi-

(m) If a square Yard of sown Wheat be marked out, and the Stalks thereon numbered in the Spring, it will be found, that Nine parts in Ten are missing at Harvest.

(n) These Rows were drilled a Foot asunder, not hoed; and were, by the Shallowness and Wetness of the Soil, very poor in the Spring; and then, by pouring Urine to the Bottom of this Row, it was so vastly increased above the rest.

(o) Like as the Vines, if well nourished, bring large Bunches of Grapes; but if ill nourished, they produce few Bunches, and those small ones; and many Claspers are formed, which would have been Bunches, if they had had sufficient Nourishment given them at the proper time.

ally juſt after the Wheat is gone out of the Bloſſom; and when ſuch hoed Grains weigh double the Weight of the ſame Number of unhoed (which they frequently will) tho' the Number of Grains in the hoed are only equal, yet the hoed Crop muſt be double.

Thus, by increaſing the Number of Stalks (*p*), bringing more of them up into Ear (*q*), making the Ears larger (*r*), and the Grain plumper, and fuller of Flour (*s*), the Hoeing Method makes a greater Crop from

(*p*) The ſame Plant that, when poor, ſends out but Two or Three Tillers, would, if well nouriſhed by the Hoe, or otherwiſe, ſend up a Multitude of Tillers, as is ſeen in hoed Wheat, and ſown Wheat.

(*q*) Mr. *Houghton* relates Eighty Ears on one ſingle Plant of Wheat, and a greater Number has been counted lately in a Garden: Thoſe Eighty, reckoned to have Fifty Grains apiece, make an Increaſe of Four thouſand Grains for one; but I have never found above Forty Ears from a ſingle Plant in my Fields; yet there is no doubt, but that every Plant would produce as many as Mr. *Houghton*'s, of the ſame Sort, with the ſame Nouriſhment: But I ſhould not deſire any to be ſo prolific in Stalks, leſt they ſhould fail of bringing ſuch a Multitude of Ears to Perfection. The Four hundred Ears, that I numbered in a Yard, were not weighed, becauſe they were told before ripe; and the greateſt Weight of Wheat that ever I had from a Yard, was the Product of about Two hundred and Fifty Ears, and ſome of them were ſmall.

(*r*) I have numbered One hundred and Nine Grains in One Ear of my hoed Cone-wheat of the grey Sort; and One Ear of my hoed Lammas-wheat has been meaſured to be Eight Inches long, which is double to thoſe of ſown Wheat. I have ſome of theſe Ears now by me almoſt as long, the longeſt being given away as a Rarity; and indeed 'tis not every Year that they grow to that Length, and 'tis always where the Plants are pretty ſingle. But there is no Year wherein One Ear of my hoed does not more than weigh Two of the ſown Ears, taking a whole Sheaf of each together without chooſing. The Sheaves of the hoed are of a different Shape from the other; almoſt all the Ears of the hoed are at the Top of the Sheaf; but moſt of the other are ſituate at the lower Part, or near the Middle of the Sheaf.

(*s*) Seed Cone wheat coming all out at the ſame Heap, planted all at the ſame Time, and on Land of the ſame Sort adjoining near together, the Wheat that was ſown produced Grains ſo ſmall, and from a Tenth Part of the Plants (*t*) that the ſowing Method can.

All

and that which was drilled ſo very large, that no Farmer or Wheat-buyer would believe them to be of the ſame Sort of Wheat, except thoſe who knew it, which were many. One Grain of the drilled weighed Two of the ſown, and there was twice the Chaff in an equal Weight of the ſown, being both weighed before and after the Wheat was ſeparated from the Chaff.

(*t*) The Fact of this nobody can doubt, who has obſerved the different Products of ſtrong and of weak Plants, how the one exceeds the other.

The greateſt Difference of having an equal Crop from a ſmall Number of ſtrong Plants, and from a great Number of weak ones, is, that the Soil is vaſtly leſs exhauſted by the former than by the latter, not only from the latter's exhauſting more in proportion to their Number when young, and whilſt each of them conſumes as much Nouriſhment as each of the ſmall Number; but alſo from the different Increaſe that a ſtrong Plant makes by receiving the ſame Proportion of Food with a weak one: For it appears from Dr. *Woodward*'s Experiments, that the Plant which receives the *leaſt* Increaſe carries off the *greateſt* Quantity of Nouriſhment in proportion to that Increaſe; and that 'tis the ſame with an Animal, all who are acquainted with fatting of Swine know; for they eat much more Food daily for the firſt Two Weeks of their being put into the Sty, than they do afterwards, when they thrive faſter; the fatter they grow, the leſs they eat.

Hence, I think, it may be inferred, that a Plant, which, by never having been robbed or ſtinted by other Plants, is ſtrong, receives a much greater Increaſe from an equal Quantity of Food, than a Number of weak Plants (as thick ones are), equalling the Bulk of the ſingle ſtrong Plant, do.

And this of the Doctor's have I ſeen by my own Obſervations confirmed in the Field in Potatoes, Turneps, Wheat, and Barley; a following Crop ſucceeds better after an equal Crop, conſiſting of a bare competent Number of ſtrong Plants, than after a Crop of thick weak ones, *cæteris paribus*.

Thus the hoed Crops, if well managed, conſiſting of fewer and ſtronger Plants than the ſown Crops of equal Produce, exhauſt the Ground leſs; whereby, and by the much (I had almoſt ſaid infinitely) greater Pulveration of the Soil, indifferent good Land may, for any thing I have yet ſeen to the contrary, produce profitable Crops always without Manure, or Change of *Species*, if the Soil be proper for it in reſpect of Heat and Moiſture; and alſo as Crops of ſome *Species*, by their living longer, by their

greater

All these Advantages will be lost by those Drillers, who do not overcome the unreasonnble Prejudices of the unexperienced, concerning the Width of Intervals.

In wide Intervals, we can raise a good Crop with less Labour, less Seed, no Dung, no Fallow, but not without a competent Quantity of Earth, which is the least expensive of any thing given to Corn; the Earth of a whole good Acre being but about the Tenth Part of the common Expence; and of indifferent Land, a Twentieth; and such I count that of Five Shillings and Six-pence *per* Acre.

The Crop enjoys all the Earth; for betwixt the last Hoeing, and the Harvest, there remains nothing but Space empty of Mould in the Middle of the Intervals.

'Tis an Objection, that great Part of those wide Intervals must be lost *(u)*, because the Wheat-roots do not

greater Bulk, or different Constitution, exhaust more than others, respect ought to be had to the Degree of Richness of the Soil, that is to produce each *Species*: The Sowing and the Hoeing Husbandry differ so much both in Pulveration and Exhaustion, that no good Argument can be drawn from the former against the latter: But tho' a too great Number of Plants be, upon many Accounts, very injurious to the Crop, yet 'tis best to have a competent Number; which yet needs not be so exact, but that we may expect a great Crop from Twenty, Forty, or Fifty Plants in a Yard of the treble Row, if well managed.

(*u*) They do reach through all the Mould (as shall be proved by-and-by); and yet may leave sufficient Pasture behind; because it is impossible for them to come into Contact with all the Mould in One Year; no more than when Ten Horses are put into an Hundred Acres of good Pasture, their Mouths come into Contact with all the Grass to eat it in one Summer, though they will go all over it, as the Vine-roots go all over the Soil of a Vineyard without exhausting it all; because those Roots feed only such a bare competent Quantity of Plants, which do not overstock their Pasture.

The Superficies of the fibrous Roots of a proper Number of Wheat-plants bear a very small Proportion to the Superficies of the fine Parts of the pulverized Earth they feed on in these Intervals; for one cubical Foot of this Earth may, as is shewn in *p.* 29.

nor reach it; but as we generally turn the Mould towards the Row at the laſt Hoeings, there is no Part of

p. 29. have many thouſand Feet of internal Superficies: But this is in proportion to the Degree of its Pulveration: and that Degree may be ſuch as is ſufficient to maintain a competent Number of Wheat-plants, without over-exhauſting the vegetable Paſture, but not ſufficient to maintain thoſe, and a great Stock of Weeds beſides, without over-exhauſting it. And this was plainly ſeen in a Field of Wheat drilled on *Six-feet* Ridges, when the South Ends of ſome of the Ridges, and the North Ends of others, had their Partitions Hand-hoed, and cleanſed of Weeds, early in the Spring, the oppoſite Ends remaining full of a ſmall *Species* of Weeds, called *Crow-needles,* which ſo exhauſted the whole Intervals of the weedy Part of the Ridges, that the next Year the whole Field being drilled again with Wheat exactly in the Middle of the laſt Intervals, the following Crop very plainly diſtinguiſhed how far each Ridge had its Partitions made clean of thoſe ſmall Weeds in the Spring, from the other End where the Weeds remained till full-grown; the Crop of the former was twice as good as that of the latter, even where both were cleanſed of Weeds the next *Spring.* This Crop ſtanding only upon that Part of the Mould, which was fartheſt from the Rows of the precedent Crop, proves that the Roots, both of the Wheat and Weeds, did enter all the Earth of the former Intervals.

It was alſo obſervable, that where the Partitions of Two of the Six-feet Ridges had been in the precedent Year cleanſed of Weeds, and thoſe of the adjoining Ridges on each Side of them not cleanſed, the Row that was the next Year planted exactly in the Middle of the Interval between thoſe two Ridges, was perceivably better than either of the Two Rows planted in the Intervals on the other Side of each of them: The Reaſon of which Difference muſt be, that the Midde of the Interval, that was between the Two cleanſed Ridges, was fed on by the Wheat only, and by no Weeds; but the other Two Intervals were fed on by the Wheat on one Side, and by both the Wheat and Weeds on the other Side of each.

There were, in the ſame Field, ſeveral Ridges together, that had the Ends of their Rows of Wheat plowed out by the Hoe-plough, and their other Ends cleanſed of Weeds: This was done on purpoſe, to ſee what Effect a Fallow would have on the next Crop, which was indeed extraordinary; for theſe fallowed Ends of the Ridges, being Horſe-hoed in the Summer, as the other Ends were, and the Intervals of them made into Ridges, the following Year produced the largeſt Crop of all; this Crop was received in 1734.

Theſe

of it above Two Feet diſtant from even the middle Row, and Seventeen Inches from either of the outſide Rows.

And I have plainly proved, that the Roots of Cone-wheat have reached Mould at Two Feet Diſtance, after paſſing through another Row at a Foot Diſtance from it, the Plants being then but Eighteen Inches high, and but half-grown.

Farmers do not grudge to beſtow Three or Four Pounds in the Buying and Carriage of Dung for an Acre; but think themſelves undone, if they afford an extraordinary Eighteen-penyworth of Earth to the wide Intervals of an Acre; not conſidering that Earth is not only the beſt, but alſo the cheapeſt Entertain-

Theſe ſeveral different Managements performed in this Field, ſhewed by the different Succeſs of the Crops in each Sort, what ought to be done, and which is the beſt Sort of Management.

This Field indeed is ſome of my beſt Land; and by all the Experiments I have ſeen on it, I do not find but that, by the beſt Management, never omitted in any Year, it might produce good annual Crops of Wheat always, without Aſſiſtance of Dung or Fallow; but it would be very difficult for me to get Hands to do this to the greateſt Perfection, unleſs I were able conſtantly to attend them.

The whole pulverized Earth of the Interval being pretty equally fed on by the former Crop, 'tis no great Matter in what Part of it the following Crop is drill'd: I never drill it but on the Middle of the laſt Year's Interval, becauſe there is the Trench whereon the next Year's Ridge is made with the greateſt Conveniency: But there may be ſome Reaſon to ſuſpect, that the Plants of the Rows exhauſt more Houriſhment from that Earth of the Intervals which is fartheſt from their Bodies, than from that which is neareſt to them: Since their fibrous Roots, at the greateſt Diſtance from the Rows, are moſt numerous, *&c.* by theſe the Plants, when they are at their greateſt Bulk, are chiefly maintained.

It muſt be *noted*, that the above Experiments would not have been a full Proof, if Weeds had been ſuffered to grow in the Partitions of the Ends of thoſe Ridges, in the Year wherein the Difference appeared. It may alſo be *noted*, that a Mixture and Variety of bad Huſbandry are uſeful for a Diſcovery of the *Theory* and *Practice* of good Huſbandry.

ment that can be given to Plants; for at Five Shillings and Six-pence Rent, the whole Earth belonging to each of our Rows cofts only Six-pence, *i. e.* a Peny for a Foot broad, and Six hundred and Sixty Feet long; that being the Sixty-fixth Part of an Acre (*x*).

And if for conftant annual Wheat-crops you make fewer than Eleven Rows on Four Perches Breadth, you will always increafe the Expence of Hoeing; becaufe then Two Furrows will not Hoe One of thofe Intervals, and you will alfo thereby leffen the Crops, but improve the Land more: And if you increafe that Number of Rows, you will thereby increafe every Expence; for there muft be Two Furrows to hoe a narrow Interval, and an Increafe of the Quantity of Seed, and the Labour in uncovering, weeding, and reaping; and alfo you will lefs improve the Land, and leffen the Crops after the Firft Year.

If the Intervals are narrower in deep Land, tho' there might be Mould enough in them, yet there would not be Room to pulverize it.

If narrower in fhallow Land, tho' there were Room, yet there would not be Mould enough in them to be pulverized.

The Horfe-hoe, well applied, doth fupply the Ufe of Dung and Fallow; but it cannot fupply the Ufe of Earth, tho' it can infinitely increafe the vegetable Pafture of it, by pulverizing it, where it is in a reafonable Quantity: Yet if the Intervals be fo narrow, that near all the Earth of them goes to make the Partitions raifed at the Top of the Ridges, there will be fo little to be pulverized, that you muft return to Fallowing,

(*x*) But the Vulgar compute this Expence of a Foot Breadth of Ground, not only as of the Rent, as they ought, but as an Eleventh Part of their own ufual Charges added to the Rent.

And there is Land enough in *England* to be had, at the Rent of Five Shillings and Six-pence the Acre, that is very proper for Wheat in the Hoeing-Hufbandry.

and

and to the Dung-cart, and to all the old exorbitant Charges (*y*).

Eight Acres, Part of a Ground of Twenty Acres, drilled with Intervals of Three Feet and an half, brought a good Crop; but the Second Year, not being hoed, the Crop was poor; and the Third Crop made that Land so foul and turfy, that 'twas forced to lie for a Fallow, there being no way to bring it into Tilth without a Summer-plowing (*z*), when the rest of the same Piece, in wider Intervals, being constantly hoed, continued in good Tilth, and never failed to yield a good Crop, without missing one Year.

In another Field, there is now a Sixth Crop of Wheat, in wide Intervals, very promising, tho' this Ground has had no sort of Dung to any of these Crops, or in several Years before them: The last Year's Crop was the Fifth, and was the best of the Five, tho' a Yard of the Row yielded but Eighteen Ounces and Three Quarters; and the Third Crop yielded Twenty Ounces Weight (*a*) of clean Wheat in

(*y*) The Objections against these wide Intervals are only for saving a Penyworth or Two of Earth in each Row, or a few Groats-worth of it in an Acre; by saving of which Earth they may lose, in the present and succeeding Crops, more Pounds.

(*z*) This Narrownefs of the Intervals, if the Damage of it be rightly computed, would amount to half the Inheritance of the Land; and was occasioned by the Wilfulness of my Bailiff, who, drilling it upon the Level, ordered the Horse to be guided half a Yard within the Mark, because he fansied the Intervals would be too wide, if he followed my Directions.

(*a*) Wheat, before Harvest, standing in Rows with wide Intervals betwixt them, may not seem, to the Eye, to equal a Crop of half the Bigness dispersed all over the Land, when sown in the common Manner; and yet there is more Deceit in the Appearance of those different Crops, whilst they are young, and in Grass: We should therefore not judge of them then by our Imagination, but as we do of the Sun and Moon nigh the Horizon, *viz.* by our Reason.

Imain the ſame Spot; but 'twas becauſe the Spot where the Twenty grew, was then a little higher than the reſt, which in Two Years became more equal; and the thin Land was more deficient in that Third Crop, than the thick Land exceeded the thin in the Fifth Crop.

In the thick the Hoe-plough went deeper, and conſequently raiſed more Paſture there; but then it went the ſhallower in the thin; and when the Land became of a more equal Depth the Fifth Year, the Plough and the Hoe-plough went deeper, all the Piece being taken together; for the Crop could be but in proportion to the different Paſture, allowing ſomewhat for the more or leſs Seaſonableneſs of the Year.

The Soil, in this our Caſe, cannot be ſupplied in Subſtance, but from the Atmoſphere. The Earth which the Rain brings can do it alone, if it fall in great Quantity; for by Water, 'tis plain, the Earth which nouriſhed *Helmont*'s Tree was ſupplied; for the Tin-cover of the Box wherein it ſtood, prevented the Dews from entering.

Dews muſt add very much to the Land, thus continually tilled and hoed; for they are more heavily charged with terreſtrial Matter than Rain is, which appears from their forcing a Deſcent through the Air, when 'tis ſtrong enough to buoy up the Clouds from falling into Rain: And Dew, when kept in a Veſſel long enough to putrefy, leaves a greater Quantity of black Matter at the Bottom of the

Imagination often deceives us by Arguments falſe or precarious; but Reaſon leads us to Demonſtration, by Weights and Meaſures: Yet this Prejudice will vaniſh at Harveſt before weighing; for then all thoſe wide Intervals that were bare, will be covered with large Ears interfering to hide them quite, and make a finer Appearance than a ſown Crop. But 'tis obſerved, that the Conewheat makes the fineſt Shew, when you look on it length ways of the Rows, both at Harveſt, and a conſiderable time before Harveſt.

Veſſel, than Rain-water does in a Veſſel of the ſame Bigneſs, filled with it till putrefied.

Dews at Land, I ſuppoſe, are firſt exhaled from Rivers, and moiſt Lands, and from the Expirations of Vegetables; moſt of the Dew which falls on it is exhaled from untilled Land; but moſt of that which falls on well tilled or well hoed Land, remains therein unexhaled; ſo that the untilled Ground helps, by that means, to enrich and augment the tilled: For if an Acre be tilled for Two Years together without ſowing, it will become richer by that Tillage, than by lying unplowed Four Years, which may be eaſily proved by Experience (*b*).

But then, as to Rain, the Sea being larger than all the Land (and its Waters, by their Motion, becoming replete with terreſtrial Matter), 'tis not unlikely, that more Vapour is raiſed from One Acre of Sea, than from One hundred Acres of Land.

Some have been ſo curious as to compute the Quantity of Rain, that falls yearly in ſome Places in *England*, by a Contrivance of a Veſſel to receive it; and 'tis found, in one of the drieſt Places, far from the Sea, to be Fourteen Inches deep, in the Compaſs of a Year; in ſome Places much more; *viz.* at *Paris*, Nineteen Inches; in *Lancaſhire*, Mr. *Townley* found, by a long-continued Series of Obſervations, that there falls above Forty Inches of Water in a Year's time.

Could we as eaſily compute the true Quantity of Earth in Rain-water, as the Quantity of Water is computed, we might perhaps find it to anſwer the Quantity of Earth taken off from our hoed Soil annually by the Wheat.

But if Land ſown with Wheat be not hoed, its Surface is ſoon incruſtate; and then much of this Water, with its Contents, runs off, and returns to

(*b*) *Non igitur Fatigatione, quemadmodum plurimi crediderunt,* nec Senio, *ſed noſtra ſcilicet* Inertia, *minus benigne nobis Arva reſpondent.* Colum. *lib.* xi. *cap.* 1.

the

the Sea, without entering the Ground; and in Summer a great deal of what remains is exhaled by the Sun, and raiſed by the Wind, both in Summer and Winter.

Some there are who think it a fatal Objection, that the more an Interval is hoed, the more Weeds will grow in it; and that the Hoe can produce, or (as they ſay) breed in it as many Weeds in one Summer, as would have come thereon in Ten Years by the old Huſbandry. But by this Objection they only maintain, that the Hoe can deſtroy as many Weeds in One Summer, as the old Huſbandry can in Ten Years.

And they might add, that ſince all Weeds that grow where the Hoe comes, are killed before they ſeed, and that few of thoſe which grow in the old Huſbandry, are killed (*c*) before their Seed be ripe and ſhed; theſe Objectors will be forced to allow, that our Huſbandry will leſſen a Stock of Weeds more in one Summer, than theirs can do to the World's End; unleſs they believe the equivocal Generation of Weeds, than which Opinion nothing can be more abſurd.

Some object againſt my Method of (*d*) weighing a Yard, or a Perch in Length of a Row, ſaying, this does not determine the Produce of a whole Field.

I an-

(*c*) Weeds cannot be killed before they grow, but will lie dormant, as they do in our Partitions, and in their ſown Land; and while Seeds are in the Ground, they are always ready to grow at the firſt Opportunity, and will certainly break out at one time or other; ſo that preventing their coming, is only like healing up a Wound before it be cured.

(*d*) I did not weigh this Yard, as different from the other Yards round about it, for I had much Difficulty to determine which Row I ſhould chuſe it in; when I was going to cut in one Row, it ſtill ſeemed that another was better, and I queſtion whether I did chuſe the beſt at laſt.

Note, Whereas I often mention the Wheat of this Field to be without Dung or Fallow, it muſt be underſtood of that Part of the Field wherein my *Weighings* and other Trials were made:

 becauſe

I anſwer, that they judge right, if the Produce of the whole Field be not of equal Goodneſs; but if it be not, it muſt be becauſe one Part of the Field is richer, or differently managed from the other Part: For the ſame Cauſes that produce Twenty Ounces of clean Wheat upon one Yard, muſt produce the ſame Quantity upon every Yard, of a Million of Acres.

When the Crop of half a Field is ſpoiled by Sheep, not hoed at all, or improperly, it would be ridiculous to compute the whole Field together for an Experiment: We might indeed weigh the pooreſt, to prove the Difference of the one from the other, to try (as they ſometimes ſeem to do) how poor a Crop we can raiſe; but my Deſign was, to try how good a Crop I could raiſe with a Tenth Part of the common Expence.

And I have often weighed the Produce of the ſame Quantity of Ground *(e)*, of all Sorts of ſown Wheat, both the beſt and the worſt; but never have found any of the ſown equal to the beſt of my drilled. Indeed we have none of the richeſt Land *(f)* in our

becauſe there was a ſmall Part once fallowed Eight or Nine Years ago, and a little Dung laid on another Part about the laſt *Michaelmas*, after the Crop of Oats was taken off. But this being a Year in which Dung is obſerved to have little or no Effect on *ſown* Wheat (my Dung being weak and laid thin), 'tis the ſame here; for thoſe Rows which are in the dunged Part, can hardly be diſtinguiſhed from the reſt of the Rows which had not been dunged: And yet the Ends of the Rows which were cleanſed of Weeds, are very diſtinguiſhable by the Colour of the Wheat, though ſome are the Third, and ſome the Fourth Crop ſince the Difference was made; and the *whole* Rows managed alike every Year, from that time to this; ſo that *here* Un-exhauſtion is more effectual than Dung. This is certain, that neither Dung nor Fallow hath been near the Part wherein my Experiments were made.

(*e*) I allow Two ſquare Yards of their Crops to One Yard in Length of my Treble Row.

(f) I am ſorry that this Farm, whereon I have practiſed Horſe-hoeing, being ſituate on an Hill, that conſiſts of Chalk on one Side, and Heath ground on the other, has been uſually noted for the pooreſt and ſhalloweſt Soil in the Neighbourhood.

Country

Country within my Reach, that being not above One Mile.

As a Yard in Length of my treble Row of the Third fucceffive Crop of Wheat, without Dung or Fallow, produced Twenty Ounces of Wheat; which, allowing Six Feet to the Ridge, is about Six Quarters (*a*) to an Acre; and, allowing Seven Inches to each Partition, and Two Inches on each Outfide, is in all Eighteen Inches of Ground to each treble Row, and but juft One-fourth Part of the Ridge. Now, if, in the old Hufbandry, the Crop was as good all over the Ground, as it was in thefe Eighteen Inches of the treble Row, they muft have Twenty-four Quarters to an Acre; but let them dung whilft they can, they will fcarce raife Twenty-four Gallons of Wheat the Third Year, on an Acre of Land of equal Goodnefs; and let them leave out their Dung, and add no more Tillage in lieu of it, and I believe they will not expect Three Quarters to an Acre, in all the Three Years put together.

The mean Price of Wheat, betwixt Dear and Cheap, is reckoned Five Shillings a Bufhel (*b*); and there-

(*a*) Eight Bufhels make a Quarter.

(*b*) 'Tis commonly faid, that a Farmer cannot thrive, who for want of Money is obliged to fell his Wheat under Five Shillings a Bufhel; but if he will fell it dear, he muft keep it when 'tis cheap: And his Way of keeping it is in the Straw, ufing his beft Contrivances to preferve it from the Mice.

The moft fecure Way of keeping a great Quantity of Wheat, that ever I heard of, is by drying it. When I lived in *Oxfordfhire*, one of my neareft Neighbours was very expert in this, having practifed it for great Part of his Life: When Wheat was under Three Shillings a Bufhel, he bought in the Markets as much of the middle Sort of Wheat as his Money would reach to purchafe: He has often told me, that his Method was to dry it upon an Hair-cloth, in a Malt-kiln, with no other Fuel than clean Wheat-Straw; never fuffering it to have any ftronger Heat than that of the Sun. The longeft time he ever let it remain in this Heat was Twelve Hours, and the fhorteft time about Four Hours; the damper the Wheat was, and the longer intended to be kept,

 the

therefore an Acre that would produce every Year, without any Expence, Eight Buſhels, would be thought

the more Drying it requires: But how to diſtinguiſh nicely the Degrees of Dampneſs, and the Number of Hours proper for its Continuance upon the Kiln, he ſaid was an Art impoſſible to be learned by any other Means than by Practice. About Three or Four and Twenty Years ago, Wheat being at Twelve Shillings a Buſhel, he had in his Granaries, as I was informed, Five thouſand Quarters of dried Wheat; none of which coſt him above Three Shillings a Buſhel.

This dried Wheat was eſteemed by the *London* Bakers to work better than any new Wheat that the Markets afforded. His Speculation, which put him upon this Project, was, that 'twas only the ſuperfluous Moiſture of the Grain that cauſed its Corruption, and made it liable to be eaten by the Wevil; and that when this Moiſture was dried out, it might be kept ſweet and good for many Years; and that the Effect of all Heat of the ſame Degree was the ſame, whether of the Straw, or of the Sun.

As a Proof, he would ſhew, that every Grain of his Wheat would grow after being kept Seven Years.

He was a moſt ſincere honeſt Yeoman, who from a ſmall Subſtance he began with, left behind him about Forty thouſand Pounds; the greateſt Part whereof was acquired by this Drying Method.

For the Hand-hoeing they uſe Hoes of Four Inches Breadth, very thin, and well ſteeled: Their Thinneſs keeps them from wearing to a thick Edge, and prevents the Neceſſity of often grinding them. Such Hoes are in Uſe with ſome Gardeners near *London*. They need not be afraid of drawing theſe little Hoes acroſs the Rows of young Wheat to take out the few Weeds that come therein at the early Hoeing; for whilſt the Wheat-plants are ſmall, it may be an Advantage to cut out ſome of the weakeſt, as they do of Turneps; for I perceive there are oftener too many Plants than too few. But the thing that cauſes the greateſt Trouble in cleanſing the Rows, is when the Seed is foul (*i. e.* full of Seeds of Weeds): Therefore I cleanſe my Seed-wheat by drawing it on a Cloth on a Table, which makes it perfectly clean.

This Hand-hoeing ſhould be performed about the End of *March*, or Beginning of *April*, before the Wheat is ſpindled (*i. e.* run up to Stalks); and if the Weather be dry enough, you may go lengthways of the Ridges with a very light Roller to break the Clods of the Partitions, whereby the Hoe will work the better.

If there ſhould afterwards more Weeds come up, they muſt not be ſuffered to ripen; and then the Soil will be every Year freer from Weeds.

This

thought an extraordinary profitable Acre; but yet a drilled Acre, that produces Sixteen Bushels of Wheat,

This Hand-hoeing of the Rows should be done at the proper time, though it happen, by late Planting, that the Horse-hoe has not gone before it; for it may be, that the Weather has kept out the Horse-hoe: and the Earth may not be dry deep enough in the Intervals for the Hoe-plough, but deep enough in the Partitions for the Hand-hoe.

And the Expence of this Hand-work on the Rows would be well answered, though there should not be one Weed in them; and so it would be, if a second Hand hoeing were bestowed on the Partitions of every Crop of Wheat not suspected of being too luxuriant.

If after the last Horse-hoeing there should be Occasion for another Hoeing of the Intervals, where the Narrowness of them, and the Leaning of tall Wheat, make it difficult or dangerous to be performed by the Hoe-plough; a slight shallow Hoeing may be performed therein by the Hand-hoe with Ease and Safety, at a very small Expence, which would be more than doubly repaid in the following Crops.

IF any one doubts of the Efficacy of thus managing Wheat, it can't cost much to make proper Trials. But then Care must be taken, that the Trials be proper. I do not advise any one to be at the Expence of my Instruments for that Purpose, but to imitate them in pulverizing, and all other directed Operations by the Spade and common Hoes. His Ridges of Experiment need be no longer than Six Feet. Instead of a Drill, make use of a triangular Piece of Wood, Seven Feet long, and Four or Five Inches thick, with one Edge of which make Channels, and place the Seed regularly even into them by Hand, and cover it with the same Piece of Wood; but if the Earth be so wet, as to cling to the Piece, then make use of it only as a Ruler, whereby to make the Channels strait with a Stick.

Let some of the Ridges have double Rows, others treble; and let some have treble Rows half-way, and leave out the middle Row in the other Half, to shew whether the double Row or the treble Row produce a better Crop.

Then for the First time of Hoeing, the Spade must work with its Back towards the Row. The Second time, in turning the Earth to the Row, the Spade's Face must be towards it. These Two, and several other Hoeings should be deep; but when the Roots are large (and the Hoeing is near the Plants), the Spade must go shallow; and neither the Face nor the Back of it must

Wheat, with the Expence of Ten or Fifteen Shillings, is above a Third Part more profitable.

I don't

be towards the Row, except when the Earth is turned towards it; and then the Face muſt be always towards it; but for the reſt of the laſt Hoeings, the Spade ſhould work with its Face towards one or other of the Ends of the Intervals, that the fewer of the Roots may be cut off, and the more of them removed, and covered again. Let the Spits be thin for the better pulverizing of the Mould. The Hand-hoe will ſometimes be uſeful in the Intervals, as well as in the Partitions.

Four or Five Perches of Land may ſuffice for making proper Trials.

The Expence of this will be little, though perhaps Ten times more than that which is done by the proper Inſtruments for the ſame Proportion of Land.

But I muſt give this Caution, that no Part of it be done out of the Reach of the Maſter's Eye; for if it ſhould, he may expect to be diſappointed.

The richer the Land, the thinner it muſt be planted to prevent the lodging of Corn.

The Maſter ought to compute the Quantity of Seed, due to each Perch, at the Rate of Five or Six Gallons to an Acre, by Weighing, *&c.* as I have ſhewn in my Eſſay.

I cannot commend more than Two Partitions in a Row, or more than One, when the Intervals are narrow; becauſe the broader the Row is, the more Earth will remain unpulverized, under the Partitions; too much of which Earth being whole, will diſappoint, at leaſt, one of the Differences mentioned in my xviith Chapter.

Indifferent Land I think moſt proper whereon to make the Experiment, and the moſt improper for Corn is barren Land, as the beſt brings the largeſt Crops.

To aſcertain the Quantity of the Crop, take a Yard in the Middle of a Ridge, and weigh its Produce.

Every Year leave one Interval unhoed, to prove the Difference of that Side of a double or treble Row next to it, from the other Side next to the hoed Interval.

But it muſt be *noted*, that the Spade doth not always pulverize ſo much as the Plough, or Hoe plough; therefore there may be occaſion for more Diggings than there would be of Horſe-hoeings.

One of the Obſervations that put me upon Trials of wide Intervals, and Horſe work for Corn, was the following; *viz.* One Half of a pooriſh Field was ſown with Barley; the other Half drilled with Turneps, the Rows Thirty Inches aſunder, at the proper Seaſon, and twice hoed with a Sort of Horſe-hoe contrived

trived for that Purpose (but nothing like that I have described); the Drill, beginning next to the Barley, left an Interval of the same (30 Inches) Breadth between the First Row of Turneps and the Barley, which, being sown on large Furrows, came up in a sort of Rows, as is common for Barley to come when sown on such wide Furrows. This Interval between the Barley and the Turneps had the same Hoeings as the rest, and had this Effect on the broad Row of Barley next to it; *viz.* Each Plant had many Stalks; it was of a very deep flourishing Colour, grew high, the Ears very long, and, in all respects, the Barley was as good as if it had been produced by the richest Land. The next Row of Barley had some little Benefit on the Side next to the strong Row; but all the rest of the Barley, either by the too late Sowing of it, the Poverty of the Soil (not being in any manner dunged), or else by the Coldness of the Land, or Coldness of the Summer, or by all of these Causes, though pretty free from Weeds, was exceeding poor, yellow, low, thin, and the Ears were very short and small

I intended to have taken the exact Difference there was between the Produce of this outside Row, and one of those that stood out of the Reach of the hoed Interval: But I was disappointed by my Neighbour's Herd of Cows, that in the Night broke in just before Harvest, and eat off almost all the Ears of the rich Row, doing very little Damage to the rest, except by treading it. It must be from the different Tastes, the one being sweet, and the other bitter, that they make their Election to eat the one, and refuse the other.

This accidental Observation was sufficient to demonstrate the Efficacy of deep Hoeing, which I look upon as synonymous to Horse-hoeing.

I immediately set about contriving my limbered Hoe, finding all other Sorts insufficient for the Exactness required in this hoeing Operation: Those drawn in any other manner, when they went too far from the Row, and the Holder went to lift the Plough nearer, it would fly back again, like the Sally of a Bell, and go at no Certainty not being subject to the Guidance of the Holder, as the limber Hoe-plough is. The *Michaelmas* following I began my present Horse-hoeing Scheme; which has never yet deceived my Expectations, when performed according to the Directions I have given my Readers. And the Practice of this Scheme proves the Advantage of deep Hoeing, by the Ends of the Ridges and Intervals; for there, whilst the drawing Cattle go on the Headland that is higher, the Furrows are shallower, and the Corn of the Rows is always there visibly poorer in proportion to that Shallowness.

Another Proof of the Difference there is between deep Hoeing and shallow, is in the Garden, where a square Perch of Cabbages, the Rows of which are Three Feet asunder; the middle Row of them having the Intervals on each Side of it deeply and well dug by the Spade at the ſame proper time, when the reſt of the Intervals are Hand-hoed; this middle Row will ſhew the Difference of thoſe Two Operations: But in this muſt be obſerved what I have here before-mentioned, of turning the Back of the Spade to the Plants, to avoid the total removing them, eſpecially in very dry Weather.

This Experiment hath been tried, and always ſucceeds with every one that has made the Trials.

But before any one makes his Trials of my Field-ſcheme, I would adviſe him to be Maſter of the Treatiſe, by making an *Index* himſelf to it: This will both direct him in his Proceedings, and ſhew him the Raſhneſs of thoſe, who go into the Practice of my Huſbandry, without the neceſſary Preparation; for they that do ſo now, ſeem to act as raſhly, as they that went into it before the Treatiſe was publiſhed. 'Tis reaſonable to preſume, that ſuch their Practice muſt be either different from, or contrary to mine.

This *Index* may be alſo uſeful for diſcovering Pretenders by an Examination, without which, Gentlemen are liable to be impoſed on by them, as I am afraid too many have been; for amongſt all thoſe who have undertaken the Management of my Scheme for Noblemen, or others, I declare I do do not know one Perſon that ſufficiently underſtands it: There may be ſome who have ſeen, or perhaps performed, ſome of the mechanical Part; but I don't think it can be properly performed without a thorough Knowlege of the Principles, which cannot be expected of ſuch illiterate Perſons; and yet is neceſſary for the proper Applications in different Caſes, which cannot be diſtinguiſhed by Pretenders: Therefore, until the Scheme becomes common, the Management muſt be under the Direction of the Maſter himſelf, or of one who has paſt his Examination, and is faithful.

To the above Trials, I here add the following, together with ſome Alterations of the former.

Gentlemen who can get the *Smyrna* Wheat, I adviſe to make Trials of it in ſingle Rows, of between 17 and 18 to an Acre, in this Method; there being no Partitions, the Intervals will be of the ſame Width as in the Ridges of 14 to an Acre, that have Partitions of Ten Inches. Thus almoſt all the Earth of the Ridges may be pulverized by the Hoe-plough in the Field, or by the Spade in this Trial; and very little Hand-work will be neceſſary for cleanſing out the Weeds that come in the Rows, and on each ſide of them. The Land will be the fitter for a ſucceeding Crop of Wheat with leſs Harrowing. But this muſt be obſerved, that, in regard to hard Froſts in Winter, and very dry Weather in Summer, the alternate Hoeing deſcribed in the Chapter of Turneps may be proper; leſt the little Earth that may be left for the Row to ſtand on, when the Furrows are turned from both Sides

of

of it, ſhould not be ſufficient to ſecure the Roots from the Injuries that may happen to them by being expoſed either to Froſt or Drought on both Sides of the Row at the ſame time.

In the Field, when the Ridges are all of an equal Breadth, the beſt Way is to plant Two of the ſingle Rows at once, by ſetting the Two Beams of the Drill at the ſame Diſtance aſunder, as each of the Ridges is broad; and the Beaſt that draws it muſt go in the Middle of the Interval, planting a Row on each Side of it; but if the Ridges are very unequal, the Beaſt (a little Horſe is beſt) that draws the Drill muſt go on the Top of a Ridge, planting one Row thereon; and the Drill for this Purpoſe is the ſame as the Turnep-drill, except that the Beam-ſhare, Seed-box, and Spindle, are the ſame as thoſe of the Wheat-drill; and 'tis but to take off from the Wheat-drill one of its Beams, and place it in the room of the Beam of the Turnep-drill, and placing the Croſs-piece of the Turnep-beam (ſee Plate 5.) on this Beam, and alſo a ſhort Wheat-hopper to be drawn by the Turnep-ſtandards, ſetting the Wheels near enough together; *i. e.* as near as the Wheels of the Wheat-drill are, I mean thoſe which plant Two Rows.

Two Gallons of *Smyrna* Wheat I judge will be Seed ſufficient for an Acre, eſpecially if planted early.

Planting one Row upon a Ridge, I think is the moſt advantageous Method of all; but, not being able to get any *Smyrna* Wheat (tho' I have been often promiſed it), I have made no Trial of it; and I do not believe the Plants of any other Sort of Wheat are large enough for ſuch ſingle Rows.

I am not quite a Stranger to this Wheat; for I have ſeen the Product of it, both in the Garden, and in the Field, above Forty Years ago.

I am now making Trials, in order to know how much a ſingle Row of White-cone Wheat will exceed half a double one: For this Purpoſe, I cauſe one Row of the double, with the Partition, to be dug out with a Spade, in Part of every Field, Two or Three Yards in a Place: Theſe I intend ſhall be hoed as the double Rows are; and where the Hoe-plough doth not reach, the Spade ſhall ſupply its Uſe.

I do not expect this ſingle Row will equal the double Row; but I am in no doubt but that it will produce more Grain than half a double Row.

I cannot tell whether the Sort of Cone-wheat that ſends out little Branches on each Side of the Ear, might not ſucceed tolerably well in ſingle Rows; for its Ear is, when well nouriſhed, larger than the Ear of the White-cone; tho' not near ſo large as that of the *Smyrna*.

Another Experiment I propoſe to be made as a Trial for the Satisfaction of ſuch ſceptical Gentlemen who may doubt the Truth

I don't know that I ever had an Acre yet, that was tolerably well managed in this Manner, but what produced much more.

CHAP.

Truth of what I have related in p. 27, 28. concerning the wonderful Effect of deep Hoeing. In a Field of very poor old decayed St. Foin, let Two or Three Perches be hedged in, in a square Piece, and Two, Three, or more Intervals, of Three or Four Feet wide each, be well pulverized by the Spade, leaving between every Two of them, Two or Three Feet of the St. Foin unmoved. Begin this Work in Summer, and repeat the Hoeing pretty often, observing the Rules I have laid down for Hoeing the Intervals of Wheat. Let not the Back of the Spade be turned towards the unmoved St. Foin, from which it throws the Earth at the First time of Hoeing; which is contrary to the First Hoeing of Wheat with a Spade; because there would otherwise be Danger of moving Wheat-roots; but there is no Danger of moving the St. Foin Roots, unless you wholly dig them out: Therefore the best Way for this Hoeing is to dig with the Back of the Spade towards one or the other End of the Interval: This cuts off the fewest Roots, and covers the most of them, and may perhaps be sometimes best for Wheat also. When the Earth is turned towards the St. Foin Rows, the Spade's Face will be towards them of course.

Be sure to leave Four or more Feet untouched next to the Hedge that bounds the Piece, to the End that the Increase of the hoed St. Foin may the more plainly appear by comparing its Plants with those that are not hoed.

If the Plants are very thick, make them thinner on one side of an Interval; and, on the other side, let them remain thick. You will certainly find the thin Plants most wonderfully increased in a Year or two, and the thick ones in proportion; and also the natural Grass, and all other Vegetables that grow near to the Intervals when they are well pulverized. I am confident mine, thus managed by Ploughs, increased some to an Hundred, some to a Thousand times the Size they were of before that Pulveration.

All the Methods I have here and elsewhere described for the Field, I advise to be tried in these few Perches for Experiments.

I think some of those Ridges whereon one End is to be managed differently from the other End, should be longer than Six Feet; else the Roots of the Wheat and Weeds may so mix, and draw Nourishment from one another in the Middle of the Ridge, that the Difference of the Managements may not so plainly be seen as when the Ridge is longer.

The few Perches of Land whereon any of the proposed Experiments are to be made, should be bounded in with dead Hedges;

and

CHAP. X.

Of SMUTTINESS.

SMUTTINESS is when the Grains of Wheat inftead of Flour, are full of a black, ftinking Powder: 'Tis a Difeafe of Wheat, which I don't know is ufual any-where but in cold Northern Countries; for if it had been common in *Greece* or *Italy*, there would probably have been fome Word to exprefs it by, in thofe Languages, as well as there is for the Blight.

I take it to be caufed by cold wet Summers; and I was confirmed in this by feveral Plants of Wheat, taken up when they were in Grafs in the Spring, and placed in Troughs in my Chamber-window, with fome of the Roots in Water. Thefe Wheat-plants fent up feveral Ears each; but at Harveft, every Grain was fmutty; and I obferved, none of the Ears ever fent out any Bloffom: This Smuttinefs could not be from any Moifture that defcended upon it, but from the Earth, which always kept very moift, as in the aforefaid Mint Experiment. The Wheat-plants in the Field, from whence thefe were taken, brought very few fmutty Grains, but brought much larger Ears than thefe.

Whatfoever the Caufe *(d)* be, there are but Two Remedies propofed; and thofe are Brining, and Change of Seed.

Brining of Wheat, to cure or prevent Smuttinefs (as I have been credibly informed), was accidentally

and fhould not be fituate within Three or Four Poles of a live Hedge or Tree.

The Three Inftruments to be ufed in thefe unexpenfive Trials, are, the Spade, to fupply the Ufe of the Plough and Hoe plough; the Hand-hoe; and a Rake, inftead of Harrows.

(d) The largeft grained, plump, fat Wheat, is more liable to Smuttinefs, than fmall-grained thin Wheat.

difcovered about Seventy Years ago, in the following Manner; *viz.* A Ship-load of Wheat was funk near *Briftol* in Autumn, and afterwards at Ebbs all taken up, after it had been foaked in Sea-water; but it being unfit for making of Bread, a Farmer fowed fome of it in a Field; and when it was found to grow very well, the whole Cargo was bought at a low Price by many Farmers, and all of it fown in different Places. At the following Harveft, all the Wheat in *England* happened to be fmutty, except the Produce of this brined Seed, and that was all clean from Smuttinefs. This Accident has been fufficient to juftify the Practice of Brining ever fince in all the adjacent Parts, and in moft Places in *England.*

I knew Two Farmers, whofe Farms lay intermixed; they bought the fame Seed together, from a very good Change of Land, and parted every Load betwixt them in the Field. The oldeft Farmer believed Brining to be but a Fancy, and fowed his Seed unbrined; the other brined all his Part of Seed, and had not a fmutty Ear in his Crop; but the old Farmer's Crop was very fmutty.

Wheat for Drilling muft have no other Brine, than what is made of pure Salt; for if there be any Brine of Meat amongft it (*e*), the Greafe will not fuffer the Wheat to be dry enough to be drilled.

If Seed-wheat be foaked in Urine, it will not grow; or if only fprinkled with it, it will moft of it die, unlefs planted prefently.

The moft expeditious Way of brining Wheat for the Drill, is to make a very ftrong Brine; and when the Wheat is laid on an Heap, fprinkle or lave it therewith; then turn it with a Shovel, and lave on more Brine; turn it again with a Shovel, until, by many Repetitions of this, the Wheat be all equally

(*e*) Urine alfo makes the Wheat fo greafy, that it will not be dry time enough to be drilled.

wet.

wet. Next, ſift on Quick-lime through a Sieve; turn the Wheat with a Shovel, and ſift on more Lime; repeat this Sifting and Turning many times, which will make it dry enough to be drilled immediately; and this has been found ſufficient to preſerve uninfected Wheat from the Smut in a bad Year, the Seed being changed.

To dry it, we uſe *(f)* Quick-lime (that is, unſlacked), which, beaten to Powder, and ſifted thereon, confines the Brine to the Surfaces of the Grains, and ſuffers none of it to be exhaled by the Air: But when Lime has been long ſlacked, and is grown weak, 'tis unfit for this Purpoſe.

Smutty Seed-wheat, tho' brined, will produce a ſmutty Crop, unleſs the Year prove very favourable.

For 'tis to be known, that favourable Years will cure the Smut, as unkind ones will cauſe it: Elſe, before Brining was uſed, and the bad Years had cauſed all the Wheat in *England* to be ſmutty, they muſt have brought their Seed from Foreign Countries, or never have had any clean Wheat: Therefore 'tis certain, that kind Years will cure the Smut: 'Tis therefore to prevent the Injury of a bad Year, that we plant clean Seed, and well brined.

But of the Two Remedies againſt Smuttineſs, a proper Change of Seed ſome think the moſt certain.

A very worthy Gentleman aſſures me, that ſince he has found out a Place that affords a Change of Seed proper to his Land, which is for theſe Ten Years

(f) But if this doth not afford Powder enough, the Pieces muſt be ſlacked immediately before uſing; for if the Lime lie long after it is ſlacked (eſpecially that made of Chalk), it will become weak, and loſe moſt of its drying Quality.

Some Farmers uſe only to boil the ſtrongeſt Quick-lime in Water, with which, inſtead of Brine, they ſprinkle their Wheat, affirming it to be as effectual as that for preventing the Smut: But this not being within the Compaſs of my own Experience, I am doubtful of it; yet I wiſh it may be found effectual, becauſe it would ſave Trouble to the Sower, and more to the Driller.

Years paſt, he never had a Smutty Ear in any of his Crops (and he never brines nor limes it), tho' all other Wheat have been often ſmutty throughout his Neighbourhood every wet Year, tho' brined and limed. He ſays, the Perſon who furniſhes him with this Seed, is very curious in changing his Seed alſo every Year.

This gives a Suſpicion, that our drowned Wheat at *Briſtol* might poſſibly be Foreign; and then might not have been ſmutty the next Year, tho' it had not been ſoaked in the Sea-water.

The Wheat ſown by the Two Farmers aforementioned might be from a good Change of Land, but the Seed not changed the precedent Year; and then it might be no more infected, than what the Brine and Lime did cure.

To know what Changes are beſt to prevent Smuttineſs of Wheat, we muſt conſult the moſt Experienced; and they tell us, that the ſtrong Clay Land is beſt to be ſent to for Seed-wheat, whatever Sort of Land it be to be ſowed upon; a White-clay is a good Change for a Red-clay, and a Red for a White. That from any ſtrong Land is better than from a light Land ; and the old Rhyme is, that Sand is a Change for no Land. But from whatever Land the Seed be taken, if it was not changed the preceding Year, it may poſſibly be infected ; and then there may be Danger, tho' we have it immediately from never ſo proper a Soil.

The ſtrongeſt Objection that has been yet made againſt conſtant annual Crops of Wheat, is, that thoſe Grains of the precedent Crop which happen to ſhed, and grow in the following Crop, will be in Danger of Smuttineſs, for want of changing thoſe individual Seeds.

All I can ſay in Anſwer is, that during theſe Five Years, which is all the time I have had theſe annual Crops, this objected Inconvenience never has happened

pened to me, even when a precedent Crop has been ſmutty.

The Reaſon I take to be, that a Crop very early planted is not ſo apt to be ſmutty; and if it be not planted early, the Grains that are ſhed grow, and are killed before, or at the time of planting the next Crop. This ſaves a Crop following a ſmutty one (which is always occaſioned by bad Seed, or bad Ordering); and when the former Crop was planted with good Seed well ordered, the ſhattered Grains of that may produce clean Wheat the Second Year; and 'tis very unlikely, that any Breed of theſe Grains ſhould remain to grow in the Crop the Third Year.

CHAP. XI.

Of Blight.

WHEAT is blighted at Two Seaſons; Firſt, when in the Bloſſom; and then its Generation is prevented and many of the Huſks are empty in the Ear, the Grains not being impregnated.

Secondly, Wheat is blighted, when the Grains are brought to the time of their Maturity, but are light, and of little Value for making of Bread; becauſe they are not well filled with Flour.

The Firſt cannot happen in *England* by the Froſt becauſe the Winters do not ſuffer it to grow ſo much, as to come into Bloſſom before the Month of *June*; but they are long continual Rains that rot or chill the Bloſſoms, and prevent their Fertility. Yet this is what ſeldom happens to any great Degree. Wheat that grows in open Fields has ſome Advantage from the Wind, that diſlodges the Water

ſooner

fooner from the Ears, than it can do in fheltry Places; and Lammas Wheat does not hold the Drops of Rain fo long as the Bearded (or Cone) Wheat, which received very great Damage by this fort of Blight in the Year 1725, the like never having been heard of before.

The Second fort of Blight, *viz.* from light Ears, is that which is moft frequent, and more general: This brings the greateft Scarcity of Wheat. The Caufe is plainly Want of Nourifhment to perfect the Grain, by whatever means that Want is occafioned.

Several Accidents kill the Plants, or injure their Health, and then the Grains are not filled; as Lightning, the Effects whereof may be obferved by the blackifh Spots and Patches in Fields of Wheat, efpecially in fuch Years as have more of it than ufual. Againft this there is no Defence.

The other Caufes of the Blight, which are moft general, and do the moft Damage, may, in fome meafure, be prevented.

One Caufe is the lodging or falling of Corn; for then the Stalks are broken near the Ground, whereby many of the Veffels are fo preffed, that the Juices cannot pafs them; and then the free Circulation is hindered; the Chyle cannot mount in fufficient Quantity to be purified, and turned into Sap; the Defect whereof makes the Plants become languid, and only juft able to live; they have Strength enough to linger on to the time of their Period, as in very old Age, but not to bring their Fruit, which is the Grain, to its natural Bulk, nor to fill it with Flour: and the fooner the Stalks fall, the lefs and thinner the Grain will be.

Hence it often happens, that when Tillage, Dung, and good Land have brought a Crop of Wheat, that in the Months of *April* and *May* promife to yield the Owner Five or Six Quarters on an Acre, then in *June* it falls down, and fcarce affords Five or Six Bushels; and that perhaps is so thin and lank, that the Expence of reaping and threshing it may overbalance its Value.

That the falling down of Wheat does cause the Ruin of the Crop, is well known; but what causes it to fall, is not so plain.

And, without knowing the true Causes, 'tis not likely that a Remedy should be found against the Disease.

I take this Weakness of the Stalks, which occasions their falling, to proceed from want of Nourishment, want of Air, want of the Sun's Rays, or of all Three.

One Argument, that it lodges for want of Nourishment, is, that a rich Acre has maintain'd a Crop of Five Quarters standing, when another poorer Acre was not able to support a Crop from falling, which was but large enough to have brought Three Quarters, if it had stood: and this in the same Year, and on the same Situation. And 'tis very plain, that if one Acre was twice as rich as the other, it must be able to nourish Five Quarters better than the other could nourish Three Quarters.

Air is necessary to the Life and Health of all Plants, tho' in very different Degrees: Aquatics, which live under Water, are content with as little Air, as their Companions the Fishes.

But Wheat, being a terrestrial Plant, (tho' in Winter it will live many Days under Water, whilst the slow Motion of its Sap gives it litle or no Increase), requires a free open Air, and does not succeed so well in low sheltery Places, as upon higher and opener Situations; where the Air has has a greater Motion, and can more easily carry off the Recrements from the Leaves, after it has shaken off the Dews and Rains, which would otherwise suffocate the Plants; and therefore the Leaves are made so susceptible of Motion from the Air, which frees them from the Dews, that would ſtop in the Recrements at the *Veſiculæ* of the Leaves, but ſhaken down will nouriſh the Plants at the Roots: The want of this Motion weakening the Wheat, 'tis (as Animals in the like ſickly Caſe are) the more unable to ſtand, and the more liable to be preſs'd down by the Weight of Rain-water, and more unable to riſe up again when down: All which Evils are remov'd by the free Motion of the Air, which ſhakes off both Dews and Rains, and thus contributes to prevent the falling (or lodging) of Wheat.

A great Quantity alſo of the Sun's Rays is neceſſary to keep Wheat ſtrong, and in Health; and in *Egypt*, and other hot Countries, it is not ſo apt to fall, as it is when ſown in Northern Climates, tho' the Produce of the South be the greateſt *(a)*.

It may be obſerv'd, that every Leaf is inſerted into a Sort of Knot, which probably delivers the Sap to be depurated at the *Veſiculæ* of the Leaves, and then receives it back again for the Nouriſhment of the Plant, doing for that Purpoſe the Office of an Heart: But the Sun with his Rays ſupplies the Part of Pulſe, to keep the Sap in Motion, and carry on its Circulation, inſtead of the Heart's *Syſtole* and *Diaſtole*. Wheat, being doubtleſs originally a Native of a hot Country, requires by its Conſtitution a conſiderable Degree of Heat to bring it to Perfection; and if much of that Degree be wanting, the Wheat will be the weaker; and when the Solar Rays cannot reach the lower Parts of the Stalks, the loweſt Leaves and Knots cannot do their Office; for which Reaſon the Chyle muſt mount higher before it be made into Sap, and there muſt be then a greater Mixture of crude Chyle next to the Ground, as by the white

(*a*) This proves that the Crop doth not lodge on account of its Bigneſs.

Colour

Colour it appears *(b)*. By this Means that Part, which, if it had a due Share of the Sun's Influence, would be harden'd like a Bone or Spring, for the Support of the Stalks, for lack of that, becomes more like to a Cartilage, ſoft and weak, unable to ſuſtain the Weight of the bending Ear, which, having its greateſt *Impetus* againſt this Part, which is moſt feeble to reſiſt it, it yields, and lets it fall to the Ground; and then the Grain will be blighted.

There is alſo another Cauſe of the Blight; and that is, the Wheat's coming too late into Bloſſom. The uſual Time is the Beginning of *June*; and if it be later, the Days ſhorten ſo faſt after the Solſtice, that the Autumn of the Year haſtening the Autumn of the Wheat's Life, the full Time of its Pregnancy (*c*) is not accompliſh'd; and then its Fruit, which is the Grain, becomes as it were abortive, and not full-grown. This Time betwixt the Generation, Bloſſoming, and the Maturity of the Grain, is, or ought to be, about Two Months.

Therefore 'tis advantageous to haſten, what we can, the Time of Bloſſoming, and to protract the Time of

(b) But now I ſuſpect this to be a Miſtake, it being more likely, that the white Colour of the Rind is owing to the Abſence of the Sun and free Air, than to the Chyle, as the Skin of thoſe Parts of our own Bodies that are concealed from them, is whiter than of thoſe which are expoſed to them, though no Chyle-veſſel comes near our Skin.

(c) Ut enim Mulieres habent ad Partum Dies certos, ſic Arbores ac Fruges. Varro, *Lib.* 1. *Cap.* 44.

Menſe Maio florent; ſic Frumenta, & Ordeum, & quæ ſunt Seminis ſingularis, Octo diebus florebunt, & deinde per Dies 40. *grandeſcunt Flore depoſito uſque ad Maturitatis Eventum.* Palladius, *Pag.* 114, 115.

Quindecim Diebus eſſe in Vaginis, Quindecim florere, Quindecim exareſcere, cum ſit maturum Frumentum. Varro, *Lib.* 1. *Cap.* 32.

But the different Heat that there is in different Climates, may alter both the Time that Plants continue in Bloſſom, and the Time betwixt the Bloſſoming and the Ripening.

Ripening: And 'tis obſerv'd, that the earlieſt ſown Wheat generally eſcapes the Blight the beſt, becauſe it comes firſt into Bloſſom.

Feeding down the Wheat with Sheep prevents the Blight, by doing what the Blight wou'd do, if the Wheat fell down, *i. e.* cauſes the Ears to be light *(a)*.

And we find, that thoſe who practiſe this Method of feeding their Wheat with Sheep in the Spring, to prevent the lodging of it, have moſt commonly their Straw weak, and Ears light.

Theſe, inſtead of making the Stalks ſtrong enough to ſupport heavy Ears, make the Ears light enough to be ſupported by weak Stalks. They know that heavy Ears make the greateſt Crop; and yet they ſtill hope to have it from light ones.

They *cauſe* the *Blight* by the very means they make uſe of to *cure* it.

This feeding of Wheat much retards the Time of its bloſſoming; and that it may bloſſom early, is one chief End of ſowing it early, to prevent the Blight. But when it is fed, what the Plants ſend up next is but a Sort of ſecond or latter Crop, which has longer to ſtand than the firſt would have required, and is always weaker than the firſt Crop would have been; and the longer time it has to continue on the Ground, the more Nouriſhment is required to maintain it; and yet, as has been ſhewn, the longer it has been ſown, the more the Earth has loſt of its Nonriſhment; and

(a) Heavy Ears never fall. If they did, that would not make them light. Wheat falls ſometimes whilſt 'tis in Graſs, and before it comes into Ear; ſo far are the Ears from cauſing it to fall. This was proved by my whole Crop the laſt Harveſt, and particularly by the *Meaſured Acre*, the Ears of which, tho' prodigious large and heavy, were none of them lodg'd, when thoſe of ſown Wheat on the other Side of the Hedge were fallen down flat, and lodg'd on the Ground.

conſe-

consequently, the Crop will be yet weaker, and in more Danger of the starving Blight *(b)*.

The most effectual Remedy against the Blight is that which removes all its Cases (except such extraordinary ones as Lightning); as,

First, *Want of Nourishment.*

The Horse-hoe will, in wide Intervals, give Wheat, throughout all the Stages of its Life, as much Nourishment as the discreet Hoer pleases.

Secondly, *Want of Air.*

Air, being a Fluid, moves most freely in a right or strait Line; for there the fewest of its Parts meet with any Resistance; as a strait River runs swifter than a crooked one, from an equal Declivity; because more of the Water strikes against the Banks at

(b) I am sure, that whenever Sheep break into my drill'd Wheat in the Spring, it lessens my Crop half, just as far as they eat the Rows. There are several Reasons why Sheep are more injurious to drilled Wheat than sown: I would not therefore be understood to decry the Practice of feeding sown Wheat, when the Thickness and Irregularity of its Plants make it necessary: I have only endeavoured to shew, that that Practice is founded upon a false Theory. For, if Wheat fell down by reason of the Luxuriance of it; a Plant of it would be more likely to fall when single, and at a great Distance from every other Plant, than when near to other Plants, because such a single Plant is *(cæteris paribus)* always the most luxuriant; and I have not seen such a one fall (except Birds pull down the Ears), but have observed the contrary, though its Ears are the largest.

The Subject I write on is Drilling and Hoeing, and of whatsoever else I think relates to the Practice or Theory thereof; which obliges me to advise against Drilling too thick upon any Sort of Land; but more especially upon very rich Land: For though I have no such Land, yet I apprehend, that a too great Number of Plants may overstock the Rows, and cause them to be liable to some of the Inconveniences of sown Wheat; and in such a Case, perhaps, Sheep may be rather useful than prejudicial to the drilled Wheat; but of this I have had no Experience: And if it should be too thick, it will be owing to the Fault of the Manager or Driller; but, I suppose, it might be a better Remedy to cut out the superfluous Plants by the Hand-hoe, in the manner that superfluous Turneps are hoed out.

the Turnings, and is there ſomewhat retarded: and the reſt moving no faſter than in the ſtrait River, the whole Stream of the crooked muſt be ſlower in its Courſe, than that of the ſtrait River.

The Air cannot paſs thro' ſown Corn in a direct Line, becauſe it muſt ſtrike againſt, and go round every Plant, they ſtanding all in the Way of its Courſe, which muſt ſtop its Current near the Earth.

And the Air amongſt ſown Corn is like Water amongſt Reeds or Oſiers in the Side of a River; it is ſo ſtopp'd in its Courſe, that it almoſt becomes an Eddy; and ſince Air is about Eight hundred Times lighter than Water, we may ſuppoſe its Current thro' the Corn is more eaſily retarded, eſpecially near the Earth, where the Corn has occaſion for the greateſt Quantity of Air to paſs: For, tho' the upper Part of the Wheat be not able to ſtop a ſlow Current of Air, yet it does ſo much raiſe even a ſwift one, as to throw it off from the Ground, and hinder it from reaching the lower Parts of the Stalks, where the Air muſt therefore remain, in a manner, ſtagnant; and the thicker the Wheat is, where it ſtands promiſcuouſly, the leſs Change of Air can it have, tho' the greater the Number of the Stalks is, the more freſh Air they muſt require.

But the confuſed Manner in which the Plants of ſown Wheat ſtand, is ſuch, that they muſt all oppoſe the free Entrance of Air amongſt them, from whatever Point of the Compaſs it comes.

Now it is quite otherwiſe with Wheat drill'd regularly with wide Intervals; for therein the Current of Air may paſs freely (like Water in a ſtrait River, where there is no Reſiſtance), and communicate its Nitre to the lower as well as upper Leaves, and carry off the Recrements they emit, not ſuffering the Plants to be weaken'd, as an Animal is, when his Lungs are forc'd to take back their own Expirations, if debarr'd from a ſufficient Supply of freſh untainted Air. And

this

this Benefit of fresh Air is plentifully, and pretty equally, distributed to every Row in a Field of ho'd Wheat.

Thirdly, *Want of the Sun's Rays.*

Sown Wheat-plants, by their irregular Position, may be said to stand in one another's Light, for want of which they are apt to fall.

'Tis true the whole Field of Plants receive the same Quantity of Sun-beams amongst them, whether they stand confusedly, or in Order: But there is a vast Difference in the Distribution of them; for none or the very least Share of Beams is obtain'd by those Parts which need the greatest Share, in the confused Plants. And when the crural Parts, that should support the whole Body of every Plant, are depriv'd of their due Share of what is so necessary to strengthen them, the Plants (like Animals in the same Case) are unable to stand.

But in drill'd Wheat, where the Plants stand in a regular Order, the Sun-beams are more duly distributed to all Parts of the Plants in the Ranks; for which Way soever the Rows are directed, if they be strait, the Rays must, some time of the Day, fall on the Intervals, and be reflected by the Ground, whence the lower Parts of the Wheat-stalks must receive the greater Share of Heat, being nearest to the Point of Incidence, having no Weeds to shadow them.

As to that Cause of the Blight, *viz.* the Wheat's dying before the full Time of its Pregnancy be accomplish'd; the Hoe removes all the Objections against planting early, and then it will blossom the earlier: And it has visibly kept Wheat green a whole Week longer, than unho'd Wheat adjoining to it, planted the same Day.

The Antients were perfect Masters of the Vine-Husbandry, which seems to have so engross'd their rural Studies, that it did not allow them so much Reflection, as to apply the Use of those Methods to the

Increaſe of Bread, which they had diſcover'd to be moſt beneficial for the Increaſe of Wine. One Method was, to hoe the Vines after they had bloſſom'd, in order to fill the Fruit, as in *Columella*, Lib. iv. Cap. 28. *Convenit tum crebris Foſſionibus implere: nam fit uberior Pulverationibus.* And if what *Palladius* ſays, *Tit.* ix. be true of the Sarritions and Sarculations in the Month of *January*, and that if Beans do twice undergo that ſcratching Operation, they will produce much Fruit, and ſo large as to fill the Buſhel almoſt as full when ſhal'd as unſhal'd.

Faba, ſi bis ſarculetur, proficiet, & multum Fructum & maximum afferet, ut ad Menſuram Modii complendi freſa propemodum ſicut integra reſpondeat.

This is to be done when Beans are Four Fingers high, and Corn when it has Four or Five Leaves to a Plant; even then the Harrowing-work, tho' it tore up ſome of the Plants, yet it was obſerv'd to do Good againſt the Blight.

Si ſiccas Segetes ſarculaveris, aliquid contra Rubiginem præſtitiſti, maxime ſi Ordeum ſiccum ſarrietur.

When the Antients obſerv'd this, 'tis a Wonder they did not plant their Corn ſo as to be capable of receiving this Benefit in Perfection. They might have imagin'd, that what was effectual againſt the Blight, when the Corn was in Graſs, muſt, in all Probability, be much more effectual when in Ear.

But the moſt general Blight that happens to Wheat in cold Climates, is cauſed by Inſects, which (ſome think) are brought in the Air by an Eaſt Wind accompanied with Moiſture, a little before the Grain is filling with that milky Juice, which afterwards hardens into Flour. Theſe Inſects depoſit their Eggs within the outer Skin (or Rind) of the Stalks; and when the young ones are hatched, they feed on the *Parenchyma*, and eat off many of the Veſſels which ſhould make and convey this Juice; and then the Grain will be more or leſs thin, in Proportion to the

Number

Number of Veſſels eaten, and as the Inſects happen to come earlier or later; for ſometimes they come ſo late, that the Grain is ſufficiently fill'd with the ſaid milky Juice before the Veſſels are eaten; and then, tho' the Straw appear thro' a Microſcope to have its Veſſels very much eaten and torn, and to be full of black Spots (which Spots are nothing elſe but the Excrements of thoſe young Inſects), yet the Grain is plump, and not blighted, there being an Obſervation, That the early ſown Wheat generally eſcapes this Blight. And it has been ſeen, where one Part of a Field is ſown earlier than the other Part, without any other Difference than the Time of ſowing, that the Grain of the lateſt ſown has been much blighted, and the Grain of the earlier has eſcaped the Blight, tho' the Straw of both were equally eaten by the Inſects. Hence it may be inferr'd, that the Milk in the one had receiv'd all the Nouriſhment neceſſary to its due Conſiſtence, before the Veſſels were deſtroy'd; but, in the other, the Veſſels, which ſhould have continued the Supply of Nouriſhment for thickening the Milk, being ſpoil'd before they have finiſh'd that Office, it remains too thin; and then the Grain, when it hardeneth, ſhrinks up, and is blighted; yet the Grain of one and the other are equally plump until they become hard: The Difference therefore is only in the Thickneſs of the Milk, that in the blighted being more watery than the other.

The chief Argument to prove, that theſe Inſects are brought by an Eaſt Wind, is, that the Wheat on the Eaſt Sides of Hedges are much blighted, when that on the Weſt Sides is not hurt: And as to the Objection, that they are bred in the Earth, and crawl thence up the Stalks of the Wheat, becauſe ſome Land is much more ſubject to produce blighted Wheat than other Land is; perhaps this Difference may be chiefly owing to the different Situation of thoſe Lands, as they are oppoſed to the *Eaſt*, or to the *Weſt*.

Another

Another Caufe why fome Wheat is more blighted than other Wheat on the fame Land, is, the different Condition in which the Infects find it; for the Rind of that which is very ftrong and flourifhing (*c*) is foft and tender; into this they can eafily penetrate to lay their Eggs; but the Wheat that is poor and yellow, has an hard tough Skin (or Rind), into which the Infects are not able to bore for the Intromiffion of their Eggs, and therefore can do it no Mifchief. It would be in vain to advife to prevent the Blight, by ftriving to make the Wheat poor; for tho' Poverty may preferve Wheat from this Blight, as well as it does People from the Gout, yet that is a Remedy which few take willingly againft either of thefe Difeafes: But this, I think, might be poffible to remedy it, if we could, from the ftrongeft Wheat, take away fo much Nourifhment as to turn its Colour (*d*) a little yellowifh juft before the Infects come (*e*) which I fuppofe to be in *June*, after the Ear is out, or at leaft fully formed.

Yet this can only be done in wide Intervals; for, unlefs the fine Earth can be thruft to fome confiderable Diftance from the Roots after they are cut off, they will foon fhoot out again, and reach it, becoming more vigorous thereby.

In dry Summers this Misfortune feldom happens, much Heat, and very little Moifture, being moft agreeable to the Conftitution of Wheat; for then its Rind

(*c*) Some Sort of Land is more fubject to this Blight than others; in fuch, Lammas Wheat muft by no means be drill'd late, and too thin, left it fhould not tiller till late in the Spring; and then, for want of a fufficient Quantity of Stalks to difpenfe with all the Nourifhment rais'd by the Hoe, may become too vigorous and luxuriant, and be the more liable to the Injury of the Blight of Infects.

(*d*) But this is a very difficult Matter.

(*e*) Whither thofe Infects go, or where they refide, from the Time of their eating their Way out of the Straw, until they return the next Year, I cannot learn.

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is more firm and hard, as it is, on the contrary, made more ſoft and ſpongy by too much Moiſture.

The moſt eaſy and ſure Remedy, that I have yet found againſt the Injury of theſe Inſects, is, to plant a Sort of Wheat that is leaſt liable to be hurt by them; *viz.* The *White-cone* (or bearded) *Wheat*, which has its Stalk or Straw like a Ruſh, not hollow, but full of Pith (except near the lower Part, and there 'tis very thick and ſtrong): 'Tis probable it has Sap-Veſſels that lie deeper, ſo as the young Inſects cannot totally deſtroy them, as they do in other Wheat: For when the Straw has the black Spots, which ſhew that the Inſects have been there bred, yet the Grain is plump, when the Grey-cone and Lammas Wheat mixt with it are blighted. This Difference might have been from the different times of ripening, this being ripe about a Week earlier than the Grey-cone, and later than the Lammas: But its being planted together both early and late, and at all Times of the Wheat-ſeed Time, and this White-cone always eſcaping with its Grain unhurt, is an Argument, that 'tis naturally fortify'd againſt the Injury of theſe Inſects, which in wet Summers are ſo pernicious to other Sorts of Wheat; and I can impute it to no other Cauſe than the different Deepneſs of the Veſſels, the Straw of other Wheat being very much thinner, and hollow from Top to Bottom; this having a ſmall Hollow at Bottom, and there the Thickneſs betwixt the outer Skin and the Cavity is more than double to that in other Sorts of Wheat; ſo that I imagine, the Inſects reach only the outermoſt Veſſels, and enough of the inner Veſſels are left untouch'd to ſupply the Grain.

This Wheat makes very good Bread, if the Miller does not grind it too ſmall, or the Baker make his Dough too hard, it requiring to be made ſofter than that of other Flour.

A Buſhel of this White-cone Wheat will make more Bread than a Buſhel of Lammas, and of the ſame

ſame Goodneſs; but it gives a little yellow Caſt to the Bread.

Another Sort of lodging Blight there is, which ſome call *Moar-Loore*, and moſtly happens on light Land: This is when the Earth, ſinking away from the Roots, leaves the Bottom of the Stalk higher than the ſubſided Ground; and then the Plant, having only theſe naked Roots to ſupport it (for which they are too weak), falls down to the Earth.

To remedy this, turn a ſhallow Furrow againſt the Rows, when they are ſtrong enough to bear it, and when the Mould is very fine and dry; then the Motion of the Stalks by the Wind will cauſe ſuch Earth to run through the Rows, and ſettle about the Roots, and cover them (*f*).

I have never ſeen any drill'd Wheat ſo much ſpoil'd by falling, as ſown Wheat ſometimes is. The drill'd never falls ſo cloſe to the Ground, but that the Air enters into Hollows that are under it, and the Wind keeps the Ears in Motion. Notwithſtanding all the Precaution that can be uſed, in ſome unſeaſonable Years Wheat will be blighted: I have known ſuch a general Blight, when ſome of my Lammas Wheat, planted late on blighting Land, was blighted, amongſt the reſt of my Neighbours, by the Inſects, but the Grain of the ſown Wheat was vaſtly more injured

(*f*) Some Land is very ſubject to the Misfortune of expoſing the Roots, and therefore is leſs proper for Wheat; for when the Roots are left bare to the Air, they will be ſhrivelled, and unable to ſupport the Plants: And on ſuch Lands the Wheat-plants have all fallen down, though in Number and Bigneſs not ſufficient to have produced the Fourth Part of a tolerable Crop, if they had ſtood. I am inclined to believe, that a thorough Tillage might be a Remedy to ſuch a looſe hollow Soil; for 'tis certain to a Demonſtration, that it would render it more *denſe*, and increaſe its ſpecific Gravity: But to enrich it ſufficiently without Manure, the Tillage muſt pulverize it much more minutely, and expoſe it longer, than is required for the ſtrongeſt Land: The Fold alſo will be very helpful on ſuch hollow Land.

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than that of the drill'd: The former was so *light*, that the greatest Part was blown away in winnowing, and the Remainder so *bad*, that it was not fit to make Bread: The drill'd made as good Bread, and had as much Flour in it, as the sown Wheat had, that was not blighted; for the Grains of the drill'd were much larger than those of the sown; being form'd to have been twice as big as the Grains of Wheat generally are, had they not been blighted.

CHAP. XII.

Of St. Foin.

St. Foin, from the Country we brought it from, is call'd *French Grass*: And for its long Continuance, some having lasted Forty Years, 'tis call'd *Everlasting Grass*, tho' it be not strictly a *Gramen*.

'Tis call'd in *French*, *Sain Foin*, i. e. *Sanum Fœnum*, from its Quality of Wholsomeness, beyond the other artificial Grasses, green and dry. 'Tis also call'd *Sanctum Fœnum*, Holy Hay.

'Tis a Plant so generally known to every Body, that there is no need to give any formal Description of that Part of it which appears above-ground, It has many red Flowers, sometimes leaving Ears Five or Six Inches long: I have measured the Stalks, and found them above Five Feet long, tho' they are commonly but about Two Feet.

The Reason why *St. Foin* will, in poor Ground, make a Forty times greater Increase than the natural Turf, is the prodigious Length (*a*) of its perpendicular

(*a*) There is a vulgar Opinion, that *St. Foin* will not succeed on any Land, where there is not an under *Stratum* of Stone or Chalk, cular Tap-root: It is ſaid to deſcend Twenty or Thirty Feet. I have been inform'd, by a Perſon of undoubted Credit, that he has broken off one of theſe Roots in a Pit, and meaſured the Part broken off, and found it fourteen Feet.

This Tap-root has alſo a Multitude of very long horizontal Roots at the upper Part thereof, which fill all the upper *Stratum*, or Staple of the Ground; and of thouſands of *St. Foin* Roots I have ſeen taken up, I never found one that was without horizontal Roots near the Surface, after one Summer's Growth; and do much wonder how Mr. *Kerkham* ſhould be ſo miſtaken, as to think they have none ſuch.

Alſo theſe Tap-roots have the horizontal ones all the Way down; but as they deſcend, they are ſtill ſhorter and ſhorter, as the uppermoſt are always the longeſt.

Any dry Ground may be made to produce this noble Plant, be it never ſo poor; but the richeſt Soil will yield the moſt of it, and the beſt.

Chalk, to ſtop the Roots from running deep; elſe, they ſay, the Plants ſpend themſelves in the Roots only, and cannot thrive in thoſe Parts of them which are above the Ground. I am almoſt aſhamed to give an Anſwer to this.

'Tis certain that every Plant is nouriſhed from its Roots (as an Animal is by its Guts); and the more and larger Roots it has, the more Nouriſhment it receives, and proſpers in proportion to it. *St. Foin* always ſucceeds where its Roots run deep; and when it does not ſucceed, it never lives to have long Roots; neither can there ever be found a Plant of it, that lives ſo long as to root deep in a Soil that is improper for it: Therefore 'tis amazing to hear ſuch Reaſoning from Men.

An under *Stratum* of very ſtrong Clay, or other Earth, which holds Water, may make a Soil improper for it; becauſe the Water kills the Root, and never ſuffers it to grow to Perfection, or to attain to its natural Bulk. The beſt *St. Foin* that ever I ſaw, had nothing in the Soil to obſtruct the Roots, and it has been found to have Roots of a prodigious Depth. If there be Springs near (or within ſeveral Feet of) the Surface of the Soil, *St. Foin* will die therein in Winter, even after it has been vigorous in the firſt Summer; and alſo after it hath produced a great Crop in the ſecond Summer.

If you venture to plant it with the Drill, according to the Method wherein I have always had the beſt Succeſs; let the Land be well prepared before you plant it. The Seed, if not well ordered, will very little of it grow; therefore 'tis convenient to try it in the manner mention'd in the Chapter of *Hoeing*; where are alſo Directions to find the proper Quantity and Depth to plant it at: I have obſerv'd, that the Heads of theſe Seeds are ſo large, and their Necks ſo weak *(b)*, that if they lie much more than half an Inch (*c*) deep, they are not able to riſe through the incumbent Mould; or if they are not cover'd, they will be malted (*d*). A Buſhel to an Acre is full twenty Seeds to each ſquare Foot, in all I try'd; but there is odds in the Largeneſs of it, which makes ſome Difference in the Number.

The worſt Seaſons to plant it are the Beginning of Winter, and in the Drought of Summer. The beſt Seaſon is early in the Spring.

'Tis the ſtronger when planted alone, and when no other Crop is ſown with it *(f)*.

If

(b) The Kernel or Seed, being much ſwollen in the Ground, I call the Head: This, when it reaches above the Ground, opens in the Middle, and is formed into the Two firſt Leaves; the Huſk always remaining at the ſame Depth at which it is cover'd: The String that paſſes from the Huſk to the Head, is the Neck; which, when by its too great Length 'tis unable to ſupport the Head till it reaches to the Air, riſes up, and doubles above it; and when it does ſo, the Head, being turn'd with its Top downwards, never can riſe any higher, but there rots in the Ground.

(c) In very light Land the Seed will come up from a greater Depth; but the moſt ſecure Way is, not to ſuffer it to be cover'd deep in any Land.

(d) We ſay it is malted, when it lies above-ground, and ſends out its Root, which is killed by the Air. And whether we plant *bad* Seed that does not grow, or *good* Seed buried or malted, the Conſequence will be much the ſame, and the Ground may be equally underſtock'd with Plants.

(f) The worſt Crop that can be ſown amongſt *St. Foin*, is Clover or Rye-Graſs; Barley or Oats continue but a little while

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If Barley, Oats, or other Corn ſown with St. Foin, do lodge, it will kill *(g)* the young St. Foin that is under it: But then ſo great a Crop of Corn will certainly anſwer the very little Expence of drilling the St. Foin again, either the next Year, or as ſoon as the Corn is off the Ground.

St. Foin drill'd betwixt Rows of Barley or Oats, always is ſtronger than when drill'd amongſt Corn that is ſown at random; and therefore is in leſs Danger of being kill'd by the Lodging of the Corn; neither is the Corn in Rows ſo liable to fall as the other.

The Quantity of Seed to be drill'd on an Acre will depend, in great Meaſure, upon the Goodneſs of it; for in ſome bad Seed, not more than One in Ten will grow; and in good Seed, not One in Twenty will miſs; which is beſt known by ſtripping off the Huſks of a certain Number of Seeds, and planting the Kernels in Earth, in the manner directed for

to rob it; but the other artificial Graſſes rob it for a Year or Two, until the artificial Paſture is near loſt; and then the St. Foin never arrives to half the Perfection as it will do when no other Graſs is ſown amongſt it.

The Injury theſe Hay-crops do to the St. Foin is beſt ſeen where ſome Parts of the ſame Field have them, and the other Parts are without them.

(g) When Barley, among which the St. Foin is planted in a dry Summer, is great, there are few Farmers that know till the next Spring, whether the St. Foin ſucceeds or not; becauſe the young Plants are not then viſible; unleſs it be to thoſe who are accuſtomed to obſerve them in all the Degrees of their Growth. I have ſeen a Field of Ten Acres of ſuch, wherein, after the Barley was carried off, nothing appeared like St. Foin; but when by the Print of the Chanels I ſearched diligently, I found the ſmall St. Foin Plants thick enough in the Rows; they had no Leaves, they being cut off by the Scythe; no Part of them that was left had any Green Colour; but from the Plants there came out many Sprigs like Hog's Briſtles, or like the Beard of Barley: This whole Piece of St. Foin ſuceeeded ſo well, that the Third Year its Crop was worth Three Pounds *per* Acre, the Land being good.

finding

finding the proper Depth to plant at, which, in this Cafe, let be half an Inch: This being done, the Quality of the Seed will be known. But until frequent Trials have furnifh'd Experience enough to the Planter to know the Difference, let him obferve, that the following are good Signs; *viz.* The Hufk of a bright Colour, the Kernel plump, of a light-grey or blue Colour, or fometimes of a fhining black; yet the Seed may be good, tho' the Hufk is of a dark Colour, if that is caufed by its receiving Rain in the Field, and not by heating in a Heap, or in the Mow; and if you cut the Kernel off in the Middle, crofs-ways, and find the Infide of a Greenifh frefh Colour, it's furely good; but if of a yellowifh Colour, and friable about the Navel, and thin, or pitted, thefe are Marks of bad Seed.

The Quantity, or rather Number of Seeds convenient to drill, ought to be computed by the Number of Plants (*b*) we propofe to have for making the beft Crop, allowing for Cafualties (*c*).

In

(*b*) Not that we need to be fo exact as to the Number of Plants, whether they be Two, Three, or Four hundred upon a fquare Perch. Neither is it poffible to know beforehand the precife Number of Plants that may live; for fometimes the Grub kills many, by eating off the firft Two Leaves.

(*c*) Many even of the beft of Seeds, both fown and drill'd, are liable to Cafualties, but not equally; for about Twenty-eight Years ago, my Servants (being prime Seedfmen) had a Fancy in my Abfence to try an Experiment of the Difference betwixt fowing and drilling of St. Foin; and in the Middle of a large Field of my beft Land they fow'd a fquare Piece of Three Acres, at the Rate of One Bufhel to an Acre, not doubting but, by their fkill in fowing even, it would fucceed as well as if drill'd; but it fucceeded fo much againft their Expectation, that the Land all round it, which was drill'd at the fame Time, with the fame Proportion of the fame Seed, brought extraordinary good Crops of St. Foin; but the fow'd Part was fo very thin, that tho' it lay ftill with the reft for Eight Years, it never was a Crop, there not being above Three or Four upon a fquare Perch, taking the Three Acres all together: Not that it can be fuppofed,

 that

In drilling St. Foin not to be ho'd, and before the Ploughs of my Drill were so perfect in making narrow Chanels as they are now (for, when the Chanels were open, they had Six times the Breadth, wherein Part of the Seed was wasted), then my Quantity was One Bushel to an Acre, sometimes Six Gallons.

But a single Acre (in the middle of a large Field of St. Foin) being drill'd late in *October*, the frosty Winter kill'd at least Nineteen of Twenty Parts *(d)* of that Bushel. At first it made such a poor Appearance, that 'twas by mere Accident, or it had been plow'd up for a Fallow; but, missing of that, a few Plants were perceiv'd in the Summer, which by their Singleness grew so vigorous, and so very large, that the Second Year of Mowing it *(e)* produc'd a Crop double to the rest of the same Field, which was drill'd in the Spring, with the same Proportion of Seed, and none of it kill'd: tho' all this Field was a much better Crop than some that was sown in the common Manner, with Seven Bushels to an Acre. I have generally observ'd the thin *(f)* to make the best Crop, after the First or Second Year.

I have

that the sown would always meet with so many Casualties as this did; for then Eight Bushels sown to an Acre might have been too thin, and much thinner than all the rest of the Field was, tho' drill'd with only One Bushel to an Acre: And 'tis often seen, that when an Acre is sown with seven Bushels of Seed, the St. Foin is as much too thick, as that sown with One Bushel was too thin.

I do not know, that of the many hundred Acres of St. Foin, that have been drill'd for me, ever one Acre was too thin, except when planted with Wheat: The young Plants were kill'd by the Frost.

(d) But I believe, there might remain alive Three or Four Plants to each square Yard, standing single, and at pretty equal Distances.

(e) But *Note*, This Acre was dunged, and in better Order than the rest.

(f) But, notwithstanding I commend the Planting of St. Foin thin, that most of the Roots may be single; yet I have Fields that

I have alſo often obſerv'd in Lands of St. Foin, lying diſperſed in a common Field (but where there was not Common for Sheep), and where the Ends of other Lands kept in Tillage, pointed againſt the Pieces of St. Foin, and the Horſes and Ploughs turning out upon the St. Foin *(g)* did plow and ſcratch out a Multitude of its Plants; ſo that it was thought to be ſpoil'd, and Law-ſuits were intended for Recompence of the Damage; that afterwards this ſcratch'd Part, ſuppoſed to be ſpoil'd, became twice as good as the reſt of the ſame Pieces, where the Ploughs did not come to tear up any Plants.

The Reaſon why the ſingle St. Foin Plants make the greateſt Crops, is, that the Quantity of the Crop is always in Proportion to the Quantity of Nouriſhment it receives from the Earth; and thoſe Plants which run deepeſt will receive moſt; and ſuch as are ſingle will run deeper than thoſe which are not ſingle.

Alſo the ſingle do ſend out all round them horizontal Roots, proportionably ſtronger and larger, whereby they are better able to penetrate, and extract more Nouriſhment from the Staple, or upper *Stratum*, than the other can do, if there be a competent Number; which is, when ho'd, fewer than any-

that were drill'd with but Four Gallons of Seed to an Acre; and yet the Rows being Seven Inches aſunder, the Roots are ſo thick in them, that the Ground is cover'd with the St. Foin Plants, which ſeem to be as thick (in Appearance) as moſt ſown St. Foin, whereon Seven or Eight Buſhels are ſown on an Acre. And I have other Fields that were drill'd with about Two Gallons of Seed to an Acre (which is Five Seeds to each ſquare Foot), the Rows Sixteen Inches aſunder, that produce better Crops, tho' the Ground be poorer. The drill'd St. Foin, being regular, is more ſingle, tho' as thick as the ſown; and for that Reaſon always makes a better Crop, and laſts longer than the ſown that is of the ſame Thickneſs, but irregular.

(g) This Plowing and Scratching was a ſort of Hoeing, which helped the St. Foin by a ſmall Degree of Pulveration, as well as by making the Plants thinner.

body imagines. 'Tis common to see a single St. Foin have a bigger Tap-root than Twenty thick ones: Their Length is in Proportion to their Bigness: Therefore that single Plant may well be supposed to have Twenty times more Depth of Earth to supply it, than all those Twenty small Roots can reach to. And tho' these under *Strata* are not so rich as the upper; yet, never having been drain'd by any Vegetable, they do afford a very considerable Quantity of Nourishment to those Roots which first enter them.

The small thick Plants are so far from equalling the Product of the single, by their Excess of Number, that the more they are, the smaller, shorter, and weaker they become; less Nourishment they have, and the less Crop they produce; and are soon starv'd, decay, and die, unless reliev'd by the Expence of frequent Manure, or that the Soil be very rich.

Single Plants exceed the other by a Multitude of Degrees, more than a Giant does a Dwarf, in Strength, as well as Stature; and therefore when natural Grass happens to come, are so much the better able to shift amongst it.

The single Plants seem also to exceed the other in their Longevity; for 'tis observ'd, that all St. Foin that has continu'd great for a good Number of Years without Manure, has been so single, that the Owners have determined to plow it up at the Beginning, for the Thinness of it.

How long this may last by Culture, I can't tell; but undoubtedly much longer than without it; and I can say, that I never knew a Plant of St. Foin die a natural Death; the most common End of it is Starving. And when an hundred thick Plants have not the Nourishment which One single Plant has, 'tis no Wonder that these (in a Croud *(h)* thus besieg'd with Hunger) should be starv'd before it.

(h) Sown Plants, when too thick, are crouded on every Side; but those that are drill'd, have always Room enough on Two Sides of them; unless the Rows are too near together.

Another Advantage the ſingle have, in reſpect of Moiſture: Theſe reach to a Depth where that is never wanting, even when the upper *Stratum* or Staple is parch'd up, as appears by the Experiment of the Mints, that if any Root of a Plant has Moiſture, that Root will communicate a Share to all the reſt. Hence it is, that, in the drieſt Summer, theſe ſingle Plants make a great Crop, when the other yield next to nothing. I remember I once ſaw a Farmer coming out of a Ground with a Load of St. Foin Hay, which he aſſured me was all he could find worth cutting, out of Forty Acres of this thick ſort, in full Perfection, Three Years after ſowing: He valued his Load at Three Pounds; but withal ſaid it came off ſo much Ground, that the Expence of Mowing, Raking, *&c.* was more than the Value; when, in the very ſame dry Summer, there was Three Tun of St. Foin to an Acre in a Field (*i*), where it was drill'd ſingle and regularly.

And I have often obſerv'd, that where the Plants are thin, the Second Crop of them ſprings again immediately after cutting; when Plants that ſtand thick in the ſame Ground, ſpring not till Rain comes; and I have ſeen the thin grown high enough to cut the Second time, before the other began to ſpring.

The beſt way to find what Number of theſe Plants it is proper to have on a Perch of Ground, is to conſider what Quantity of Hay one large Plant will produce (for, if cultivated, they will be all ſuch).

Without Culture theſe Plants never attain to a Fourth Part of the Bulk they do with it: Therefore very few have ſeen any one Plant at its full Bigneſs. One Plant, well cultivated, has in the ſame Ground

(*i*) This was on rich deep Land in *Oxfordſhire*; and the other St. Foin, which was ſo poor, was on thin Slate Land near *Canſham* in *Wiltſhire* in the *Bath Road.* It is now about Forty Years ſince.

made a greater Produce, than One thouſand ſmall ones uncultivated.

But the Hay of a large ſingle cultivated Plant will weigh more than half a Pound; and 112 Plants upon a ſquare Perch, weighing but a Quarter of a Pound apiece one with another, amount to Two Tun to an Acre.

If St. Foin be planted on ſome ſorts of Land early in the Spring, and ho'd, it may bring a Crop the ſame Summer; for I once planted a few Seeds of it on ſandy Ground in my Garden, at the End of *February*, which produced large Plants above Two Feet high, that went into Bloſſom the following *June*; tho' there was a ſevere Froſt in *March*, which kill'd abundance of Wheat, yet did not hurt theſe Plants: This ſhews that St. Foin is a quick Grower, unleſs it be planted on poor cold Ground, or for Want of Culture.

And tho' the poor Land, and ill Management generally allotted to it, cauſe it to yield but One mowing Crop a Year; yet it has yielded Two great ones on rich ſandy Land, even when ſown in the common ordinary matter.

Thin St. Foin cannot be expected to cover all the Ground at firſt, any more than an Orchard of Apple-trees will, when firſt planted at Thirty Feet Diſtance from each other every Way; yet this is reckon'd a proper Diſtance to make a good and laſting Orchard. But if theſe ſhould be planted at Three Feet Diſtance, as they ſtand in the Nurſery, it would not be more unreaſonoble than the common Method of ſowing St. Foin is; and there would be much the ſame Conſequence in both, from covering all the Ground at firſt Planting; except that the St. Foin, being abundantly longer rooted downwards than Apple-trees are, has the greater Diſadvantage, when by its Thickneſs 'tis

prevented

prevented from growing to its full Bulk, and Length of Roots *(k)*.

The Difference is only this: People are accuſtom'd to ſee Apple-trees planted at their due Diſtance: but few have ſeen St. Foin planted and cultivated at the Diſtance moſt proper to St. Foin; or ever conſider'd about it, ſo much as to make the neceſſary Trials.

I have conſtantly found, that, upon doubling any Number of narrow Rows, having equal Number of Plants in each Row, the Crops have been very much diminiſh'd; and, upon leaving out every other Row, that is, leſſening the Number of Rows to half, the Crops are increaſed; and where Two Rows are wide aſunder at one End of a Piece, and near at the other End, the Plants are gradually leſs and leſs, as the Rows approach nearer together.

We ought never to expect a full Crop of St. Foin the Firſt Year *(l)*, if we intend to have good Crops afterwards, and that it ſhall continue to produce ſuch, for the ſame Reaſons that muſt be given for planting an Orchard at other Diſtances than a Nurſery.

The common Error proceeds from miſtaking the Cauſe of a great or ſmall Crop.

Where the Spaces betwixt Rows are wide (if there be not too many Plants in them) we always ſee the St. Foin grow large, and make the greateſt Crop; but when 'tis young, or after cutting, we ſee room

(k) Horizontal-rooted Plants ſuffer no greater Injury by their Paſture's being over-ſtock'd than Cattle do; becauſe their Paſture lying near the Surface of the Ground, they have it all amongſt them: But St. Foin, and other long Tap-rooted Plants ſuffer yet more, becauſe great Part of their over-ſtock'd Paſture is loſt by them all, when they hinder one another from reaching down to it, by ſhortening one another's Roots, which they do when they all become *Dwarfs* by reaſon of their Over-thickneſs.

(l) But when it has been planted on rich ſandy Land, and proper, it has produced very great Crops the firſt Year; but then the Summer wherein it grew amongſt the Barley, muſt not be reckoned as the firſt Year.

(as we fansy) for more of such Plants, to make a yet larger Crop; not considering that 'tis the Wideness of those Spaces, and less Number of Plants, that cause the Crop to be so large, there being more Pasture for those Plants.

Where these Spaces are narrower, and the Rows of equal Thickness, we see the Plants less when grown, and that they make a less Crop; and yet there seems to be room for more Rows, which we fansy might make the Crop larger, not considering that 'tis the Narrowness of those Spaces that causes the Plants and Crop to be less, for want of sufficient Pasture.

Thus, fondly increasing the Number of our Rows and Plants, we bring our Crop (unless the Soil be rich) to nothing, by too much over-stocking their Pasture; and, if that Pasture be over-stock'd, the Crop will be diminish'd more than in proportion to that Over-charge; for perhaps 'tis not impossible to prove (if we would be curious), that Plants, by wanting a Fourth Part of their due *Quantum* of Nourishment, will be diminish'd to half *(m)* of the Bulk they would have attained to, had they been supply'd with the other Fourth Patt.

I have observ'd ho'd St. Foin to grow more, and increase its Bulk more, in Two Weeks, than unho'd St. Foin in the same Ground (and without any other Difference) hath done in Six Weeks; and the quicker it grows, by being better fed, the sweeter and richer Food it will make for Cattle, whether it be spent green or dry *(n)*.

(m) When Plants have not their due Nourishment, they suffer the more by Cold and Drought; so that want of Nourishment diminishing their Gr wth One-fourth, Cold, or Drought, or both, may diminish it another fourth.

(n) Cattle are the best Judges of the Goodness of Grass, and they always choose to feed on St Foin that is most vigorous, and refuse that which is poor and yellow. And the richest sweetest Grass will always make the best Hay; for the drying of it does not change the Quality of the Grass.

At

At whatever Diftance the Rows be fet, if they have too many Plants in them, the Crop will be very much injured; and the greater the Excefs is beyond the juft Number, the more void Space there will be amongft them; becaufe the fmaller the Plants are, the lefs Ground they cover.

I have had the Experience of drilling at all Diftances, from Thirty-three Inches to Seven Inches, betwixt the Rows; and recommend the following Diftance, for the different Methods of drilling; whether the *St. Foin* be defign'd for hoeing, or not. As,

Firft, For *Horfe-hoeing*, I think it is beft to drill double Rows with Eight-inch Partitions, and Thirty-inch Intervals; which need only be ho'd alternately, leaving every other Interval for making the Hay thereon.

Indeed I have never yet had a whole Field of ho'd *St. Foin*; but have enough to fhew, that Horfe-hoeing makes it ftrong upon very poor Land, and caufes it to produce two Crops a Year upon indifferent Land.

It is not neceffary to hoe this every Year; but we may intermit the Hoeing for three or four Years together, or more, if the Land be good.

Whilft the Plants are fmall the firft Year, Care muft be taken not to cover them with the Plough: Afterwards there will be no great Danger, efpecially in Winter, the Earth not being fuffered to lie on them too long.

Secondly, For *Hand-hoeing*, drill the Rows Sixteen Inches afunder, and fingle out the Plants, fo as to make them Eight Inches apart at leaft in the Rows, contriving rather to leave the Mafter-plants, than to be exact in the Diftance: This muft be done whilft they are very young, or in Summer; elfe they will come again that are cut off by the Hoe.

Laftly, when *St. Foin* is drill'd without any Intention of hoeing, the beft Way (I think) is to plant fingle Rows, at Eight Inches Diftance, with no greater Quantity of Seed, than when the Rows are at Sixteen Inches Diftance; becaufe, by this Method, the fame Number of Plants in the Rows, that are but Eight Inches apart, will be much more fingle, than thofe in the Rows at Sixteen Inches apart are, without being fet out by the Hoe.

Which of thefe Methods foever is practis'd, the Land fhould be made as clean from all Grafs, and as well pulveriz'd, as poffible, before Drilling.

The Tines of the Drill-harrow muft exactly follow the Shares, which leaving the Chanels open, the Tines cover the Seed, fome at Bottom, and fome on each Side; fo that it is cover'd very fhallow, tho' it lies deep within the Ground, where there is more Moifture, than nearer to the upper level Surface: This caufes the Seed to come up in dry Weather; and yet it is not in Danger of being buried by a too great Weight of Mould incumbent on it.

But take heed that no other Harrow come on it after 'tis drill'd; for that might bury it. I never care to roll it at all, unlefs on account of the Barley; and then only in very dry Weather, with a light Roller, lengthways of the Rows, immediately after 'tis drill'd; or elfe ftay Three Weeks afterwards before it be roll'd, for fear of breaking off the Heads of the young *St. Foin.*

Be fure to fuffer no Cattle to come on the young *St. Foin* the firft Winter *(a)*, after the Corn is cut that

(a) The firft Winter is the Time to lay on Manure, after the Crop of Corn is off; fuch as *Peat-Afhes*, or the like; becaufe, there being no natural Grafs to partake of it, and the Plants being lefs, lefs will fupply them; and becaufe, when made ftrong in their Youth, they will come to greater Perfection: But I never ufed any Manure on my *St. Foin*, becaufe mine generally had no Occafion for Manure before it was old; and *Soot* is feldom to be had of fufficient Quantity in the Country; and little *Coal* is burnt hereabouts, except by the *Smiths*, whofe *Afhes* are not good. The Price and Carriage of *Peat-Afh* will be Ten Shillings for an Acre, which would yet be well beftowed in a Place where Hay is vendible; but, by reafon of the great Quantity of watered Meadows, and Plenty of St. Foin, Clover, and Hay, raifed of late Years by Farmers for their own Ufe,

that grows amongſt it; their very Feet would injure it, by treading the Ground hard, as well as their Mouths by cropping it; Nor let any Sheep come at it, even in the following Summer and Winter.

One Acre of well-drill'd *St. Foin*, conſidering the different Goodneſs of the Crops, and the Duration of it, is generally worth Two Acres of ſown *St. Foin* on the ſame Land, tho' the Expence of drilling be Twenty Times leſs than the Expence of ſowing it.

One of the Cauſes why *St. Foin*, that is properly drill'd, laſteth longer *(b)* without Manure than the ſown, is, That the former neither over nor underſtocks the Paſture; and the latter commonly, if not always, doth one or the other, if not both; *viz.* Plants too thick in ſome Places, and too thin in others; either 'tis not ſingle, but in Bunches; or if it be ſingle, 'tis too thin; it being next to impoſſible to have the Plants come true and regular, or nearly ſo, by ſowing at *random.* Plants too thick ſoon exhauſt the Paſture they reach, which never is more than a ſmall Part of that below the Staple: When the Plants are too thin, the *St. Foin* cannot be ſaid to laſt at all, becauſe it never is a Crop.

They who *ſow* Eight or Ten Buſhels of good Seed on an Acre, in a good Seaſon, among their Corn, with Intent that by its Thickneſs it ſhould kill other Graſs, reduce their *St. Foin* almoſt to that poor Condition I have ſeen it in, where it grows naturally

Uſe, here are now few or no Buyers of Hay, eſpecially theſe open Winters; ſo that laying out Money in that Manner would be in Effect to buy what I cannot ſell. I think it better to let a little more Land lie ſtill in St. Foin, than to be at the Expence of Manure; but yet ſhall not neglect to uſe it, when I ſhall find it likely to be profitable to me.

(b) I have now a great many ſingle *St. Foin* Plants in my Fields, that are near Thirty Years of Age, and yet ſeem as young and vigorous as ever; and yet it is common for thick *St. Foin* to wear out in Nine or Ten Years, and in poor Land much ſooner, if not often manured by *Soot, Peat-Aſh,* or *Coal-Aſh.*

wild

wild without ſowing or Tillage, upon the *Calabrian* Hills near *Croto:* It makes there ſuch a deſpicable Appearance, that one would wonder how any body ſhould have taken it in their Head to propagate ſo unpromiſing a Plant; and yet there has ſcarce been an Exotic brought to *England* in this or the laſt Age, capable of making a greater or more general Improvement, were it duly cultivated.

Some think the *Cytiſus* would exceed it; but I am afraid the Labour of ſhearing thoſe Shrubs by the Hands of *Engliſh* Servants, would coſt too much of its Profit.

Luſerne, requiring more Culture, and being much more difficult to be fitted with a proper Soil, never can be ſo general as *St. Foin.*

But now let us conſider the beſt Methods of ordering *St. Foin* for Hay and Seed. The Profit of *St. Foin* Fields, ariſing from either of theſe Ways, is a great Advantage to their Owner, above that of nanatural Meadows; for, if Meadow-hay cannot have good Weather to be cut in its Seaſon, it can ſerve for little other Uſe than as Dung, and yet the Expence of mowing it, and carrying it off muſt not be omitted. But if there be not Weather to cut *St. Foin* before bloſſoming, we may expect it till in Flower, or may ſtay till the Bloſſoms are off; and if it ſtill rain on, may ſtand for Seed, and turn to as good Account as any of the former: So that it has Four Chances to One of the Meadow.

The elevated, but not mountainous, Situation of the dry Land whereon *St. Foin* is moſtly planted, renders it ſo commodious for making of Hay, that it eſcapes there the Injury of Weather, when Hay in low Meadows is utterly ſpoil'd.

On the high Ground the Wind will dry more in an Hour, than on the Meadows in a whole Day. The Sun too has a more benign Influence above, and ſends off the Dew about Two Hours earlier in the Morning,

Morning, and holds it up as much longer in the Evening. By these Advantages the *St. Foin* has the more Time to dry, and is made with half the Expence of Meadow-hay.

But before the Manner of making it be describ'd, the proper Time of cutting it ought to be determin'd; and upon that depend the Degrees of its Excellence (besides upon the Weather, which is not in our Power); for tho' all Sorts of this Hay, if well made, be good, yet there is a vast Difference and Variety in them.

The several Sorts may be principally distinguish'd by the following Terms; *viz.* First, The *Virgin.* Secondly, The *Blossom'd.* Thirdly, The *Full-grown.* And, Fourthly, The *Thresh'd Hay.*

The First of these is best of all, beyond Comparison; and (except *Luserne)* has not in the World its Equal. This must be cut before the Blossoms appear: For when it stands till full-blown, the most spirituous, volatile, and nourishing Parts of its Juices are spent on the next Generation; and this being done all at once, the Sap is much depauperated, and the *St. Foin* can never recover that Richness it had in its Virgin State. And tho', when in Blossom, it be *literally* in the *Flower* of its Age, 'tis really in the *Declension* of it. If it be said, that what is not in the Stalk is gone into the Flower, 'tis a Mistake; because much the greatest Part of its Quintessence perspires thence into the Atmosphere.

And moreover, That all Vegetables are, in some Degree, weaken'd by the Action of continuing their Kind, may be inferr'd from those Plants which will live several Years, if not suffer'd to blossom; but, whenever they blossom, it causes their Death, tho' in the first Year of their Life. For in Plants (as Dr. *Willis* observes in Animals) Nature is more solicitous to continue the Species, than for the Benefit of the Individual.

Part of a drill'd *St. Foin* Ground was cut the Beginning of *May*, before bloſſoming *(c)*; and from the Time of cutting, until it was ſet up in Ricks, being about Ten Days, the Sun never ſhone upon it *(d)*; but the Weather was miſty: At laſt it was forc'd to be carried together for fear of Rain, ſo green, that out of the largeſt Stalks one might wring milky Juice; yet by making the Hay up in ſeveral little Ricks, and drawing up a great Chaff Baſket in the Middle of each, its Firing was prevented; but it look'd of a dark Colour by heating; and was the very beſt *(e)* Hay that ever I had.

The other Part of the Ground was afterwards cut in the Prime of its Flower, and made into Hay by the Heat of the Sun, without Rain or Miſt: This came out of the Ricks at Winter with a much finer Colour, and as fine a Smell as the Virgin Hay; but did not come near it in fatting of Sheep, or keeping

(c) By cutting before bloſſoming, is not meant before any one Bloſſom appears; for here and there a Bud will begin to open with a red Colour long before the reſt: Therefore, when we perceive only a very few Bloſſoms beginning to open (perhaps but One of a Thouſand), we regard them as none.

(d) This alſo was an Advantage to this Hay; for Apothecaries find, that Herbs dried in the Shade retain much more of their Virtue than thoſe dried in the Sun; but Farmers not having any ſuch Conveniency of drying their Hay in the Shade with Safety, muſt always chooſe to dry it by the Sun; becauſe in cloudy Weather there is Danger of Rain; and therefore ſuch excellent Hay muſt be had by Chance; for to be well made in the Shade, it muſt be in Danger of being ſpoiled or damaged by Rain.

(e) This Hay, ſo cut before bloſſoming, has kept a Team of working Stone-horſes, round the Year, fat without Corn; and when tried with Beans and Oats mixed with Chaff, they refuſed it for this Hay. The ſame fatted ſome Sheep in the Winter, in a Pen, with only it and Water; they thrived faſter than other Sheep at the ſame time fed with Peaſe and Oats. The Hay was weighed to them, and the clear Profit amounted to Four Pounds *per* Tun. They made no Waſte. Tho' the Stalks were of an extraordinary Bigneſs, they would break off ſhort, being very brittle. This grew on rich Ground in *Oxfordſhire*.

Horfes fat at hard Work without any Corn, as the Virgin Hay did.

This fuperfine Hay cannot well be had of poor uncultivated (*f*) *St. Foin*: becaufe that may not be much above an Handful high, when 'tis in Condition to be fo cut; and would then make a very light Crop, and would be a great while ere it fprang up again: But the rich will have Two or Three Tun to an Acre, and fpring again immediately for a fecond Crop; fo that little or no Quantity would be loft by fo great an Improvement of it's Quality. For ho'd *St. Foin* upon a poor chalky Hill, cut at the fame time with that uncultivated on a rich Valley, does in dry Weather grow again without Delay, when the Valley attends a Month or more for a Rain, to excite its vegetative Motion.

This Hay the Owner (if he be wife) will not fell at any common Price; but endeavour to have fome of it every Year, if poffible, for his own Ufe.

The Second Sort of *St. Foin* Hay is that cut in the Flower; and tho' much inferior to the *Virgin* Hay, it far exceeds any other Kind, as yet commonly propagated in *England*; and if it be a full Crop, by good Culture, may amount to above three Tun to an Acre. This is that *St. Foin* which is moft commonly made; and the larger it is, the more nourifhing for Horfes. I have known Farmers, after full Experience, go Three Miles to fetch the largeft ftalky *St. Foin*, when they could have bought the fmall fine leafy Sort of it at home, for the fame Price by the Tun.

The next and laft Sort of *St. Foin* that is cut only for Hay, is, the *full-grown*, the Bloffoms being gone, or going off: This alfo is good Hay, tho' it fall fhort, by many Degrees, of the other Two Sorts: It makes a greater Crop than either of them, becaufe it grows to its full Bulk, and fhrinks little in drying.

(*f*) I reckon Manure of *Peat-Afhes*, *Soot*, or the like, to be a Culture.

This

This gives the Owner a Third Chance of having Weather to make good Hay, and ſpins out the Hay-Seaſon 'till about *Midſummer*; and then in about a Fortnight, or Three Weeks, after the Hay is finiſh'd, the Seed is ripe. But, firſt, of the manner of making *St. Foin* Hay.

In a Day or Two after *St. Foin* is mow'd, it will, in good Weather, be dry on the upper Side: Then turn the Swarths, not ſingly, but Two and Two together; for by thus turning them in Pairs, there is a double Space of Ground betwixt Pair and Pair, which needs but once raking; whereas, if the Swarths were turn'd ſingly, that is, all the ſame Way, ſuppoſe to the *Eaſt* or *Weſt*, then all the Ground will require to be twice raked; at leaſt, more of it, than the other Way.

As ſoon as both Sides of the Swarths are dry from Rain and Dew, make them up into little Cocks the ſame Day they are turn'd, if conveniently you can; for when 'tis in Cock, a leſs Part of it will be expoſed to the Injuries of the Night, than when in Swarth.

Dew, being of a nitrous penetrating Nature, enters the Pores of thoſe Plants it reaches, and during the Night poſſeſſes the Room from whence ſome Part of the Juices is dry'd out: Thus it intimately mixes with the remaining Sap; and, when the Dew is again exhal'd, it carries up moſt of the vegetable Spirits along with it, which might have been there fix'd, had they not been taken away in that ſubtile Vehicle.

If *St. Foin* be ſpread very thin upon the Ground, and ſo remain for a Week in hot Weather, the Sun and Dew will exhauſt all its Juices, and leave it no more Virtue than is in Straw.

Therefore tis beſt to keep as much of our Hay as we can from being expoſed to the Dews, whilſt 'tis in making; and we have a better Opportunity of doing it in this, than in natural Hay; becauſe the bigger the Cocks are, the leſs Superficies (in propor-

tion

tion to the Quantity they contain) will be expoſed to the Dew, and *St. Foin* may be ſafely made in much larger Cocks than natural Hay of equal Dryneſs can, which, ſinking down cloſer, excludes the Air ſo neceſſary for keeping it ſweet, that if the Weather prevents its being frequently mov'd and open'd, it will ferment, look yellow, and be ſpoil'd. Againſt this Misfortune there is no Remedy, but to keep it in the leſſer Cocks, until thoroughly dry. *St. Foin* Cocks (twice as big as Cocks of natural Hay), by the leſs Flexibility of the Stalk admitting the Air, will remain longer without fermenting.

This being able to endure more Days unmov'd, is alſo an Advantage upon another Account beſides the Weather; for tho' in other Countries, People are not prohibited uſing the neceſſary Labour on *all Days* for preſerving their Hay, even where the certainer Weather makes it leſs neceſſary than here, yet 'tis otherwiſe in *England*; where many a Thouſand Load of natural Hay is ſpoil'd by that Prohibition for want of being open'd; and often, by the Loſs of one Day's Work, the Farmer loſes his Charges, and Year's Rent; which ſhews, that to make Hay while the Sun ſhines, is an exotic Proverb againſt *Engliſh* Laws; whereunto *St. Foin* being, in regard of Sundays and Holidays, more conformable, ought to be the Hay as proper to *England* as thoſe Laws are.

But to return to our Hay-makers: When the firſt Cocks have ſtood one Night, if nothing hinder, let them double, treble, or quadruple the Cocks, according as all Circumſtances require, in this manner; *viz.* Spread Two, Three, or more, together, in a freſh Place; and after an Hour or Two turn them, and make that Number up into one Cock; but when the Weather is doubtful, let not the Cocks be thrown or ſpread, but inlarge them, by ſhaking ſeveral of them into one; and thus hollowing them to let in the Air, continue increaſing their Bulk, and diminiſhing their

Number daily, until they be ſufficiently dry to be carried to the Rick.

This I have found the moſt ſecure Way: Tho' it be ſomething longer in making, there is much leſs Danger than when a great Quantity of Hay is ſpread at once; for then a ſudden Shower will do more Harm to one Acre of that, than to Twenty Acres in Cock.

And the very beſt Hay I ever knew in *England*, was of *St. Foin* made without ever ſpreading, or the Sun's ſhining on it. This Way, tho' it be longer ere finiſh'd, is done with leſs Labour than the other.

Not only a little Rain, but even a Miſt, will turn *Clover Hay* black; but *St. Foin* will not with any Weather turn black, until it be almoſt rotten, its Leaves being thinner than thoſe of *Clover*.

If *St. Foin* be laid up pretty green, it will take no Damage, provided it be ſet in ſmall round Ricks, with a large Baſket drawn up in the Middle of each, to leave a Vent-hole there, thro' which the ſuperfluous Moiſture of the Hay tranſpires.

As ſoon as its Heating is over, theſe Ricks ought to be thatch'd; and all *St. Foin* Ricks, that are made when the Hay is full dry'd in the Cocks, ought to be thatch'd immediately after the making them.

That which is laid up moſt dry'd, will come out of the Rick of a green Colour, that which has much heated in the Rick, will have a brown Colour.

The Seed is a Fourth Chance the Owner has to make Profit of his *St. Foin*: But this, if the *Hoeing-Huſbandry* were general, would not be vendible in great Quantities for planting; becauſe an ordinary Crop of an Acre will produce Seed enough to drill an Hundred Acres, which would not want replanting in a long Time.

The other Uſe then of this Seed is for Provender; and it has been affirm'd by ſome, who have made Trials of it, that Three Buſhels of good *St. Foin* Seed

Seed given to Horſes, will nouriſh them as much as Four Buſhels of Oats. When well order'd, it is ſo *ſweet*, that moſt Sorts of Cattle are greedy of it. I never knew ſo much of it given to Hogs, as to make them become fat Bacon; but I have known Hogs made very good Pork with it, for an Experiment; and being valued at the Beginning of their feeding, and the Pork by the Score when the Hogs were kill'd, which, computed with the Quantity of Seed they eat, did not amount to near the Value of the ſame Seed ſold for ſowing; that being Three Shillings *per* Buſhel, and the Profit made by giving it to the Hogs was but Two Shillings a Buſhel.

The Goodneſs of the Seed, and of the Hay out of which it is threſh'd, depends very much upon the manner of ordering them.

This threſh'd Hay, when not damaged by wet Weather, has been found more nouriſhing to Horſes than coarſe Water-meadow Hay; and, when 'tis cut ſmall by an Engine, is good Food for Cattle, and much better than Chaff of Corn.

It requires ſome Experience in it, to know the moſt proper Degree of Ripeneſs, at which the ſeeded *St. Foin* ought to be cut; for the Seed is never all ripe together; ſome Ears bloſſom before others; every Ear begins bloſſoming at the lower Part of it, and ſo continues gradually to do upward for many Days; and before the Flower is gone off the Top, the Bottom of the Ear has almoſt fill'd the Seeds that grow there; ſo that if we ſhould defer cutting until the top Seeds are quite ripe, the lower, which are the beſt, would ſhed, and be loſt.

The beſt time to cut is, when the greateſt Part of the Seed is well fill'd, the firſt-blown ripe, and the laſt blown beginning to be full.

The natural Colour of the Kernel, which is the real Seed, is grey or bluiſh when ripe; and the Huſk, which contains the Seed is, when ripe, of a browniſh

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Colour. Both Hufk and Seed continue perfectly green for fome time after full-grown; and if you open the Hufk, the Seed will appear exactly like a green Pea when gather'd to boil, and will, like that, eafily be fplit into Two Parts. Yet St. Foin Seed in this green Plight will ripen after Cutting, have as fine a Colour, and be as good in all Refpects, as that which was ripe before Cutting: Some, for want of obferving this, have fuffer'd their Seed to ftand fo long, till it was all ripe, and loft in Cutting.

St. Foin Seed fhould not be cut in the Heat of the Day, whilft the Sun fhines out: for then much, even of the unripe Seed, will fhed in Mowing: Therefore, in very hot Weather, the Mower fhould begin to work very early in the Morning, or rather in the Night; and when they perceive the Seed to fhatter, leave off, and reft till towards the Evening.

After Cutting we muft obferve the fame Rule as in mowing it; *viz.* not to make this Hay whilft the Sun fhines.

Sometimes it may, if the Seed be pretty ripe, be cock'd immediately after the Scythe; or if the Swarths muft be turn'd, let it be done whilft they are moift; not Two together, as in the other Hay aforemention'd. If the Swarths be turn'd with the Rake's Handle, 'tis beft to raife up the Ear-fides firft, and let the Stub-fide reft on the Ground in turning; but if it be done by the Rake's Teeth, then let them take hold on the Stub-fide, the Ears bearing on the Earth in turning over. But 'tis commonly Rain that occafions the Swarths to want Turning *(a)*.

If it be cock'd at all *(b)*, the fooner 'tis made into Cocks, the better; becaufe, if the Swarths be dry,

(a) If the Swarths be not very great, we never turn them at all, becaufe the Sun or Wind will quickly dry them.

(b) Sometimes when we defign to threfh in the Field, we make no Cocks at all, and but only juft feparate the Swarths in the

dry, much of the Seed will be loſt in ſeparating them, the Ears being entangled together. When moiſt, the Seed ſticks faſts to the Ear; but, when dry, will drop out with the leaſt Touch or Shaking.

There are Two ways of threſhing it, the one in the Field, the other in the Barn: The firſt cannot be done but in very fine Weather, and whilſt the Sun ſhines in the Heat of the Day: The beſt Manner of this is, to have a large Sheet pegg'd down to the Ground, for Two Men with their Flails to threſh on: Two Perſons carry a ſmall Sheet by its Corners, and lay it down cloſe to a large Cock, and, with Two Sticks thruſt under the Bottom of it, gently turn it over, or lift it up upon the Sheet, and carry and throw it on the great Sheet to the Threſhers; but when the Cocks are ſmall, they carry ſeveral at once, thrown upon the little Sheet carefully with Forks; thoſe which are near, they carry to the Threſhers with the Forks only. As faſt as it is threſh'd, one Perſon ſtands to take away the Hay, and lay it into an Heap: And ſometimes a Boy ſtands upon it, to make it into a ſmall Rick of about a Load. As often as the great Sheet is full, they riddle it thro' a large Sieve to ſeparate the Seed and Chaff from the broken Stalks, and put it into Sacks to be carried into the Barn to be winnow'd.

Two Threſhers will employ Two of theſe little Sheets, and Four Perſons in bringing to them; and when the Cocks are threſh'd, which ſtand at a conſiderable Diſtance all round them, they remove the Threſhing-ſheet to another Place. There belong to a Set for one Threſhing-ſheet Seven or Eight Perſons; but the Number of Sheets ſhould be according to the

the Dew of the Morning dividing them into Parts of about Two Feet in each Part. By this means the St. Foin is ſooner dry'd, than when it lies thicker, as it muſt do, if made into Cocks.

Quantity to be thus thresh'd: The sooner these thresh'd Cocks are remov'd, and made into bigger Ricks, the better; and unless they be thatch'd, the Rain will run a great Way into them, and spoil the Hay; but they may be thatch'd with the Hay itself, if there be not Straw convenient for it.

But the chiefest Care yet remains; and that is, to cure the Seed: If that be neglected, it will be of little or no Value *(a)*; and the better it has escap'd the Wet in the Field, the sooner its own Spirits will spoil it in the Barn or Granary. I have known it lie a Fortnight in Swarth, till the wet Weather has turn'd the Husks quite black: This was thresh'd in the Field, and immediately put into large Vessels, holding about Twenty Bushels each. It had by being often wet, and often dry, been so exhausted of its fiery Spirits, that it remain'd cool in the Vessels, without ever fermenting in the least, till the next Spring; and then it grew as well as ever any did that was planted.

But of Seed thresh'd in the Field, without ever being wetted, if it be immediately winnow'd, and a single Bushel laid in an Heap, or put into a Sack,

(a) But there is yet another Care to be taken of St. Foin Seed, besides the curing it; and that is, to keep it from Rats and Mice after 'tis cured; or else, if their Number be large, they will in a Winter eat up all the Seed of a considerable Quantity, leaving only empty Husks, which to the Eye appear the same as when the Seeds are in them. A Man cannot without Difficulty take a Seed out of its Husk; but the Vermin are so dextrous at it, that they will eat the Seed almost as fast out of the Husks, as if they were pulled out for them. I saw a Rat killed as he was running from an Heap of it, that had Seven peeled Seeds in his Mouth not swallowed; which is a Sign, that he was not long in taking them out. They take them out so cleverly, that the Hole in the Husk shuts itself up when the Seed is out of it. But, if you feel the Husk between your Finger and Thumb, you will find it empty. Also a Sackful of them is very light; yet there have been some so ignorant and incurious as to sow such empty Husks for several Years successively; and none coming up, they concluded their Land to be improper for St. Foin.

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it will in few Days ferment to ſuch a Degree, that the greateſt Part of it will loſe its vegetative Quality: The larger the Heap, the worſe: During the Fermentation it will be very hot, and ſmell ſour.

Many, to prevent this, ſpread it upon a Malt-Floor, turning it often; or, when the Quantity is ſmall, upon a Barn-floor; but ſtill I find, that this Way a great deal of it is ſpoil'd; for it will heat, tho' it be ſpread but an handful thick, and they never ſpread it thinner: Beſides, they may miſs ſome Hours of the right times of turning it; for it muſt be done very often; it ſhould be ſtirr'd in the Night as well as the Day, until the Heating be over; and yet, do what they can, it never will keep its Colour ſo bright as that which is well houſed, well dry'd, and threſh'd in the Winter: For in the Barn the Stalks keep it hollow; there are few Ears or Seeds that touch one another; and the Spirits have room to fly off by Degrees, the Air entering to reeeive them.

The only Way I have found to imitate and equal this, is to winnow it from the Sheet; then lay a Layer of Wheat-ſtraw (or if that be wanting, of very dry-threſh'd Hay); then ſpread thereon a thin Layer of Seed, and thus *Stratum ſuper Stratum*, Six or Seven Feet high, and as much in Breath; then begin another Stack; let there be Straw enough, and do not tread on the Stacks; by this means the Seed mixing with the Straw, will be kept cool, and come out in the Spring with as green a Colour as when it was put in, and not one Seed of a Thouſand will fail to grow when planted. A little Barn-room will contain a great Quantity in this Manner.

I have had above One hundred Quarters of clean Seed thus manag'd in one Bay of a ſmall Barn. We do not ſtay to winnow it clean before we lay it up in the Straw; but only paſs it through a large Sieve, and with the Van blow out the Chaff, and winnow it clean in the Spring.

This Field-threſhing requires extraordinary fine Sun-ſhiny Weather, which ſome Summers do not afford at the Seaſon, for threſhing a great Quantity of it; for 'tis but a ſmall Part of the Day in which the Seed can be threſh'd clean out. They who have a ſmall Quantity of it, do carry it into a Barn early in the Morning, or even in the Night; whilſt the Dew is on it; for then the Seed ſticks faſt to the Ear: As it dries, they threſh it out; and if they cure it well, have thus ſometimes good Seed, but generally the Hay is ſpoil'd.

There is one Method of ſaving all the Seed good, and the Hay too, by carrying it unthreſh'd to the Barn or Rick, in a particular Manner, tho' it be a great Quantity, more than can preſently be threſh'd; but muſt be laid up in Mows or Ricks, as Corn is. Then if it be carry'd in, in the Dews or Damp, the Hay is ſure to be ſpoil'd, if not both Hay and Seed: When 'tis taken up dry, the Seed comes out with a Touch, and the greateſt Part is loſt in pitching up the Cocks, binding and jolting in carrying home.

To avoid this Dilemma, a Perſon who happen'd to have a great Crop of Seed on One hundred and Fifty Acres together (and being by Weather delay'd 'till Wheat-harveſt came on, ſo that moſt Labourers went to Reaping) was forc'd to a Contrivance of getting it in as follows; *viz* Three Waggons had each a Board with an Hole in, fix'd croſs the Middle of each Waggon, by Iron Pins, to the Top of the Rades or Sides: There was a Crane which a Man could lift, and ſet into the Hole in the Board, and, having an Iron Gudgeon at the Bottom, which went into a Socket in the Bottom of the Waggon, would turn quite round: The Poſt of the Crane was Ten Feet Four Inches long, its Arm Four Feet Eight Inches long, brac'd; having a treble Pulley at the End of it, and another to anſwer it with an Hook.

About

About Forty Sheets were provided, capable of holding each One hundred and Fifty, or Two hundred Pounds Weight of it; theſe had Knots or Buttons at the Corners and Middles, made by ſewing up a little Hay in theſe Knots, as big as Apples, into Part of the Sheet; for if any Buckle, or other thing, be ſew'd to a Sheet plain, it will tear the Sheet. Half theſe Buttons have Strings ty'd to them; theſe Sheets are ſpread among the Cocks, fill'd by Two, and ty'd up by Two other Perſons: There is alſo a light Fir Ladder, wide at Bottom, the Top of it faſten'd by a Piece of Cord to the brace of the Crane: they hitch the Hook of the lower Pulley to a fill'd Sheet, and by a little Horſe at the End of the Pulley-rope, draw it up ſliding on the Ladder; 'tis up in a Moment: Then the Man who is below, hitches the Crook of the Pulley to the lower Round of the Ladder, and the Loader above pulls up the Ladder from the Ground, till the Waggon comes to another Sheet. The Waggons are lengthen'd by Cart-Ladders before and behind, for the more eaſy placing of the Sheets. When about Twelve or Fifteen of them are loaded, they have a Rope fix'd to the Fore-part of each Waggon, which they bring over the Top of all the loaded Sheets, and wreſt it at the Tail, to hold on the Sheets faſt from falling off with Jolting. Then the Loader pulls out the Crane, and puts it into the next Waggon in the ſame Manner. One Waggon is loading whilſt another is emptying in the Barn, by treble Pulleys likewiſe; becauſe 'tis inconvenient to take it out of the Sheets by Prongs; but the Pulleys will eaſily draw off Two or Three Sheets together. One Waggon is always going to the Field, or coming home. This Contrivance makes more Expedition than one would imagine: Three Loads have been loaded, and ſent off, in the ſame Time this way, that one Load of Hay has been loading, binding, and raking off the Outſides

ſides of it, in the next Ground, in the common Way.

I will not relate the manner of making a Rick of this Seed in its Hay, of monſtrous Dimenſions, by a ſort of Maſt-pole Forty-four Feet high, with a Ten Feet Crane at the Top, which made the ſame Expedition; becauſe I think, that where ſuch a Quantity is, *Dutch* Barns with moving Roofs are better. Such a Rick is troubleſome to thatch, and the Wind has more Power to blow the Thatch off ſo high in the Air, than if it were lower. Neither would I adviſe any one to reſerve much more St. Foin for Threſhing, than his Barn will contain; becauſe tho' ſometimes it brings the greateſt Profit by Threſhing, yet ſome Years 'tis apt to be blighted.

I have been told by my Neighbour, that he had a Crop of Five Quarters of St. Foin Seed on an Acre; but the moſt Profit that ever I took notice of, was on half an Acre, which was drill'd very thin, and had no Crop of Corn with it; by which Advantage it produc'd a good Crop of Seed the next Year after it was planted, and the Third Year this Half-Acre produc'd (as was try'd by a Wager) within a Trifle of Two Quarters of Seed, which was ſold for Two Pounds and Ten Shillings: The threſh'd Hay of it was ſold in the Place for One Pound, and Two Quarters of Chaff ſold for Twelve Shillings; in all Four Pounds and Two Shillings. There was alſo a very good Aftermath, which was worth the Charges of Cutting and Threſhing: So that the clear Profit of the One Year of this Half Acre of Ground amounted to Four Pounds Two Shillings: And it was remarkable, that at the ſame Time the reſt of the ſame Field, being in all Ten Acres, had a Crop of Barley ſown on Three Plowings, which (the Summer being dry) was offered to be ſold at One Pound *per* Acre.

I believe

I believe the greateſt Part of the St. Foin that is ſown, is ſpoil'd by being indiſcreetly fed by Sheep *(b)*; which Damage is occaſion'd merely by ſuffering them to continue feeding it too long at a Time, eſpecially in the Spring; for then the Sap moves quick, and muſt be depurated by the Leaves; and as the Sun's nearer Approach accelerates the Motion or Ferment of the Juices, more *Pabulum* is receiv'd by the Roots; but for want of Leaves to diſcharge the Recrements, and enliven the Sap with nitro-aereous Particles (the Sheep devouring the Buds continually as faſt as they appear), the St. Foin's vital Flame (if I may ſo call it) is extinguiſh'd; the Circulation ceaſing, the Sap ſtagnates, and then it ends in Corruption *(c)*. But let the Sheep eat it never ſo low, in a ſhort time, without continuing thereon, or cropping the next Buds which ſucceed thoſe they have eaten, the Plants will recover and grow again as vigorouſly as ever, and if with a Spade, in the Winter you cut off the St. Foin Heads an Handful deep, and take them away, together with their upper Earth, the Wound in the remaining Root will heal, and ſend out more Heads as good as thoſe cut off, if thoſe ſecond Heads be preſerv'd from Cattle, until they attain to a Bigneſs competent to bear Leaves ſuffi-

(b) I never ſuffer Sheep to come upon St. Foin, except betwixt Mowing-time and *All-Saints*. And there is ſo much Danger of ſpoiling St. Foin by the Fraud of Shepherds, that I knew a Gentleman that bound his Tenant never to ſuffer any Sheep to come thereon; and by this means his St. Foin continued in Perfection much longer than is uſual, where St. Foin is ſuffer'd to be fed by Sheep.

(c) Natural Graſs is not kill'd by conſtant feeding, becauſe no ſort of Cattle can bite it ſo low as to deprive it of all its Leaves; and 'tis, like Eels, more tenacious of Life than the reſt of its Genius, and will ſend out Leaves from the very Roots when reverſed, as is too often ſeen where turffy Land is plow'd up in large Furrows.

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cient for the Uſe of the reviving Plants: Nay, I have ſeen Plants of St. Foin cut off in the Winter a Foot deep, and the Earth of that Depth taken away; and the remaining Root recover'd, and grew to an extraordinary Bigneſs: But this was preſerv'd from Cattle at firſt.

I eſteem St. Foin to be much more profitable than Clover, becauſe St. Foin is never known to do any perceivable Damage to the Corn amongſt which 'tis planted; but Clover often ſpoils a Crop of Barley *(a)*; and I have known, that the Crop of Barley has been valued to have ſuffer'd Four Pounds *per* Acre Damage by a Crop of broad Clover's growing in it in a wet Summer: In a dry Summer both Sorts of Clover are apt to miſs growing; and if it does grow, and the next Summer (wherein it ought to be a Crop) prove very dry, it fails on moſt ſorts of Land, tho' it was vigorous enough to ſpoil the Barley the Year it was ſown; at beſt, 'tis of but very ſhort Duration, and therefore is not to be depended on by the Farmer, for maintaining his Cattle, which the broad Clover will alſo kill, ſometimes by cauſing them to ſwell, unleſs great Care be taken to prevent it. The broad Clover is eſteem'd a foul Feed for Horſes. The Hop Clover is gone out of the Ground ſooner than the broad Clover; I never knew it cut more than once: Indeed Cattle are never ſwollen by feeding on it; but then it affords but very little Feeding for them, except the Land whereon it grows be very rich.

St. Foin is obſerv'd to enrich whatever Ground 'tis planted on, tho' a Crop be taken off it yearly.

(a) But this Damage may be prevented by drilling the Clover after the Barley is an Handful high or more; for then the Barley will keep it under, and not ſuffer it to grow to any conſiderable Bigneſs till after Harveſt; nor will this Drill, being drawn by Hand, do any Damage to the Barley.

Poor

Poor Slate Land *(a)*, when it has borne ſown St. Foin for Six or Seven Years, being plow'd up, and well till'd, produces Three Crops of Corn; and then they ſow it with St. Foin again.

Rich arable Land was planted with it, and mow'd annually with very great Crops ('twas drill'd in Nine-inch Rows, with Six Gallons of Seed to an Acre; One Crop of it was ſold at Four Pounds *per* Acre): This, after about Seven Years, and in full Perfection, was plow'd up by a Tenant, and continued for many Years after ſo rich, that, inſtead of dunging or fallowing it for Wheat, they were forc'd to ſow that upon Barley-ſtubble, and to feed the Wheat with Sheep in the Spring, to prevent its being too luxuant.

But 'tis to be noted, that the Land muſt be well till'd at the breaking up of old St. Foin, or elſe the Firſt Crops of Corn may be expected to fail: For I knew a Tenant, who, the laſt Year of his Term, plow'd up a Field of St. Foin, that would have yielded him Three Pounds *per* Acre; but, thinking to make more Profit of it by Corn, he ſow'd it with White Oats upon once Plowing; and it proving a dry Summer, he loſt his Plowing and Seed; for he had no Crop of Oats, and was forc'd to leave the Land as a Fallow to his Succeſſor.

Many more Inſtances there are of this Failure of the Crop of Corn after St. Foin has been broken up, and not well till'd.

(a) The Poverty of this ſort of Land, lying upon Slate or Stone, generally proceeds from the Thinneſs of it; and, if it were thicker, it would be good Land: Much of this Earth, being diſperſed among the Crannies or Interſtices of the Slate and Stone to a great Depth, is reach'd by the Tap-roots of the St. Foin, but cannot be reach'd by the Roots of Corn; and therefore, when conſtantly kept in Tillage, is of ſmall Value: Upon which Account ſuch Land is greatly improveable by St. Foin, even when ſown in the common manner.

When St. Foin is grown old, and worn out, as 'tis ſaid to be when the artificial Paſture is gone, and the natural Paſture is become inſufficient for the Number of Plants that are on it, to be maintained; and is ſo poor, that it produces no profitable Crop, ſo that the Ground is thought proper to be plow'd up, and ſown with Corn, in order to be replanted *(a)*; the moſt effectual Way to bring it into Tilth ſpeedily, is, to plow it up in the Winter, with a Four-coulterd Plough, and make it fit for Turneps by the following Seaſon; and if the Turneps be well ho'd, and eſpecially if ſpent by Sheep on the Ground, 'twill be in excellent Order to be ſown with Barley the following Spring; and then it may be drill'd with St. Foin amongſt the Barley.

To return to the Benefit Land receives by having been planted ſome Years with St. Foin: All the Experienc'd know, that Land is enriched by it; but they do not agree upon the Reaſon why.

They agree as to the Ὅτι, but not the Διότι.

Some are of Opinion, 'tis becauſe the St. Foin takes a different Sort of Nouriſhment to that of

(a) Or if you perceive, that there is a competent Number of Plants alive, and tolerably ſingle; be they never ſo poor, you may recover them to a flouriſhing Condition in the following manner, without replanting: Pulverize the whole Field in Intervals of about Three Feet each, leaving betwixt every Two of them Four Feet Breadth of Ground unplow'd. When the Turf of theſe Intervals, being cut by the Four coulter'd Plough, is perfectly rotten, one Furrow made by any ſort of Plough will hoe one of theſe Intervals, by changing the whole Surface of it. The poorer the Land is, the more Hoeings will be required; and the oftener 'tis ho'd, with proper Intermiſſions the firſt Year, the ſtronger the St. Foin will become, and the more Years it will continue good, without a Repetition of Hoeing.

The Expence of this cannot be great; becauſe the Plough, in hoeing an Acre in this manner Nine Times, travels no farther than it muſt to plow an Acre once in the common Manner.

I need not tell the Owner, that the Earth of theſe Intervals muſt be made level, before the St. Foin can be mowed.

Corn:

Corn: But that I think is diſprov'd in the Chapter of *Change of Species*, where 'tis ſhewn, that all Plants in the ſame Soil muſt take the ſame Food.

Mr. *Kirkham* thinks St. Foin has no collateral or horizontal Roots in the upper Part of the Ground where the Plough tills for Corn; and therefore has no Nouriſhment from that Part of the Soil which feeds the Corn. This would be a very good Account for it, were it not utterly contrary to Matter of Fact, as every one may ſee.

But ſo far it is right, that large *(a)* St. Foin draws the greateſt Part of its Nouriſhment from below the Reach of the Plough; and what Part it does receive from the Staple is overbalanc'd by the Second Crop, or After-leaſe, being ſpent by Cattle on the Ground; different from Corn, which is very near wholly maintain'd by the plow'd Part of the Earth, and is all carry'd off.

For tho' the under *Stratum* of Earth be much poorer than the upper; yet that, never having been drain'd by any ſort of Vegetables, muſt afford conſiderable Nouriſhment to the Firſt that comes there.

And beſides, in ſuch Land whoſe Poverty proceeds from the Rain's carrying its Riches too quickly down through the upper *Stratum*, the under *Stratum* muſt be the richer *(b)* for receiving what the upper *Stratum* lets paſs unarreſted.

(a) For large St. Foin, being ſingle, has large Roots, and very long, which probably deſcend Twenty Feet deep: Now, if we allow Four or Five Inches the Depth of the Staple, to afford a Supply equal to Two Feet below it, taking the lower Nineteen Feet Seven Inches together, upon this Computation, the Part below the Staple gives the St. Foin about Nine Parts in Ten of its Suſtenance.

(b) In light poor Land the Water carrying ſome impregnated Earth along with it down lower than it does in ſtrong Land, that is more tenacious of ſuch impregnated Particles, the under *Strata* of ſtrong Land are likely to be poorer than thoſe of light Land.

'Tis

'Tis well known, that many Eſtates have been much improv'd by St. Foin; therefore there is no occaſion to mention Particulars. Only I will take Notice, that the Firſt in *England* was one of about One hundred and Forty Pounds *per Annum*, ſown with St. Foin, and ſold for Fourteen Thouſand Pounds; and as I hear, continues, by the ſame Improvement, ſtill of the ſame Value. This is, I ſuppoſe, the ſame that Mr. *Kirkham* mentions in *Oxfordſhire*.

Another Farm of Ten Pounds *per Annum* Rent, which, whilſt in Arable (*a*), was like to have undone the Tenant; but being all planted with St. Foin by the Owner, was lett at One hundred and Ten Pounds *per Annum*, and prov'd a good Bargain.

If it ſhould be aſk'd, Why St. Foin is an Improvement ſo much greater in *England*, than in other Countries? it might be anſwer'd by ſhewing the Reaſon why *Engliſh* Arable is of ſo much leſs Value than Foreign (*b*) where the Land is of equal Goodneſs, and the Corn produc'd of equal Price.

CHAP. XIII.

Of LUSERNE.

LA *Luſerne* is that famous *Herba Medica* ſo much extoll'd by the Antients.

The high Eſteem they had of its Uſe appears by the extraordinary Pains they beſtow'd on its Culture.

(*a*) Theſe Eſtates conſiſted of thin Slate Land; which before it was planted with St. Foin, was valued at two Shillings *per* Acre, and ſome Part of it at One Shilling *per* Acre (as I have been inform'd); and yet Oxen are well fatted by the St. Foin it produces.

(*b*) 'Tis doubtleſs from the extraordinary Price of *Engliſh* Labour above that of other Countries, occaſioned by *Engliſh* Statutes being in this Reſpect different from all other Laws in the World.

Its

Its Leaves resemble those of Trefoil: It bears a blue Blossom very like to double Violets, leaving a Pod like a Screw, which contains the Seeds about the Bigness of broad Clover, tho' longer, and more of the Kidney-shape.

The Stalks grow more perpendicular than any of the other artificial Grasses that I know, slender, full of Knots and Leaves: 'Tis of very near an equal Bigness from Bottom to Top: When cut, if vigorous, the Stalks will spring out again from the Stubs, immediately below where the Scythe parted them; which makes them the sooner ready for another Mowing; an Advantage which no other Grass has.

It has a Tap-root that penetrates deeper into the Bowels of the Earth, than any other Vegetable she produces.

Tho' one Luserne-root be much more taper than another towards the upper Part of it, 'tis sometimes seen, that a single ho'd Plant of it has many of these perpendicular Roots, some of them springing out from the very Branches of its Crown.

Its Roots are abundantly longer than the Roots of St. Foin: I have One that measures very near Two Inches Diameter: Those which are higher than the Ground have a Bark like a Tree. Upon this account, and by its Stalks springing again just below the Place where cut off, and by the woody Hardness of its Stalks, when they stand too long without cutting, it seems that Luserne is of a Nature nearly approaching to that of a Shrub.

Luserne is the only Hay in the World that can pretend to excel or equal St. Foin. I have known Instances of the pinguefying Virtue of this *Medica Hay*, that come up to the highest Encomiums given it by the *Romans*; which being to the Vulgar incredible, I forbear to relate, but leave to be confirm'd by the Experience of others, when it becomes frequent in *England*.

Luſerne in Graſs is much ſweeter than St. Foin, or any other artificial or natural Graſs. This, when ho'd, may be given to Cattle cut green, for Six Months; but then Care muſt be taken to (*a*) prevent their Swelling by its Luſciouſneſs, and not to give them too much at once, until they be accuſtom'd to it.

The Quantities of Luſerne Seed annually imported, and ſown without Succeſs, not diſcouraging People from continuing its Importation, ſhews there is more need of a ſucceſsful Way of Planting, than recommending it in *England*.

I ſhall take Notice of ſome of the Reaſons why I conclude there is no Hope of making any Improvement by planting it in *England*, in any manner practis'd by the Antients or Moderns.

I wonder how any one ſhould attempt to plant it here, who has ſeen in *Columella*, and other Authors, the Deſcription of the manner the old *Romans* planted it in. They choſe out the very beſt Land, that was both *pinguis* and *putris*; they dung'd and till'd it to the greateſt Perfection, and laid it out in Beds, as we do for Onions or Aſparagus; they ſow'd it

(*a*) The Swelling of Cattle by eating too much green Luſerne, Clover, or Turnep-leaves, happens only to ſuch as chew the Cud, becauſe they ſwallow more in leſs Time than other Cattle do; and a large Quantity of ſuch luſcious Greens being ſwallow'd by a Beaſt, fermenting to a great Degree, heats and rarifies the internal Air, which by its Spring becoming too ſtrong for that Column of the Atmoſphere that enters at the Trachea, it preſſes the Lungs againſt the Thorax ſo cloſely, that the Weight of the external Column is not of Force to open their Veſicles, and then the Circulation of the Blood is ſtopt, and the Beaſt is ſtrangled.

Moſt Farmers know how to prevent the Swelling, ſo that now-a-days it ſeldom happens; but when it does, there is an effectual way of curing it, if taken in Time: They cut a Hole into the Maw near the Back in a proper manner, whereat the rarified Air ruſhes out, and the Lungs again perform their Action of Reſpiration.

very

very thick, for that miserable Reason of enabling it by its Thickness the better to kill the Grass. The Beds being harrow'd very fine before Sowing, which was in the End of *April*; the Seed required to be speedily cover'd, lest the Sun's Heat should spoil it. But with what Instrument must it be cover'd? For, after Sowing, the Place must not be touch'd with Iron. *At medica obruitur non aratro, sed ligneis rastellis.* '*Medica*-seed is cover'd, not with the 'Plough, but with little (or rather light) wooden 'Harrows.' Two Days Work (of a Team) were spent on this Harrowing of one Acre. Some time after it came up, they scratch'd it again and again with the same wooden Instruments: This was call'd Sarrition: Then by Runcation they weeded it over and over, *Ne alterius generis herba invalidam medicam perimat.* 'Lest 'other Grass should kill it whilst it was weak.' The First Crop they let stand till some of the Seed shatter'd, to fill the Ground yet fuller of Plants: After that they might cut it as young as they pleas'd; but must be sure to water it often after cutting. Then after a few Days, when it began to spring, they repeated their Runcation: and so continuing to weed out all manner of Grass for the First Two or Three Years, it used to bring Four or Six Crops a Year, and last Ten Years.

English Gardeners make Forty Pounds of an Acre of Asparagus, or Cabbage-plants, with half the Labour and Expence that was bestow'd on an Acre of *Roman Medica*.

We know not the Price Hay and Grass were at in *Italy*, while the *Roman Empire* was in its Glory, and *Rome*, then the Metropolis of the World, drew the Riches of all Parts thither; its Price must be then very high.

And the *Romans* had not only Servants, but plenty of Slaves, for whom they had scarce sufficient Employment: This might lessen the Expence of this tedious Method of Planting, and ordering the *Medica*. But when the *Romans* were brought down to the Level of other Nations, and in Danger of being Slaves, inftead of having them; and the Lands of *Italy* came to be cultivated by *Italian* Hands only; they found fomething elfe more neceffary to employ them in, than the Sarritions, Runcations, and Rigations of the *Medica*. Their Labour being beftow'd in getting Bread for themfelves, they fubftituted other artificial Graffes of more eafy Culture, in the room of *Medica*, for the Food of their Cattle. They were fo bigotted to all the Superftitions of their Anceftors, that they were content to lofe the Ufe of that moft beneficial Plant, rather than attempt to cultivate it by a new, tho' more rational Method, when they were become unable any longer to continue it by the old.

Thus, as I take it, Superftition has chafed *Medica* from the *Roman* Territories, and fo little of it is planted there, that beyond the *Alps* I could not find one whole Acre of it.

Luferne makes a great Improvement in the South of *France*: There, when their low fandy Land is well prepar'd, and very clean, they fow it alone, in *March*, and at *Michaelmas*, as we do Clover: Their fowing it at thofe Seafons is of a double Advantage: Firft, it faves the Labour of watering it, which would be impracticable for fo many thoufand Acres, as there are planted. Secondly, Thofe Seafons being much moifter than that wherein the *Romans* fow'd it, the Grub has Opportunity of eating more of it at its firft coming up; and often the Froft kills fome of it. By thefe Advantages the Ground is lefs overftock'd.

The Summers there are much drier than in *Italy*, fo that the Sun fcorches up the natural Grafs, and fuffers it not to come to a Turf till after fome Years; and therefore has lefs need of Weeding.

But

But as that natural Graſs increaſes, the Crops of Luſerne are proportionably diminiſh'd: And tho' Luſerne is ſaid to laſt Ten or Twelve Years; yet it is in Perfection only for a very few Years. Whilſt it is at beſt on their richeſt Land, and in a kind Summer, they have at Seven Crops Ten Tuns to an Acre, as I have computed them from the Relation of ſome of the Inhabitants of *Pezenas*. This was extraordinary: for I obſerv'd, that moſt of their common Crops made a very thin Swarth.

When the Ground begins to be turffy and hard, many of the Luſerne-plants die, and the reſt ſend up very few Stalks: The People know this is the Deſtruction of it, and therefore I have ſeen ſome of them, in that Caſe, half-plow it, thinking thereby to deſtroy the Turf: This does for a time much ſtrengthen the Luſerne-plants; but it ſo much ſtrengthens the Graſs alſo, that the Turf grows the ſtronger; and then there is no Remedy but to plow it up, make the Ground clean, and replant it.

In more Northern Climates, where it rains oftener, the Ground ſooner becomes hard; and in the Land otherwiſe moſt proper for Luſerne, the Graſs grows infinitely faſter, and will be as ſtrong a Turf in Two Years, as in the hot Countries in Ten. Upon this Account, about *Paris*, even near the Walls, they plow up Luſerne, and ſow St. Foin in its room, becauſe that endures Graſs and hard Ground better, tho' it brings but One Crop a Year, or Two at moſt.

And in many Places in *Franche Comtè* and *Switzerland*, I have ſeen Luſerne in the Corners of Vineyards, not above Two or Three Perches together, which they will at any Expence have to cure their Horſes when ſick; ſince they cannot obtain, by their Culture, Quantities ſufficient to maintain them as their ordinary Food, there being too much Rain, and too little of the Sun's violent Heat, to prevent the ſpeedy Increaſe of Graſs amongſt it.

How then can we expect Succeſs in ſowing it in *England*, where Rains are yet more frequent, and the Sun is weaker? 'Tis not One Year in Ten, that the natural Graſs is here ſcorch'd up. In our rich Land the Graſs comes to a Turf very ſoon, and poor Land will not by the common Sowing bring Luſerne to any Perfection, tho' no Graſs ſhould annoy it.

I have here ſeen Part of a Meadow Breaſt-plow'd, and, when the Turf was dead, dug up and planted as a Garden: After it had been drill'd with Carrots, ho'd, and made, in all Appearance, perfectly clean, it was ſown with Luſerne, which came up and flouriſh'd very well the Firſt Year, and indifferently the Second; but, after that, the Graſs came, and the Luſerne grew faint; and in Three or Four Years time there was no more left, but juſt to ſhew by here-and-there a ſingle poor Stalk, that there had been Luſerne ſown, except one Plant of it, which was cleanſed of Graſs the Third Year; and this recover'd, and ſent up Abundance of Stalks for Two Years after it; and then the Graſs returning, that Plant dwindled again.

I have often try'd it in the richeſt Part of my Garden, and conſtantly find, that, however vigorouſly it grows at the firſt, yet it ſoon declines, when the Graſs appears amongſt it, which is always the ſooner, by how much the Soil (in *England*) is richer, unleſs the Spade or Hoe prevent it.

Here have been alſo many Fields of a poorer white-iſh Soil ſown with it, which are not very ſubject to be over-run with Graſs, as the rich Land is; and tho' theſe were ſo well till'd as ſcarce any Graſs appear'd, during the many Years the Luſerne liv'd therein, yet it never grew to any Perfection here neither; nor was there any one Crop worth much more than the Cutting, it was always ſo poor, thin, and ſhort. And, by what Intelligence I can get, all

Experience proves, that every Soil in this Iſland is too rich, too poor, or too cold, for the Luſerne Improvement by the common Huſbandry.

I believe every one will be confirmed in this, who ſhall upon full Inquiry find, that, amongſt the great Quantities which have been ſown in this Kingdom in that manner, never any of it was known to continue good and flouriſhing Three Years; and that, on the contrary, never any one Plant of it in any warm Soil, cultivated by the Hoeing manner, was known to fail here, or in any other Country, as long as the Hoeing (or Digging about it, which is equivalent) was continued to it with proper Repetitions.

A Multitude of ſuch hoed Plants have I known, and are now to be ſeen in both poor and rich Lands: Therefore it ſeems poſſible, that Thouſands of *Engliſh* Acres may be capable, by the Hoeing Culture, to produce Crops of Luſerne every Year for an Age. For as the greater Moiſture, and leſs intenſe Heat of this Climate, are, upon the Accounts mentioned, injurious to Luſerne, yet this is only to ſuch as is ſown and cultivated in the common Manner, becauſe our Climate, upon the very ſame Accounts, is very advantageous to hoed Luſerne.

In hot Countries, when the Summer is drier than ordinary, the Sun ſo ſcorches it, that they have fewer and much poorer Crops, than in moiſter Summers; *viz.* only Four or Five, inſtead of Six or Seven; but, in the drieſt Summer I ever knew in *England*, hoed Luſerne yielded the moſt Crops.

Our Summer Days are longer, have more of the Sun's Warmth, and leſs of his fiery Heat; he cheriſhes, but never burns Luſerne, or any other hoed long Tap-rooted Plant in *England*.

The well hoed Earth, being open, receives and retains the Dews; the benign ſolar Influence is ſufficient to put them in Motion, but not to exhale them from thence. The Hoe prevents the Turf, which would otherwiſe by its Blades or Roots intercept, and return back the Dews into the Atmoſphere, with the Aſſiſtance of a moderate Heat. So that this Huſbandry ſecures Luſerne from the Injury of a wet Summer, and alſo cauſes the Rain-water to ſink down more ſpeedily, and diſperſe its Riches all the Way of its Paſſage; otherwiſe the Water would be more apt to ſtand on the Surface, chill the Earth, and keep off the Sun and Air from drying it: For, when the Surface is dry and open, Luſerne will bear a very great Degree of Heat, or grow with a mean one. I have ſeen this hoed Luſerne, in a ſheltry Place of my Garden, ſo much grown in a mild Winter, as to be meaſured Fourteen Inches and an half high at *Chriſtmas*; and a very large ſingle Plant of it, which had not been hoed for Two Years before, was laid bare by digging out the Earth all around it a Foot deep, to obſerve the Manner of its Tap-root; and then the Earth was thrown in again, and the Hole filled up. This was on the Twenty-ſeventh of *September*. Upon this mellowing of the Soil about it, it ſent out more Stalks in *October*, than it had done in the whole Summer before; they grew very vigorouſly, until a great Snow fell in *December*, which alſo preſerved the Verdure of them, till that was melted away, and a black Froſt came after it, and killed thoſe Stalks. It is probable this Plant ſent out immediately new fibrous horizontal Roots, which did grow apace to extract the Nouriſhment from this new-made Paſture, in proportion to the quick Growth of the Stalks, which in Summer have been meaſured, and found to grow in Height Three Inches and an half in a Night and a Day; this being almoſt One Inch in Six Hours.

And it has been my Obſervation, that this Plant, in hot and cold Countries, thrives both with a much greater, or leſs Degree of Heat and Moiſture, when it is hoed; for if it has Plenty of Nouriſhment, which

Hoeing

Hoeing always gives it, a very little Heat above, and the Moiſture alone (which is never wanting to the deep Tap-root) ſuffice, and that Plenty of Food enables it the better to endure the Extremes of either Heat or Cold.

We need not much apprehend the Danger of *Engliſh* Winters; for Luſerne will endure thoſe which are more rigorous. In the Principality of *Neufchâtel* the Winters are ſo ſevere, as to kill all the Roſemary left abroad; yet Luſerne ſurvives them there: This proves it more hardy than Roſemary, which is planted for Hedges in *England*; and here is ſcarce twice in an Age a Froſt able to kill it.

I have one ſingle Luſerne-plant in a poor Arable Field, that has ſtood the Teſt of Two-and-twenty Winters, beſides the Feeding of Sheep at all Seaſons, and yet remains as ſtrong as ever. What Quantity of Hay this Plant yearly produces, cannot be known, becauſe at thoſe times that Cattle are kept from it, the Hares conſtantly crop it, being ſweeter than any other Graſs.

But this happens to be fortunately ſituate, where 'tis not altogether deſtitute of the Benefit of Hoeing. 'Tis in an Angle, where, every time the Field is till'd, the Plough goes over it in turning from the Furrows of one Land and one Head-land; but it is after the Plough is lifted out of the Ground, and turned up on one ſide, ſo that the Share only breaks the Turf very ſmall all around it, without plowing up the Plant: Yet it has eſcaped it ſo narrowly, that the Fin of the Plough-ſhare has ſplit it into Four Parts; Three of which remain, and grow never the worſe, but the Fourth is torn off, and the Wound healed up.

By the extreme hard Winter that happened about the Year 1708, or 1709, ſome of the Luſerne in *Languedoc* was killed: Yet this was no Argument of its Tenderneſs, but rather the contrary; becauſe then all the Olive-trees and Walnut-trees were there killed, tho'

tho' the greateſt Part of the Luſerne eſcaped unhurt: And I did not hear one Walnut-tree was killed that Winter in *England*. Perhaps thoſe in *France*, having being accuſtomed to much hotter Summers, were unable to endure the Rigour of the ſame Winter, that could do no Harm to the ſame Species in *England*, where our Winters do not ſeem to exceed ſome of theirs in Cold, ſo much as their Summers do ours in Heat. And ſince the Extremes are not ſo far aſunder here, the ſame Degree of Cold may to our Plants ſeem tepid, which to thoſe in *Languedoc* muſt ſeem rigorous, differing a more remote Degree from the oppoſite Extremity of Heat in Summer.

And, beſides the Difference of Heat and Cold in different Climates, there is another more neceſſary to be obſerved; and that is, the Difference of the Hardineſs in different Individuals of the ſame Species: The ſame Froſt that kills a faint languiſhing Plant of Luſerne, will be deſpiſed by a robuſt one, which, being well fed by the Hoe, becomes a Giant cloath'd and fenced with a thick Bark, that renders it impregnable againſt all Weather; its Rind is to it a Coat of Mail or Buff, impenetrable by Froſt: But the unhoed is generally ſmall and weak; its thin tender Bark expoſes it almoſt naked to the Froſt; it being, for want of a ſufficient Paſture, ſtarv'd and half-dead already, 'tis the more eaſily killed by the Cold.

I formerly lived ſome Years in *Languedoc*, where are many Hundred Acres of Luſerne; and I never could find a very large Plant amongſt it, unleſs in ſuch Pieces as had been plowed up, tilled, and ſown with Corn: Here indeed thoſe Plants that remained (as always ſome would do) grew to an extraordinary Bulk; and One of thoſe ſingle tilled Plants did ſeem to produce a greater Quantity of Stalks, than Twenty of ſuch as had not been plowed up; and as there were no large Plants amongſt the unplowed, ſo there were no ſmall amongſt the plowed ones. The ſame thing

has

has been obſerved in all other Places where Luſerne has been plowed (*a*).

And in *Wiltſhire* ſeveral Grounds of it ſtood ſome Years without ever coming to a Subſtance to be of any Value, tho' the Land was whitiſh, and ſcarce any Graſs appeared amongſt the Luſerne; and therefore its Poorneſs was thought to proceed from the Soil's being improper; but when it had been broken up, and ſown ſeveral Years with Corn, and afterwards lain down with St. Foin, all the Luſerne-plants which remained (and they were many) grew large and ſtrong, ſhooting up a Yard in Height ſoon after the St. Foin was cut; and if there had been a competent Number of them undeſtroyed by the Plough, they would have yielded Crops of an extraordinary Value, where before Plowing it grew but few Inches above the Ground.

It ſeems that in this ſort of Land the Earth grows ſtale, ere the Luſerne arrives at a Tenth Part of its Stature: But this is moſt remarkable, that Tillage transforms thoſe Luſerne-plants from Dwarfs to Giants; and then they are able to contend with, if not conquer, ſo ſtrong Plants as St. Foin is, tho' before Plowing they were unable to reſiſt the Depredations of a few hairy Spires of Graſs.

Since Tillage can thus recover Luſerne, after it has long languiſhed in the loweſt Ebb of Life, and reſtore it to Health, Youth, and Vigour, and augment its Stature even after it has paſſed the Age of its full Growth; to what Bulk would it arrive, regularly planted, and hoed from its Infancy to Maturity without any Check to ſtint it!

We can never know how poor a Soil will bear this Plant, unleſs it be tried by the Hoeing Culture.

For 'tis wondrous how ſo great a Man as Dr. *Woodward* ſhould imagine, that Difference of Soil

(*a*) This Plowing is a Hoeing to the Luſerne.

ſhould be the Reaſon why Apples in *Herefordſhire*, and Cherries in *Kent*, ſucceed better than in other Places, when in truth they are ſeen to proſper as well almoſt all over *England*, where planted, cultivated, and preſerved.

I believe Plants are more altered as to their Growth, by being cultivated or not, than by Change of Climates differing in very many Degrees of Latitude. I ſay, in their Growth, not always in their Fruit; for tho' a Peach-tree, well cultivated in a Standard, will grow here vigorouſly, and be very beautiful; yet its Fruit will be of little Value, unleſs it be planted againſt a good Wall: So Luſerne, unleſs cultivated upon a well expoſed Gravel, will yield little Seed in *England*.

The Soil to plant it on is either an hot Gravel, a very rich dry Sand, or ſome other rich warm Land, that has not an under *Stratum* of Clay, nor is too near the Springs of Water; for, if the Earth below be of a cold Nature, which I take to be occaſioned by its holding of Water, the Luſerne will not long proſper therein, of whatever Sort the upper *Stratum* of Earth may be: This may be gueſſed at by the Vegetables a Soil naturally produces, as Fern, and the like; which, Mr. *Evelyn* obſerves, do indicate a Soil ſubject to Extremities of Heat and Cold; and condemns ſuch a Soil as accurſed. I agree to that Sentence, as far as relates to Cold; but am not ſatisfied of its abounding with Heat; and I am ſure I know ſome Land very ſubject to Fern, which is very far from being barren, when well cultivated, and well ſuited with Vegetables; but, from among theſe, Luſerne muſt be excluded.

Luſerne in hot Countries grows beſt near Rivers, where its Roots reach the Water, which helps to mitigate the exceſſive Heat of the Climate; but here the Heats are ſo moderate, that if Luſerne-roots are in Water (for 'tis that that makes Earth cold) it diminiſhes nifhes too much the juft Proportion of Heat, which Luferne requires.

The natural Poornefs of an hot Gravel may be compenfated by Dung, more Heat, and the Benefit of the Hoe.

The natural Richnefs of the other forts of Land being increafed by hoeing and cleanfing it from Grafs, Luferne will thrive therein with the lefs Heat; for what the Soil wants of one of thefe Two Qualities, muft be made up with the other; and it has grown high in hoed rich Ground at *Chriftmas*, when that in Land of an hotter Nature, but poorer, has not been able to peep out, for want of more Nourifhment: So, if rich Land be clayey, very wet and cold, tho' very rich, it requires much Heat, for as high a Growth of Luferne at *Midfummer*.

The beft Seafon of planting it in *England* is in *April*, after the Danger of Froft is over; for a fmall Froft will deftroy the whole Crop, when the Plants firft appear; and too much Wet, with cold Weather, will rot the Seeds in the Ground; fo that about the Middle of *April* may be generally efteemed as the beft Seafon for fowing this Seed.

The hoed Plants of Luferne having larger Roots, and yielding more Crops than thofe of St. Foin, Reafon feems to require, that the Number of the former be lefs.

But, on the other hand, if we confider, that as the Luferne-roots exceed the St. Foin in Bignefs, fo they alfo do in Length, by as great a Proportion; being generally lefs taper, and as they go deeper, they have more Earth to nourifh them; they alfo require a better Soil, and more frequent Aids from the Hoe; and, by their extraordinary quick Growth, receive a fpeedier Relief from it, than the Roots of St. Foin do.

Thus, if by reaching deeper in a better Soil, and being more hoed, Luferne receives, from a fquare Perch

Perch of Ground, Nouriſhment in a proportion double to that whereby its Roots exceed thoſe of St. Foin in Bigneſs, then I do not ſee why we ſhould not leave the Number of Luſerne-plants double to the Number of thoſe we leave in St. Foin.

But if the Exceſs of Nouriſhment were no more than the Exceſs of Bigneſs of Roots, I think an equal Number of Plants ſhould be left in Luſerne, and in St. Foin: Yet ſince the hot or cold Conſtitution of a Plant, and alſo the Quantity it can produce, ought to be conſidered, as well as its Bulk, in relation to the Nouriſhment it requires, more Trials are neceſſary for determining the exact Number of Luſerne-plants proper to be placed on a ſquare Perch, than have been hitherto made.

Perhaps it will be thought heterodox to maintain by any Arguments, that to err in falling ſomewhat ſhort of the juſt Number, is not of worſe Conſequence, than exceeding it.

Where they ſtand at Four or Five Inches aſunder in the Rows, 'tis obſerved, that tho' the Intervals betwixt the Rows be wide, yet the Plants are much the larger, and produce more that ſtand in the outſide Rows (the Ground without being clean); and eſpecially thoſe at each End of the outſide Rows, that is, the Corner-plants, are largeſt of all. I need not ſay, that had all the other Plants as much Room and Tillage as the Corner ones have, they would be as large, and produce each as much Hay; for thoſe which ſtand perfectly ſingle in Places by themſelves, are ſeen to be larger, and produce more, than thoſe Corner ones; and of the larger and longer Roots our Stock does conſiſt, the more Nouriſhment they are capable of taking, as has been ſhewn. Where ſome Plants of the Luſerne have been planted Two Feet aſunder, in poor dry Land, which was kept clean from Weeds, and frequently digged, each Plant has ſent forth upward of Three Hundred Stalks, and

and theſe have been Six or Seven Inches high by the Middle of *March*.

And it muſt be likewiſe obſerv'd, that the Crop will be produc'd in Proportion to the Nouriſhment it receives; for if the moſt gigantic Luſerne plant, which, when pamper'd by the Hoe, has made a Produce more like a Tree than an Herb, remains a few Years without that or ſome equivalent Culture, it will by little and little ceaſe to produce more than a few poor ſickly Stalks, juſt to ſhew its Species; and then, if this Culture be repeated, will recover its priſtine Strength, and yield as great a Crop as ever; but, if that be longer omitted, will die: The Vaſtneſs of its Root avails nothing, unleſs it has Food in proportion to it.

Hence it appears, that the moſt fatal Diſeaſe incident to Luſerne is ſtarving, and that rarely ſuffers any of its Plants to arrive at the full Period of their Growth or Age; it prevents their Fertility even in the Prime of their Youth, and kills them before they have liv'd out Half, or perhaps the Tenth Part, of their Days. How long its Life might otherwiſe be, nobody knows, unleſs a Plant could be found to die when well fed; for when it is, 'tis ſo tenacious of Life, that, I am told, beheading will not diſpatch it *(a)*.

'Tis therefore neceſſary, that our Rows be plac'd at ſuch a Diſtance, as that their Intervals may be wide enough for the Hoe-plough to raiſe an artificial Paſture, ſufficient to ſuſtain the Number of Plants in them.

Whoever ſhall make Trials of this Huſbandry (for that is all I propoſe to others), I would adviſe them to begin with Rows that have Intervals of Thirty-three Inches; for, if they begin with much

(a) But I have cut off the Heads of ſome myſelf to try, and could not find that any one would ſprout again, tho' *St. Foin* will; perhaps I tried at the wrong Seaſon.

narrower

narrower Diſtances, they may be by that means diſappointed of Succeſs: But tho' they ſhould afterwards find a Way to hoe them at ſomewhat nearer Diſtances; yet the Loſs of a few Perches of Ground would not be much; neither can they be wholly loſt, ſince the Roots of theſe Plants may be prov'd to extend much farther horizontally, than from Row to Row at that Diſtance. And the wider the Intervals are, the more Earth will be till'd in a Perch of Ground; becauſe Six Rows, which will be therein at Thirty-three Inches Diſtance, will admit the Hoe-plough to till more Earth, than Nine Rows at Twenty-two Inches Diſtance from each other: And, beſides, 'tis not proper, that every time of hoeing, the Plough ſhould come very near to the Plants, unleſs when Graſs comes amongſt them; and then they may, in Thirty-three Inch Spaces, be perfectly cleanſed in this manner: *viz.* Plow a good Furrow from each Side of every Row; and then with Harrows, or other Inſtruments proper for that Purpoſe, going croſs them, you will pull out both Earth and Graſs from betwixt the Plants; then, after a convenient Time, plow theſe Furrows back again to the Rows; this will in a manner tranſplant the upper Part of the Roots, and bury the Graſs, tho' it be not dead, by lying open to be dry'd by the Sun: Then harrow the Ground to break it more, and to level it, and go once over it with a very light Roller, to the End that the Hay may be raked up the cleaner.

I am aware of the common Prejudice, which is, that People, when they have never ſeen a Plantation of theſe Plants in Perfection, are apt to form to themſelves the Idea of ſuch ſmall ones as they have been uſed to ſee; and thence imagine it impoſſible that this (tho' a double) Number ſhould be ſufficient to make a Crop. But they might, with equal Reaſon, imagine the ſame of Apple-trees at a Year's Growth, which are leſs than theſe at the ſame Age; and

and so plant a Thousand Trees in the Room proper for one. The Antients direct the Planting of Seventeen *Cytisus* Plants in a Perch of Ground; and I do not believe, that ever those Seventeen could yield a Crop equal to Two hundred Twenty-four Luserne-plants; for as many Ounces of Hay as each of these yields, so many Ton of Hay will one Crop of an Acre produce: Thus by weighing the Product of one Plant (supposing them all equal) the Quantity of the Crop may be determin'd, and prov'd greater than Fancy from their Number represents.

	s.	d.
April 14. One single unho'd Plant of Luserne had Thirty-one Stalks, which, by Silver-Money, weigh'd green —	23	0
24. The same dried to Hay, weigh'd	6	6
14. The Stalks of one single ho'd Luserne-plant green, weigh'd —	56	0
24. The same dry'd —— —	14	6
14. Eighteen Inches in Length of a Row, being five indifferent Plants, weigh'd green one Pound and an half *Avoirdupois*		
24. Dry'd to Hay, it weigh'd —	28	6
25. One Foot of an ho'd Row, being One hundred and Sixty-Stalks of two Luserne Plants of Six or Seven Years old, weigh'd Two Pound green —		
But the same dry'd, to the 9th of *May*, weigh'd no more than —— —	31	6

Which last is about Three Tons to an Acre.

This I am certain of, that the least competent Number of Plants will bring the greatest Number of Crops: since I see the Stalks of a single ho'd Plant grow higher in Fifteen Days, than one amongst near Neighbours does in Thirty Days.

The greatest Difference between the Culture of this and St. Foin is, that Luserne Rows should be more grown, before the Plants be made single in them by the Hand-hoe, lest the Fly should destroy some after-

afterwards, and then they might become too thin. For Luserne is ſometimes eaten by the Fly, as Turneps are, tho' St. Foin be never liable to that Misfortune, if ſown in a proper Seaſon. Luſerne muſt alſo be more frequently ho'd (*a*), in ſome Proportion to the more frequent Crops it produces.

I ſhall not go about to compute the Difference of Expence beſtow'd in the *Roman* Culture and in this; yet it will appear theirs was incomparably more chargeable, and that the Exceſs of Charge was occaſioned by their Error in the Theory of Huſbandry.

They ſow'd it ſo thick, that the Plants muſt needs be very ſmall; and when Ten of them were no bigger than one good ſingle ho'd Plant would have been, in the ſame Space of the Earth's Surface, they could have but a Ninth Part of the Earth's Depth, which the one would have had. The Defect of Depth muſt be therefore made up, in ſome Meaſure, by the extraordinary Richneſs of the Surface. Upon this Account few Lands were capable of bearing *Medica*. Their ſowing it ſo late made the firſt Waterings neceſſary; and the Shortneſs of the Roots required the repeated Rigations, after the Crops were cut: For

(*a*) The Hoe-plough is the Inſtrument to bring it to Perfection: but then I doubt it muſt lie ſtill ſome Years, leſt the plow'd Earth injure the Hay that is made upon it; and when it is come to a Turf, and the Luſerne wants renewing, the Four coulter'd Plough is the only Inſtrument that can prepare the Turf to be kill'd, and cure the Luſerne; which Plough muſt be uſed in the following Manner: Turn its Furrows toward one Row, and from the next; that is, plow round one Row, and that will finiſh Two Intervals, and ſo on; and the next Plowing muſt be towards thoſe Rows, from whence they were turn'd the firſt time; take care the firſt Furrows do not lie long enough on the Rows to kill the Plants, which will be much longer in Winter than in Summer. But you may leave every Third or Fourth Interval unhoed for making the Hay on, which will be yet more beneficial, if the Swarths in mowing ſhould fall thereon. This unhoed Interval may be plowed when there is Occaſion, and another left in its ſtead.

Columella

Columella faith in *Lib.* ii. *Cap.* 11. *Cum fecueris autem, fæpius eam rigato.* But had it been cultivated by the hoeing Method, the Tap-roots would have defcended as deep as a Well, and, from the Springs below, have fent up Water to the Plants, befides what the Hoe would have caufed the horizontal Roots to receive from Dews at the Surface above. At how much a cheaper Rate Water is fupply'd by thefe Means, than by carrying it perhaps a great Way, and then fprinkling it by Hand over the Beds, which were made Ten feet wide between Path and Path for that Purpofe, let any one judge; as alfo what a laborious Tafk it was to pick out the Grafs with Fingers from amongft it, in the hard dry Ground in the Summer, after mowing the Crop, as *Columella* directs in his forementíon'd Chapter, which the Horfe-hoe would have done with Eafe, at a Twentieth Part of that Expence. However, fince they faw the *Medica* was as impatient of Grafs as the Vineyards were, 'tis a Wonder they did not give it the fame Culture with the *Bidens*, which would have been much better and cheaper, than to cleanfe the *Medica* with Fingers. Indeed Fingers were made before the *Bidens*; but fure the Effect of its Ufe in raifing Juices to the Vine, had infpired the *Romans* with more judicious Speculations, than to give that for a Reafon why they ho'd the *Medica* with their Fingers, rather than with the *Bidens*.

Oh! But this was made with Iron, and *Medica* had, in thofe Times, an Antipathy to Iron; and after it was fown, the Place muft not be touch'd by that Metal; therefore the Seed muft not be cover'd with a Plough, nor with Iron Harrows. But if they had made Trials enough, to know that half an Inch was a proper Depth to cover this Seed at, thefe *Virtuofi* would have been convinc'd, that it had no lefs Antipathy to thefe Inftruments, of what *Matter* foever they were made, if they bury'd it Five or Six

Inches deep, which the Plough muſt do, and the Weight of Iron Harrows in ſuch fine Ground not much leſs. Had the Plough been all of Wood, the Furrow would have lain never the lighter upon the Seed; and if the wooden Harrows had been loaded with a Weight capable of preſſing it down as deep, it would have been no more able to riſe, than if it had been buried with Iron Harrows: This *Columella* ſeems to be ſenſible of, when he ſays, *Raſtellis ligneis*; *viz.* That it was not ſufficient for them to be made of Wood, unleſs they were diminutive; for then they were light ones. 'Tis probable the Plough ſuffer'd none to come up, and the heavy Harrows very few, tho' perhaps Plants enough, had they calculated what Number were ſufficient: But unleſs the Ground were cover'd with them at firſt, it ſeems they had not Patience to wait till the Plants grew large enough, to fill it with a bare competent Number, and thought it not worth while to weed and water, what they fanſied to be an inſufficicient Number. 'Twas expected that the Thickneſs of the Plants ſhould help to kill the Graſs: Yet upon due Obſervation 'tis found, that when their exceſſive Numbers have brought a Famine amongſt them, they are forc'd to prey upon one another; and tho' the ſtronger ſurvive, yet even thoſe are ſo weaken'd by Hunger, that they become the leſs able to contend with Graſs, whoſe good Fortune it was, that Superſtition would not permit the *Romans* to interpoſe, by attacking it with Iron Weapons.

I hope theſe Hints may be improv'd for the Abolition of old Errors, and for the Diſcovery of new Truths; to the end that Luſerne may be planted in a more reaſonable Method than has been commonly practis'd: And when the Theory is true, 'tis impoſſible the Practice ſhould be falſe, if rightly apply'd; but if it fail of Succeſs, the Event will be a Proof

Proof either of a Miſapplication, or that the Theory is falſe.

Luſerne ſhould be order'd for Hay in the ſame Manner as is directed for St. Foin in the foregoing Chapter: But it muſt be obſerv'd, that Luſerne is more worſted by being ſuffer'd to ſurvive its Virginity before cutting; and therefore the richeſt and moſt nouriſhing Hay is cut whilſt the Stalks are ſingle, without any collateral Branches ſhooting out of them; and when they are ſo, neither Bloſſoms nor even their Buds appear. But of that ſown in the old Faſhion, the laſt Crops, for want of a new Supply of Nouriſhment, grow ſo ſlowly, that ere it is high enough to be cut, the Bloſſoms are blown out, and the Stalks, tho' very ſmall, are become *woody*, *hard*, and *dry*, and make the Hay nothing near ſo nouriſhing as that of the firſt Crops.

But in that which is ho'd, the laſt Crops of it will, by virtue of the greater Quantity of Nouriſhment it receives, grow faſter, and be of an Height fit to cut before bloſſoming, and thence being as young and vigorous, make as good Hay as the firſt Crops; ſo that Hoeing does not only procure more and larger Crops, but alſo better Hay.

This is moſt certain, that unleſs we can keep our Luſerne pretty clean from natural Graſs, we cannot expect it to ſucceed, let the Soil be never ſo proper.

C H A P. XIV.

Of Change of SPECIES.

I. *That Plants of the most different Nature feed on the same Sort of Food.*

II. *That there is no Plant but what must rob any other Plant within its Reach.*

III. *That a Soil which is proper to one Sort of* Vegetable *once, is, in Respect of the Sort of Food it gives, proper to it always.*

IF any one of these *Three Propositions* be true, as I hope to prove all of them are, then it will follow, that there is no need to change the Species of *Vegetables* from one Year to another, in respect to the different Food the same Soil is, tho' falsely, supposed to yield *(a)*.

The common Opinion is contrary to all these (as it must be, if contrary to any one of them): And since an Error in this fundamental Principle of *Vegetation* is of very ill Consequence; and since Dr. *Woodward*, who has been serviceable in other respects *(b)* to this Art, has unhappily fallen in with the Vulgar in this Point; his Arguments for this Error require to be answer'd in the first Place.

(a) For if all Plants rob one another, it must be because they all feed on the same Sort of Food; and, admitting they do, there can be no Necessity of changing the Species of them, from one Soil to another; but the same Quantity of the same Food, with the same Heat and Moisture which maintains any Species one Year, must do it any other Year.

(*b*) By proving, in his Experiments, that Earth is the *Pabulum* of Plants.

The

The Doctor ſays *(c)* ‘ It is not poſſible to imagine ‘ how one uniform, homogeneous Matter, having its ‘ Principles, or original Parts, all of the ſame Sub‐ ‘ ſtance, Conſtitution, Magnitude, Figure, and Gra‐ ‘ vity, ſhould ever conſtitute Bodies ſo egregiouſly ‘ *unlike*, in all thoſe Reſpects, as Vegetables of dif‐ ‘ ferent Kinds are; nay, even as the different Parts ‘ of the *ſame* Vegetable.

‘ That there ſhould be that vaſt Difference in ‘ them, in their ſeveral Conſtitutions, Makes, Pro‐ ‘ perties, and Effects, and yet all ariſe from the very ‘ ſame Sort of Matter, would be very ſtrange.’

Anſwer. ’Tis very probable, that the terreſtrial Particles which conſtitute *Vegetables*, tho’ inconceivably minute, may be of great Variety of Figure, and other Differences; elſe they could not be capable of the ſeveral Ferments, *&c.* they muſt undergo in the Veſſels of Plants. Their Smalneſs can be no Objection to their Variety, ſince even the Particles of Light are of various Kinds.

But as the Doctor aſſerts, ‘ That each Part of the ‘ ſame *Vegetable* requires a peculiar ſpecific Matter ‘ for its Formation and Nouriſhment; and that there ‘ are very many and different Ingredients to go to the ‘ Compoſition of the ſame individual Plants;’

From hence muſt be inferred, that the ſame Plant takes in very many and different Ingredients (and it is proved, that no Plant refuſes any Ingredient *(d)* that is capable of entering its Roots. Tho’ the terreſtrial Particles which nouriſh *Vegetables*, be not perfectly homogeneous; yet moſt of the various

(c) In *Philoſ. Tranſ.* No. 253.

(d) Dr. *Grew*, in his Anatomy of Plants, by microſcopical Inſpection, found, that the outer Superficies of Roots was of a ſpongy Subſtance; and ’tis well known, that no ſuch Body can refuſe to imbibe whatever Liquor comes in Contact with it, but will by its ſpringy Poroſity abſorb any ſort of Moiſture.

Taſtes and Flavours of Plants are made in and by the Veſſels *(e)*.

Doctor *Woodward* ſays, ‘ That Water will paſs ‘ Pores and Interſtices, that neither Air, nor any ‘ other Fluid, will: This enables it to enter the fineſt ‘ Tubes and Veſſels of Plants, and to introduce the ‘ terreſtrial Matter, conveying it to all Parts of them ; ‘ whilſt each, by means of Organs ’tis endow’d with ‘ for the Purpoſe, intercepts, and aſſumes into itſelf, ‘ ſuch Particles as are ſuitable to its own Nature (*f*); ‘ letting the reſt paſs on *through the common Ducts*.’

Here then he ſays plainly, That each Plant receives the terreſtrial Matter in groſs, both ſuitable and

(*e*) We are convinced, that ’tis the Veſſels of Plants that make the different Flavours ; becauſe there is none of theſe Flavours in the Earth of which they are made, until that has enter’d and been alter’d by the vegetable Veſſels.

(*f*) If the Doctor’s Plants were ſo nice in leaving vegetable Matter *behind, quiet and undiſturb’d*, ’tis a Wonder they would take up the mineral Matter, as, he ſays, they did, that kill’d themſelves with Nitre.

Theſe Plants might, with much leſs Difficulty, have diſtinguiſh’d the mineral Matter from the vegetable Matter, than they could diſtinguiſh the different Particles of vegetable Matter from one another, and muſt have been very unwiſe to chuſe out the Nitre (their Poiſon) from the Water and Earth, and to leave the vegetable Particles behind ; none of which could be ſo improper to them as the Nitre.

It may perhaps be objected, that ſuch like pernicious Matter kills a Plant by only deſtroying its Roots, and by cloſing the Pores ; which prevents the Nouriſhment from entering to maintain its Life ; and that ſuch Matter doth not itſelf enter to act as Poiſon upon the Sap, or upon the Veſſels of the Body, or Leaves : But it plainly appears that it doth enter, and act as Poiſon ; for when ſome of the Roots of a Mint, growing in Water, are put into ſalt Water, it kills the whole Plant, although the reſt of the Roots remaining in the freſh Water were ſufficient to maintain it, if the other Roots had been cut off at the Time they were removed into the Salt Water ; and alſo all the Leaves, when dead, will be full of Salt.

Or if the Juice of wild Garlick-ſeed be made uſe of inſtead of the ſalt Water, it will have the ſame Effect ; and every one of the Mint-leaves will have a ſtrong Taſte of Garlick in it.

unſuit-

unſuitable to its Nature, retains the ſuitable Particles for its Augment, and the unſuitable lets paſs through it. And in another Place he ſays they are exhal'd into the Atmoſphere.

And this will appear to be the true Caſe of Plants; and directly contradicts what he advances, in ſaying, 'That each Sort of Grain takes forth that peculiar 'Matter that is proper for its own Nouriſhment. 'Firſt, the Wheat draws off thoſe Particles that ſuit 'the Body of that Plant, *the reſt lying all quiet and* '*undiſturb'd the while.* And when the Earth has 'yielded up all them, thoſe that are proper for Bar'ley, a different Grain, remain ſtill behind, till the 'ſucceſſive Crops of that Corn fetch them forth too; 'and ſo the Oats and Peaſe in their turn, till, in fine, 'all is carried off.'

In the former Paragraph he ſays, each Plant *lets paſs through it* the reſt of the Particles that are not ſuitable to its own Nature. In the latter Paragraph he ſays, That each *leaves* the unſuitable *all behind* for another Sort; and ſo on.

Both cannot be true.

If the latter were true, Change of Sorts would be as neceſſary as it is commonly thought. But if the former be true, as I hope to prove it is, then there can be no Uſe of changing of Sorts in Reſpect of different Nouriſhment.

If in this Series of Crops each Sort were ſo juſt as to take only ſuch Particles, as are peculiarly proper to it, letting all the reſt alone to the other Sorts to which they belonged, as the Doctor imagines; then it would be equal to them all, which of the Sorts were ſown firſt or laſt: But let the Wheat be ſown after the Barley, Peaſe, and Oats, inſtead of being ſown before them, and then it would evidently appear, by that ſtarv'd Crop of Wheat, either that ſome or all of thoſe other Grains had violated this natural Probity, or elſe that Nature has

has given to *Vegetables* no ſuch Law of *Meum* and *Tuum* (*g*).

If theſe Things were, as the Doctor affirms, why do Farmers loſe a Year's Rent, and be at the Charge of fallowing and manuring their Land, after ſo few Crops; ſince there are many more Sorts of Grain as different from theſe and one another, as thoſe are which they uſually ſow?

They ſtill find, that the firſt Crops are beſt; and the longer they continue ſowing, the worſt the laſt Crops will prove, be they of never ſo different a Species; unleſs the Land were not in ſo good Tilth for the firſt Crop as for the ſubſequent; or unleſs the laſt ſown be of a more robuſt Species.

This Matter might be eaſily clear'd, could we perfectly know the Nature of thoſe ſuppoſed *unſuitable* (*h*) *Particles*; but, in Truth, there is no more to be

(*g*) A Charlock could not rob a Turnep, and ſtarve it, more than ſeveral Turneps can do, unleſs the Charlock did take from it the ſame Particles which would nouriſh a Turnep: and unleſs the Charlock did devour a greater Quantity of that Nouriſhment than ſeveral Turneps could take.

Flax, Oats, and Poppy, could not burn or waſte the Soil, and make it leſs able to produce ſucceeding Crops of different Species, unleſs they did exhauſt the ſame Particles which would have nouriſh'd Plants of different Species: For let the Quantity of Particles theſe Burners take be never ſo great, the following Crops would not miſs them, or ſuffer any Damage by the Want or Loſs of them, were they not the ſame Particles which would have nouriſhed thoſe Crops, if the Burners had left them *behind, quiet and undiſturbed.* Neither could Weeds be of any Prejudice to Corn, if they did draw off thoſe Particles only that ſuit the Bodies of Weeds, *the reſt lying all quiet and undiſturbed the while.* But conſtant Experience ſhews, that all Sorts of Weeds, more or leſs, diminiſh the Crop of Corn.

(*h*) But we muſt not conclude, that theſe Particles, which paſs through a Plant (being a vaſtly greater Quantity than thoſe that abide in it for its Augment), are all unſuitable, becauſe no one of them happens to hit upon a fit *Nidus*: For ſince the Life of Animals depends upon that of Plants, 'tis not unreaſonable to imagine, that Nature may have provided a conſiderable Overplus be known of ſuch of them, than that they are carried away by the Atmoſphere to a Diſtance, according to the Velocity of the Air; perhaps ſeveral Miles off, at leaſt, never like to return to the Spot of Ground from whence the Plants have raiſed them.

But ſuppoſe theſe caſt-off Particles were, when taken in, unfit for the Nouriſhment of any manner of Vegetables: Then the Doctor muſt fanſy the Wheat to be of a very ſcrupulous Conſcience, to feed on theſe Particles, which were neither fit for its own Nouriſhment, nor of any other Plant; and at the ſame time to forbear to take the Food of Barley, Peaſe, and Oats, letting that *lie ſtill and undiſturb'd the while*, as he ſays it does, tho' he gives no manner of Reaſon for it.

'Tis needleſs to bring ſtronger Arguments, than the Doctor's Experiments afford, againſt his own vulgar Opinion, of Plants diſtinguiſhing the particular Sort of terreſtrial Matter, that, he ſays, is proper to each Sort of *Vegetable*, in theſe Words; *viz.* ' Each Sort ' takes forth that peculiar Matter that is proper for its ' own Nouriſhment, the *reſt lying all quiet and undiſturb'd* ' *the while.*

He ſays, that great Part of the terreſtrial Matter, mixed with the Water, paſſes up into the Plant along with it; which it could not do, if only the peculiar Matter, proper to each Plant, did paſs up into it: And after he has ſhewed how apt the vegetable Matter is to attend Water in all its Motions, and to follow it into each of its Receſſes; being by no Filtrations or Percolations wholly ſeparable from it; 'tis ſtrange he ſhould think that each Plant leaves the greateſt Part of it behind, ſeparated from the Water which the Plant imbibes.

plus for maintaining the Life of individual Plants, when ſhe has provided ſuch an innumerable Overplus for continuing every Species of Animals.

There

There are, doubtless, more than a Million of Sorts of Plants, all of which would have taken up the Water, and had each as much Right to its Share, or proper Matter in it, as the Doctor's Plants had; and then there would be but a very small (or a Millionth) Part of it proper to each of his Plants: And these leaving all the rest behind, both of the Water wherewith the Glasses at first were filled, when the Plants were put into them; and also of all the additional Water daily supply'd into them afterwards; I say, so much more terrestrial Matter brought into these Glasses, in Proportion to the added Water, and so very small a Part as could be proper to each of his Plants being carried off; there must have remain'd in these Glasses a much greater Quantity of terrestrial Matter at the End of the Experiment, than remained in the Glasses *F* or *G*, which had no Plants in them, nor any Water added to, or diminished from them; but the quite contrary appear'd. 'And the Water in 'the Glasses *F* and *G*, at the End of the Experiment, 'exhibited a larger Quantity of terrestrial Matter, 'than any of those that had Plants in them did. The 'Sediment at the Bottom of the Glasses was greater, 'and the *Nubeculæ* diffused thro' the Body of the 'Water thicker.' Had the *Cataputia* insum'd, with the Two thousand Five hundred and One Grains of Water, no more than its proper Share of the vegetable Matter, it could not have attained thence an Increase of Three Grains and a Quarter, nor even the Thousandth Part of One Grain. But he found 'this 'terrestrial Matter, contained in all Water, to be of 'Two Kinds: The one properly, a vegetable Matter, 'but consisting of very different Particles; some of 'which are proper for the Nourishment of some 'kind of Plants, others for different Sorts,' &c.

This, indeed, would have been a most wonderful Discovery, and might have given us a great Light, if he had told us in what Language and Character

these

theſe proper Differences were ſtamp'd or written upon the vegetable Particles; which Particles themſelves, he ſays, were ſcarce viſible. Certainly it muſt be a great Art (much beyond that of Dr. *Wallis*) to decypher the Language of Plants, from inviſible Characters.

But that this Dream may deceive none, except ſuch who are very fond of old Errors, there is an *Experimentum Crucis* which may convince them; *viz.* At the proper Seaſon, tap a Birch-tree in the Body or Boughs, and you may have thence a large Quantity of clear Liquor, very little altered from Water; and you may ſee, that every other Species of Plants, that will grow in Water, will receive this; live and grow in it, as well as in common Water. You may make a like Experiment by tapping other Trees, or by Water diſtilled from Vegetables; and you will find no Species of Plants, into which this Water will not enter, and paſs through it, and nouriſh it too; unleſs it be ſuch a Species as requires more Heat than Water admits; or unleſs the peculiar Veſſels of that it has firſt paſſed through, have ſo altered the vegetable Particles contained in that Water, as that it acts as Poiſon upon ſome other particular Species.

The Doctor concludes, 'That Water is only the 'Agent that conveys the vegetable Matter to the 'Bodies of Plants, that introduces and diſtributes 'it to their ſeveral Parts for their Nouriſhment: 'That Matter is ſluggiſh and inactive, and would 'lie eternally confin'd to its Beds of Earth, without 'ever advancing up into Plants, did not Water, or 'ſome like Inſtrument, fetch it forth, and carry it 'unto them.'

That Water is very capable of the Office of a Carrier to Plants, I think the Doctor has made moſt evident; but as to the Office of ſuch an Agent as his Hypotheſis beſtows upon it, it ſeems impoſſible to be executed by Water. For it cannot be imagined, that

that Water, being itſelf but mere homogenial Matter, void of all Degrees of Life, ſhould diſtinguiſh each Particle of vegetable Matter, proper and peculiar to every different Species of Plants, which are innumerable; and when 'tis to act for the Wheat, to find out all the Particles proper to that ſort of Grain, to rouſe only thoſe particular Sluggards from their Beds of Earth, letting all the reſt lie quiet and undiſturbed the while. This Agent frees the Wheat-Particles from their Confinement, and conveys, introduces, and diſtributes them, and only them, into the ſeveral Parts of the Wheat.

Since 'tis unreaſonable to believe, that Water can have ſuch extraordinary Skill in Botany, or in Micrography, as to be qualified for a ſufficient Agent in ſuch an abſtruſe Matter, I conceive Water to be only an Inſtrument or Vehicle, which takes up indifferently any Particles it meets with (and is able to carry), and advances them (or the *Pabulum* they yield) up into the Firſt Plant, whoſe Root it comes in Contact with; and that every Plant it meets with does accept thereof, without diſtinguiſhing any different Sorts or Properties in them, until they be ſo far introduc'd and advanc'd up into the vegetable Veſſels, that it would be in vain to diſtinguiſh them; for whether the terreſtrial Matter, Plants imbibe with the Water, will kill or nouriſh them, appears by its Effects; but which cannot be foreknown or prevented without the Help of Faculties, which Plants are not endow'd with.

Mr. *Bradley* ſeems to have carried this Error farther than any Author ever did before; but he ſupports it by Affirmations only, or by ſuch Arguments (I cannot ſay Reaſons; for no Reaſon can be againſt any Truth) as go near to confute the very Opinion he pretends to advance by them.

He aſcribes to Vegetables the Senſe of Taſte, by which he thinks they take ſuch Nouriſhment as is moſt

moſt agreeable to their reſpective Natures, refuſing the reſt; and will rather ſtarve, than eat what is diſagreeable to their Palate.

In the Preface to his *Vol.* I. *Page* 10. of his *Huſbandry* and *Gardening*, he ſays, ‘ They feed as differently as Horſes do from Dogs, or Dogs from ‘ Fiſh.’

But what does he mean by this Inſtance, *Vol.* I. *p.* 39. *viz.* ‘ That Thyme, and other Aromatics, being planted ‘ near an Apricot-tree, would deſtroy that Tree?’ Does it not help to confirm, that every Plant does not draw exactly the ſame Share of Nouriſhment?

I believe there is no need for him to give more Inſtances to diſprove his Aſſertion than this one. His Concluſion, taken by itſelf, is ſo far right; *viz.* ‘ That ‘ if the Nouriſhment the Earth afforded to the Thyme ‘ and Apricot-tree, had been divided into Two ‘ Shares, both could not have had them.’

But this his Inſtance proves, That thoſe Aromatics robb’d the Apricot-tree of ſo much of its Share as to ſtarve it; and that they, tho’ of ſo very different a Nature, did draw from the Earth the ſame Nouriſhment which the Apricot-tree ſhould have taken for its Support, had not the Aromatics been too hard for it, in drawing it off for their own Maintenance:

Unleſs he believes, that all the Juices of the Aromatics were as Poiſon to the Apricot; and that, according to my Experiment of the Mint, ſome of their Roots might diſcharge ſome kind of Moiſture in dry Weather, given them by others, that had it for their Uſe; and that the Apricot-roots, mingling with them, might imbibe enough of that Liquor, altered ſufficiently by their Veſſels, to poiſon and kill the Tree.

But then, where was the Tree’s diſtinguiſhing Palate? Why did it not refuſe this Juice, which was ſo diſagreeable as to kill it? And as to his Notion of Vege-

Vegetables having Palates, let us ſee how it agrees with what he affirms.

‘ That 'tis the Veſſels of Plants that make, by ‘ their Filtrations, Percolations, *&c.* all the different ‘ Taſtes and Flavours of the Matter, which is the ‘ Aliment of Plants; and that, before it be by them ‘ ſo filtred, *&c.* it is only a Fund of inſipid Subſtance, ‘ capable of being altered by ſuch Veſſels, into any ‘ Form, Colour, or Flavour.’

And *Vol.* I. *p.* 38. ‘ The different Strainers, or ‘ Veſſels of the ſeveral Plants, growing upon that ‘ Spot of Earth, thus impregnated with Salts, alter ‘ thoſe Salts or Juices, according to the ſeveral Fi-‘ gures or Dimenſions of their Strainers; ſo that one ‘ Plant varies, in Taſte and Smell, from others, tho' ‘ all draw their Nouriſhment from the ſame Stock ‘ lodged in the Earth.’ See Mr. *Bradley*'s *Palates of Plants*, and the inſipid Subſtance he allots them to diſtinguiſh the Taſte of, how they agree.

They muſt, it ſeems, within their own Bodies, give the Flavour to this inſipid Subſtance, before their Palates can be of any Uſe; and, even then, 'tis impoſſible to be of any Uſe, but in the manner of the the Dog returning to his Vomit.

They would have as much Occaſion for the Senſe of Smelling, as of Taſte; but, after all, of what Uſe could either of the Two be to Plants, without local Motion of their Roots? which they are ſo deſtitute of, that no Mouth of a Root can ever remove itſelf from the very Point where it was firſt formed, becauſe a Root has all its longitudinal Increaſe at the very End; for, ſhould the Spaces betwixt the Branchings increaſe in Length, thoſe Branches would be broken off, and left behind, or elſe drawn out of their Cavities; which muſt deſtroy the Plant. All the Branches, except the foremoſt, would be found with their Extremities pointing towards the Stem; the contrary of which

which Posture they are seen to have: And if they moved backwards, that would have much the same Effect on all the collateral Branchings to destroy them. Smell and Taste then could be of no manner of Use to Vegetables, if they had them; they would have no Remedy or Possibility to mend themselves from the same Mouths, removing to search out other Food, in case they had Power to dislike or refuse what was offered them.

Therefore the crude Earth, being their Food, simple and free from any Alterations by Vessels, remaining insipid, cannot give, neither can Plants receive, require, or make use of, any Variety from it, as Animals do from their Diet. It would be lost upon them, and Nature would have acted in vain, to give Smell and Taste to Vegetables, and nothing but insipid Earth for an Object of them; or to give them a charming Variety of Relish and Savour in their Food, without giving them Senses necessary to perceive or enjoy them; which would be like Light and Colours to the Blind, Sound and Music to the Deaf, or like giving Eyes and Ears to Animals, without Light or Sound to affect them.

The Mouths of Plants, situate in the convex Superficies of Roots, are analogous to the Lacteals, or Mouths, in the concave Superficies of the Intestines of Animals.

These spongy Superficies of animal Guts, and vegetable Roots, have no more Taste or Power of refusing whatever comes in Contact with them, the one than the other.

The free open Air would be equally injurious to both; and if exposed to it, it would dry and close up the fine Orifices in Guts and Roots: Therefore Nature has guarded both from it.

Nature has also provided for the Preservation of both Vegetables and Animals (I do not say equally) in reſpect of their Food; which might poiſon them, or might not be fit to nouriſh them.

The Security of Plants (the beſt that can be) is their Food itſelf, Earth; which, having been altered by no Veſſels, is always ſafe and nouriſhing to them; For a Plant is never known to be poiſoned by its own natural Soil, nor ſtarved, if it were enough of it, with the requiſite Quantities of Heat and Moiſture.

Roots, being therefore the Guts of Plants, have no need to be guarded by Senſes; and all the Parts and Paſſages, which ſerve to diſtinguiſh and prepare the Food of Animals, before it reach the Guts, are omitted in Plants, and not at all neceſſary to them.

But as the Food of moſt Animals is Earth, very variouſly changed and modified by vegetable or animal Veſſels, or by both, and ſome of it is made wholſome, ſome poiſonous; ſo that if this doubtful Food ſhould be committed to the Inteſtines, without Examination, as the pure unaltered Earth is to Roots, there would, in all Probability, be very few Animals living in the World, except there be any that feed on Earth at firſt Hand only, as Plants do.

Therefore, leſt this Food, ſo much more refined than that of Plants, ſhould, by that very means, become a fatal Curſe, inſtead of a Bleſſing to Animals, Nature has endowed them with Smell and Taſte, as Sentinels, without whoſe Scrutiny theſe various uncertain Ingredients are not admitted to come where they can enter the Lacteals, and to diſtinguiſh, at a ſufficient Diſtance, what is wholſome and friendly, from what is hurtful; for when 'tis once paſſed out of the Stomach into the Guts, 'tis too late to have Benefit from Emetics; its Venom muſt then be imbibed by the Lacteal Mouths, and mix with the Blood, as that muſt mix with the Sap, which comes in Contact with the Lacteals in the Superficies of Roots, Nature having left this unguarded.

Yet

Yet Plants ſeem to be better ſecured by the Salubrity and Simplicity of their Food, than Animals are by their Senſes: To compenſate that Inequality of Danger; Animals have Pleaſure from their Senſes, except ſome miſerable Animals (and ſuch there are) that have more Pain than Pleaſure from them. But I ſuppoſe, more Animals than Plants are poiſon'd; and that a poiſonous Animal is leſs fatal to a Plant, than a poiſonous Plant is to an Animal.

It being ſufficiently proved, that every ſort of Vegetables, growing in the ſame Soil, takes, and is nouriſhed, by the ſame Sort of Food; it follows from hence, that the beneficial Change of Sorts of Seeds or Plants, we ſee in the common Huſbandry, is not from the Quality of the Sorts of Food, but from other Cauſes; ſuch as,

I. *Quantity of the Food.*

II. *Conſtitution of the Plants.*

III. *Quantity of the Tillage.*

In Dr. *Woodward*'s Caſe, upon his Hypotheſis, the Three Proportions of Seeds, *viz.* Barley, Oats, and Peaſe, might be ſown all together in the ſame Acre of Ground, the ſame Year, and make Three as good Crops as if ſown ſingly in Three ſucceſſive Years, and his Two Crops of Wheat in one Year likewiſe. But every Farmer can tell, that theſe Three Proportions of Seed would not yield half the Crop together, as one would do ſingle; and would ſcarce produce more than to ſhew what Grains were ſown, and which of the Sorts were the ſtrongeſt, and the moſt able Robber.

Though this Failure would, in Truth, be from no other Cauſe than want of the ſufficient Quantity of Food, which thoſe Three Crops required; yet, perhaps, the Doctor might think, that all Three Crops might ſucceed together very well, taking each its proper Nouriſhment, were it not for want of Room, Air, and Sun.

I have been credibly inform'd, that on One Perch of Ground there has grown a Bufhel of Corn, which is Twenty Quarters to an Acre. Mr. *Houghton* relates Twenty-fix, and even Thirty Quarters, of Wheat on One Acre. There have certainly grown Twelve Quarters of Barley to an Acre, throughout a whole Field: Therefore, unlefs a Crop exceed the leaft of thefe, or indeed the greateft of them (if the Relation be true), a Crop cannot fail for want of Room; for one Acre (be it of what Nature it will, as to the Soil of it) muft have as much room for a Crop to grow on, as any other Acre.

Then there was room for all Dr. *Woodward*'s Three Crops together, to produce as much as Three common Crops do. Yet all thefe together will fcarce yield one Quarter of Corn, tho' there is room, at leaft, for Twelve.

The fame *Air* and *Sun* that had Room to do their Office to Mr. *Houghton*'s Acre, why fhould they not have Room to do the fame to Doctor *Woodward*'s Acre, when the Three Crops growing on it at once, through pretty good ones, might require lefs Room than Mr. *Houghton*'s Crop did?

I perceive that thofe Authors, who explain *Vegetation*, by faying the Earth imbibes certain Qualities from the Air, and by fpecific Qualities, and the like, do alfo lay a great Strefs upon the *perpendicular* Growth of *Vegetables*; feeming to fanfy there is little elfe neceffary to a good Crop, but Room.

Mr. *Bradley*, in his Arguments concerning the Value of an Hill, does implicitly fay as much.

But if they would but confider the Diameters of the Stems, with the Meafure of the Surface of an Acre, they would be convinced, that many, even of Mr. *Houghton*'s Crops, might ftand in a perpendicular Pofture upon an Acre, and Room be left.

One true Caufe of a Crop's failing, is want of a Quantity of Food to maintain the Quantity of Vegetables, which the Food fhould nourifh.

When the Quantity of Food which is ſufficient for another Species (that requires leſs), but not for that which laſt grew, to grow again the next Year, then that other is beneficial to be planted after it.

The Second true Cauſe is from the Conſtitution of Plants; ſome require more Food than others, and ſome are of a ſtronger Make, and better able to penetrate the Earth, and forage for themſelves.

Therefore Oats may ſucceed a Crop of Wheat on ſtrong Land, with once plowing, when Barley will not; becauſe Barley is not ſo well able to penetrate as Oats, or Beans, or Peaſe, are.

So a Pear-tree may ſucceed a Plum-tree, when another Plum-tree cannot; becauſe a Pear is a much ſtronger Tree, and grows to a much greater Bulk; ſo inclined to be a Giant, that 'tis hard to make it a Dwarf; and will penetrate and force its Way thro' the untill'd Earth, where the other cannot; being of a weaker and leſs robuſt Conſtitution, not ſo well able to ſhift for itſelf.

The Pear could penetrate Pores, that the other could not. Mr. *Evelyn* ſays, in his Diſcourſe of Foreſt-trees, ' That a Pear will ſtrike Root thro' the ' rougheſt and moſt impenetrable Rocks and Clifts ' of Stone itſelf.' He ſays likewiſe, in his *Pomona*, ' That Pears will thrive where neither Apple or other ' Fruit could in Appearance be expected.'

I can ſcarce think, that a large Plant takes in larger Particles than a ſmall one, for its Nouriſhment: If it did, I can't believe, that the Thyme could have ſtarv'd the Apricot-tree; it muſt have left the larger Particles of Food for that Tree, which probably would have ſufficed to keep it alive: I rather think, that great and ſmall Plants are ſuſtain'd by the ſame minute Particles; for, as the fine Particles of Oats will nouriſh an Ox, ſo they will nouriſh a Tom-tit, or a Mite.

Some Plants are of an hotter Conſtitution, and have a quicker Digeſtion, like Cormorants or Pigeons, devouring more greedily, and a greater Quantity of Food, than thoſe of a colder Temperature, of equal Bulk, whoſe Sap, having a more languid Motion, in proportion to the leſs Degree of Heat in it, ſends off fewer Recrements; and therefore a leſs Supply of Food is required in their room. This may make ſome Difference in the one's ſucceeding the other; becauſe the hot-conſtitution'd leaves not enough for its own Species to ſucceed again, but leaves enough for a Species of a colder Conſtitution to ſucceed it.

But the Third and chiefeſt Cauſe of the Benefit of changing Sorts is Quantity of Tillage, in proportion to which the Food will be produced.

The true Cauſe why Wheat is not (eſpecially on any ſtrong Soil) to be ſown immediately after Wheat, is, That the firſt Wheat ſtanding almoſt a Year on the Ground, by which it muſt grow harder; and Wheat Seed-time being ſoon after Harveſt in *England*, there is not Space of Time to till the Land ſo much as a ſecond Crop of Wheat requires.

Tho' ſometimes in poorer Land, that is lighter, Wheat has ſucceeded Wheat with tolerable Succeſs; when I have ſeen, on very rich ſtrong Land, the firſt Crop loſt by being much too big, and one following it immediately, quite loſt by the Poorneſs of it, and not worth cutting.

This was enough to ſatisfy, that the Tillage which was ſo much eaſier perform'd in leſs Time, ſufficed for the light Land, but not for the ſtrong: and, if the ſtrong Land could have been brought into as good Tilth as the light (like as in the new Huſbandry it may), it would have produced a much better ſecond Crop than the light Land did.

From all that has been ſaid, theſe may be laid down as Maxims; *viz.* That the ſame Quantity of

Tillage

Tillage will produce the ſame Quantity of Food in the ſame Land *(a)*; and that the ſame Quantity of Food will maintain the ſame Quantity of Vegetables.

'Tis ſeen, that the ſame Sort of Weeds, which once come naturally in a Soil, if ſuffer'd to grow, will always proſper in proportion to the Tillage and Manure beſtow'd upon it, without any Change. And ſo are all manner of Plants, that have been yet try'd by the new Huſbandry, ſeen to do.

A Vineyard, if not tilled, will ſoon decay, even in rich Ground, as may be ſeen in thoſe in *France*, lying intermingled as our Lands do in common Fields. Thoſe Lands of Vines, which by reaſon of ſome Law-ſuit depending about the Property of them, or otherwiſe, lie a Year or two untilled, produce no Grapes, ſend out no Shoots hardly: the Leaves look yellow, and ſeem dead, in Compariſon of thoſe on each Side of them; which, being tilled, are full of Fruit, ſend out an hundred times more Wood, and their Leaves are large and flouriſhing; and continue to do the ſame annually for Ages, if the Plough or Hoe do not neglect them.

No Change of Sorts is needful in them, if the ſame annual Quantity of Tillage (which appears to provide the ſame annual Quantity of Food) be continued to the Vines.

But what in the Vineyards proves this Theſis moſt fully is, That where they conſtantly till the low Vines

(a) And *cæteris paribus*; for when the Land has been more exhauſted, more Tillage (or Dung) or Reſt will be required to produce the ſame Quantity of Food, than when the Land hath been leſs exhauſted. By Tillage is here meant, not only the Number of Plowings, but the Degree of Diviſion or Pulveration of the Soil; or, if perchance the Soil is extraordinary much exhauſted by many Crops, without proper Tillage between them, the greater Degree of Pulveration, by Plowing or Dung (which is only a *Succedaneum* of Tillage), and alſo a longer Time of Expoſure, may be neceſſary to counterpoiſe that extraordinary Exhauſtion.

with the Plough, which is almoſt the ſame with the Hoe-plough, the Stems are planted about Four Feet aſunder, chequerwiſe; ſo that they plow them Four ways. When any of theſe Plants happen to die, new ones are immediately planted in their room, and exactly in the Points or Angles where the other have rotted; elſe, if planted out of thoſe Angles, they would ſtand in the Way of the Plough: Theſe young Vines, I ſay, ſo planted in the very Graves, as it were, of their Predeceſſors, grow, thrive, and proſper well, the Soil being thus conſtantly tilled: And if a Plum-tree, or any other Plant, had ſuch Tillage, it might as well ſucceed one of its own Species, as thoſe Vines do.

'Tis obſerved, that White-thorns will not proſper, ſet in the Gaps of a White thorn Hedge: But I have ſeen the Banks of ſuch Gaps dug and thrown down one Summer, and made up again, and White-thorns there replanted the following Winter, with good Succeſs.

But note, That the annual plowing the Vines is more beneficial than the one Summer Tillage of the Banks, the Vines having it repeated to them yearly.

I have, by Experience and Obſervation, found it to be a Rule, That long Tap-rooted Plants, as Clover and St. Foin, will not ſucceed immediately after thoſe of their own or any other Species of long Tap-roots, ſo well as after horizontal-rooted Plants; but, on the contrary, horizontal will ſucceed thoſe Tap-roots as well or better than they will ſucceed horizontal.

I confeſs, this Obſervation did, for a great while, cheat me into the common Belief, That different Species of Plants feed on different Food; till I was delivered from that Error, by taking Notice, that thoſe Tap-roots would thrive exceedingly well after Turneps, which have alſo pretty long Tap-roots, though Turneps never thrive well immediately after Clover,

Clover *(a)*, or St. Foin: I found the true Caufe of this Exception to that Rule to be chiefly the different Tillage *(b)*.

Land muft be well tilled for Turneps, which alfo are commonly hoed; they ftand fcarce ever above Three-quarters of a Year, and are then fed on the Ground; and then the fucceeding Crop of Corn has, by that means, the Benefit of twice as much Tillage from the Hoe, as otherwife would be given to it; and the Broad Clover, or St. Foin, fown with the Corn (if the Corn be not fo big as to kill it), will enjoy, in its Turn, a Proportion of the extraordinary Tillage, and of the Dung of Cattle, which feed the Turneps, and thrive accordingly: But Broad Clover and St. Foin, being perennial Plants, ftand on the Ground fo long, that it lies feveral Years untilled; fo that Turneps, fown immediately after thefe, do fail, for want of their due Tillage, for which there is not fufficient time, by plowing often enough; becaufe, by the common Ploughs, it requires Two or Three Years to make it fine enough for Turneps, or for a Repetition of Clover, or St. Foin, in ftrong or fwerdy Land.

Another Reafon why any Crop fucceeds well after Turneps (and befides their being fpent on the Ground where they grow) is their cold Conftitution, by which they are maintained with lefs Food than another Plant of the fame Bulk.

The *Parenchyma*, or flefhy Part of a Turnep, confifting of a watry Subftance, which cools the Veffels, whereby the Sap's Motion is very flow, in proportion to the very low Degree of Heat it has, and

(a) But when Clover has been fed by Cattle, the Ground being good, and well tilled, Turneps may thrive immediately after Clover: Therefore this is an Exception to the general Rule.

(b) Very mellow rich Land is fo full of vegetable Food, that 'tis an Exception to moft Rules; and therefore I fpeak not of that.

fends

fends off its Recrements in the fame Proportion likewife; and therefore requires the lefs of the terrene Nourifhment to fupply thofe Recrements.

This is feen, when a Bufhel of Turneps, mixed with a Quantity of Wheaten Flour, is made into Bread, and well baked: This Bufhel of Turneps gives but few Ounces Increafe in Weight, more than the fame Quantity of Wheaten Flour made into Bread, and baked without any Turneps. This fhews there is in a Turnep very little Earth (which is the moft permanent Subftance of a Plant); the Oven difcharges in Vapour near all but the largeft Veffels: Its earthly Subftance being fo fmall, is a Proof 'tis maintained by a fmall Quantity of Earth: and, upon that Account alfo, of lefs Damage to the next Crop than another Plant would be, which required more of the folid Nourifhment to conftitute its firmer Body, as a Charlock does; for when a Charlock comes up, contiguous to, and at the fame time with a Turnep, it does fo rob the Turnep, that it attains not to be of the Weight of Five Ounces; when a fingle Turnep, having no more Scope of Ground, and, in all refpects (but the Vicinity of the Charlock), equal, weighs Five Pounds, yet that Charlock does not weigh One Pound.

And where Three Turneps coming up, and growing thus contiguous, will weigh Four Pounds; a Charlock joined with Two or Three Turneps, all together, will be lefs than one Pound, upon no lefs Space of Ground.

This Obfervation cannot be made, except where Turneps are drilled in Rows; and there 'tis eafy to demonftrate, that a Charlock, during the time of its fhort Life, draws much more Earth than a Turnep of equal Bulk, from an equal Quantity of Ground (*c*).

The

(*c*) 'Tis certain that Turneps, when they ftand for Seed, fuck and impoverifh the Ground exceedingly: For though they are of a

The true Cauſe why Clover and St. Foin do not ſucceed ſo well after their own reſpective Species, or that of each other, as Corn, *&c.* can, is, that they take great Part of their Nouriſhment from below the Plough's Reach, ſo as that under Earth cannot be tilled deep enough, but the upper Part may be tilled deep enough for the horizontal Roots of Corn, *&c.* towards which, the Rotting of the Clover and St. Foin Roots, when cut off by the Plough, do not a little contribute *(d)*; And there's no doubt but that, if the

a cold Conſtitution, and conſequently conſume leſs Food than Plants of an hotter Conſtitution, and of the ſame Bulk; yet theſe Seed-turneps being of ſo vaſt a Bulk, as ſometimes Eighty Quarters of their Roots grow on an Acre, and their Stalks have been meaſured Seven Feet high, and their Roots having continued at near their full Bigneſs for about Ten Months together, and then carried off, they drain the Land more than a Crop of other Vegetables of a leſs Bulk, and an hotter Conſtitution, and which live a leſs time; or than Wheat, which, though it lives as long, is very ſmall, except in the Four laſt Months.

(d) That the Rotting of vegetable Roots in the Ground doth ferment therein, and improve it for horizontal-rooted Plants, I am convinced by an Accident; *viz.* My Man had plowed off the Earth cloſe to the Rows in a Field of extraordinary large Turneps deſigned for Seed. This Earth was neglected to be thrown back to the Rows, until a ſevere Froſt in the Winter came, and killed the Turneps; upon which, in the Spring, the Field was ſown with Barley upon the Level, with only *once* plowing, and that croſs-ways of the Rows The Turneps had ſtood ſo wide aſunder, that the Spot whereon each had rotted, appeared like the Spot whereon an Horſe had urined in till'd Ground, and was of a deeper Colour, and much higher, than the Barley that grew round thoſe Spots; and yet none of it was poor. As the Roots of Clover, and St. Foin, are very much leſs; yet the greater Number rotting in plowed Ground muſt be of great Uſe to a following Crop of Corn.

I will here relate Two Examples of this in St. Foin: The one is, That a Field of Twenty-five Acres drilled with St. Foin, except Three Acres in the Middle of it, which was, at the ſame time, ſown with Hop-Clover; after Eight Years the whole Field was plowed up by a Tenant, and ſown with Corn: The St. Foin had been mowed yearly, as the Hop-Clover was not mowed at all, the under Earth could be as well tilled for the Tap-roots, as the upper Earth is for the horizontal, the Tap-roots would ſucceed one another as well as the horizontal would ſucceed them, or thoſe of their own Species, or as the Tap-roots do the horizontal.

all, but fed by Horſes teddered (or ſtaked) thereon the Firſt and Second Years; and after that had nothing on it but poor natural Graſs.

The whole Field was managed alike, when plowed up; but the Three Acres produced viſibly worſe Crops of Corn than the reſt all round it, which had produced St. Foin.

The other Example or Inſtance was, Where an Acre, Part of a Field, was, by a Fancy, drilled with St. Foin in ſingle Rows, about Thirty-three Inches aſunder, but was never hoed: After Seven Years it was plowed up with the reſt of the Field croſs the Rows, and ſown with Oats upon the Back Three Months after plowing. Theſe Rows were as viſible in the Oats, as if the St. Foin had been ſtill remaining there: The Oats in the Rows where the St. Foin had been, looked of a deep green flouriſhing Colour, at firſt coming up, and until they were about half a Foot high, and the Spaces between them looked yellowiſh; but afterwards the Difference of their Colour diſappeared, all the Crop being very good. Upon this I imputed it to the Rotting of the Roots, which by their Singleneſs were very large; and when the different Colours diſappeared, I ſuppoſe the Roots of all the Oats had reached to the Benefit of the rotted Roots, which might alſo be then ſpread farther into the Spaces; and I doubt not but that the Rotting of Broad Clover-roots has the ſame Effect as of St. Foin, for manuring of Land, eſpecially when the Roots are large.

Some have objected againſt this Opinion, and ſay the Effect was rather to be imputed to the Rows of St. Foin ſhadowing the Earth under them, or elſe from their keeping the Earth under them free from Couch-graſs, of which the Intervals were full: But I think it more probable, that the Couch-graſs, having very long horizontal Roots, might draw Nouriſhment from the Earth under the Rows, and from the Intervals equally.

And as to the Shadow of the Rows, tho', for the Firſt and Second Years, the St. Foin Plants were very large; yet, being afterwards, for Five or Six Years, until plowed up, conſtantly fed by Cattle, and being more ſweet, was eaten very low, whilſt the Couch-graſs remained intire in the Intervals, and ſhadowed them more than the Earth of the Rows was ſhadowed by the St. Foin: Beſides, the rotten Turneps, which were freed from both theſe Objections, had the ſame Effect on the Barley, as the St. Foin had on the Oats.

The

The under Earth, in ſome time, is repleniſhed by what the Rains leave, when they ſink through it; and then Tap-rooted Plants may be there nouriſhed again, tho' the upper Earth be drained by the Corn; ſo that no Change is ſo beneficial, as that betwixt Tap-rooted Plants, and thoſe which have only horizontal ones. The former are provided for by Rains, though not ſo ſpeedily as the latter are by Tillage and Hoeing.

Paſtures require no Change of Herbs; becauſe they have annually the ſame Supply of Food from the Dunging of Cattle that feed on them, and from the Benefit of the Atmoſphere.

Meadows hold out without Change of Species of Graſs, tho' a Crop be carried off every Year; the Richneſs of that Soil, with the Help of the Atmoſphere, Dung of Cattle in feeding the After-Crop, or elſe Flooding, from the overflowing of ſome River, ſome, or all of which, ſupply the Place of the Plough to a Meadow.

Woods alſo hold out beyond Memory or Tradition, without changing Sorts of Trees; and this by the Leaves, and perhaps old Wood, rotting on the Soil annually, which operate as a Manure; becauſe, as has been ſaid, Earth which has once paſſed any Veſſels, is ſo changed, that, for a long time after, it does not retain its Homogeneity *(e)* ſo much as to mix with pure Earth, without fermenting; and by the Deſcent of the Atmoſphere, the Trees ſhadowing the Soil, to prevent the Re-aſcent of what that brings down; all this, reſembling Tillage, continually divides the Soil, and renews the Food equal to the Conſumption of it made by the Wood.

And the laſt Argument I ſhall attempt to bring for Confirmation of all I have advanced, is that

(e) Not that the Particles of Earth are ſtrictly homogeneous, but that they are much leſs heterogeneous, before they are altered by Veſſels, than afterwards.

which

which proves both the Truth and Uſe of the reſt; *viz.* That when any Sort of Vegetable, by the due Degrees of Heat and Moiſture it requires, is agreeable to a Soil, it may, by the new Horſe-hoeing Huſbandry, be continued without ever changing the Species.

CHAP. XV.

Of Change of INDIVIDUALS.

SEEDS, in their natural Climate, do not degenerate, unleſs Culture has improved them; and then, upon Omiſſion of that Culture, they return to their firſt natural State.

As the Benefit of changing of Species of Seeds is from Difference of Tillage, ſo the Benefit of changing Individuals of the ſame Species appears to be from thoſe Cauſes which are, generally, themſelves, the Effects of different Climates, ſuch as Heat and Moiſture, which may alſo vary very much in the ſame Latitude and Neighbourhood; as the ſame Mountain in the Country of the *Mogul* (related by Mr. *Evelyn*, from Monſieur *Bernier)*, on the South Side produces *Indian* Plants, and on the North Side *European* Plants, from different Expoſures; and ſome Land, retaining Water longer, 'is colder; ſome, ſuffering it to paſs down quicker, and by the Nature and Figure of its Parts, cauſes ſuch a Refraction and Reflexion of the Sun's Rays, which give a great Warmth, as in Sand, and gravelly Grounds, that are well ſituate, and have an under Stratum of ſome Sort of hollow Matter, next under the Staple *(a)*,

(a) This hollow Matter lets the Water paſs down the ſooner from the Surface, whereby the Staple of the Ground becomes the drier, and conſequently warmer.

or upper Stratum, wherein the Plough is exercifed.

This beneficial Change of Individuals feems rather to be from the forementioned Caufes, than from Change of Food; and thefe Caufes fhew their Efficacy, chiefly in the Generation or Fœtation of thofe Seeds; as Flax-feed brought from *Holland*, and fown here, will bring as fine Flax as there; but the very next Generation of it coarfer, and fo degenerating gradually, after Two or Three Defcents, becomes no better than the common ordinary Sort; yet its Food is the fame, when the Flax is fine, as when 'tis coarfe.

And fo it is, when Individuals of Wheat are changed: So Silk-worms, hatched and bred in *France*, of Eggs or Seed brought from *Italy*, will make as fine Silk as the *Italian*; but the Eggs of thefe laid in *France* and their Iffue, will make no better Silk than the *French*; though their Food be from Leaves of the fame Mulberry-trees, when they make fine Silk and coarfe: Therefore 'tis from the Climate, where the Eggs are impregnated, not where they have their Incubation or Food, when hatched, and fed to their Lives End, that this Difference happens.

Common Barley, fown once in the burning Sand at *Patney* in *Wiltfhire*, will, for many Years after, if fown on indifferent warm Ground, be ripe Two or Three Weeks fooner than any other *(b)*, which has never

(b) Barley is far from being improved by becoming rath-ripe; for it lofes more good Qualities than it gets by being fown at *Patney*: 'Tis fo tender, that if it be fown early, the Froft is apt to kill it; or if it be fown late in *May*, on the fame Day, and in the fame Soil, with the fame Sort of Barley that is not rath-ripe, it will be much thinner bodied than the late-ripe; and befides, if it happens to have any Check by Cold or Drought, it never recovers it as the other doth, at what time foever it is fown. It is now, I am informed, gone out of Fafhion, and very few Farmers have fown it of late Years. I know a little Parifh, that. I

never been impregnate at *Patney:* But if ſown a Degree farther North, on cold clayey Land, will, in Two or Three Years, loſe this Quality, and become as late ripe as any other.

Indeed *Patney* is far from improving the Species of Barley, except we think it improved by becoming more weak and tender, and ſhorter-lived; which laſt-mentioned Quality fits it for ſuch Countries, where the Summers are too ſhort for other Barley to ripen.

The Grains or Seeds of Vegetables are their Eggs; and the individual Plants, immediately proceeding from them, have not only the Virtues they received in Embryo (or rather *in plantulis)*, but the Diſeaſes alſo; for when ſmutty Wheat is ſown, unleſs the Year prove very favourable, the Crop will be ſmutty; which is an evident Token of *mala ſtamina.*

The ſmutty Grains will not grow; for they turn to a black Powder: But when ſome of theſe are in a Crop, then, to be ſure, many of the reſt are infected; and the Diſeaſe will ſhew itſelf in the next Generation, or Deſcent of it, if the Year wherein 'tis planted prove a wet one.

Weeds, and their Seed, in the Fields where they grow naturally, for Time immemorial, come to as great Perfection as ever, without Change of Soil.

Theſe Weeds, with Acorns, and other Maſts, Crabs, Sloes, Hips, and Haws, are thought to have been, originally, the only natural Product of our Climate: Therefore other Plants being Exotics, many of them, as to their Iudividuals, require Culture and Change of Soil, without which they are liable more or leſs to degenerate.

But to ſay, that the Soil can cauſe Wheat to degenerate into Rye, or convert Rye into Wheat, is what

I believe, formerly loſt about Two hundred Pounds *per Ann.* by ſowing rath-ripe Barley: But long and dear Experience hath now convinced them of their Error, and obliged them totally to diſuſe it.

reflects

reflects upon the Credit of *Laurembergius:* 'Tis as eaſy to believe, that an Horſe, by feeding in a certain Paſture, will degenerate into a Bull, and in other Paſture revert to an Horſe again; theſe are ſcarce of more different Species than Wheat and Rye are: If the different Soil of *Wittemberg* and *Thuringia* change one Species, they may the other.

CHAP. XVI.

Of RIDGES.

THE Method of plowing Land up into Ridges is a particular Sort of Tillage; the chief Uſe of which is, the Alteration it makes in the Degrees of Heat and Moiſture, being two of the grand Requiſites of Vegetation; for very different Degrees of theſe are neceſſary to different Species of Vegetables.

Thoſe Vegetables commonly ſown in our Fields, require a middle Degree of both, not being able to live on the Sides of perpendicular Walls in hot Countries, nor under Water in cold ones, neither are they amphibious, but muſt have a Surface of Earth not cover'd, nor much ſoak'd with Water, which deprives them of their neceſſary Degree of Heat, and cauſes them to languiſh. The Symptoms of their Diſeaſe are a pale or yellow Colour in their Leaves, and a Ceſſation of Growth, and Death enſues as ſure as from a Dropſy.

The only Remedy to prevent this Diſeaſe in Plants is, to lay ſuch wet Land up into Ridges, that the Water may run off into the Furrows, and be convey'd by Ditches or Drains into ſome River.

The more a Soil is fill'd with Water, the leſs Heat it will have.

The Two Sorts of Land moſt liable to be overglutted with Water, are Hills, whereof the *Upper Stratum* (or Staple) is Mould lying upon a *Second Stratum* of Clay;

And generally all ſtrong deep Land.

Hills are made wet and ſpewy by the Rain-water which falls thereon, and ſoaks into them as into other Land; but being ſtopp'd by the Clay lying next the Surface or Staple, cannot enter the Clay; and for want of Entrance, ſpreads itſelf upon it; and as Water naturally tends downwards, it is by the incumbent Mould partly ſtopp'd in its Deſcent from the upper towards the lower Side of an Hill; and being follow'd and preſs'd on by more Water from above, is forced to riſe up into the Mould lying upon it, which it fills as a Ciſtern does a Fountain (or *Jet d'Eau*). The Land of ſuch an Hill is not the leſs wet or ſpewy for being laid up in Ridges, if they be made from the higher to the lower Part of the Field; for the Force of the Water's Weight continued will raiſe it ſo, as to cauſe it to iſſue out at the very Tops of thoſe Ridges; the Earth becomes a ſort of Pap or Batter, and being like a Quagmire, in going over it, the Feet of Men and Cattle ſink in till they come to the Clay.

There are two Methods of draining ſuch a wet Hill: The one is to dig many Trenches, croſs the Hill horizontally (*a*), and either fill them up with Stones looſe or archwiſe, through which the Water, when it ſoaks into the Trenches, may run off at one or both Ends of them into ſome Ditch, which is lower,

(*a*) For if they are made with the Deſcent, and not acroſs it, then they will be parallel to the Rills of Water, that run upon the Surface of the Clay under the Staple (or upper *Stratum* of Mould), and would be no more effectual for draining the Hill, than the digging of one River parallel to another, without joining it in any Part, would be effectual for draining the other River of its Water.

and

and carries it away; then they cover the Trenches with Mould, and plow over them as in dry level Ground.

This Method has been found effectual for a time, but not of long Continuance; for the Trenches are apt to be ſtopp'd up, and then the Springs break out again as before: Beſides, this is a very chargeable Work, and in many Places the Expence of it may almoſt equal the Purchaſe of the Land.

Therefore 'tis a better Method to plow the Ridges croſs the Hill almoſt horizontally, that their parting Furrows, lying open, may each ſerve as a Drain to the Ridge next below it; for when the Plough has made the Bottom of theſe horizontal Furrows a few Inches deeper than the Surface of the Clay, the Water will run to their Ends very ſecurely, without riſing into the Mould, provided no Part of the Furrows be lower than their Ends.

Theſe parting Furrows, and their Ridges, muſt be made more or leſs oblique, according to the Form and Declivity of the Hill; but the more horizontal they are, the ſooner the Rain-water will run off the Lands; for in that Caſe it will run to the Furrows, and reach them at right Angles, which it will not do when the Ridges (or Lands) are oblique; and therefore the Water's Courſe croſs the Lands will be longer *(a)*. Every one of theſe horizontal Trenches receives

(a) The natural Courſe of Water being downwards, it would always run by the neareſt Way to the Bottom of the Hill, if nothing ſtopt it; but the Water runs from an Hill in Two Manners; *viz.* Upon the Surface of the Staple, and upon the Surface of the Clay that is under the Staple; that which runs under keeps its ſtrait Courſe from the Top to the Bottom of an Hill, under a Ridge that is made exactly with the Deſcent of the Hill, except that Part of the Water that riſes up into the Mould, and a very little that ſoaks into the Furrows, for when the Furrows are not made exactly with the Deſcent, the more oblique they are to the Deſcent, the longer will be the Water's Courſe under the Ridges; and the ſhorter, as they are nearer being at Right Angles to the Deſcent.

receives all the Water from the Rills, or little Gutters, wherein the Water runs betwixt the Mould and the Clay; theſe are all cut off by the Trenches, which receive the Water at their upper Sides, and carry it away, as the Trunks of Lead plac'd under the Eaves of a Houſe do carry away the Rain-water.

If there were no other Manner of plowing Ridges on the Sides of Hills than what is commonly practiſed on the Plains, this Method of leaving open Furrows (or Drains on Declivities) would be impracticable; becauſe the Plough could not turn up the Furrows againſt the Hill, and againſt the Ridge alſo, from the lower Side of it: But the eaſy Remedy againſt that Inconvenience is, to plow ſuch Ridges in Pairs, without throwing any Earth into the Trenches, and then the Ridges will be plain a-top, and the Rain-water will run ſpeedily downward to the next Trench, and thence to the Head-land, and ſo out of the Field. Theſe Trenches will be made, as well as kept always open, by this plowing in Pairs; and is abundantly more eaſy than the Way of plowing Ridges ſingly. This plowing in Pairs prevents alſo another Inconveniency, which would otherwiſe happen to theſe horizontal Ridges; and that is, they being higheſt in the Middle, the Rain-water could not run freely from the upper Half of a Ridge towards the next Furrow below it, but would be apt to ſink in there, and ſoak thro' the Ridge; but when Ridges lie in Pairs, the Water will run off from a whole Ridge, as well as off the lower Half of a Ridge that is plow'd ſingly, and higheſt in the Middle.

Deſcent. 'Tis alſo the ſame with the Water that falls upon the Surface of the Ridges; for the more horizontal they are, the ſhorter its Courſe will be from them to the Furrows, which carry it off; and the leſs of the Water will ſink into the Ridges, the leſs oblique and the nearer to Right Angles to the Deſcent they are made.

Note,

Note, That every time of plowing, the Pairs muſt be changed, ſo that the Furrow, which had Two Ridges turned towards it one time, muſt have Two turned from it the next time: This Method keeps the Surfaces of all the Ridges (or Lands) pretty near even *(a)*.

Farmers are at more Trouble and Pains to drown ſuch Land (it being common to break their Horſes Wind in plowing up Hill) than they would be at, if they laid their Ridges in the abovesaid Manner, which would effectually make them dry. Many hundred Acres of good Ground are ſpoiled; and many a good Horſe, in plowing againſt the Hill, and againſt all Reaſon, Demonſtration, and Experience too; which might be learned even from the *Iriſh*, who drain their Bogs, and make them fruitful, whilſt ſome *Engliſh* beſtow much Labour to drown and make barren many of their Hills, which would more eaſily be made dry and fertile.

I have obſerved, that thoſe Places of ſuch an Hill, that, when plowed with the Deſcent, were the wetteſt, and never produced any thing that was ſown on them, became the very richeſt, when made dry by plowing croſs the Deſcent. This ſhews that Water does not impoveriſh Land, but the contrary; tho', whilſt it ſtands thereon, it prevents the Heat which is neceſſary to the Production of moſt Sorts of Vegetables: And where it runs ſwiftly, it carries much Earth away with it; where it runs ſlowly, it depoſits and leaves much behind it.

Though in all Places, where this Way of making the Ridges croſs the Deſcent of Hills is practiſed, the Land becomes dry; yet very few Farmers will

(a) *Note*, This cannot be done on an Hill, whoſe Declivity is ſo great, that the Plough is not able to turn a Furrow againſt it. But in this Caſe, perhaps, it may be ſufficient to plow the Ridges obliquely enough for the Furrow to be turned both Ways.

alter their old Method (*a*); no, not even to try the Experiment; but ſtill complain their Gronnd is ſo wet and ſpewy, that it brings them little or no Profit: and if the Year prove moiſt, they are great Loſers by ſowing it (*b*).

(*a*) But ſome of late are convinced, by obſerving that an Hill of mine has been made dry by this means for Fourteen Years paſt, which before was always more wet and ſpewy than any Field in the Neighbourhood; and from the time of incloſing it out of an Heath (or Common), and the converting it to arable, which was about Seventy Years ago, it had been reputed as little better than barren, on account of its Wetneſs; and that it has been the moſt profitable Field of my Farm ever ſince it has been under this new Management. I have alſo another Field, that lies about a Mile and an half from me: It doth not belong to the Farm where I live, but was thrown upon my Hands, no Tenant caring to rent it, becauſe great Part of it was full of Springs, and barren: This alſo, having been kept in Lands plowed croſs the Deſcent (which is but a ſmall Declivity), is become dry: And now the moſt prejudiced Farmers agree, that keeping the Lands or Ridges of wet Ground always croſs the Deſcent doth cure its Spewineſs. Hereupon ſome have attempted to put this Method in Practice on their wet Land; and, after it has been well tilled up Hill and down, have plowed it the laſt time for ſowing of Wheat in flat Lands croſs the Deſcent; but by Miſmanagement their Furrows are higher at each End than the Middle, ſo that none of the Water can run off either downwards or ſideways, or any other Way.

Had the Furrows carried off the Water at both or either of their Ends, it might have been effectual, notwithſtanding the broad Lands, becauſe their Ground hath a much leſs Declivity, and is much leſs ſpewy, than my Hill was: They will doubtleſs find their Miſtake, and amend it, having a Precedent before their Eyes; but if they had none within their own Inſpection, I queſtion whether this Miſmanagement might not diſcourage them from proſecuting their Project any further.

(*b*) Remember, in making Ridges of all Sorts, and of whatſoever Figure the Piece is, that no Ridge ought to have any more Furrows at one End, than at the other End; for if there be, the Plough muſt be turned in the Middle of the Piece, which will cauſe the Land to be trodden by the Horſes; but if each End have an equal Number of Furrows, the Horſes in turning will tread only upon the Head lands, which may be plowed afterwards; or if deſign'd to be Horſe-ho'd, the Head-lands ſhould be narrow, and not plowed at all.

The

The Benefit of laying up ſtrong deep Land into Ridges is very great; tho' there be no Springs in it, as are in the Hills aforementioned.

This Land, when it lies flat, and is plowed ſometimes one Way, ſometimes the other, by croſs-plowing, retains the Rain-water a long time ſoaking into it; by that Misfortune, the Plough is kept out Two or Three Weeks longer than if the ſame were in round Ridges; nay, ſometimes its Flatneſs keeps it from drying till the Seaſon of plowing, and even of ſowing too, be loſt.

The Reaſons commonly given againſt ſuch Ridges are theſe following.

I. *They prevent the fanſied Benefit of croſs-plowing.*

II. *Farmers think they loſe Part of their Ground, by leaving more Furrows betwixt Ridges, than when they lay their Land flat, where the Lands are made much larger than round Ridges can conveniently be; and becauſe alſo the Furrows betwixt Ridges muſt be broader, and lie open; but the other they fill up by the Harrows.*

The firſt of theſe I have already anſwered elſewhere, by ſhewing, that Croſs-plowing is oftener injurious than beneficial.

The Second I ſhall ſufficiently confute, if I can make appear, that no Ground is loſt, but much may be gained, by Ridges.

What I mean by gaining of Ground, is the increaſing of the Earth's Surface: For if a flat Piece be plow'd up into Ridges, and if in each Sixteen Feet Breadth there be an empty Furrow of Two Feet; and yet, by the Height and Roundneſs of the Ridges, they have Eighteen Feet of Surface capable of producing Corn, equally to Eighteen Feet whilſt the Piece was flat; there will be one Eighth Part of profitable Ground or Surface gain'd, more than it had when level; and this, I believe, Experience will prove, if the thing were well examined into.

But againſt this Increaſe of profitable Ground, there is an Objection, which I muſt not call a frivolous one, in reſpect to the Authors who bring it; yet, I hope, the Deſire of finding the Truth will juſtify me to examine it; and the Arguments brought to ſuſtain it.

This Opinion of theirs is founded upon their Notion (which I think very erroneous) of the perpendicular Growth of Vegetables; and is, by Mr. *Bradley*, ſet in its beſt Light, in his *Vol.* I. *Pag.* 8. *uſque ad Pag.* 13. and in his Cuts, repreſenting Three Hills; but his Arguments ſeem to be ſuch as all Arguments are, which pretend to prove a thing to be what it is not; *viz.* Sophiſtical ones.

The Hypotheſis he endeavours to prove, is in *Pag.* 8. thus: ‘ An Hill may contain Four equal Sides, ‘ which meet in a Point at the Top; but the Contents ‘ of theſe Four Sides can produce no more, either of ‘ Grain or Trees, than the plain Ground, upon which ‘ the Hill ſtands, or has at its Baſe: and yet, by the ‘ Meaſure of the Sides, we find twice the Number of ‘ Acres, Roods, and Poles, which meaſure in the ‘ Baſe, or Ground-plat; and therefore *Page* 9. Hills ‘ are worth no more than half their Superficial Mea- ‘ ſure; *i. e.* Two Acres upon the Side of the Hill to ‘ pay as much as one upon the Plain, provided the ‘ Soil of both is equally rich.’

To prove it, he gives an Example in *Fig.* III. of Buildings upon an Hill; ſhewing, that the Two Sides of the Hill will only bear the ſame Number of Houſes, that may ſtand in the Line at the Baſe.

This is foreign to the Queſtion, of how much Grain, or how many Trees, the Hill will produce. For Vegetables, being fed by the Earth, require much more of its Surface to nouriſh them, than is neceſſary for them to ſtand on; but Buildings require no more of of the Surface but Room to ſtand on: Therefore no ſuch Argument, taken from Buildings, can be applied to Vegetables.

This Argument of Mr. *Bradley*'s gives no more Satisfaction to the Queſtion about producing of Vegetables, than a Grazier would do, being aſked, how many Oxen a certain Paſture-ground would maintain, if he ſhould anſwer, by ſatisfying you with the Number of Churches which might ſtand thereon.

The like Anſwer, in effect, may be given to the Argument in *Fig.* IV. of the Pales; only he has forgot to ſhew, that to mound over the Hill would require double the Rails, or double the Hedge-wood (except Stakes) as to mound the Baſe; if it did not, the Hill would be yet of the more Value, becauſe thereon more Surface might be fenced in at leſs Expence.

In his *Fig.* II. he gives no good Reaſon why the Hill ſhould not bear twice the Number of Trees as the Baſe can do; for there is as much Room for Two hundred Trees on the Hill, as for One hundred on the Baſe, becauſe he allows the Surface to be double to that of the Baſe. He ought to meaſure the Diſtances of the Trees on the Hill, by a Line parallel to the Surface they grow on, as well as he does the Diſtances of thoſe below.

And ſuppoſe the Row at the Baſe, together with the Surface they grow on, were rais'd up, ſo that it ſhould become parallel to half the Row on the Hill, would not the Trees in the Baſe Row be twice as near to one another as the Trees in the Hill Row are? And ſuppoſe a Line had been ty'd from the Tops of all the lower Trees, before the Row was ſo rais'd up at one End, and then, after the Situation of the Row was ſo alter'd, if by this Line the Trees ſhould be pull'd from being perpendicular to the Surface they grow on, and made to ſtand oblique to that, and perpendicular to the Horizon, as the upper Trees are; would the Diſtances of the Trees from one another be alter'd alter'd by this Change of Poſture? No, for their Bottoms would be at the ſame Diſtances, becauſe not removed; and their Tops, becauſe the ſame Line holds them, at the ſame Diſtances in both Poſtures.

Mr. *Bradley*'s Lines, drawn from the Trees below, which are one Perch aſunder, make the Two Rows of Trees falſly ſeem to be at equal Diſtances, becauſe theſe Lines are parallel to each other: But this is a Deceit; for, in Truth, the Diſtances of the Trees are not meaſured by the Diſtances of thoſe Lines, but by the extreme Points at the Ends of the Lines *(a)*; and thoſe Two Points above, where the Lines cut the Row obliquely, and at unequal Angles are twice as far aſunder as the endmoſt or extreme Points below are, where the Lines cut the Row at right Angles. Hence may be inferr'd, that there is Room for twice as many Trees to grow on the Hill as on the Baſe, and twice as much Grain for the ſame Reaſon; becauſe there is twice the Surface for the Roots to ſpread in. And ſince Mr. *Bradley* allows the Hill to contain Two Perches to One of the Baſe, and the Soil of both to be of equal Goodneſs; and yet affirms, that the Two can produce no more of Grain or Trees than the one Perch can; I cannot ſee, why it ſhould not be as reaſonable to ſay, that Two Quarters of Oats will maintain an Horſe no longer, nor better, than One Quarter of Oats, of equal Goodneſs, will do.

In *Page* 13. he concludes thus: ‘ That Hills, in ‘ their Meaſure, contain only as much profitable ‘ Land as the Plain or Plat of Ground they ſtand ‘ upon; and as a Proof of that, all Vegetables or ‘ Plants have an erect Method of Growth.’

This Proof of Mr. *Bradley*'s is founded upon an Argument which has no Conſequence, unleſs it were

(a) Theſe upper Trees are meaſured by the unequal Length of the Lines, not by their parallel Diſtance, as the lower Trees are; therefore his Meaſure is a Quibble.

firſt

firſt proved, that the Surface of Earth could produce and maintain as many Vegetables or Plants as could ſtand thereon in an erect Poſture; which Suppoſition is as impoſſible, as that half an Acre ſhould produce and maintain and Hecatomb, without Mr. *Bradley*'s teaching Oxen to live upon Air for their Food, as he thinks *Van Helmont*'s Tree did.

All expert Huſbandmen muſt needs be convinced, that the greateſt Crop of Vegetables that ever grew, might ſtand in an erect Poſture, upon a twentieth (and I may ſay the Hundredth) Part of the Surface that produced it; therefore there muſt be Nineteen Parts for the Roots to ſpread, unoccupied by the Trunks Stems, or Stalks.

And tho' it be true, than an Hill will ſupport no more of theſe, than its Baſe, when placed in an erect Poſture, cloſe together, as in a Sheaf; yet this cloſe Poſition is only proper for them when they are dead, and require no more Nouriſhment than Houſes and Pales do; and conſequently require no Room but to ſtand on. Therefore this Argument of Mr. *Bradley*'s muſt not be admitted in vegetative Growth, where there is always required Nineteen times more Room in the Surface, for the Uſe of the Roots, than what the Stems, Trunks, or Stalks, do poſſeſs upon it: And the more Room there is for the Roots, the greater Number of Plants may be produced.

Neither can I admit, that all Vegetables or Plants have an erect Method of Growth; becauſe the contrary is ſeen in Chamomile, and divers other Vegetables, which have an horizontal Method of Growth.

But what is more material to this Purpoſe, to be obſerved, is, that all Vegetables have horizontal Roots, and Roots parallel to the Earth's Surface or Superficies; and unleſs thoſe Roots have a ſufficient Superficies of Earth to range in, for Nouriſhment of a Plant, the Stem and Branches cannot proſper, what-

whatever be their Method of Growth above the Earth; and if there be not a due Quantity of Food for the Roots within the Earth, a very little Space may contain the external Parts of Vegetables upon it.

From what has been ſaid, I think we may conclude, that Mr. *Bradley*'s Hill may produce more Vegetables than the Baſe whereon it ſtands; and therefore it is of more Value than half its ſuperficial Meaſure; *i. e.* Two Acres on the Hill are worth more than one Acre on the Plain, the Soil being equally rich, as he allows it to be, in his Caſe.

Now, indeed, whether Mr. *Bradley* might not poſſibly be deceived in his Opinion of the equal Richneſs of his Hill, and his Plain, I will not diſpute: I will only ſay this, that 'tis generally otherwiſe. But where a Plain is plow'd up into moderate Ridges, their Height being in proportion to the Depth of the Staple, below which the Plough muſt take nothing into the Ridges, the Soil is equally rich, whether it be plowed plain, or ridged up. And as the Surface is in the Ridges increaſed, there is nothing in all Mr. *Bradley*'s Arguments, that ſhews, why that increaſed Surface ſhould not produce more Vegetables than the ſame Earth could do whilſt it was level.

There are other Reaſons why it ſhould produce more when ridged *(a)*, beſides the Increaſe of Surface; as,

I. *'Tis then more free from the Injuries of too much Water.*

(a) To the Three we may add a Fourth Reaſon, *viz.* the raiſing the Thickneſs of the Staple in the Ridges, keeping the Surface drier in wet Weather, and moiſter at the Bottom of the Staple in dry Weather. And I have ſeen Barley that was drilled on my raiſed little Ridges flouriſh in a dry Summer on the Brow of my chalky Hill, and on my loweſt Land in wet Weather, when the Barley hand-ſown contiguous to it on each Side thoſe Ridges, ſown on the Level the ſame Day that the Ridges were drilled, have looked yellow and ſickly; and yet it is not wet Land.

II.

II. *'Tis better protected against cold Winds; becauſe the Ridges are a Shelter to one another.*

III. *If the Surface be much exhauſted, by too frequent Sowing, the Ridges may be made juſt where the Furrows were, and then the Surface will be intirely changed.*

The following general Rules ought to be obſerved about Ridges; *viz.*

That, as to their Height, regard muſt be had to the Nature of the Soil, in its difficult Admiſſion of Water; for the greater that is, the greater Declivities the Ridges ſhould have; and then, if the Soil be not deep, they ſhould generally be made the narrower.

There is one thing which Mr. *Bradley* takes no notice of; *viz.* That no more of the Rain, or other Benefits of the Atmoſphere, which deſcend perpendicularly, can fall on an Hill, or on a Ridge, than what would fall on the Baſe, or Ground-plot. But 'tis probable, that more of the fine Vapour, which ſwims in the Current of the Air horizontally, does ſtrike and break againſt thoſe Eminences, and ſo make an Equivalent *(b)*, except that it runs off more quickly.

Notwithſtanding all I have here ſaid, in behalf of Ridges, I muſt confeſs, that, for my Hoeing-Huſbandry, I ſhould prefer Land that is naturally dry enough, without a Neceſſity of being laid up in any larger or higher Ridges than what may contain Six Feet in Breadth (*c*), that Size being the largeſt that is proper for the regular Operation of the Horſe-hoe.

CHAP.

(b) But though Ridges do alter or increaſe the Surface, the Quantity of Soil or Earth remaining the ſame as on the Level, and of no greater Depth than can be tilled, it may produce equal Crops of Corn with the Level, and no more; except from the Advantage the Ridges may give it in lying drier.

(c) Since the Printing of my Eſſay, I find, upon Trial, that theſe narrow Ridges are as effectual as any for carrying the Water off from my clayey Hill; and that they be made much leſs horizontal

CHAP. XVII.

Of Differences *between the* Old *and the* New Hufbandry.

IN order to make a Comparifon between the Hoeing-Hufbandry, and the old Way, there are Four Things, whereof the Differences ought to be very well confidered.

I. *The Expence*
II. *The Goodnefs* } of a Crop.
III. *The Certainty*
IV. *The Condition in which the Land is left after a Crop.*

The Profit or Lofs arifing from Land, is not to be computed, only from the Value of the Crop it produces; but from its Value, after all Expences of Seed, Tillage, *&c.* are deducted.

Thus, when an Acre brings a Crop worth *Four Pounds*, and the Expences thereof amount to *Five Ponnds*, the Owner's Lofs is *One Pound*; and when an Acre brings a Crop which yields *Thirty Shillings*, and the Expence amounts to no more than *Ten Shillings*, the Owner receives *One Pound*, clear Profit, from this Acre's very fmall Crop, as the other lofes *One Pound* by his greater Crop.

horizontal than broad Ridges, whereby their Furrows are the more eafily turned upwards againft the Declivity.

I have not tried any narrower Ridge than that of Six Feet upon this Hill: But I have had full Experience of Five-feet and of Four-feet Ridges upon other Land; and find that all Sizes of thefe narrow Ridges are very advantageous, even where the Crop is to be fown upon the Level; for fewer Furrows are neceffary for the Tilling of an Acre, when 'tis kept in fuch Ridges, than in broad Lands; and after wet Weather the Ridges will be fit to be plowed much fooner than level Ground.

The

The uſual Expences of an Acre of Wheat, ſown in the old Huſbandry, *in the Country where I live, is, in in ſome Places, for Two Buſhels and an half of Seed; in other Places Four Buſhels and an half; the leaſt of theſe Quantities at* Three Shillings per *Buſhel, being the preſent Price, is* Seven Shillings *and* Six-pence. *For Three Plowings, Harrowing, and Sowing,* Sixteen Shillings; *but if plow'd Four times, which is better,* One Pound. *For Thirty Load of Dung, to a Statute Acre, is* Two Pounds Five Shillings. *For Carriage of the Dung, according to the Diſtance, from* Two Shillings *to* Six-pence *the Load,* One Shilling *being the Price moſt common, is* One Pound Ten Shillings. *The Price for Weeding is very uncertain; it has ſometimes coſt* Twelve Shillings, *ſometimes* Two Shillings per *Acre.*

	l.	*s.*	*d.*
In Seed and Tillage, nothing can be abated of — — —	01	03	06
For the Weeding, one Year with another, is more than — —	00	02	00
For the Rent of the Year's Fallow	00	10	00
For the Dung; 'tis in ſome Places a little cheaper, neither do they always lay on quite ſo much; therefore abating 15*s. in that Article, we may well ſet Dung and Carriage at* — — —	02	10	00
Reaping commonly 5*s. ſometimes leſs*	00	04	06
Total	04	10	00

Folding of Land with Sheep is reckoned abundantly cheaper than Cart-dung; but this is to be queſtioned, becauſe much Land muſt lie ſtill for keeping a Flock (unleſs there be Downs); and for their whole Year's keeping, with both Graſs and Hay, there are but Three Months of the Twelve wherein the Fold is of any conſiderable Value; this makes the Price of their Manure *quadruple to what it would be, if equally good all the Year, like Cart-dung: And folding Sheep yield little Profit, besides their Dung; because the Wool of a Flock, except it be a large one, will scarce pay the Shepherd and the Shearers. But there is another thing yet, which more inhances the Price of Sheep-Dung; and that is, the dunging the Land with their Bodies, when they all die of the Rot, which happens too frequently in many Places; and then the whole Crop of Corn must go to purchase another Flock, which may have the same Fate the ensuing Year, if the Summer prove wet; and so may the Farmer be served for several more successive Years, unless he should break, and another take his Place, or that dry Summers come in time to prevent it. To avoid this Misfortune, he would be glad to purchase Cart-dung at the highest Price, for supplying the Place of his Fold; but 'tis only near Cities, and great Towns, that a sufficient Quantity can be procured.*

But, supposing the Price of Dunging to be only Two Pounds Ten Shillings, and the general Expence of an Acre of Wheat, when sown, at Three Shillings per *Bushel, to be Four Pounds Ten Shillings, with the Year's Rent of the Fallow;*

The Expences of planting an Acre of Wheat in the Hoeing-Husbandry, is Three Pecks of *(a)* of Seed, at *Three Shillings per* Bushel, is *Two Shillings* and *Three-pence.* The whole Tillage, if done by Horses, would be *Eight Shillings*; because our Two Plowings, and Six Hoeings *(b)*, are equal to Two Plowings;

(a) Sometimes half a Bushel is the most just Quantity of Seed, to drill on an Acre.

(b) But we sometimes plow our Six-feet Ridges before Drilling, at Five or Six Furrows, which is a Furrow or Two more than I have reckoned: But we do not always hoe Six times afterwards. But it is better for successive Wheat-crops to bestow the Labour of as many Hoeings as amount to three plain Plowings in a Year, it being a greater Damage to omit one necessary Hoeing, than is the Expence of several Hoeings.

the

the common Price whereof is *Four Shillings* each; but this we diminifh half, when done by Oxen kept on St. Foin, in this manner; *viz.* Land worth *Thirty Shillings* Rent, drill'd with St. Foin, will well maintain an Ox a Year *(a)*, and fometimes Hay will be left to pay for the Making: We cannot therefore allow more than *One Shilling* a Week for his Work, becaufe his Keeping comes but to *Seven-pence* a Week round the Year.

In plain Plowing, Six Feet contains Eight Furrows; but we plow a Six-feet Ridge at Four Furrows, becaufe in this there are Two Furrows cover'd in the Middle of it, and one on each Side of it lies open. Now what we call one Hoeing, is only Two Furrows of this Ridge, which is equal to a Fourth Part of one plain Plowing; fo that the Hoeing of Four Acres requires an equal Number of Furrows with one Acre that is plow'd plain, and equal Time to do it in (except that the Land, that is kept in Hoeing, works much eafier than that which is not).

All the Tillage we ever beftow upon a Crop of Wheat that follows a ho'd Crop, is equal to Eight Hoeings *(b)*; Two of which may require Four Oxen each, One of them Three Oxen, and the other Five Hoeings Two Oxen each. However, allow Three Oxen to each fingle Hoeing, taking them all one with another, which is Three Oxen more than it comes to in the Whole.

(a) Or an Ox may be well kept Nine Months, with an Acre of indifferent Horfe-ho'd Turneps; and if we value them only at the Expence and Rent of the Land, this will be a yet cheaper Way of maintaining Oxen. Upon more Experience it is found, that St. Foin Hay alone, or with a fmall Quantity of Turneps, is beft for working Oxen in the Winter; but a Plenty of Turneps with the fame Hay is better for fatting Oxen that do not work.

(b) But the Number of Oxen required will be according to their Bignefs and Strength, and to the Depth and Strength of the Soil, which alfo will be the eafier Draught for the Oxen, the oftener the Intervals are hoed.

Begin at Five in the Morning, and in about Six Hours you may hoe Three Acres, being equal in Furrows to Three Rood; *i. e.* Three Quarters of an Acre. Then turn the Oxen to Graſs, and after reſting, eating, and drinking, Two Hours and an half, with another Set of Oxen begin Hoeing again; and by or before half an Hour after Seven at Night, another like Quantity may be ho'd. Theſe are the Hours the Statute has appointed all Labourers to work, during the Summer Half-year.

To hoe theſe Six Acres a Day, each Set of Oxen draw the Plough only Eight Miles and a Quarter, which they may very well do in Five Hours; and then the Holder and Driver will be at their Work of Plowing Ten Hours, and will have Four Hours and an half to reſt, *&c.*

The Expence then of hoeing Six Acres in a Day, in this manner, may be accounted, at *One Shilling* the Man that holds the Plough, *Six-pence* the Boy that drives the Plough, *One Shilling* for the Six Oxen, and *Six-pence* for keeping the Tackle in Repair. The whole Sum for hoeing theſe Six Acres is *Three Shillings*, being *Six-pence per* Acre *(a)*.

They who follow the old Huſbandry cannot keep Oxen ſo cheap, becauſe they can do nothing without the Fold, and Store-ſheep will ſpoil the St. Foin. They may almoſt as well keep Foxes and Geeſe together, as Store-ſheep and good St. Foin. Beſides, the ſowed St. Foin coſt Ten times as much the Planting as drill'd St. Foin does, and muſt be frequently manured, or elſe it will ſoon decay; eſpecially upon all ſorts of chalky Land, whereon 'tis moſt commonly ſown.

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(a) But where there is not the Convenience of keeping Oxen, the Price of Hoeing with Horſes is One Shilling each time.

When a Roller is uſed, which is leſs than a Hoeing, becauſe one Perſon to lead is enough, and that may be a Boy; and once in an Interval may ſuffice; then 'tis leſs Labour than half a Hoeing; and for this we may well abate One Hoeing of the Eight.

The Expence of drilling cannot be much; for as we can hoe Six Acres a Day, at Two Furrows on each Six-feet Ridge, so we may drill Twenty-four Acres a Day, with a Drill that plants Two of those Ridges at once; and this we may reckon a *Peny Half-peny* an Acre. But because we find it less Trouble to drill single Ridges, we will set the Drilling, at most, *Six-pence per* Acre.

As every successive Crop (if well managed) is more free from Weeds than the preceding Crop; I will set it all together at *Six-pence (a)* an Acre for Weeding (*b*).

For a Boy or a Woman to follow the Hoe-plough, to uncover the young Wheat, when any Clods of Earth happen to fall on it, for which Trouble there is seldom necessary above once *(c)* to a Crop, *Two-pence* an Acre. *One Peny* is too much for Brine and Lime for an Acre.

Reaping this Wheat is not worth above half as much as the Reaping of a sown Crop of equal Value; because the drill'd standing upon about a Sixth Part of the Ground, a Reaper may cut almost as much of the Row at one Stroke, at he could at Six, if the same stood dispersed all over the Ground, as the sowed does; and because he who reaps sowed Wheat,

(a) This is when the Land has been well cleansed of Weeds in the preceding Crop, or Fallow, or both.

(b) This may be enough, if the Land be well cleansed the Year before, and considering that several Years in such there is no Occasion for Weeding at all: And as this Calculation is comparative with the old Way, we should examine the Price of weeding the sown Corn, which by the best Information I can get, was in the Year 1735. about 4 *s. per* Acre for Weeding of Barley; and of Wheat, round about where I live, about 6 *s.* and in *Wiltshire*, 15 *s. per* Acre for their Wheat, amongst which much Damage is done by the Weeder's Feet, and yet some Weeds are left.

(c) But this Expence being so small, 'tis better that a Person should follow at every Hoeing, where we suspect, that any Damage may happen from any Earth's falling on, or pressing too hard against some of the Plants.

muſt reap the Weeds along with the Wheat; but the drilled has no Weeds; and beſides, there go a greater Quantity of Straw, and more Sheaves, to a Buſhel of the ſowed, than of the drilled (*a*). And ſince ſome Hundred Acres of drilled Wheat have been reaped at *Two Shillings* and *Six-pence per* Acre, I will count that to be the Price.

The whole Expence *of an Acre of drilled Wheat.*

	l.	*s.*	*d.*
For Seed — — — — —	00	02	03
For Tillage — — — —	00	04	00
For Drilling — — — —	00	00	06
For Weeding — — — —	00	00	06
For Uncovering — — —	00	00	02
For Brine and Lime — —	00	00	01
For Reaping — — — —	00	02	06
Total	00	10	00
The Expence of an Acre of ſowed Wheat is — —	04	00	00
To which muſt be added, for the Year's Rent of the Fallow	00	10	00
Total	04	10	00

If I have reckoned the Expence of the drilled at the loweſt Price, to bring it to an even Sum; I have alſo abated in the other more than the whole Expence of the drilled amounts unto.

And thus the Expence of a drilled Crop of Wheat is but the Ninth Part of the Expence of a Crop ſown in the common Manner.

'Tis alſo ſome Advantage, that leſs Stock is required where no Store-ſheep are uſed.

(*a*) One Sheaf of the latter will yield more Wheat than Two of the former of equal Diameter.

II.

II. *Of the different Goodness of a Crop.*

The Goodness of a Crop consists in the Quality of it, as well as the Quantity; and Wheat being the most useful Grain, a Crop of this is better than a Crop of any other Corn, and the ho'd Wheat has larger Ears (and a fuller Body) than sow'd Wheat. We can have more of it, because the same Land will produce it every Year, and even Land, which, by the Old Husbandry, would not be made to bear Wheat at all: So that, in many Places, the New Husbandry can raise Ten Acres of Wheat for One that the Old can do: because where Land is poor, they sow but a Tenth Part of it with Wheat.

We do not pretend, that we have always greater Crops, or so great as some sown Crops are, especially if those mention'd by Mr. *Houghton* be not mistaken.

The greatest Produce I ever had from a single Yard in Length of a double Row, was Eighteen Ounces: The Partition of this being Six Inches, and the Interval Thirty Inches, was, by Computation, Ten Quarters (or Eighty Bushels) to an Acre.

I had also Twenty Ounces to a like Yard of a Third successive Crop of Wheat; but this being a treble Row, and the Partitions and Interval being wider, and supposed to be in all Six Feet, was computed to Six Quarters to an Acre. And if these Rows had been better order'd than they were, and the Earth richer, and more pulveriz'd, more Stalks would have tillered out, and more Ears would have attained their full Size, and have equall'd the best, which must have made a much greater Crop than either of these were.

But to compare the different Profit, we may proceed thus: The Rent and Expence of a drill'd Acre being One Pound, and of a sow'd Acre Five Pounds; One Quarter of Corn, produced by the drill'd, bears an equal Proportion in Profit to the One Pound, as Five Quarters, produced by the other, do to the Five

Pounds. As ſuppoſe it be of Wheat, at Two Shillings and Six-pence a Buſhel, there is neither Gain nor Loſs in the one nor the other Acre, though the former yield but One Quarter, and the other Five; but if the drill'd Acre yield Two Quarters, and the ſow'd Acre Four Quarters at the ſame Price, the drill'd brings the Farmer One Pound clear Profit, and the ſown, by its Four Quarters, brings the other One Pound Loſs. Likewiſe ſuppoſe the drilling Farmer to have his Five Pounds laid out on Five Acres of Wheat, and the other to have his Five Pounds laid out on One dung'd Acre; then let the Wheat they produce be at what Price it will, if the Five Acres have an equal Crop to the one Acre, the Gain or Loſs muſt be equal: But when Wheat is cheap, as we ſay it is when ſold at Two and Six-pence a Buſhel, then if the Farmer, who follows the old Method, has Five Quarters on his Acre, he muſt ſell it all to pay his Rent and Expence; but the other having Five Quarters on each of his Five Acres, the Crop of One of them will pay the Rent and Expence of all his Five Acres *(a)*, and he may keep the remaining Twenty Quarters, till he can ſell them at Five Shillings a Buſhel, which amounts to Forty Pounds, wherewith he may be able to buy Four of his Five Acres at Twenty Years Purchaſe, out of One Year's Crop, whilſt the Farmer who purſues the old Method, muſt be content to have only his Labour for his Travel; or if he pretends to keep his Wheat till he ſells it at Five Shillings a Buſhel, he commonly runs in Debt to his Neighbours, and in Arrear of his Rent; and if the Markets do not riſe in time, or if his Crops

(a) Or ſuppoſe a drill'd Acre to produce no more than One Third of the ſow'd Acre's Crop, whoſe Expence is Five times as much as of the drill'd, 'tis much more profitable, becauſe a Third of Five Pounds is One Pound Thirteen and Four-pence; and a Fifth of the Rent and Expence being only One Pound, ſuch drill'd Acre pays the Owner Thirteen and Four-pence more Profit, than the other which brings a Crop treble to the drill'd.

fail

fail in the Interim, his Landlord seizes on his Stock, and then he knows not how it may be sold; Actions are brought against him; the Bailiffs and Attorneys pull him to Pieces; and then he is undone (*a*).

III. *The Certainty of a Crop.*

The Certainty of a Crop is much to be regarded; it being better to be secure of a moderate Crop, than to have but a mere Hazard of a great one. The Farmer who adheres to the old Method is often deceiv'd in his Expectation, when his Crop at coming into Ear is very big, as well as when 'tis in Danger of being too little. Our hoeing Farmer is much less liable to the Hazard of either of those Extremes; for when his Wheat is big, 'tis not apt to lodge or fall down, which Accident is usually the utter Ruin of the other; he is free from the Causes which make the contrary Crop too little.

A very effectual Means to prevent the failing of a Crop of Wheat, is to plow the pulveriz'd Earth for Seed early, and when 'tis dry. The early Season also is more likely to be dry than the latter Season is.

1\. *The Advocate for the old Method is commonly late in his sowing; because he can't fallow his Ground early, for fear of killing the Couch, and other Grass that maintains his folding Sheep, which*
2\. *are so necessary to his Husbandry: And when 'tis sow'd late, it must not be sow'd dry, for then the*
3\. *Winter might kill the young Wheat. Neither can he at that time plow dry, and sow wet, because he commonly sows under Furrow; that is, sows the Seed first, and plows it in as fast as 'tis sown. If he*
4\. *sows early (as he may if he will) in light Land, he must not sow dry, for fear the Poppies and other Weeds should grow, and devour his Crop; and if his*
5\. *Land be strong, let it be sown early, wet or dry (tho'*

(*a*) Tho' only Five Acres and one Acre be put, yet we may imagine them Two hundred and Fifty, and Fifty to enrich the one, or break the other Farmer.

wet is worſt), 'tis apt to grow ſo ſtale and hard by Spring, that his Crop is in Danger of ſtarving, unleſs the Land be very rich, or much dung'd: and then the Winter and Spring proving kind, it may not be in leſs Danger of being ſo big as to fall down, and be ſpoil'd.

6. *Another thing is, that though he had no other Impediment againſt plowing dry, and ſowing wet, 'tis ſeldom that he has time to do it in; for he muſt plow all his Ground, which is Eight Furrrows in Six Feet;*
7. *and, whilſt it is wet, muſt lie ſtill with his Plough. When he ſows under Furrow, he fears to plow deep, leſt he bury too much of his Seed; and if he*
8. *plows ſhallow, his Crop loſes the Benefit of deep plowing, which is very great. When he ſows upon*
9. *Furrow (that is after 'tis plow'd) he muſt harrow the Ground level to cover the Seed; and that expoſes the Wheat the more to the cold Winds, and ſuffers the Snow to be blown off it, and the Water to lie longer on it; all which are great Injuries to it.*

Our Hoeing Huſbandry is different in all of the fore-mentioned Particulars.

1. We can plow the Two Furrows whereon the next Crop is to ſtand, immediately after the preſent Crop is off.

2. We have no Uſe of the Fold; becauſe our Ground has annually a Crop growing on it, and it muſt lie ſtill a Year, if we would fold it, and that Crop would be loſt; and all the Good the Fold could do to the Land, would be only to help to pulverize it for one ſingle Crop; its Benefit not laſting to the Second Year. And ſo we ſhould be certain of loſing one Crop for the very uncertain Hopes of procuring one the enſuing Year by the Fold; when 'tis manifeſt by the adjoining Crops, that we can have a much better Crop every Year, without a Fold, or any other Manure.

3. We can plow dry, and drill wet, without any manner of Inconvenience.

4. He

4. He fears the Weeds will grow, and destroy his Crop: We hope they will grow, to the end we may destroy them (*a*).

5. We do not fear to plant our Wheat early (so that we plow dry), because we can help the Hardness or Staleness of the Land by Hoeing.

6. The Two Furrows of every Ridge whereon the Rows are to be drilled, we plow dry; and if the Weather prove wet before these are all finished, we can plow the other Two Furrows up to them, until it be dry enough to return to our plowing the first Two Furrows; and after finishing them, let the Weather be wet or dry, we can plow the last Two Furrows. We can plow our Two Furrows in the Fourth Part of the Time they can plow their Eight, which they must plow dry all of them, in every Six Feet; for they cannot plow part dry, and the rest when 'tis wet, as we can.

7. We never plant our Seed under Furrow, but place it just at the Depth which we judge most proper; and that is pretty shallow, about Two Inches deep; and then there is no Danger of burying it.

8. We not only plow a deep Furrow, but also plow to the Depth of Two Furrows; that is, we trench-plow where the Land will allow it (*b*); and we have the greatest Convenience imaginable for doing this, because there are Two of our Four Furrows

(*a*) For, before they grow, they cannot be killed; but if they are all killed as soon as they appear, there will be no Danger of their exhausting the Land, or re-stocking it with their Seed; and 'tis our Fault if we drill more than we can keep clean from Weeds by the Horse-hoe, Hand-hoe, and Hands; the First for the Intervals, the Second for the Partitions, and the Third for the Rows: By the Two former, as soon after they appear as they can; but by the last, when they are grown high enough to be conveniently taken hold of.

(*b*) Very little of my Land will admit the Plough to go the Depth of Two common Furrows without reaching the Chalk; But deep Land may be easily thus Trench-plowed with great Advantage; and even when there is only the Depth of a single Furrow, that may sometimes be advantageously plowed at twice.

always

always lying open; and Two plowed Furrows (that is, one plowed under another) are as much more advantageous for the nouriſhing a Crop, as Two Buſhels of Oats are better than one for nouriſhing an Horſe: Or if the Staple of the Land be too thin or ſhallow, we can help it by raiſing the Ridges prepared for the Rows the higher above the Level.

9. We alſo raiſe an high Ridge in the Middle of each Interval above the Wheat before Winter, to protect it from the cold Winds, and to prevent the Snow from being driven away by them. And the Furrows or Trenches, from whence the Earth of theſe Ridges is taken, ſerve to drain off the Water from the Wheat, ſo that, being drier, it muſt be warmer than the harrowed Wheat, which has neither Furrows to keep it dry, nor Ridges to ſhelter it *(a)*, as every Row of ours has on both Sides of it.

IV. *The Condition in which the Land is left after a Crop.*

The different Condition the Land is left in after a Crop *(b)*, by the one and the other Huſbandry, is not

(a) This is a Miſtake; for the Ridges in the Middle of the Intervals do not always, nor often in thin ſhallow Land lie high enough to make a Shelter to the Rows, they being higher: But when Wheat is drilled on the Level, 'tis ſheltered by the Ridges raiſed in the Intervals: But we never weed or hand-hoe Wheat before the Spring.

(b) If indifferent Land be well pulverized by the Plough for one whole Year, it will produce a good Crop: But then, if, inſtead of being ſown, it be kept pulverized on for another Year without being exhauſted by any Vegetables, it will acquire from the Atmoſphere an extraordinary great Degree of Fertility more than it had before ſuch Second Year's Pulveration and Unexhauſtion. This being granted, which no Man of Experience can deny, what Reaſon can there be why ſuch a Number of Plants, competent for a profitable Crop, may not be maintained on it the Second Year, that may keep the Degree of their Exhauſtion in *Æquilibrio* with that Degree of Fertility, which the ſame Land had acquired at the End of the Firſt Year of its Pulveration, the ſame Degree of Pulveration being continued to it by Hoeing in the Second Year? Or why may it not produce annual Crops always, if the ſame *Equilibrium* be continually kept? Two unanſwerable

not lefs confiderable than the different Profit of the Crop.

A Piece of Eleven Acres of a poor, thin, chalky Hill was fown with Barley in the common Manner, after a hoed Crop of Wheat; and produced full Five Quarters and an half to each Acre (reckoning the Tythe); which was much more than any Land in all the Neighbourhood yielded the fame Year; tho' fome of it be fo rich, as that One Acre is worth Three Acres of this Land: And no Man living can remember, that ever this produced above half fuch a Crop before, even when the beft of the common Management has been beftowed upon it.

A Field, that is a fort of an Heath-ground, ufed to bring fuch poor Crops of Corn, that heretofore the Parfon carried away a whole Crop of Oats from it, believing it had been only his Tythe. The beft Management that ever they did or could beftow upon it, was to let it reft Two or Three Years, and then fallow and dung it, and fow it with Wheat, next to that with Barley and Clover, and then let it reft again; but I cannot hear of any good Crop that it ever produced by this or any other of their Methods; 'twas ftill reckoned fo poor, that nobody cared to rent it. They faid Dung and Labour were thrown away upon it, then immediately after Two fown Crops of black Oats had been taken off it, the laft of which was fcarce worth the mowing, it was put into the

fwerable Reafons may be given why this *Equilibrium* cannot be kept in the random Sowing, as it may in the Hoeing Method; *viz.* Firft, In the former, the Land is by the Number of fown Plants and Weeds much more (we may fuppofe at leaft Five times more) exhaufted: And, Secondly, No Pulveration is continued to the Soil, whilft the Crop is on it; which is that Part of the Year wherein is the moft proper (if not the only proper) Seafon for pulverizing. Therefore, allowing, that, in the random way, a Soil cannot, for want of Quantity of vegetable Food, continue to produce annual Crops without Manure, or perhaps with it; yet that is no Reafon why it may not produce them in the Hoeing Culture duly performed.

Hoeing Management; and when Three hoed Crops *(a)* had been taken from it, it was sown with Barley, and brought a very good Crop, much better than ever it was known to yield before; and then a good Crop of hoed Wheat succeeded the Barley, and then it was again sown with Barley, upon the Wheat-stubble; and that also was better than the Barley it used to produce.

Now all the Farmers of the Neighbourhood affirm, that it is impossible but that this must be very rich Ground, because they have seen it produce Six Crops in Six Years, without Dung or Fallow, and never one of them fail. But, alas! this different Reputation they give to the Land, does not at all belong to it, but to the different Sorts of Husbandry; for the Nature of it cannot be altered but by that, the Crops being all carried off it, and nothing added to supply the Substance those Crops take from it, except (what Mr. *Evelyn* calls) the celestial Influences; and that these are received by the Earth, in proportion to the Degrees of its Pulveration.

A Field was drilled with Barley after an hoed Crop; and another adjoining to it on the same Side of the same poor Hill, and exactly the same Sort of Land, was drilled with Barley also, Part of it after the sown Crop, the same Day with the other; there was only this Difference in the Soil, that the former of these had no manner of Compost on it for many Years before, and the latter was dunged the Year before: Yet its Crop was not near so good as that which followed the hoed Crop *(b)*; tho' the latter had twice the Plowing that the former had before drilling, and the same Hoeings afterwards; *viz.* Each was hoed Three times.

A Field of about Seventeen Acres was Summer-fallowed, and drilled with Wheat; and with the Hoeing brought a very good Crop (except Part of it,

(*a*) These Three hoed Crops were of Turneps and Potatoes.

(*b*) This was a Wheat Crop, and often well hoed.

which

which being eaten by trefpaffing Sheep in the Winter, was fomewhat blighted); the *Michaelmas* after that was taken off, the fame Field was drilled again with Wheat, upon the Stubble of the former, and hoed: This Second Crop was a good one, fcarce any in the Neighbourhood better. A Piece of Wheat adjoining to it, on the very fame Sort of Land (except that this latter was always reckoned better, being thicker in Mould above the Chalk), fown at the fame time on dunged Fallows, and the Ground always dunged once in Three Years; yet this Crop failed fo much, as to be judged, by fome Farmers, not to exceed the Tythe of the other: That the hoed Field has received no Dung or Manure for many Years paft, is becaufe it lies out of the Reach for carrying of Cart-Dung, and no Fold being kept on my Farm: But I cannot fay, I think there was quite fo much Odds betwixt this Second undunged hoed Crop and the fown; yet this is certain, that the former is a good, and the latter a very bad Crop.

I could give many more Inftances of the fame Kind, where hoed Crops and fown Crops have fucceeded better after hoed Crops than after fown Crops, and never yet have feen the contrary; and therefore am convinced, that the Hoeing *(a)* (if it be duly performed) enriches the Soil more than Dung and Fallows, and leaves the Land in a much better Condition for a fucceeding Crop. The Reafon I take to be very obvious:

(*a*) This is more efpecially meant of Fallows in the common Hufbandry, and a moderate Quantity of common Dung, or the Fold: And there may be fuch a poor Sand, or other barrenifh Soil, fo fubject to Conftipation in the Winter, as to require Dung when planted with Wheat, there being no general Rule without Exceptions; and 'tis impoffible for me to know the Number of thefe Exceptions. Well it is for the Hoer, whofe Land is of fuch a kind, that he can keep it in Heart without Dung by Hoeing; for when he has no Fold, he plows his Ground with Oxen, and plants it moftly with Wheat, the Straw whereof being for other Ufes, he can make but very little Dung.

obvious: The artificial Paſture of Plants is made and increaſed by Pulveration only; and nothing elſe there is in our Power to enrich our Ground, but to pulverize it *(a)*, and keep it from being exhauſted by Vegetables.

(a) Theſe Two are all we have in our Power; for pulverizing includes an Expoſure to the Atmoſphere; without which, I think, it cannot be reduced to Particles minute enough, or have their Superficies ſo impregnated as to become a fertile Paſture for Plants. The Experiment related by Mr. *Evelyn* of artificial Pulveration, ſeems to prove ſuch an Expoſure neceſſary; as alſo the frequent turning (or inceſſantly agitating) that fine Duſt for a Year, before the barren exhauſted Earth was made rich and prolific: For, beſides the Benefit of Pulveration and Impregnation, Land is more enriched in proportion to the Time of Expoſure, during which it is free from Exhauſtion, and continually receiving from the Atmoſphere: Therefore frequent Turning and Expoſure are both contained in the Words *pulverize, and not exhauſt*; and to comply with the latter, we ſhould endeavour, that our Land may be never exhauſted by any other Plants than by thoſe we would propagate, and by no more of them neither, than what are neceſſary for producing a reaſonable Crop; which, upon full Trial, will be found a very ſmall Number in compariſon to thoſe that are commonly ſown; and then, if the Supply from the Atmoſphere by Help of the Pulveration exceeds the Exhauſtion, the Land will become richer, tho' conſtant Crops are produced of the ſame Species; as in the Vineyards; and the Soil of theſe is ſo much improved by a bare competent Exhauſtion, and the uſual Pulveration, that after producing good annual Crops without Dung, until Age has killed the Vines, they leave the Soil better than they found it; and better than contiguous Land of the ſame Sort kept in arable Field-culture.

By Pulveration are meant all the Benefits of it that accrue to the Paſture of Plants; and by Exhauſtion, all the Injuries that can be done to that Paſture, except Burning. And as the Benefits of Pulveration viſibly continue for ſeveral Years, ſo do the Injuries of Exhauſtion; which appear by the Ends of ſome of my Rows that have been cleanſed of Weeds in their Partitions by the Hand-hoe, and the other Ends of the ſame Rows not cleanſed; the Difference is viſible in the Colour of the Wheat in the Third and Fourth following Crops, equally managed; and this is no more to be wondered at, than that Two unequal Sums, being equally increaſed or diminiſhed, ſhould remain unequal, until an Addition to the leſſer, or a Subtraction from the greater, be made; which, in caſe of the Soil, muſt be either by a greater Pulveration, or a leſſer Exhauſtion. 'Tis by this that both Ends of getables *(a)*. Superinductions of Earth are an Addition of more Ground, or changing it, and are more properly purchasing than cultivating.

Their

of these Rows in time become equal: For tho' Ten Plants that produce an Ounce of Wheat, insume more *Pabulum* than one Plant that produces the same Quantity (the Reason for which is given in the Note on *p.* 121.); yet a Plant that produces Six or Seven Drams, insumes less than one that produces an Ounce; for a Plant which produces Six Drams of Wheat cannot be a poor one, and therefore insumes no more *Pabulum* than in proportion to its Augment and Product. Thus the Soil of those Ends, which, by being doubly exhausted by Weeds and Wheat plants, was made poorer, gradually recovers an Equality with the other Ends, by being for several Years less exhausted than the other Ends are by larger Plants, whilst the Number of Plants, and the Pulveration of each, are equal.

To the Reasons already given there is another to be added, why Horse hoed Wheat exhausts the Soil less than sown Crops, where the Product of Wheat produced by each is equal: Which Reason is, that the former has much less Straw than the latter; as appears by the different Quantities of Grain that a Sheaf of each of equal Diameter yields; one of the former yielding generally double to one of the latter; for a Sheaf of the sown has not only more small Under-ears, but also its best Ears bear a less Proportion to their Straw than the other; for a Straw of sown Wheat Six Feet high, I have found to have an Ear but of half the Size of an Ear of drilled Wheat on a Stalk Five Feet high, having measured both of them standing in the Field, and rubbed out the Grain of them. This Difference I impute to the different Supply of Nourishment at the time when the Ears are forming.

Thus the sown Crop exhausts a Soil much more by its greater Quantity of Straw.

And this is one Reason why annual Crops of sown Wheat cannot succeed as Crops of Horse hoed Wheat do. There must be Dung and Fallow to repair the Exhaustion of the sown; neither of which are necessary for Crops of the Horse-hoed.

(a) It may be asked, How 'tis possible that Eight Hoeings, which are but equal, in Labour, to Two plain Plowings, should so much exceed Three plain Plowings, as to procure as good or a better Crop without Manure, than the common Three Plowings can do with Manure, and enrich the Land also.

The Answer is, That each Hoeing of the Five or Six being done to the Wheat-plants, though it does not clean plow the whole Interval underneath, yet it changeth the whole external Superficies (or Surface) thereof, whereby it becomes impregnate

by

Their One Year's Tillage, which is but Two Plowings before Seed-time, commonly makes but little Dust; and that which it does make, has but a short time to lie exposed for Impregnation; and after the Wheat is sown, the Land lies unmoved for near Twelve Months, all the while gradually losing its Pasture, by subsiding, and by being continually exhausted in feeding a treble Stock of Wheat-plants, and a Stock of Weeds, which are sometimes a greater Stock. This puts the Advocates for the old Method upon a Necessity of using of Dung, which is, at best, but a Succedaneum *of the Hoe; for it depends chiefly on the Weather, and other Accidents, whether it may prove sufficient by Fermentation to pulverize in the Spring, or no: And it is a Question whether it will equal Two additional (a) Hoeings, or but one; tho', as I have computed it, one Dunging costs the Price of One hundred Hoeings.*

When they have done all they can, the Pasture they raise is generally too little for the Stock that is to be maintained upon it, and much the greatest Part of the Wheat-plants are starved; for from Twenty Gallons of Seed they sow on an Acre, they receive commonly no more than Twenty Bushels *(b)* of Wheat in their Crop, which is but an Increase of Eight Grains for one: Now, considering how many Grains there are in one good Ear, and how many Ears

by the nitrous Air, as much as if it were all clean plowed at the time of every Hoeing, and the Weeds are as much stifled, or suffocated.

(a) Additional, because there must first be several Hoeings to make our treble Row equal to an undunged Six-feet Ridge of sown Wheat.

(b) And they have oftener less than Sixteen Bushels; and in the Harvest 1735, a substantial experienced Farmer had no more than Four Bushels of Wheat to an Acre throughout a Field of Forty Acres, being robbed by Poppies; and I have known a Crop that has amounted to do more than Two Bushels to an Acre, and some Crops less, tho' dunged and fallowed; so that, taking the common sown Crops of Wheat one with another, they are thought not to amount to Sixteen Bushels to an Acre, *communibus annis.*

on

on one Plant, we find, that there is not One Plant in in Ten that lives till Harveft, even when there has not been Froft in the Winter fufficient to kill any of them; or if we count the Number of Plants that come up on a certain Meafure of Ground, and count them again in the Spring, and likewife at Harveft, we fhall be fatisfied, that moft or all of the Plants that are miffing, could die by no other Accident than want of Nourifhment.

They are obliged to fow this great Quantity of Seed, to the end that the Wheat, by the great Number of Plants, may be the better able to contend with the Weeds; and yet, too often, at Harveft, we fee a great Crop of Weeds, and very little Wheat among them. Therefore this Pafture, being infufficient to maintain the prefent Crop, without ftarving the greateft Part of its Plants, is likely to be lefs able to maintain a fubfequent Crop, than that Pafture which is not fo much exhaufted.

When their Crop of Wheat is much lefs than ours, their Vacancies, if computed all together, may be greater than thofe of our Partitions and Intervals; theirs, by being irregular, ferve chiefly for the Protection of Weeds; for they cannot be plow'd out, without deftroying the Corn, any more than Cannons firing at a Breach, whereon both Sides are contending, can kill Enemies, and not Friends.

Their Plants ftand on the Ground in a confufed manner, like a Rabble; ours like a difciplin'd Army: We make the moft of our Ground; for we can, if we pleafe, cleanfe the Partitions with a Hand-hoe (*b*); and for the reft, if the Soil be deep enough to be drill'd on the Level (*c*), in treble Rows, the Par-

(*b*) Of all annual Weeds.

(*c*) This is only put as a Suppofition; for I have for thefe feveral Years left off drilling on the Level, and do advife againft it; becaufe altho' Mould fhould not be wanting for the Partitions in deep rich Land, yet it is much more difficult to hoe on the Level than on Ridges.

titions at Six Inches *(d)*, the Intervals Five Feet; Five Parts in Six of the whole Field may be pulveriz'd every Year, and at proper times all round the Year.

The Partions being one Sixth-part for the Crop to ſtand on, and to be nouriſhed in the Winter, one other Sixth-part being well pulveriz'd, may be ſufficient to nouriſh it from thence till Harveſt *(e)*; the Remainder, being Two-thirds of the Whole, may be kept unexhauſted, the One-third for one Year, and the other Third of it Two Years; all kept open for the Reception of the Benefits deſcending from above, during ſo long a time; whilſt the ſowed Land is ſhut againſt them every Summer, except the little time in which it is fallow'd, once in Three Years, and a little, perhaps, whilſt they plow it for Barley in the Winter, which is a Seaſon ſeldom proper for pulverizing the Ground.

Their Land muſt have been exhauſted as well by thoſe ſupernumerary Plants of Wheat, while they lived, as by thoſe that remain for the Crop, and by the Weeds. Our Land muſt be much leſs exhauſted, when it has never above one Third-part of the Wheat-plants to nouriſh that they have, and generally no Weeds; ſo that our ho'd Land having much more vegetable Paſture made, and continually renewed, to ſo much a leſs Stock of Plants *(f)*, muſt needs be

(d) But when it is drilled upon Ridges, the Proportion is leſs, by how much the Partitions, being thicker in Mould, contain more than a Sixth-part of the whole Six Feet of Earth, and the Proportion of unexhauſted Earth will be alter'd likewiſe; and I only mention theſe Diſtances to avoid Fractions.

(e) This may be done, tho' the Roots of a competent Number of Plants run through the Whole, in the manner herein before explained.

(f) Therefore, whenever a Soil receives more Supplies of fine Earth from the Atmoſphere, than is exhauſted by all the Plants that grow in the Soil, it becomes richer; but if the contrary, then it becomes poorer.

leſt,

left, by every Crop, in a much better Condition than theirs is left, in by any one of their sown Crops, altho' our Crops of Corn at Harvest be better than theirs (*g*).

They object against us, saying, That sometimes the Hoeing makes Wheat too strong and gross, whereby it becomes the more liable to the Blacks (or Blight of Insects): But this is the Fault of the Hoer; for he may choose whether he will make it too strong, because he may apply his Hoeings at proper times only, and apportion the Nourishment to the Number and Bulk of his Plants. However, by this Objection they allow, that the Hoe can give Nourishment enough, and therefore they cannot maintain, that there is a Necessity of Dung (*h*) in the Hoeing-Husbandry; and

(*g*) On an undung'd low Six feet Ridge, we have Three Rows, Eight Inches asunder, all which being equal, during the Winter, but each of the Two outside Rows at Harvest producing Ten times as much Wheat as the middle Row doth, all Three together produce a Quantity equal to One-and-twenty of this middle Row. Now, supposing the Roots of this Row not to reach through the outside Rows, so as to receive any Benefit from the ho'd Intervals, then this Row might only be equal to one of Nine Rows, which should have been drilled Eight Inches asunder on this Ridge, and then our Three would only be equal to Twenty-one of such Nine Rows. But since it can be demonstrated, that the Roots of our middle Row do pass through both the outside Rows far into the ho'd Intervals, we may well suppose it to be at least double to what it would have been, if it had no Benefit from the Hoeing, and then our Three will be equal to Forty-two of such Nine unho'd Rows. Thus our Crop is Thirty-three in Forty-two (or almost Four Parts in Five) increased by the Hoeing; for though many Fields of Wheat have been drilled all over in Rows Eight Inches asunder, it never has been judged, in Twenty Years Experience, that a Crop so planted, though not ho'd, was, by its Evenness and Regularity, less, *cæteris paribus*, than a Crop sown a random.

(*h*) As for the Quantity of vegetable Matter of Dung, when reduced to Earth by Putrefaction, it is very inconsiderable, and, of many sorts of Manure, next to nothing.

The almost only Use of all Manure is the same as of Tillage; *viz.* the Pulveration it makes by Fermentation, as Tillage doth by and that, if our Crops of Wheat ſhould happen to ſuffer, by being too ſtrong, our Loſs will be leſs than theirs, when that is too ſtrong, ſince it will coſt them Nine times our Expence to make it ſo.

A Second Objection is, That as Hoeing makes poor Land become rich enough to bear good Crops of Wheat for ſeveral Years ſucceſſively, the ſame muſt needs make very good Land become too rich for Wheat. I anſwer, That if poſſibly it ſhould ſo happen, there are Two Remedies to be uſed in ſuch a Caſe; the one is to plant it with Beans, or ſome other Vegetables, which cannot be over-nouriſhed, as Turneps, Carrots, Cabbages, and ſuch-like, which are excellent Food for fatting of Cattle; or elſe they may make uſe of the other infallible Remedy, when that rich Land, by producing Crops every Year in the Hoeing-Huſbandry, is grown too vigorous and reſty, they may ſoon take down its Mettle, by ſowing it a few Years in their old Huſbandry, which will fill it again with a new Stock of Weeds, that will ſuck it out of Heart, and exhauſt more of its Vigour, than the Dung (*i*), that helps to produce them, can reſtore.

There is a Third Objection, and that is, That the Benefit of ſome Ground is loſt where the Hoe-plough turns at each End of the Lands: But this cannot be much, if any, Damage; becauſe about Four Square

by Attrition or Contuſion; and with theſe Differences, that Dung, which is the moſt common Manure, is apt to increaſe Weeds, a Tillage (of which Hoeing is chief) deſtroys them, and Manure is ſcanty in moſt Places, but Tillage may be had every-where. Another Difference is, the vaſt Diſproportion of the Price of Manure and that of Tillage.

Note, As we have no way to enrich the Soil, but by Pulveration of Manure, or of Inſtruments, or of both; ſo Nature has ordain'd, that the Soil ſhall be exhauſted by nothing, but by the Roots of Plants.

(*i*) Dung made of the Straw of ſown Corn generally abounds with the Seed of Weeds.

Perch

Perch to a Statute Acre is ſufficient for this Purpoſe; and that, at the Rate of *Ten Shillings* Rent, comes to but *Three-pence*, tho' this varies, according as the Piece is longer or ſhorter; and ſuppoſing the moſt to be Eight Perch, that is but *Six-pence per* Acre; and that is not loſt neither; for whether it be of natural or artificial Graſs, the Hoe-plough, in turning on it, will ſcratch it, and leave ſome Earth on it, which will enrich it ſo much, that it may be worth its Rent for Baiting of Horſes or Oxen upon it. And beſides, theſe Ends are commonly near Quick-hedges or Trees, which do ſo exhauſt it, that when no Cattle come there to manure it, 'tis not worth the Labour of plowing it.

C H A P. XVIII.

Of PLOUGHS.

BY what means Ploughs and Tillage itſelf came at firſt to be invented is uncertain; therefore we are at Liberty to gueſs: And it ſeems moſt probable, that it was, like moſt other Inventions, found out by Accident, and that the firſt Tillers or Plowers of the Ground were Hogs: Men in thoſe Days, having ſufficient Leiſure for Speculation, obſerv'd, that when any ſort of Seed happen'd to fall on a Spot of Ground well routed up by the Swine (which Inſtinct had inſtructed to dig in Search of their Food), it grew and proſpered much better than in the whole unbroken Turf. This Obſervation muſt naturally induce rational Creatures to the Contrivance of ſome Inſtrument, which might imitate, if not excel Brutes in this Operation of breaking and dividing the Surface of the Earth, in order to increaſe and better its Product.

That ſome ſuch Accident gave Men the Firſt Hints of *original Agriculture*, may be inferr'd from the very little (or no) Probability of its being invented originally upon Arguments which might convince the Underſtanding (by juſt Concluſions from Ideas of the Earth and Vegetation) of any reaſonable Grounds to hope, that the Effect of increaſing the Earth's Produce ſhould follow the Cauſe of Tillage; or, in other Words, why it ſhould produce more when tilled than when untilled. Therefore it is very unlikely, that Men ſhould begin to take Pains to till the Land without any Sort of Reaſon why they did it. And no ſuch Reaſon could they have before the Invention, as they had afterwards: For when they accidentally ſaw that Effect follow that Cauſe, then they were well convinced it did ſo. But tho' this Argument, *viz.* Tillage increaſes the Product of the Earth, becauſe it does, has been ſufficient to continue the Practice of Tillage ever ſince; yet it is impoſſible for the Inventors to have had this Argument before the Invention, in caſe it had been invented by Men, and not fortuitouſly diſcover'd.

Had there ever been extant any other or better Arguments, whereon this Practice, ſo uſeful to Mankind, was founded; ſure, ſome of all the great and learned Authors, who have written on this Subject, would have mention'd them. Philoſophers, Orators, and Poets, have treated of it in the ſame Theory by which it was firſt diſcover'd, and by no other; *viz.* Land produces more when tilled; and ſome ſeem to ſay, the more it is tilled, the more it produces. It does, becauſe it does; not a Word of the Paſture of Plants, or any thing like it. So that all the antient *Scriptores de re ruſticâ* have done, was only to keep that Theory in the ſame Degree of Perfection in which the firſt Diſcoverers received it.

The briſtled Animals broke up the Ground, becauſe they uſed to find their Food there by digging;

Men

Men till it, becaufe they find Tillage procures them better Food than Acorns.

The Reafons are the fame for one and the other.

Thefe Writers, aſham'd to acknowlege fo noble a Difcovery to be owing to fo mean a Foundation, make no mention of the true Teachers, but attribute the Invention to *Ceres*, a Goddefs of their own making; ſhe, as they pretend, firſt taught the Art of Tillage. With this Fable they were fo well pleafed, that they never attempted to improve that Art, leſt they ſhould derogate from the Divinity of *Ceres*, in fuppofing her Invention imperfect.

With what Inſtrument Men firſt tilled the Ground we don't know exactly; but there may be Reafons to believe it was with the Spade, and probably a wooden one, and very rough.

For whilſt People liv'd on Acorns, there was no need of the Smith; fuch Food required no Knives for eating it, nor was it worth while to make Swords to fight for it; and without Iron the Spade could not be well hewn, or ſhap'd; but if it had been fuch as it is at prefent, there never was any thing comparable to it, for the true Ufe of Tillage. Yet the Spade could not make that Expedition, which was neceſſary when Tillage became general in the Fields; and therefore in time the Spade came wholly to be appropriate to the moſt perfect Sort of Tillage in the Garden. Then the Plough fupply'd the Place of the Spade in the Field; and tho' it could not (fuch as it was) till the Land near fo well, yet it could till ten times more of it, and with lefs human Labour.

Why they did not improve the Plough, fo that it might alfo till as well as the Spade, feems owing to their Primitive Theory, which gave no Mathematical Reafon to ſhew wherein the true Method of Tillage did confiſt; *viz.* in dividing the Earth into many Parts, to increafe its internal Superficies, which is the Paſture of Plants.

The Difference betwixt the Operation of the Spade, and that of the common Plough, is only this; that the former commonly divides the Soil into ſmaller Pieces, and goes deeper.

How eaſy and natural it is to contrive a Plough that may equal the Spade, if not exceed it, in going deeper, and cutting the Soil into ſmaller Pieces, than the Spade commonly does, I leave to the Judgment of thoſe who have ſeen the Four-coulter'd Plough.

The Plough deſcrib'd by *Virgil* had no Coulter; neither do I remember to have ſeen any Coulter in *Italy*, or the South of *France*; and, as I have been informed, the Ploughs in *Greece*, and all the *Eaſt*, are of much the ſame Faſhion: Neither is it practicable to uſe a Coulter in ſuch a Plough; becauſe the Share does not cut the Bottom of the Furrow horizontally, but obliquely; in going one way, it turns off the Furrow to the right Hand; but in coming back, it turns it to the Left (*a*). Therefore, if it had a Coulter, it muſt have been on the wrong Side every other Furrow: And beſides, as the Handle (for it has but one) always holds the Plough towards one Side, with the Bottom of the Share towards the unplow'd Land, it would cauſe the Coulter to go much too low when it went on the Furrow-ſide, and it would not touch the Ground, when it went on the Land-ſide.

'Tis a great Miſtake in thoſe who ſay *Virgil*'s Plough had Two Earth-boards; for it had none at all; but the Share itſelf always going obliquely, ſerved inſtead of an Earth-board; and the Two Ears, which were the Corners of a Piece of Wood lying under

(*a*) *Note*, This *Eaſtern* Plough always goes forward, and returns back in the ſame Furrow, making only one Land of a whole Field: Though it turns its one Furrow towards the Right, and the other towards the Left of the Holder; yet every Furrow is turned towards the ſame Point of the Compaſs, as when we plow with a Turn-wriſt Plough.

the

the Share, did the Office of Ground-wrests: This Fashion continues to this Day in those Countries, and in *Languedoc*.

This sort of Plough performs tolerably when Ground is fine, and makes a shift to break up light Land; and I could never find any other Land there; I am sure none comparable to ours for Strength: And it would be next to impossible, to break up such as we in *England* call strong Land with it.

I do not find, that the Arable Lands about *Rome* are ever suffered to lie still long enough to come to a Turf; but I have observed in the low rich Lands in the *Calabria*'s, subject to the Invasions of the *Turks*, that there is Turf, and that these Ploughs go over the Land Two or Three times before the Turf of it is all broken, tho' the Soil be a very mellow Sort of Garden-mould. Having no Coulters to cut it, they break and tear Turf into little Pieces. This was done in the Month of *November*; and had I not seen Men and Oxen at the Work, or had there been Oaks in the Place, I should rather have thought that Tillage performed by a Race of the first Teachers of it, in muzzling Acorns, than by Ploughs. However, the Mould being naturally very mellow, when the Turf is broken with shallow Plowing, they can plow deeper afterwards.

The *English* Ploughs are very different from the *Eastern*, as in general the Soil is.

These, when well made, cut off the Furrow at the Bottom horizontally; and therefore, it being as thick on the Land-side as on the Furrow-side, the Plough cannot break it off from the whole Land, at such a Thickness (being Six times greater than the *Eastern* Ploughs have to break off), and must of Necessity have a Coulter to cut it off: By this means the Furrow is turned perfectly whole, and no Part of the Turf of it broken; and if it lie long without new turning, the Grass from the Edges will spread,

and

and form a new Turf (or Swerd) on the other Side, which was the Bottom of the Furrow before turning, but is now become the Surface of the Earth, and may ſoon become greener with Graſs than before Plowing; and often the very Roots ſend up new Heads to help to ſtock the reverſed Furrow, the former Heads being converted into Roots, ſo that it is doubly cloathed and braced on both Sides, or, as it were, kay'd together, firm and ſolid, almoſt as a Plank; it may be drawn from one Side of a Field to the other without breaking, and might poſſibly be made uſe of, inſtead of *Virgil*'s *Crates Viminea*, for harrowing or ſmoothing of fine-tilled Ground; but not without much Time, Labour, and Difficulty, can it be made ſuch itſelf.

If you plow whole ſtrong turfy Furrows croſs-ways, as *Virgil* directs, and as it is too commonly practiſed, the Coulter cannot eaſily cut them, becauſe, being looſe underneath, they do not make a ſufficient Reſiſtance or Preſſure againſt its Edge, but move before it, and ſo are apt to be drawn and driven up into Heaps, with their Surfaces lying all manner of Ways, and ſituate in all manner of Poſtures: So the Turf, which is not turned, continuing in the open Air, grows on, and with its vigorous Roots holds the Earth faſt together, and will not ſuffer the neceſſary Diviſion to be made, which would be, if the Turf were rotten, and which is the End of all Tillage, *viz.* to increaſe the Paſture of Plants.

Next, ſome have vaſt heavy Drags, with great long Iron Tines in them; and tho' theſe huge broken Pieces of Furrows, being looſer than before, require keener Edges to cut them; yet theſe Drag-tines have no Edge at all, but are as blunt as the Furrows they ſhould cut. Theſe Drags draw them ſometimes into larger Heaps, leaving the under *Stratum* bare betwixt them, only ſhaking off ſome of their Mould in tumbling them about, and ſcratching their Surfaces, without

without reducing them to a moderate Finenefs, until this ill-broken Land has, for above a Year, and fometimes longer, entertained Ploughs, Cattle, and Men, with a frequent laborious Exercife, for which they are obliged to the one Coulter.

If the Soil be fhallow, it may be broken up with a narrow Furrow, which will the fooner be brought in Tilth; but if it be a deep Soil, the Furrows muft be proportionably large, or elfe a Part of the good Mould muft be left under unmoved, and fo loft; for a narrow Furrow cannot be plowed deep, becaufe the Plough will continually flip out from the hard Land toward the Right-hand, unlefs the rifing Furrow be of fufficient Weight to prefs the Plough towards the Left, and keep it in its Work: The deeper you plow, the greater Weight is required to prefs it; fo that the deeper your Land is, the worfe (or into the larger Furrows) muft it be broken up with one Coulter, infomuch that, if the Land be ftrong (as moft deep Ground in *England* is), it is a Work of fome Years to conquer it, after it has been refted. And often it happens, that the exceffive Charge of this Tillage reduces the Profit of rich Land below that of poor.

This gives an Opportunity to deceitful Servants, of impofing upon their ignorant Mafters. They plow fuch deep Land with a fmall fhallow Furrow, to the end the Turf and Furrows may be broken, and made fine the fooner; pretending they will plow it deeper the next time (which is called Stirring), which thefe Rogues know very well cannot be done, and intend no more than that the Plough coming the eafier after the Horfes, their Coats may fhine the better; and tho' there be no Crop at Harveft, they muft have Four Meals a Day all the Year, and extravagant Wages at *Michaelmas*, or at any time of the Year, when they think fit to mifbehave themfelves.

This

This ſort of Land muſt not be ſtirred, *i. e.* plowed the Second time in wet Weather; for that will cauſe the Graſs and Weeds to multiply, beſides the treading the Ground into hard Dabs, *&c.* And, in dry Weather, the Plough will never enter any deeper than it went the firſt time; the Reſiſtance below being ſo much more than the Preſſure above, the Plough will riſe up continually; or, if it goes deep enough for the Weight of Earth to keep it down, another Inconvenience will follow, which is that mentioned by *Columella*, *Page* 47. *Quod omnis humus, quamvis lætiſſima, tamen inferiorem partem jejuniorem habet, eamque attrahunt excitatæ majores glebæ; quo evenit, ut infœcundior materia miſta pinguiori ſegetem minus uberem reddat.* The vulgar *Engliſh* Phraſe is, It ſpaults up from below the Staple. Hence the treacherous Plowman is ſecure of an eaſy Summer's Work, if he can perſuade his Maſter to ſuffer him to fallow the Ground with a ſhallow Furrow.

Another way to conquer a ſtrong Turf is, to plow it firſt with a Breaſt-plough, very thin; and, when the Swerd is rotten, then plow it at the proper Depth: But this Method is (beſides the extraordinary Charge of it) liable to other great Misfortunes. If the Turf be pared up in Winter, or early in the Spring, it is a Chance but the Rains cauſe it to grow ſtronger than before, inſtead of its Rotting.

And if it be pared later, tho' dry Weather do follow, and continue long enough to kill the Turf, yet this loſes time; the Seaſon of plowing is retarded; for all the Staple ſtill remains untilled; and, before that can be well done, the Year is too far ſpent for ſowing it with Wheat, which is the moſt proper Grain for ſuch ſtrong Land *(a)*; and few will have Patience to wait, and plow on till another Wheat-ſeed

(a) Beſides, moſt ſtrong Land has Stones in it, which will not admit the Uſe of the Breaſt-plough.

time.

time. The dry Weather alſo, which in Summer kills the Swerd, renders the Plowing obnoxious to moſt or all the Evils afore-mentioned.

A Farmer inquires concerning the Four-coulter Plough, as in the following Dialogue.

Farm. *What muſt we do then? Muſt we have recourſe to the Spade for breaking up our rich, ſtrong, ſwerdy Land?*

Reſp. If you can procure Men to dig it faithfully in Pieces, not above Two Inches and an half thick, at the Price of about Eight Shillings *per* Acre, it would do very well, and anſwer all the Ends of Tillage; but, tho' you bargain with them to dig it at that Size for Three Pounds *per* Acre, you will find, upon Examination, moſt of the Pieces or Spits, which are dug out of your Sight, to be of twice that Thickneſs. And no great Quantities can be this way managed, altho' the Price of Corn ſhould anſwer ſuch an extravagant Expence.

Farm. *Since it is ſo difficult to bring our ſtrong Land into Tilth, after it has reſted, that it cannot be ſpeedily done by a Plough without a Coulter, or by one with a Coulter, in wet Weather or dry, nor with a Breaſt-plough, without a certain Expence, and an uncertain Succeſs, the Spade is too chargeable a Tillage for the Field: It ſeems to me, upon the Whole, that we are Loſers by this* inaratæ gratia terræ, *unleſs we could contrive ſome other Method of reducing it ſooner, and with leſs Charge, into Tilth; for I obſerve, that, when we ſow it upon the Back, the Corn and Graſs (or Couch), coming both together, exhauſt the Ground ſo much, that by that time we can (which is about Three Years) reduce the great Lumps to a tolerable Fineneſs, it grows full of Graſs and Weeds (which we call Foul), and loſes that Fertility we expected it ſhould acquire by Reſt, becoming,*

coming, in our Terms, both out of Tilth, and out of Heart.

Resp. If you know all this to be true, and that without a Coulter you cannot break it up at all; and that with one Coulter you cannot any way cut the Furrow ſmall enough, or leſs than Ten Inches broad; why do not you cut it with Four Coulters, which will reduce the ſame Furrow into Four equal Parts, of Two Inches and an half each in Breadth, and of the Depth of the Staple, tho' that ſhould be Two Spit, or Sixteen Inches deep?

Farm. *How can that be done?*

Resp. Every jot as eaſily as with one Coulter: For, before the Furrow is raiſed by the Share, it lies faſt, and makes a ſufficient Reſiſtance equally againſt the Edges of all the Coulters; tho', after it be raiſed and looſe, it yields and recedes every way, except downwards; ſo that it cannot be cut by any Edge, but ſuch as attacks it perpendicularly from above, as that of the Spade does.

Farm. *This ſeems to me reaſonable; and, having very lately heard talk of this Plough, I would gladly know more of it.*

Resp. The Furrow, being cut into Four Parts, has not only Four times the Superficies on the Eight Sides which it would have had on Two Sides; but it is alſo more divided croſs-ways; *viz.* The Ground-wreſt preſſes and breaks the lower (or Right-hand) Quarter; the other Three Quarters, in riſing and coming over the Earth-board, muſt make a crooked Line about a Fourth longer than the ſtrait one they made before moved; therefore their Thinneſs not being able to hold them together, they are broken into many more Pieces, for want of Tenacity to extend to a longer Line, contrary to a whole Furrow, whoſe great Breadth enables it to ſtretch and extend from a ſhorter to a longer Line, without breaking; and, as it it is turned off, the Parts are drawn together again by the Spring of the Turf or Swerd *(a)*, and ſo remain whole after Plowing. Thus the Four-coultered Plow can divide the Soil into above Twenty times more Parts than the common Plough; and ſometimes, when the Earth is of a right Temper betwixt wet and dry, the Earth-board, in turning the Furrows off, will break them into Duſt, having more Superficies than is made by Four common Plowings; and it is impoſſible there ſhould be any large Pieces amongſt it.

Now, what a prodigious Advantage muſt the Influences of the Atmoſphere have upon theſe ſmall Parts, for making a further Diviſion of them! Froſt, Water, Drought, and nitrous Air, eaſily penetrate to their very Centers, which cannot in the largeſt of them be more than one Inch and a Quarter diſtant from their Superficies. This Advantage, with a few ſubſequent common Plowings, performed in proper Seaſons, reſolves the Earth almoſt all to a Powder. The Swerd, ſome being immerſed or buried and mixed among ſo great a Proportion of Mould, is ſoon rotten and loſt; ſome of the Swerd lying looſe a-top, the Earth preſently drops out of it; and then the Roots are dried up, and die. Thus is the whole Staple of the Ground brought into perfect Tilth in

(a) A ſwerdy Furrow cut off by only one Coulter, being whole, is apt to ſtand up on its Edge, or lie hollow; and then, being open to the Air, it does not rot; but when it is cut by ſeveral Coulters, it has not Strength to ſupport itſelf, it falls down, lies cloſe to the Earth under it, and, excluding the free Air from the Turf, it ſoon becomes rotten. And for killing the Turf of ſwerdy Land is the chief Uſe of the Four-coultered Plough: For doing of which there is this Advantage, that as in a whole Furrow there are often Strings of Couch-graſs, Three or Four Feet long; but, when cut by this Plough, there is ſcarce a String left of one Foot long: And theſe Strings being apt to ſend out Roots from every Knot or Joint, the ſhorter they are cut, the more they will be expoſed to the Air and Sun, which will kill them the ſooner.

a very

a very ſhort time beyond what the Spade ever does in ſuch ſwerdy Land.

Farm. *What ſort of Weather is beſt for uſing this Plough?*

Reſp. Any Weather, except the Ground be ſo dry and hard that the Plough cannot enter it; but it is very proper to be done, when the Earth is ſo wet, that by no means it ought to be plowed with any other Plough; for it never can be too moiſt for this, unleſs the Cattle which draw it be mired; becauſe, tho' all the Cattle ſhould not go in the Furrow, yet their Treadings are cut ſo ſmall by the Coulters, that the Earth is not kept from diſſolving, as when turned off whole in common Tillage. 'Tis obſerved, that the Inciſions made by the Coulters on ſwerdy Land, will not heal, or ſo cloſe up, but that they will open again by the next Plowing, though it be a great while after. A Farmer who uſes this Plough, may till in all Weathers and all Seaſons of the Year, either in fallowing with this, which is beſt in wet, or in ſtirring with the common ones, which muſt be done in dry Weather; and when the Ground is broken up with this, it may be ſtirred in the drieſt Weather that can be, without the Danger of tearing (or ſpaulting) up of the under *Stratum* along with the Staple, becauſe this is all broken before, and then no more can riſe with it; as it does to the Ruin of the Soil, when in common Tillage they go deeper the Second time than the Firſt: Alſo, if there be a Neceſſity of ſtirring ſome ſort of Land when it is wet, it ought either to be done with this Plough, or elſe with a common one drawn by a ſingle Row of Cattle treading all in the Furrow; for tho' ſome Land be very fine, yet, when plowed by a double Row of Cattle in wet Weather, it will be made into large Pieces by the Treading, and perhaps not diſſolve again in a long time: Therefore it is better to be prevented.

Farm.

Farm. *I perceive this Plough lays the Foundation for all good Husbandry; and there can be no other way to bring Land into perfect Tilth in so short a Time, or with so little Expence. And I am convinc'd, that no Farmer ought to be without it, who desires to be free from the Danger of his Land being ever out of Tilth: But I have heard it objected, that it is harder to draw than the common Ploughs; and that its Beam being longer, upon account of the Four Coulters, it lies farther behind, and comes harder after the Horses.*

Resp. I must confess, there is something in that Objection; for this Plough, being something longer, may be a little the harder Draught; and also its Weight and Strength must bear a Proportion to the Length of it. But this small Increase of the Draught would have been a much stronger (if not a fatal) Objection, had that Custom been general, of Horses drawing by their Tails, as 'tis said to have been formerly in some Places; for then, perhaps, a sufficient Strength of Horses could not be applied to the Plough. But in Countries where Traces are in Use, every Horse of the Team may draw the Plough equally, and then there will be no other Inconvenience, besides the adding one Horse, or keeping a stronger Team: And he cannot be wise, who would lose the Profit of his Land, for the Odds of sometimes adding a Horse to his Plough. And I am very certain, that this Plough requires a much less Strength of Cattle to draw it in moist Weather, which is the most proper to use it in, than to draw a common Plough in the same Ground, and at the same Depth, in dry Weather; and can seldom be used safely in any other. And the Vulgar, who have always a wrong Cause ready at hand to apply to every thing, impute that Draught to the Fashion of the Plough, which ought to be imputed to its going deeper; and this great Depth at which 'tis capable of plowing, *viz.* Two

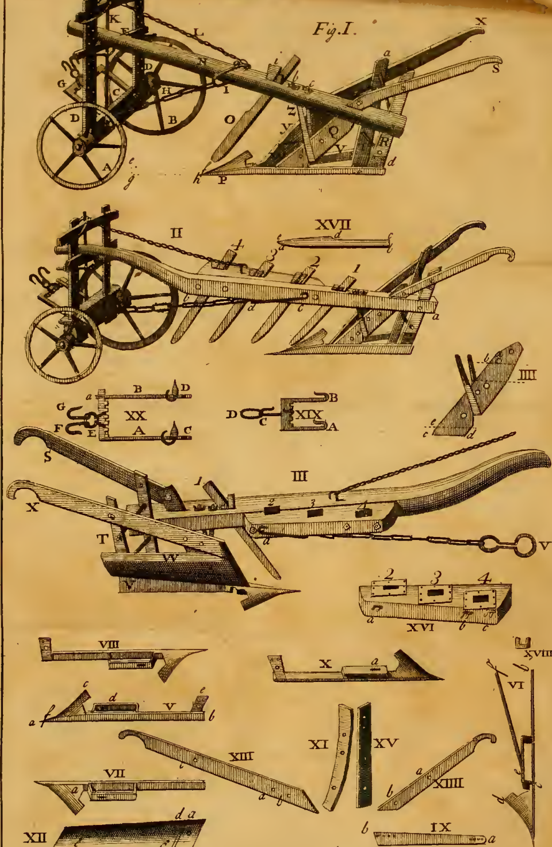
Spit deep, is one extraordinary Benefit of it, tho' it may, on Occaſion, go as ſhallow as any.

The Draught is not ſo much increaſed by adding Three Coulters, as may be imagined; for when the Ground is moiſt, the Inciſions are eaſily made by the Edges; and when they are cut ſmall, the Furrows riſe much more eaſily upon the Share and Earth-Board, than if whole.

Farm. *If this Plough be ſo beneficial, having ſo many Advantages, and only the Two Inconveniencies, one of requiring a little more Strength to draw it, and the other its being unfit for dry hard Ground, I wonder why it is not become more common?*

Reſp. It has been uſed with very great Succeſs for theſe ſeveral Years laſt paſt, but never like to be common, unleſs it be deſcribed in a more geometrical Manner, than any Plough has hitherto been; for the Plough-wrights find it difficult enough to make a common Plough with one Coulter to perform as it ought, for want of the neceſſary Rules of their Art. It is upon this Account that the Two-coulter'd Ploughs are uſed in few Places, though they have been found of excellent Uſe, and have been formerly common: But, alas! when the Makers, who by their diligent Study and much Practice had attained the Perfection of their Art, died for want of learning to write their Rules mathematically, and ſhew how the mechanical Powers were applicable to them, the Art was in a Manner loſt, at the Death of thoſe Artiſts; and then the unſkilful Plough-wrights, deſtitute of the true Rules, were not able to make a Two-coulter'd Plough to perform well, and then it was left off. Very lately 'tis revived, ſince the Three and Four-coulter'd ones have been uſed; from whence ſome have made a Shift to take the Rules of placing Two Coulters into a Plough, and they begin to be common again; and, no doubt, will ceaſe again as ſoon as the Rules are forgot.

'Tis



B. Cole. Delin. et Sculp.

'Tis ſtrange that no Author ſhould have written fully of the Fabric of Ploughs! Men of the greateſt Learning have ſpent their Time in contriving Inſtruments to meaſure the immenſe Diſtance of the Stars, and in finding out the Dimenſions, and even Weight, of the Planets: They think it more eligible to ſtudy the Art of plowing the Sea with Ships, than of tilling the Land with Ploughs; they beſtow the utmoſt of their Skill, learnedly, to pervert the natural Uſe of all the Elements for Deſtruction of their own Species, by the bloody Art of War. Some waſte their whole Lives in ſtudying how to arm Death with new Engines of Horror, and inventing an infinite Variety of Slaughter; but think it beneath Men of Learning (who only are capable of doing it) to employ their learned Labours in the Invention of new (or even improving the old) Inſtruments for increaſing of Bread.

The eaſieſt Method of perpetuating the Uſe of the many coulter'd Ploughs, and other newly-invented Inſtruments of Huſbandry, is by Models, *i. e.* the Things themſelves in little; and theſe may be all portable even in a Man's Pocket: Every Part muſt be fully deſcribed, with the true Dimenſions, and the mathematical Reaſons, on which their Contrivance is founded. Directions alſo for uſing them muſt be given at the ſame time that their Manner of making is deſcribed. In ſome, the very Horſes which draw muſt be repreſented, to ſhew the manner of fixing the Horſes, and the Traces: Cautions againſt all the Errors that may happen by the want of Experience in the Makers or Uſers, muſt be given.

When this is done, and the Rules put into a Method, the new Hoeing-Huſbandry, in all its Branches, will be much more eaſy and certain than the old; becauſe there are no mathematical Rules extant in any Method; and a Man may practiſe the old random Huſbandry all his Life, without attaining ſo much Certainty in Agriculture as may be learned in a few Hours from ſuch a Treatiſe.

 The

The Rules, indeed, require much Labour, Study, and Experience, to compoſe them; but when finiſh'd, will be moſt eaſy to practiſe: Like the Rules for meaſuring Timber; their Uſe is, at firſt Sight, eaſy to every Carpenter, and to moſt Artificers who work in Wood; but no illiterate Perſon is able to compoſe thoſe Rules, or to meaſure Timber without them.

C H A P. XIX.

The Deſcription of a Four-coulter'd Plough.

TO deſcribe all Parts of a Plough geometrically, would require more Time and Learning than I am Maſter of: Therefore leaving that to be done by ſomebody elſe, who is better qualified for it, I ſhall at preſent attempt little more than what relates to the Three added Coulters.

In *Plate* 1. *Fig.* 1. is the Portrait of a common Two-wheel'd Plough uſed in *Berkſhire*, *Hampſhire*, *Oxfordſhire*, and *Wiltſhire*, and in moſt other Countries of *South-Britain*; and is generally eſteemed the beſt Plough for all Sorts of Land, except ſuch miry Clays that ſtick to the Wheels, and clog them up, ſo as they cannot turn round.

But they have, in ſome Places, a Contrivance to prevent this Inconvenience; which is done by winding Thumb-ropes of Straw about the Iron Circles of the Wheels, and about the Spokes. The Wheels preſſing againſt the Ground, the Thumb-ropes are diſtended on each Side: which Motion throws off the Dirt, and prevents its ſticking to the Wheels, which it would otherwiſe do.

'Tis commonly divided into Two Parts; *viz.* the Plough-head, and the Plough-tail.

The Plough-head contains the Two Wheels A, B, and their Axis or Spindle of Iron paſſing thro' the Box

Box C, turning round both therein, and in the Wheels; the Two Crow-ſtaves D, D, faſtened into the Box perpendicularly, and having in each Two Rows of Holes, whereby to raiſe or ſink the Beam, by pinning up or down the Pillow E, to increaſe or diminiſh the Depth of the Furrow; the Gallows F, thro' which the Crow-ſtaves paſs at top, by Mortiſes, into which they are pinned; G the Wilds with its Links and Crooks of Iron, whereby the whole Plough is drawn; H the Two-chain, which faſtens the Plough-tail to the Plough-head, by the Collar I at one End, and by the other End paſſing thro' a Hole in the Middle of the Box, is pinned in by the Stake K; L the Bridle-chain, one End whereof is faſtened to the Beam by a Pin, and the other End to the Top of the Stake, which Stake is held up to the left Crow-ſtaff, by the With M, paſſing round it above, and under the End of the Gallows below; or inſtead of this With, by a Piece of Cord, and ſometimes by the End of the Bridle-chain, when that is long enough.

The Plough-tail conſiſts of the Beam N: the Coulter O; the Share P; and the Sheat Q; the Hinder-ſheat R, paſſing thro' the Beam near its End; S the ſhort Handle, faſtened to the Top of the Hinder-ſheat by a Pin, and to the Top of the Sheat by another Pin; T the Drock which belongs to the right Side of the Plough-tail, and whereto the Ground-wriſt V is faſten'd; as is the Earth-board, whoſe Fore-part W is ſeen before the Sheat; and alſo the long Handle X, whoſe Fore-part Y appears before the Sheat, and is faſten'd to the Drock by a Pin at *a*, the other End of which Pin goes into the Beam. Z is the double Retch, which holds up the Sheat, and paſſes through the Beam to be faſten'd by its Screws and Nuts at *b* and *c*.

But without intrenching much farther upon the common Plough-wright's Art, whoſe Trade is his Living, I'll haſten to ſhew the neceſſary Difference there is betwixt the common Plough, and the Four-coulter Plough, beginning with *Fig.* 2. where it is repreſented as ſtanding upon a level Surface.

Fig. 2. And, Firſt, The Beam differs in Length, being Ten Feet Four Inches long, as the other Plough-beam is but Eight Feet; it differs in Shape, as the other is ſtrait from one End to the other, but this is ſtrait only from *a* to *b*, and thence turns up of a ſudden, in the manner that is ſhewn in the Cut; ſo that a Line let down perpendicular, from the Corner at *a*, to the even Surface whereon the Plough ſtands, would be Eleven Inches and an half, which is its Height in that Place; and, if another Line were let down, from the turning of the Beam at *b*, to the ſame Surface, it would be One Foot Eight Inches and an half, which is the Height that the Beam ſtands from the Ground, at that Part; and a Third Line let down to the Surface, from the Bottom of the Beam, at that Part which bears upon the Pillow, will ſhew the Beam to be Two Feet Ten Inches high above the Surface in that Part.

From the End *a*, to the Back-part of the firſt Coulter, is Three Feet Two Inches; from thence, to the Back of the next Coulter, is Thirteen Inches; thence to the Third, Thirteen Inches; and from thence to the Fourth, the ſame. From *a* to *b* is Seven Feet.

This Crookedneſs of the Beam is to avoid the too great Length of the foremoſt Coulters, which would be neceſſary if the Beam was ſtrait; and then, unleſs they were vaſtly thick and heavy, they would be apt to bend, and the Point of the Fourth would be at ſo great a Diſtance from its Coulter-hole, that it would have the greater Power to looſen the Wedges, whereby the Coulter would riſe up out of its Work, as it never doth when the Beam is made in this bending Manner. This Beam is made either of Aſh, which is the lighteſt, or of Oak, which is the moſt

durable.

durable. Its Depth and Breadth may vary, according to the heavier or lighter Soil it is to till; but this before us is in Depth Five Inches at the firſt Coulter-hole, and in Breadth Four Inches.

Fig. 4. Is the Sheat Q in *Fig.* 1. (broad Seven Inches) with the Iron Retch on it, the left Leg of which Retch muſt ſtand foremoſt, to the end that the Edge of its Fore-part, that is flat, may fit cloſe to the Wood of the Sheat: This Retch holds the Sheat faſt up to the Beam by its Nuts and Screws; as alſo doth a Pin driven into the Hole *a*, which Hole being a ſmall Part of it within the Beam, the Pin being driven into the Hole, draws up the Sheat very tight to the Beam. The principal thing to be taken notice of here, is the Angle *b c d*, which ſhews the Elevation of the Sheat; the Line *c d* is ſuppoſed to be equal with the Bottom of the Share (or rather with the plain Surface whereon it ſtands); when this Angle at *c* is larger than of Forty-five Degrees, a common Plough never goes well: In my Four-coulter Plough I chooſe to have it of Forty-two or Forty-three at the moſt.

Fig. 5. Is the Share; *a* is the End of the Point; *b* is the Tail of the Share, long from *a* to *b* Three Feet Nine Inches; *c* the Fin; *d* the Socket, into which the Bottom of the Sheat enters; *e* a thin Plate of Iron riveted to the Tail of the Share: By this Plate, the Tail of the Share is held to the hinder Sheat, as at *d* in *Fig.* 1. by a ſmall Iron Pin with a Screw at its End, and a Nut ſcrew'd on it on the inner or right Side of that Sheat. From *a* to *f* is the Point, long about Three Inches and an half, flat underneath, and round at Top: It ſhould be of hard Steel underneath. From *f* to *c* is the Edge of the Fin, which ſhould be well ſteeled; the Length of it is uncertain, but it ſhould never make a leſs Angle at *f* than it appears to make in this *Fig.* The Socket is a Mortiſe of about a Foot long, at the upper Part, Two Inches deep: The Fore-end of this Mortiſe muſt not be perpendicular, but oblique, conformable to the Fore-part of the Sheat which enters it; the upper Edge of which Fore-part muſt always bear againſt the Sheat at *e* in *Fig.* 4. but if this End of the Socket ſhould not be quite ſo oblique as the Sheat, it may be help'd, by taking off a little of the Wood at the Point *c*.

Fig. 6. Shews the Share, with its right Side upwards, in the ſame Poſture as when it plows; whoſe Side *a b* ſhould be perfectly ſtrait, but its under Side at *c*, which is its Neck, ſhould be a little hollow from the Ground, but never more than half an Inch in any Plough, and a Quarter of an Inch in a Four-coulter Plough; ſo that the Share, when it is firſt made, ſtanding upon its Bottom, bears upon the level Surface only in Three Places; *viz.* at the very Point *a*, at the Tail *b*, and at the Corner of the Fin *d*.

Fig. 7. Is the Share, turn'd Bottom upwards; and ſhews the Concavity of the Fin at *a*; which muſt be greateſt in a ſtony rubbly Soil.

Fig. 8. Shews the Share, the right Side upwards, but leaning towards the Left.

In placing of the Share rightly upon the Sheat, conſiſts the well going of a Plough, and is the moſt difficult Part of a Plough-wright's Trade, and is very difficult to be ſhewn. Suppoſing the Axis of the ſtrait Beam, and the left Side of the Share, to be both horizontal, they muſt never be parallel to each other; for if they were, the Tail of the Share, bearing againſt the Side of the Trench, as much as the Point, would cauſe the Point to incline to the right Hand, and go out of the Ground into the Furrow. If the Point of the Share ſhould be ſet, ſo that its Side ſhould make an Angle on the right Side of the Axis of the Beam, this Inconvenience would be much greater; and if its Point ſhould incline much to the

Left, and make too large an Angle on that Side with the Axis of the Beam, the Plough would run quite to the left Hand; and if the Holder, to prevent its running out of the Ground, turns the upper Part of his Plough towards the left Hand, the Fin of the Share will riſe up, and cut the Furrow diagonally *(a)*, leaving it half unplow'd; beſide, the Plough will riſe up at the Tail, and go all upon the Point of the Share: To avoid theſe Inconveniences, the ſtrait Side of the Share muſt make an Angle on the left Side of the Beam, but ſo very acute, that the Tail of the Share may only preſs leſs againſt the Side of the Trench than the Point does. This Angle is ſhewn by the prick'd Lines at the Bottom of *Fig.* 1. where the prick'd Line *e f* is ſuppoſed to be

(*a*) This is the greateſt Misfortune incident to a common Two-wheeled Plough, and happens generally by the Fault of the Maker, though ſometimes by the Plowman's ſetting it ſo, that the Point of the Share turns too much to the Left. I have ſeen Land plowed in this manner, where not half of it has been moved, nor better tilled than by Raftering, not only cut diagonally, but alſo half the Surface hath remained whole, where when the Earth that was thrown on it was removed, the Weeds appeared unhurt on the unplowed Surface. In this Caſe, they for a Remedy ſet the Plough to go deeper; and then, if it go deep enough for the Fin to cut off the Furrow at a juſt Depth, the Point will go below the Staple, which may ruin the Soil, unleſs it be very deep

When our *Engliſh* Ploughs go in this manner, they make much worſe Work than the *Eaſtern* Ploughs, that have no Coulter; for theſe, contrary to ours, though they always cut their Furrow diagonally, cut it thin on that Side from which it is turned, as our bad Ploughs leave it thin on that Side towards which it is turned. The Earth the *Eaſterns* leave by their Diagonal in one Furrow, is taken off by the next; but ours leaving Part of their Furrow behind them, on the Side next to the plowed Part of the Field, come at it no more; but the other can plow cleaner, their Diagonal being contrary to ours, which leaves the Trench deepeſt on the Side next to the unplowed Part of the Field; but unleſs the Fin of the Four-coulterd Plough go parallel to the Surface of the Earth, it will not plough at all; or will leave Two or Three of its Four Furrows untouched.

the

the Axis of the Beam let down to the Surface, and the prick'd Line *g f* parallel to the left Side of the Share; but this Angle will vary as thoſe Two prick'd Lines are produc'd forwards to the Fore-end of a long and a ſhort Beam, keeping the ſame Subtenſe: For Plough-wrights always take this Subtenſe at the Fore-end of a Beam, whether it be a long Beam or ſhort one; and it is the Subtenſe *e g*, that determines the Inclination the Point of the Share muſt have toward the left Hand. Plough-wrights differ much in this Matter; but, by what I can learn by thoſe that make the Ploughs I ſee perform the beſt, this Subtenſe at the Fore-end of an Eight-feet Beam ſhould never be more than one Inch and an half; and by full Experience I find, that whether the Beam be long or ſhort, the Subtenſe muſt be the ſame; for when my Plough-wrights take this Subtenſe at Eight Feet from the Tail, when they make my Four-coulter Plough, whoſe Beam is Ten Feet Four Inches long, the Point of the Share will incline too much to the Left, and it will not go well until this Fault be mended, by taking the ſame Subtenſe quite at the End of the Beam; which makes the mentioned Angle more acute.

Fig. 3. Shews the right-hand Side, and upper Side of the Four-coulter Plough, of which V the Iron Ground-wriſt is ſhewn in *Fig.* 9. long Two Feet Five Inches, deep at the End *b* Four Inches, and Three-eighths of an Inch thick, except at the End *a*, where it is thin enough to bend, ſo as to fit cloſe to the Share, as at *e*, in *Fig.* 6. The Ground-wriſt has Four ſmall Holes near its End *a*, into one of which goes a Nail, to faſten it to the Sheat, thro' the long Hole in the Side of the Socket of the Share, as at *a*, in *Fig.* 10. and then it will ſtand in the Poſture ſhewn by *e f*, in *Fig.* 6. From the Outſide of the Ground-wriſt at *f*, to the Outſide of the Share at *b*, is Eleven Inches and an half, which is the Width of the

the lower Part of the Plough-tail at the Ground; the Ground-wrist has several Holes at the upper Side of its broadest End, as at *b*, in *Fig.* 9. by which it is nailed to the lower Part of the Drock T, as in *Fig.* 3. which Drock with its Perforations is shewn in *Fig.* 11.

Fig. 12. Is the Earth-board, with its Inside upwards; the Notch *a b* shews the Rising of the Wood, which takes hold of the Edge of the Sheat, to hold it the firmer, to which it is fastened by the Holes *c* and *d*; and at the other End it is fastened to the Drock, at the Hole *e*. All which is seen as it stands mark'd with W, in *Fig.* 3. But this Pin, with which it is fastened to the Drock, is bigger in the Middle than at each End; which prevents the Earth-board from coming near the Drock: By this Pin, the Earth-board is set at a greater or less Distance from the Drock, as there is Occasion to throw off the Furrow farther from the Plough at some times than at others: It always stands considerably farther out on the right Hand than the Ground-wrist does, which is one Reason that the Drock is made crooked, bending outwards in that Part.

The long Handle X is *Fig.* 13. long Five Feet Four Inches, broad in the widest Part Four Inches, pinned to the Sheat thro' the Holes *a b*, and pinned to the Drock through the Hole *c*.

The short Handle S is *Fig.* 14. and is long Three Feet Nine Inches, pinned to the hinder Sheat (being *Fig.* 15.) by the Hole *a*, and to the Top of the Fore-sheat above the Beam by the Hole *b*.

The Handles are made so long, for the more easy guiding of the Plough; but the lazy Ploughman is apt to cut them off shorter, close up to the Plough, to the end that, bearing his whole Weight thereon, he may in a manner ride instead of walking; but if he should thus ride on long Handles, he would tilt up the Fore-end of the Beam, and raise the Share out of the Ground.

The

The chief, and moſt indeſpenſably neceſſary thing to be obſerved, is, to ~~place~~ the Four Coulters in ſuch a manner, that the Four imaginary Planes deſcribed by the Edges of the Four Coulters, as the Plough moves forwards, be all of them parallel to each other, or very nearly ſo; for if any one of them ſhould be much inclined to, or recede from, either of the other three, they could not enter the Ground together. In order to place them thus, the Coulter-holes muſt be made through the Beam, in the manner as they are ſhewn in *Fig.* 3. *viz.* the Second Coulter-hole is Two Inches and an half more on the Right than the Firſt, the Third, Two and an half more on the right Hand than the Second, and the Fourth, Two Inches and an half more on the right Hand than the Third, conformable to the Four Inciſions or Cuts they are to make in a Ten-inch Furrow: And becauſe no ſingle Beam is broad enough to hold the Four Coulter-holes at this Diſtance, we are forced to add the Piece ſhewn in *Fig.* 16. The Second Hole is made Part in the Beam, and Part in this Piece; the Third and Fourth are made wholly in this Piece, in which *a*, *b*, *c*, are the Ends of the Three Screws, which faſten the Piece to the right Side of the Beam by their Nuts.

The Diſtance of Two Inches and an half, by which each of the Three added Coulters ſtand more to the right Hand than that immediately behind it, muſt be reckoned from the Middle of one Hole to the Middle of the other.

The Fore-part of every Hole muſt incline a little towards the Left; ſo that the Backs of the Coulters may not bear againſt the left Side of the Inciſions made by the Edges.

Each Hole, being a Mortiſe, is one Inch and a quarter wide, with its Two oppoſite Sides parallel from Top to Bottom; each of theſe Mortiſes, or Holes, are long at Top Three Inches and an half, and at Bottom Three Inches; the Back-part, or Hinder-

end,

end, of each Coulter-hole is not perpendicular, but oblique, and determines the Obliquity of the Standing of the Coulter, which is wedged tight up to it by the Poll-wedge *i*, *Fig.* 1. as all Coulters are.

Fig. 17. Is a Coulter; *a b* is its Length, being Two Feet Eight Inches, before it is worn; *e d* is its Edge, Sixteen Inches long; *d c* is the Length of its Handle, Sixteen Inches; this is made thus long, at firſt, to ſtand above the Plough, that it may be driven down lower, according as the Point wears ſhorter; this Handle is One Inch and Seven Eighths broad, and Seven Eighths of an Inch thick, equally thro' its whole Length: Its Breadth and Thickneſs might be deſcribed by a rectangled Parallelogram.

In all Ploughs this firſt Coulter is, or ought to be, placed in the Beam in manner following; *viz.* its Back to bear againſt the Back of the Coulter-hole, its right Side above to bear againſt the upper Edge of the Coulter-hole, and its left Side to bear againſt the lower Edge of the Coulter-hole; ſo that always Three Wedges at leaſt will be neceſſary to hold the Coulter; the Poll-wedge before it, as at *i*, in *Fig.* 1. another Wedge on the left Side of it above, and a Third on the right Side underneath: The Coulter-hole muſt be ſo made, that the Coulter ſtanding thus acroſs the Hole, its Point may incline ſo much towards the Left, as to be about Two Inches and an half farther to the Left *(a)* than the Point of the Share, if it were driven down as low as it; but it never ought to be ſo low in any Plough: As to its bearing forwards, the Point of the Coulter ſhould never be before the Middle of the Point of the Share: What Angle the Coulter would make with the Bottom of the Share, may be ſeen by the Poſture it ſtands in, in *Fig.* 1. If it ſhould be ſet much more obliquely, it would have a

(a) I find that ſometimes it is neceſſary in ſome of theſe Ploughs for the Point of this Coulter to ſtand yet farther on the Left of the Share's Point.

greater

greater Force to raiſe up the Poll-wedge, and get looſe.

The Three added Coulters ſhould ſtand in the ſame Poſture with this already deſcribed, in regard to the Inclination of their Points towards the Left: And this is a very great Advantage to them; for by this means, when the Fin is rais'd up, by turning the Handles towards the Left, their Points do not riſe out of the Ground on the right Hand, as they would do without this deſcribed Inclination towards the Left; but in regard to their Pointing forwards, I find it beſt, that every one of the Three ſhould be a little more perpendicular than that next behind it. So the Coulter 4 ſtands the neareſt to Perpendicular of any of them. By this means there being more Room betwixt them above than below, they are the more eaſily freed from the Turf, whenever the Pieces, being covered with a great Quantity of Couch-graſs, or the like, riſe up betwixt them: which tho' this ſeldom happens, makes a Neceſſity for a Man, or a Boy, to go on the Side with a forked Stick, to puſh out the Turf and Graſs, which might otherwiſe fill the Spaces betwixt the Coulters, and raiſe up the Plough out of its Work.

'Tis to be obſerved, that none of theſe Coulters ought to deſcend ſo low as the Bottom of the Share, except when you plow very ſhallow: 'Tis always ſufficient that they cut through the Turf, let the Plough go never ſo deep in the Ground.

It is neceſſary alſo, that when you plow very ſhallow, the Fin of the Share be broad enough to cut off the Fourth Piece or Furrow; elſe that, lying faſt, will be apt to raiſe up the Ground-wriſt, and throw out the Plough: But when you plow deep, the Ground-wriſt will break off this Fourth Furrow, altho' the Fin be not broad enough to reach it.

Sometimes the Firſt or left Furrow is apt to come through betwixt the Firſt Coulter and the Sheat, and ſo ſo falls on the left-hand Side of the Plough : This is no Injury; but yet it is prevented, by letting the Second Coulter ſtand a lighter higher than the Third; and then the Second Furrow, holding the Firſt at its Bottom, will carry it over, together with itſelf, on the right Side by the Earth-board; but yet never ſet this, or any of the Three added Coulters, ſo high that they may not cut through the Turf. But as for the firſt Coulter, tho' it ſhould cut but an Inch or Two within the Ground, the Share will break off the firſt Furrow in raiſing it up.

Remember, as often as the Point of any Coulter is worn too ſhort, that you drive down the Coulter with a large Hammer, carried for that Purpoſe; and when it is driven low enough, faſten the Wedges again, ſo as to keep the Coulters in their right Poſtures, that their Inciſions may be all of them equidiſtant.

Fig. 18. Is a Nut, with Two of its oppoſite Corners turn'd up, by which it is driven round by a Hammer, and has ſo great a Force, that Three of them, with their Screws properly placed, hold the Piece, *Fig.* 16. as faſt to the Plough-beam, as if they both were made of one Piece of Wood; but as often as the Wood ſhrinks in dry Weather, the Nuts muſt be ſcrew'd farther on, both here and in all other Places where they are uſed: particularly, thoſe which hold up the Retch; for if the Sheat ſhould once get looſe, there is no Cure but by a new one.

Betwixt this Nut and the Wood, there ſhould be a thin Iron Bolſter, about the Thickneſs of a Shilling, broader than the Nut, to prevent the Nut from eating into the Wood, eſpecially when it is to be often ſcrew'd, as on the Retch of theſe Ploughs, and moſt of all on the Hoe-plough; but ſometimes we uſe a Piece of Shoe-leather inſtead of an Iron Bolſter.

Note, There muſt be Iron Plates upon all the Coulter-holes both above and below, Three of which

are

are ſeen on the Piece in *Fig.* 16. There is no need to ſay how they muſt be nailed on with many Nails made for the Purpoſe.

Fig. 19. Is the Iron Collar, faſtened to the Beam by Two ſhort Crooks A, B, which take hold of Two ſhort Pins driven into the Plough juſt behind the Second Coulter-hole, one on one Side, and the other on the other Side of the Beam. The Crook A is ſeen on the left Side of the Beam near *c*, in *Fig.* 2. the Crook B doing the ſame on the other Side of the Beam, which is ſeen near *a*, in *Fig.* 3. C is the Crook (for its Shape called a C) which holds the Tow-chain to the Collar by the Link D, being Part of the ſaid Chain taking hold of its Fore-claw; the other Claw taking hold of one of the Five Notches of the Collar: This Collar is partly ſeen at *d*, in *Fig.* 2. Both the Claws of the Crook (or C) turn upwards, ſo that they cannot take hold of any thing that may riſe under the Plough: The Uſe of the Notches is to help the Direction of the Point of the Share, which has been deſcribed by the prick'd Lines under *Fig.* 1. As the Point of the Share wears, it inclines a little more towards the Right, and is remedied by moving the Crook into a Notch nearer to the Left, which will direct the Point a little more towards the Left: This is more eaſy to be done here than in the common Plough, whoſe Collar moves round the Beam: We can, by changing the Crook from one Notch to another, incline the Point of the Share towards the Right or Left at Pleaſure. The Length of each Side of this Collar is a Foot long.

The Tow-chain is beſt ſeen in *Fig.* 3. where the Link Y is that which paſſes thro' the Box, and is pinned in by the Stake, as has been ſhewn in *Fig.* 1. which Stake is commonly nailed to the Box, to prevent its riſing up. When we would draw up the Plough a little nearer to the Crow-ſtaves, we take hold of the Crook by a Second or Third Link.

Note,

Note, That the ſhortening of the Chain does alſo a little incline the Point of the Share towards the Left.

Fig. 20. is the Iron-wilds. The Leg A is of one Piece with that which has the Notch, and that paſſes thro' the Leg B by the Loop at *a*; both which Legs paſs thro' the Box, and are pinned in behind it, by the crooked Pins C, D. This Figure is ſeen with its Crooks on it; both in *Fig.* 1. and *Fig.* 2. *Note*, That the Holes in the Box, thro' which theſe Legs paſs, muſt not be made at right Angles with the Box, but muſt incline upwards, ſo that the Fore-part of the Wilds may be higher than the Hinder-part, or elſe the Upper-part of the Crow-ſtaves would lean quite back when the Plough is drawn. If the Beaſts that draw immediately next to the Plough be very high, their Traces muſt be the longer; elſe they and the Wilds making too ſmall an Angle with the Tow-chain at the Box, when they draw hard, the Wheels will riſe from the Ground, and be apt to overturn: This Angle I ſuppoſe ſhould not be leſs than of 160 Degrees, and the Angle made by the Tow-chain or Traces that are drawn by the Cattle that go before them, will make an Angle with the Tow-chain at the Box yet much more obtuſe. The Uſe of theſe Notches in the Wilds is, to give the Plough a broader or narrower Furrow: If the Links are moved to the Notches on the right Hand, it brings the Wheels towards the left Hand, which gives a greater Furrow; and when the Links are moved towards the left Hand, it gives a leſs Furrow, by bringing the Wheels towards the right Hand.

The Diſtance betwixt the Two Legs of the Wilds is Eight Inches and an half; the Length of the Legs is Nineteen Inches. They muſt be of convenient Strength. The Links being placed in Notches diſtant from one another, prevents one Wheel from advanceing before the other; which would happen, if the Links were both in One Notch, or in Two adjoining

 Notches,

Notches, except they were middle Notches: These Links are each Six Inches and an half long.

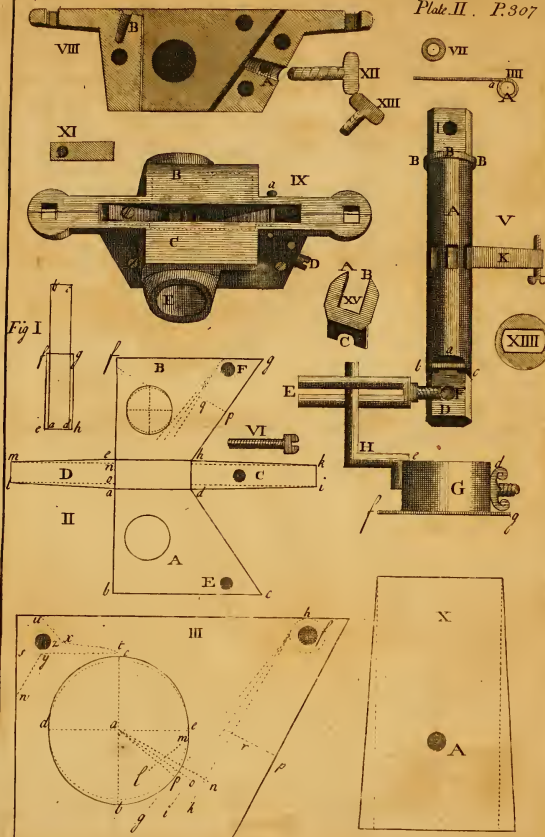
E is the Ring, by which the Two Links, and the Two Crooks F and G, are held together, and on which they all move.

The Height of the Wheels in *Fig.* 2. The left-hand Wheel is Twenty Inches Diameter; the Diameter of the right Wheel is Two Feet Three Inches; the Diſtance the Wheels are ſet from each other at the Ground, is Two Feet Five Inches and an half; the Crow-ſtaves are One Foot Eleven Inches high, from the Box to the Gallows; they both ſtand perpendicular to the Box, and the Diſtance between the Crow-ſtaves is Ten Inches and an half. The Pillow is pinned up at its Ends by Two ſmall Iron Pins, which are chained to it, that if they drop, they may not be loſt. Theſe appear in *Fig.* 1. and *Fig.* 2. The Height from the level Surface, up to the Hole in the Box, where the Tow-chain paſſes through it, is Thirteen Inches (being Two Inches below the Holes of the Wilds, on the Hinder-ſide of the Box); the Height at the other End, where the Crook of the Collar takes hold of the Pin in the Beam at *c*, in *Fig.* 2. is Twenty Inches high above the ſame level Surface, and ſhews how much the Chain deſcends forward, for drawing down the Plough, and by which Deſcent may be known what Angle the Chain would make with the Surface, if it were produced forwards in a ſtrait Line; which is a thing material for the good going of a Plough; and ſo is the Angle the Tow-chain makes with the Beam: About the Middle of this Tow-chain, there ſhould be a Swivel, whereby one End of the Chain may turn without the other.

When this Four-coulter Plough is made, I would adviſe, that it be tried with only the firſt Coulter, before the other Three are put in; for if the Plough does not go well with One Coulter, it is not likely it ſhould go well with Four; and I never yet have ſeen

or

Plate II . P.307



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or heard of any that went well with One Coulter, that did not alſo go well with Four, being placed as is here directed.

The Proofs of a Plough's performing well are theſe; *viz.* If it makes a Furrow of an equal Depth on the right Hand and on the left; and turns it off fairly: If, in its going, the Tail of the Share, and the Bottom of the Drock, bear againſt the Bottom of the Furrow; and if it goes eaſy in the Hands of the Holder, without preſſing one Arm more than the other; then the Plough is certainly a good one.

The Ploughman who is accuſtom'd to a Two-wheel'd Plough, never ſuffers the Wheels to overturn, in turning out at the Land's End, from one Furrow to another; for which Purpoſe, after he has lifted the Plough a little round, he has a Knack of holding up the Crow-ſtaves with the End of the Beam, by preſſing his Hand hard againſt the Handle, whilſt the Plough lies down on one Side, until the Horſes, the Wheels, and the Plough, come near to a Line in the Beginning of the Furrow; and then he lifts up his Plough, and goes on.

CHAP. XX.

Of the Drill-Boxes.

THE Drill is the Engine that plants our Corn and other Seeds in Rows: It makes the Chanels, ſows the Seed into them, and covers them at the ſame time, with great Exactneſs and Expedition.

The principal Parts of the Drill are, the Seed-box, the Hopper, and the Plough, with its Harrow.

Of theſe the Seed-box is the Chief: It meaſures (or rather numbers) out the Seed which it receives

from

from the Hopper: It is for this Purpofe as an artificial Hand, which performs the Tafk of delivering out the Seed, more equally than can be done by a natural Hand.

It is defcribed, together with fome of its Appurtenances, in *Plates* 2 and 3.

The MORTISE.

As the Seed-box is the principal Part of a Drill, fo is the Mortife the principal Part of the Seed-box.

The following Defcriptions fhew how this Mortife differs from a common Mortife.

Fig. 1. *Plate* 2. fhews both the upper and lower Edges of a Turnep-Seed-box, and the Manner how they are pofited one over another. *a b c d* is a rectangled Parallelogram, and fhews the upper Edges (or Top) of the Mortife. *e f g h*, being a Figure of the fame Denomination with the former, is the lower Edges (or Bottom) of the Mortife. The Line *e h* is the Length of the lower Edge of the Hinder-end of the Mortife. *a d* is the upper Edge of the Hinder-end of the Mortife, and pofited juft over the lower Edge of the fame End. The Space between the Line *a b*, and the Line *e f*, fhews half the Excefs whereby the Bottom of the Mortife exceeds the Top in Breadth; as the Space on the oppofite Side, betwixt the Line *c d*, and the Line *g h*, fhews the other Half of that Excefs, both which Halves, taken together, fhew the whole Bevel (or Angle of Inclination) defcribed in *Fig.* 2. That Part of the Line *a b*, from the Angle at *b* to the Line *f g*, which interfects it, fhews the Excefs whereby the Top of the Mortife exceeds the Bottom in Length.

Fig. 2. Is the Mortife cut down by its Four Corners, and laid open. *a b c d* is a Trapezium, with Two parallel Sides, and mark'd A, the right Side of the Mortife; its oppofite Side *e f g h*, mark'd B, the

the left Side of the Mortiſe; the Areas of both being true Planes *(a)*.

d i k b Shew the Fore-end of the Mortiſe, mark'd C. *a l m e* ſhew the Hinder-end of the Mortiſe, mark'd D. *a d b e* ſhew the Bottom of the Mortiſe already deſcribed in *Fig.* 1. If theſe oppoſite Sides and Ends were all raiſed up, until the Angle at *b* join the Angle at *l*, and that at *m* join *f*, and that at *g* join *k*, and that *i* join *c*, the Top of the Mortiſe would be formed, and the ſame with the Parallelogram *a b c d*, in *Fig.* 1. and then the intire Mortiſe of the Turnep Seed-box would appear in its true Form, ſtanding upon its Bottom.

This differs from a common Mortiſe, in that it is impoſſible to fit it with a Tenon; becauſe it is narrower above, and ſhorter below, as in *Fig.* 1.

The Areas, or imaginary Planes, of the Top and Bottom of the Mortiſe, are parallel to each other, but not equal.

Its Two oppoſite Sides are equal, but not parallel, by reaſon of their Inclination to each other upwards, which is the Bevel hereafter to be deſcribed.

The Two Ends are neither parallel nor equal, becauſe the Hinder-end D is perpendicular to the Top and Bottom, and the Fore-end oblique, and therefore longer.

(a) Take care that theſe oppoſite Sides be ſure to be true Planes, eſpecially all that Part of their Areas, that is before the tranſverſe Axes of their Ellipſes herein after deſcribed; for ſhould they be otherwiſe, the Bevel of the Mortiſe would be ſpoiled, and ſo would the Ellipſes, and the acute Triangles, on the Sides of the Tongue; which how neceſſary they are to be true, is ſhewn in the proper Place. Workmen are very apt to fail in this when they file by Hand, and make theſe Sides of the Mortiſe convex inſtead of plane. Therefore this might be done with leſs Difficulty, and more Exactneſs, with a File placed in a Frame, whereby it might move upon a true Level without riſing or ſinking of either End.

When Two oppoſite Sides, or Surfaces, are inclined to each other upwards, I call that Inclination a Bevel; but when they are inclined downwards, I call it a Bevel revers'd.

The Line *a e*, being the Bottom, or Baſe, of the Hinder-end D, by being longer than the Line *l m*, ſhews that the Mortiſe is bevel.

The Two prick'd Lines *m n* and *l o*, with the Line *l m*, and Part of the Line *a e*, make a rectangled Parallelogram, which ſhews the exact Depth of the Mortiſe, and forms on each Side of it a rectangled Triangle, the one *m e n*, and the other *l o a*; which Triangles being ſimilar and equal, and their acute Angles at *l* and *m* being each of Four Degrees, make the whole Bevel, or Inclination of the Sides of the Mortiſe, to be of Eight Degrees, their Hypothenuſes being the ſame with the Sides of the Mortiſe.

This End D, being raiſed up to its Place, will be at right Angles with the Plane of the Top and of the Bottom of the Mortiſe; which, being both rectangled Parallelograms, prove that Bevel, or Angle of Inclination, to be the ſame from one End to the other of the Sides, which Sides are the Hypothenuſes of thoſe Two Triangles: But this could not be proved by the Triangles in the oppoſite End C; becauſe the Baſes being the ſame with the other, and having their Legs longer, the vertical Angles at *k* and *i* are more acute. The Legs are longer; becauſe the End C, when in its Place, is not at right Angles with the Top and Bottom of the Mortiſe, as the End D is.

The next thing to be deſcribed in the Mortiſe, is the Bore, great Hole, or Perforation; which is beſt ſhewn in the Side of a Mortiſe of a Wheat-drill, being larger, as in *Fig.* 3. wherein *c e b d* is the great Hole, and is a Section of an hollow Cylinder, that paſſes through the Mortiſe, with its Axis parallel to the Edges of the Ends of the Mortiſe: This

Cylinder,

Cylinder, being cut by the Side of the Mortise obliquely, and not parallel to its Base, is an Ellipse.

The prick'd curve Line is a Circle parallel to the Base of the Cylinder, and the curve Line *b d c e* is the Ellipsis; and this Curve is more or less elliptical (or oval) in proportion to the Angle of Inclination, or Bevel, of the Sides of the Mortise.

Of this Ellipse the longest Diameter (or *Axis transversus*) *b c* is at right Angles with the upper and lower Edges of the Sides of the Mortise.

Its shortest Diameter (or *Axis rectus*) *d e*, is the Diameter of the Cylinder, bisecting the *Axis transversus* at right Angles in the Centre *a*; and is in this Figure one Inch and an half.

This Ellipse being concentric with the Circle, the Letter *a* is the Centre of both.

The Semi-ellipsis *c e b* is the Part of chief Use; and therefore the Edge must of Necessity be smooth, and without Flaws, as must the Surfaces of the Sides of the Mortise betwixt the Ellipse and the Fore-end.

The Tongue of the Seed-box (*Plate* 3. *Fig.* 1.) differs from that in the Sound-board of an Organ (from which I took the Idea of it) in Shape, in Situation, and in the Manner of its being fix'd to the Mortise.

The Tongue, in the Organ, is on its Surface a long Square, or rectangled Parallelogram, a little broader and longer than the Mortise (or Grove) it shuts against; but this Tongue on its upper Surface, which is here turned downwards, being a Plane, is a Trapezium, of the same Shape with the Fore-end of the Mortise just now described, except that the Tongue has a less Bevel.

The Situation of that in the Organ is on the Outside of the Mortise, which it shuts by its Spring behind it, and opens immediately by the Finger of the Organist pressing down the Key to let in the compressed Air to its Pipes; but this Tongue is situate within the Mortise of the Seed-box, and placed almoſt, in a manner, diagonally; for, had it been placed like the other, the Seed getting betwixt it and the Edges of the Mortiſe, would not have given Way to its Shutting (as the Air does to the other), but have kept it always open; which would have render'd it uſeleſs for ſowing of Seeds.

The Manner of faſtening the Organ-tongue to its Mortiſe is by Parchment and Leather glu'd to its Surface, and alſo to the Sound-board, at its End which is oppoſite to that preſſed open by the Key, and ſhut by the Spring; but this our Tongue is held within the Mortiſe, and moves on an Axis, which paſſes thro' its upper and narrower End, which Axis is the Pin A (which muſt be exactly parallel to the Edge of the End of the Mortiſe), and alſo thro' the Hole *f* in *Fig.* 3. in *Plate* 2. which is ſeen in its Place at A in *Fig.* 3. *Plate* 3. and likewiſe through both Sides of the Mortiſe near their upper Edges, and as near the Fore-end of the Mortiſe as may be, without the Tongue's rubbing againſt the ſaid Fore-end.

The Breadth of the Tongue muſt be conformed to the Breadth and Bevel of the Mortiſe, and when it is on its Axis, it being raiſed tight up as far as the ſhort prick'd Line *l m* in *Fig.* 3. *Plate* 2. being One-eighth Part of the great Hole, and being there, you ſee its upper Edges touch both Sides of the Mortiſe by their whole Length: Then it is rightly made: and by this touching both Sides of the Mortiſe tightly and cloſely, when raiſed up to that Degree, it appears, that the Two upper Edges of the Sides of the Tongue are inclined to each other in an Angle that is more acute, by about One-third, than is the Angle of Inclination of the Sides of the Mortiſe.

Hence, when the Tongue is let down to its Place, there will be on each Side of it an empty Space, betwixt it and the Mortiſe, of the Form of a very acute

acute Triangle, whofe vertical Angle is more or lefs acute, according as the Tongue approaches nearer to, or recedes farther from the Spindle.

This *Fig.* 1. *Plate* 3. is the brafs Tongue with its Back-fide upwards. The Two outer Lines *a b* and *c d* are the Edges of the upper Surface (tho' turned downwards in this Figure), which are inclined to each other, as afore-mentioned; but the Two inner Lines *e f* and *g h* are nearer to each other, whereby this under Surface is narrower than the upper: Both muft be plain Surfaces, but the upper and its Two Edges very free from Flaws, and fmooth, or polifhed.

The Reafon why the under Surface is narrower than the upper, is to preferve the Bevel of the empty Triangle: For though the Bevel of the Sides of the Mortife would be fufficient for this, if both Sides of the Tongue were fure to keep equally diftant from the Spindle; yet as the Tongue never is fo tight on its Axis, but that fometimes one Corner of it may be nearer to the Spindle than the other, in this Cafe, that Side which is neareft to the Spindle would reverfe that Bevel, fo as to make the fmall empty Space that is betwixt the Mortife and the Tongue, wider above than underneath.

C C are the Two little Knobs that prevent the Spring from flipping to either Side, and are at the Diftance from one another of the Breadth of the Spring.

Fig. 2. fhews one Side, and the Thicknefs of the Tongue the other Side, being the fame. *a b* fhews the polifhed Surface (being a true Plane), whereon the Seed runs down to the Spindle. *c d* the Back-fide, which lies turned uppermoft in *Fig.* 1. *b e d* fhews one End of the hollow Cylinder of the Tongue, thro' which its Axis paffes.

The Length of the Tongue muft be fuch, as will reach lower than juft to touch the Bottom of the great

great Hole as a Tangent: for, if it be not longer than that, it might happen, that when the Mortise is empty of Seed, and the Tongue set up close, a Wheel might, in Turning, or otherwise, go a little backwards, and cause a Notch of the Spindle to take hold of the End of the Tongue, and tear it out of the Mortise: Therefore let the Tongue reach a little below the Spindle, as the pricked Line *g h*, in *Fig.* 3. of *Plate* 2. doth.

As for the Posture in which the Tongue ought to stand in the Mortise, it is shewn by the Three pricked Lines in *Fig.* 3. *Plate* 2. where the pricked Line *g h* makes an Angle of Forty-five Degrees, being the nearest that it can stand to the Spindle; the pricked Line *i h* makes a somewhat greater Angle, and it is a mean (or middle) Distance from the Spindle; and the pricked Line *k h* is supposed to be its greatest Distance, where the Tongue makes its greatest Angle with the Top and Bottom of the Mortise. If the Tongue stood so obliquely as to make an Angle much less than Forty-Five, the Tongue would rise too much against the Bevel of the Mortise, and the Spring would have the greater Difficulty in returning it to its Place, when driven back by the Force of the Notches.

And beside, when the Tongue stood wide from the Spindle, there might be so much Room betwixt it and the Sides of the Mortise, that some Seeds might fall thro' there.

The Steel Spring is D, properly placed upon the Back of the Tongue, in *Fig.* 1. *Plate* 3.

At first, I made the Spring double, *i. e.* with Two Legs, in Imitation of that in the Organ, and fastened into its Tongue, much after the same manner as the Spring of the Organ is into its Tongue or Flap, which prevents the compressed Air from passing out of the Sound-board, except whilst the Key is thrust down

down by the Finger of the Player; but the Drill-ſpring requiring to be of a vaſtly greater Strength than that, I made it of Steel, of the Breadth of half an Inch, inſtead of Braſs Wire: This performed very well, and ſeveral Drills are yet extant, that have only this Sort of Springs: Yet I found there was great Difficulty to ſet the Legs at their due Diſtance from each other; for their Seaſoning would alter them from what they were, whilſt the Steel was ſoft: They alſo took up too much Room in the upper Part of the Mortiſe. Then, to remedy theſe Inconveniencies, I made it ſingle, with only one Leg, which by full Experience is found to be much better than the double one; it does not contain a Fourth Part of the Metal, and is moſt eaſily made, requiring none of that Trouble and Nicety that the double Spring doth. I ſhall therefore give a Deſcription of the ſingle Spring only.

B, the End of the Screw, which holds the Spring to the Tongue, thro' a Hole near the upper End of the Spring; D, the Middle, againſt which the End of the Setting-ſcrew bears.

Its Length is almoſt the whole Length of the Tongue; the End E reaching very near to the lower End of the Tongue, and the End B is as near the upper End of the Tongue; as it can be placed without touching the Cylinder of the Tongue.

The Breadth is uſually about half an Inch; the Thickneſs muſt be in proportion to its other Dimenſions, and according to the Degree of Stiffneſs required.

The longer it is, the thicker it muſt be, to have the ſame Stiffneſs; but the broader it is, the thinner it muſt be of the ſame Length; ſo that it is hard to determine its Thickneſs. It is made ſtiffer or ſtronger by being cut ſhorter; it is made weaker, or leſs ſtiff, by filing or grinding it either thinner or narrower.

The

The common Thicknefs is about that of a Shilling *(a)*.

The Degrees of Stiffnefs are meafured in this manner; *viz.* Fix Two Boards together, leaving a Chink betwixt them, in one Place of an Inch long; lay the Spring (when feafoned acrofs this Chink) with its Middle exactly over it; then put a String over the Spring, which may pafs with both Ends thro' the Chink, and tie fo much Weight to the Ends of the String under the Boards, that will pull down the Middle of the Spring, till it touch the Chink, and is ftrait with both its Ends; This will fhew the Degree of Stiffnefs. But note, That the Spring muft be crooked, and bear only upon its Ends, with the hollow Side upwards.

If ten or a dozen Pounds Weight pull it down to the Board, it is a good Degree of Stiffnefs, for a large Box: We are not confined to be very nice or exact in the Degree of Stiffnefs; for by our Fingers preffing it, we that are practifed in it, know well enough, whether a Spring be of a fufficient Degree of Stiffnefs, without weighing it; but for fuch who are unacquainted with them, it is beft not to truft to Guefs, but Weights; and to adjuft the Stiffnefs to that of a Spring, that has been known to perform well.

The Spring muft bear againft the Back of the Tongue at each End, and lie hollow in the Middle: But the Degree of Hollownefs of the Spring is very material; for thereon depends the Diftance of the Tongue's Motion towards the Spindle by Force of the Spring, and back again quite to the Setting-fcrew, by the Seed that is preffed againft it by Force of the Notches, when they are moved by the Wheels; becaufe the more the Spring is curved, the farther

(a) Not quite fo thick as a milled Shilling, but rather of an old broad ftamped Shilling, which is a little thinner.

will

will it thruſt the Tongue from its Middle, if its Strength be ſuperior to the Force that reſiſts it, as it ought to be when a Notch is paſſed and before the next: This Motion of the Tongue is called its Play.

In order to meaſure the Diſtance (or Quantity) of this Motion, we muſt conſider, that the Tongue, moving on its Axis above, deſcribes with its lower End the Arch of a Circle, the Chord of which Arch is the Meaſure required.

To meaſure this by the Angle the Tongue makes at its Centre, would be no Rule for making Boxes; becauſe ſome Tongues are longer, ſome ſhorter, in proportion to the different Diameters of the Spindles they move againſt; and yet the Play of the ſhorteſt muſt be as much as that of the longeſt, that is, it muſt deſcribe as great an Arch at the Place of Preſſure (deſcribed in *Fig.* 3. *Plate* 2.); and therefore the ſhorteſt Tongue would make the greateſt Angle.

A ſhort and eaſy Way, then, for a Mechanic to meaſure, is thus: Screw in the Setting-ſcrew until the Tongue come within a quarter of an Inch of touching the Spindle; then take out the Spindle, and from the Centre of the Hole draw a Line on the Side of the Mortiſe, perpendicular to the Tongue, and at the Tongue's Edge make a Mark with the Compaſſes, or a Pen; then force back the Tongue againſt the Setting-ſcrew as far as it will go (that is, until the Spring touch the whole Back of the Tongue); produce the ſaid Line to the ſame Edge of the Tongue, or ſet the End of the Rule thereon, and draw another Line, by the Rule, from the Mark to the Edge of the Tongue, when fartheſt back, and there make the ſecond Mark. The Ruler uſed this Way will ſhew both the Perpendicular, and the Meaſure.

But yet a quicker Way is, to ſet the Tongue, by the Setting-ſcrew up to the Edge of the Hole; and, when it is forced back, meaſure from the Tongue to the neareſt Part of the Hole; which will ever be a perpendicular Line drawn from the Centre of the Hole to the Place of Preſſure above-mentioned, and make another Mark there: Now the Diſtance between theſe Two Marks is the Meaſure (near enough) of the Tongue's Play at the Place of Preſſure. Tho' this Line drawn on the Side of the Mortiſe be not exactly perpendicular to the Surface of the Tongue; but only to its Edge; yet the Difference is next to nothing, and not to be regarded.

If its Meaſure be a quarter of an Inch, it is what Experience ſhews to be of a good Size for all Corn and Peas; a little leſs is no Harm, but greater is the moſt fatal Error, into which moſt of the Pretenders to the making of this Machine have fallen; they give the Tongue half an Inch, ſometimes Three quarters of an Inch Play. The Miſchief of this Error is yet farther increaſed, if the Spring be weak, if the Mortiſe have too great a Bevel, or if the Angle made by the Tongue at the upper Edge of the Mortiſe be too acute.

When the Tongue has too great Play, the Seed is apt to be turned out too faſt, or elſe too ſlow, in ſpite of the Driller. For when the Tongue is ſet at its due Diſtance from the Spindle, and is thruſt quite back by the Seed preſſed againſt it by the Turning of the Notches; but the Spring being unable to return the Tongue to its former Place at ſuch a Diſtance, at the time of paſſing the Intervals which are betwixt the Notches; then the Space between the Spindle and the Tongue being too open, the Seed is ſent down too faſt.

To prevent that, they ſet up the Tongue to the Spindle; and then, as often as the Spring happens to overcome the Force of the Seed's Preſſure (as ſometimes it will), it is ſent out too ſlowly.

The Inequality of the Running of the Seed makes ſuch Boxes uſeleſs, which the Expence of Two-pence

(for

(for another Spring, or new Seafoning of that) at moft would rectify, if the Maker underftood how to mend his own Work. If time did permit, more fhould be faid on this Point, becaufe I find it is the *Pons Afini* of a Workman. Sometimes it may be prevented, when the Spring is too hollow, and gives too much Play. Screw the Screw, that holds it on the Tongue, down clofer, fo that the lower Part of the Screw's Head prefs againft the Spring, and thereby force its Middle nearer to the Tongue, until you find its Play leffened to its juft Diftance.

The Spring, remaining in this compreffed State, has loft the weakeft, and retains only the ftrongeft, Part of its elaftic Force. Therefore, if you find it then too ftiff, make it weaker by Filing or Grinding, or elfe put another into its Place, which is honeftly worth no more than Two-pence.

This Holding-fcrew has a pretty broad Head, and is fcrewed in by a Notch, like the Screw-pin of a Gun-lock.

The Hole in the Spring muft be fomewhat bigger than the Holding-fcrew, becaufe the Spring muft have room to move and play thereon.

If the Middle of the Spring were againft the Middle of that Part of the Tongue, that is betwixt its Axis and the Place of Preffure, the Diftance of the Spring's Hollownefs would be juft half the Diftance of the Spring's Play, to wit, the One-eighth Part of an Inch; but as the Spring does not quite reach up to the Axis, and reaches much below the Place of Preffure, the Hollownefs at the Place where the Setting-fcrew bears againft the Middle of the Spring at D, is confiderably nearer to the Place of Preffure than to the Axis of the Tongue; this Hollownefs of the Spring at the Setting-fcrew may be fomething more than the One-eighth Part of an Inch, to give the Spring a Quarter of an Inch Play: but it feldom has fo much.

Fig.

Fig. 4. in *Plate* 2. ſhews the Length and Thickneſs of the Steel Spring of a Turnep Seed-box: This ſerves both for a Tongue and Spring: It is made firſt ſtrait, and then the narroweſt End of it is turned round, till it reach to *a*, and forms the Cylinder A, thro' which its Axis paſſes; but is not welded or joined to the other Part of the Spring at *a:* It is placed in the Box with the Cylinder Part underneath. The Face of this Spring is ſeen upon its Axis, mark'd K. in *Fig.* 5. Its Axis is to paſs thro' the Hole E, and ſcrew into the Hole F, in *Fig.* 2. as is ſeen more plainly at *a* in *Fig.* 9.

As the Top of every Tongue ought to be even with the upper Edges of the Mortiſe, the Thickneſs of the Cylinder of the Braſs Tongue cauſes the Hole in the Sides of the Mortiſe, into which it is held by its Axis, to be far enough from the Edges of the Mortiſe, to be bored and ſcrewed without Danger of breaking the ſaid Edges; but the Spring of the Turnep-drill being ſo very thin, there is ſome Difficulty in making the Hole ſo high, and near the Edges: To prevent which Danger, *Fig.* 7. ſhews the End of a ſmall hollow Cylinder of Iron or Braſs, of the Thickneſs of the Mortiſe; which, being put into the Cylinder A, in *Fig.* 4. raiſes the Spring higher above the Hole; ſo that it may be made as low in a Turnep Mortiſe, as that is which holds the Braſs Tongue in the Wheat-drill. But we do not always uſe this inner Cylinder *(a)*; but muſt then take the more Care in boring the Hole, or elſe it will burſt out at the Edges of the Mortiſe.

Its Shape muſt conform to that of the Braſs Tongue already deſcribed.

(a) For, inſtead of this, we may uſe a Bit of Woolen Cloth of the Breadth of the Mortiſe, glued on to the Bottom of the Hopper, which, filling the Vacuity above the Steel Tongue, prevents any Seed from running over it, though the Holes are bored as low in the Mortiſe as if the Cylinder *Fig.* 7. were to be uſed.

The

The Degree of its Stiffnefs is known by weighing, as has been directed for the other Spring; and being laid with its Face downwards over a Chink, with a fmall Piece of Wood of the Thicknefs of a Barley-corn at Each end, and a String taking hold of its Middle, and defcending thro' the Chink, the Weight of Five Pounds, tied to the End of the String, will juft bend the Spring, till it touch the Edges of the Chink; and this is the Stiffnefs of a Spring that has performed well, for many Years, in drilling of Turnep-feed.

The SETTING-SCREW.

Fig. 6. is the Iron Setting-fcrew, which paffes thro' the Hole in the Fore-end of the Mortife, *Fig.* 2. and paffes up to the Middle of the Spring by the prick'd Line *p q* in the fame Figure. The Ufe of this Setting-fcrew is, to increafe or diminifh the Proportion of Seed to be turned out by the Notches; and this it does by forcing up the Spring and Tongue (where there is one) nearer to, or farther from the Spindle, whereby the Seed-paffage is made wider or narrower, as is fhewn by the Three prick'd Lines in *Fig.* 2. and *Fig.* 3.

Obferve, that the prick'd Line *p q*, *Fig.* 2. (being the Mortife of the Turnep-box) ftands higher than the fame Line doth in *Fig.* 3. which is the Mortife of the Wheat-box. The Reafon of this Difference is, becaufe the Spring in the Wheat-box bears at its lower End againft the Tongue below the Seed-paffage, and at its upper End below the Axis of the Tongue, whereby the Middle of that Spring is lower than the Spring of the Turnep-box, which, being both Spring and Tongue, bears againft its Axis above, and againft the Seed-paffage below; therefore its Middle is higher. This Setting-fcrew fhould be placed perpendicular to the Tongue when at its mean or middle Diftance from the Spindle, which may be fuppofed to be the middlemoſt of the Three mention'd prick'd Lines. This Setting-ſcrew ought to be ſmooth and round at its End, which bears againſt the Spring; for, if it ſhould have ſharp Corners or Edges, the Spring might be wounded by them, and in time might break there, being preſs'd by every Notch that turns againſt it; and, as I have computed it, a Spring undergoes One hundred thouſand of theſe Preſſures in one Day's Work; and yet, in my whole Practice, I have had only one Spring broken, and that was in drilling a large Sort of Peas with a Wheat-drill, and was occaſioned by a jagged End of the Setting-ſcrew, which was not placed perpendicular to the Spring, by which means the rough End of the Screw made Scratches againſt it a Quarter of an Inch long, and ſo deep, that the Spring broke off there: Let not this Setting-ſcrew be any longer than juſt to force the Tongue up to the Spindle; for, if it ſhould be longer, an ignorant Driller might happen, by the Force of the Screw, to break the Tongue, or its Axis; but in the Turnep-drill, which has only a Spring inſtead of a Tongue, the Setting-ſcrew may be a Thread or Two longer; becauſe the Spring will yield a little to it, after it touches the Spindle, and is ſometimes of Uſe in that reſpect, when the Notches are too large. This Screw muſt be of ſuch a Bigneſs, that it may not be in Danger of bending; for if it ſhould be bent, it could not be ſcrew'd up with any Certainty, becauſe its End, being crooked, would be below its Place at one Half-turn, and above it at the other Half-turn, and ſo the Spring might be ſet farther from the Spindle inſtead of nearer, and nearer inſtead of farther, by the Crookedneſs of the Setting-ſcrew. Its Head may be made with a Notch in it, to be ſcrew'd in with a Knife, or elſe with a Head like a T, to be turn'd with the Fingers, which I think is beſt, eſpecially for a Wheat-drill; becauſe as the Brine and Lime, which ſtick on the Wheat, grow drier, it will run fafter; and therefore the Setting-fcrew muft be frequently fcrew'd in to leffen the Seed-paffage.

The Seed-paffage, or Place of Preffure, is where the Seed paffes down betwixt the Spindle and the Tongue; and is in that Part where they are neareft together; for there the Seed is prefs'd hardeft by the Force of the Notches, which carry it down: And this Paffage is higher or lower, as the Tongue ftands nearer or farther from the Spindle; for as it ftands wider, it becomes nearer to perpendicular to the Top of the Mortife, and then the Seed-paffage is higher; and when it ftands neareft to the Spindle, then the Seed-paffage is loweft. This appears in *Fig.* 3. by the Three prick'd Lines *a n*, *a o*, and *a p*.

The Spindle, with its Notches, is beft fhewn where it is large, and made of Wood, as that of the Wheat Seed-box; it is a folid Cylinder that paffes thro', and fills the great Hole, or hollow Cylinder, of the Seed-box; it is of various Lengths, according to the Diftance its Wheels go afunder; it is always in large Boxes the Axis of Two Wheels, and turns round with them, as the Axis of the One Wheel of a Wheelbarrow does with that: Thefe Wheels, by their Circumferences, meafure out the Ground over which they carry the Seed-box, and, by the Notches in their Axis, deliver down the Seed equally, whether they move fwift or flow; becaufe an equal Number of Notchfuls of Seed will be deliver'd thro' the Seed-paffage at each Revolution of the Wheels.

The Notches refemble thofe in the Hinder-Cylinder of a Cyder-mill, which break the Apples by turning againft the Notches of the Fore-cylinder, as our Notches turn againft the Tongue; and bruife the Apples which come betwixt them, as our Notches might fometimes bruife foft Seeds, if the Tongue ftood clofe to the Notches, without any Spring behind it to give Way to their Preffure, and return the Tongue again to its Place, at every Interval betwixt Notch and Notch.

The beſt Way, that I can think of, to ſhew the making of theſe Notches, is by a Section of the Spindle at right Angles, in the Middle of the Notches, as in *Fig.* 4. of *Plate* 3. which is a Circle whoſe Circumference is cut off by Six Notches; which ſhew the different Sort of Notches, that increaſe or diminiſh the Proportion of Seed to be carried thro' the Seed-paſſage by them: The Length of the Notches we never alter; but make them always parallel to the Axis of the Spindle, and of the Length of the Diſtance there is between the lower Ends of the oppoſite *Axes tranſverſi* of the Ellipſes, or great Holes, of the Mortiſe; for if any Part of the Surface of the Spindle ſhould be betwixt the End of a Notch and the Hole, one or more Seeds coming betwixt that Surface and the Tongue, might hold it open, and prevent its preſſing againſt the Notch, to hold the Seed therein from falling without the Turning of the Wheels.

This Proportion of Seed is alter'd by the Number of Notches, and by their Depth or Breadth, or by both. *b c* is the Depth of a Notch, which we call its Side; and is that which takes hold of the Seed, and carries it down thro' the Seed-paſſage. The Manner of cutting this is ſeen by its being a Portion of the *Radius* A *c*. The Bottom of a Notch is made in different Forms *(a)*: As, firſt, it may be convex, as

(a) The convex Form is beſt for turning out a great Proportion of Seed; becauſe ſuch a Bottom may be broader than one of any other Form, in a Notch of the ſame Depth and Capacity; and ſuch a Notch, having its Capacity more in Breadth than Depth, will be leſs liable to let fall any Seed without the Turning of the Wheels, than a Notch that is deeper and narrower, except it be very narrow, which it cannot be for throwing out a large Proportion of Seed; for a great Number of Notches cannot have altogether the ſame Capacity as a leſſer Number of the ſame Depth

as is ſhewn by the curve Line *b d*. We may enlarge the Capacity of this Notch, by taking off the Convexity of its Bottom, as in the Bottom of the Notch ſhewn by the Line *e f*; and if we would increaſe it more, we make it concave, as *g h*.

But of whatever Sort or Dimenſions one Notch is made, all the reſt ſhould be the ſame exactly; and conſequently, the Interſtices (or Intervals) between Notch and Notch, of which the Line *f c*, being an Arch of the Circle, is the Breadth, muſt be equal *(a)*, and cannot be otherwiſe, if the Notches are all equal and equidiſtant, as they appear in the adjoining *Fig.* 5. which is a Section like the former, and ſhews Six Intervals, with their Six Notches, of the Size wherewith we drill St. Foin with high Wheels; but when we would drill very thin, it is better to have but Four or Five Notches inſtead of Six.

Fig. 6. ſhews a Notch of the Spindle. *a b* is the upper Edge of the Side of the Notch, being always an acute ſolid Angle. *c d* is the Edge of its Bottom, being always an obtuſe Angle. *e f* is the Angle made by the Side and Bottom, and is always ſhorter than the aforeſaid Two Edges, by reaſon of the Obliquity of the Two Ends; this Angle is never obtuſe, except when the Bottom of the Notch is concave. Theſe Three Lines muſt be parallel to the Axis of the Spindle.

Fig. 7. is one End of the afore-deſcribed Notch; the Line *a b* being joined to the Line *f d* of *Fig.* 6.

Depth may. The concave Notch, if it were as broad as the convex may be, would make the Interſtice, that is before it, liable to be broken out, and ſo Two Notches would become One; but the Convexity of the other ſupports the Interſtice like an Arch, and for that Reaſon may be made to reach almoſt quite to the Notch that is before it, without that Danger.

(a) But theſe cannot be equal, unleſs the Notches are all of equal Breadth, and equidiſtant from one another; and if they are otherwiſe, the Seed will not be equally delivered to the Ground.

and the Line *a c*, being joined to the Line *b f* in *Fig.* 6. would be the End of that Notch in its proper Poſture; and then the Line *b c*, being an Arch of the cylindrical Spindle, would be the Edge of the upper End of the Notch. *a b c*, being the Area of this End, is a Plane, and, when in its Place, makes an Angle of Forty-five Degrees with the Axis of the Spindle. The other End is the ſame with this in all reſpects, except that, being oppoſite to it, it is inclined to it in an Angle of Ninety Degrees, at the bottom Angle of the Notch, at the Line *e f* in *Fig.* 6.

Fig. 8. is a Notch lying with its Ends near it, and is of the ſame Dimenſions with thoſe appearing in the Seed-box, *Fig.* 3.

The Cover B appears with its upper Surface rightly placed in the Mortiſe, in *Fig.* 3. of *Plate* 3. where its Breadth is ſhewn to be the ſame with that of the Mortiſe; but its Shape, and other Dimenſions, are beſt ſeen in *Fig.* 3. of *Plate* 2. where *ſ t* is its Length, and reaches from the Hinder-end of the Mortiſe, to within the Tenth of an Inch of the upper End of the *Axis tranſverſus* of the Ellipſis; its greateſt Depth is from *v* to *w*, and is made ſo deep, that its Bottom, at *w*, bearing againſt the End of the Mortiſe, may prevent its Point, which is at *t*, from ſinking down to touch the Spindle, which it neither muſt do, nor be ſo high above it as to ſuffer a Seed to paſs between the Spindle and it, tho' the Seed is not apt to paſs that Way, becauſe the Notches throw it forwards from the Cover. *z* is the Hole, thro' which an Iron Screw-pin paſſes, and ſcrews into the oppoſite Sides of the Mortiſe, to hold it firm in its Place: 'Tis made ſo thin betwixt x and *y* both for Lightneſs, and that the Seed may come the more freely to the Notches, without Danger of Arching at that End. The Uſe of the *Cover* is to prevent any Seed from falling down behind the Spindle.

Fig.

Fig. 10. *Plate* 2. is the Fore-end of a Wheat Mortiſe, with its Hole A, thro' which the Setting-ſcrew is ſcrew'd, and paſſes up to the Back of the Tongue by the Line *q r* in *Fig.* 3.

Fig. 9. in *Plate* 3. is the hinder End of a Wheat Mortiſe, which by its prick'd Lines, and the Two right-angled Triangles they make, ſhews the Bevel of the Mortiſe, and alſo its Depth; it alſo ſhews the Difference of the Bevel of the Mortiſe, and that of the Tongue, *Fig.* 1. which is placed againſt it: Theſe Figures having been already demonſtrated in the Deſcription of the Turnep Mortiſe, and in theſe, I need ſay no more of it, but that I think theſe laſt-mention'd Figures ſufficient Directions for underſtanding and making the Mortiſe of a Wheat-drill.

Fig. 3. of *Plate* 3. exhibits to View a Wheat Seed-box, with its Appurtenances, ſtanding upon its Bottom; B the Braſs Cover; C the Tongue hanging upon its Axis; *c* the End of the Iron Screw that holds on the Spring, coming thro' the Tongue, and filed ſmooth with it; *a*, *a*, *a*, are Three Notches of the Spindle, with their bevel Ends; *b*, *b*, are Two Interſtices betwixt the Notches.

Hitherto we have been ſpeaking of the Parts contained in the Wheat Seed-box; let us now come to the Parts containing: As, firſt, *d e f g* is the upper Surface of the Braſs Seed-box, ſhewing the Top of the Mortiſe, and what it contains; *h h h*, and *h h h*, ſhew the Ends of the hollow Cylinder, and its Baſes coming out on each Side, farther than the Box; for if it did not project farther out than the Sides of the Box, the Surface of it would be ſo narrow, that it would cut the wooden Spindle by the Friction made between it and the Spindle; but the Surface, being of this Breadth, never wears into the Spindle, but makes it ſmooth and ſhining; *i i i*, and *i i i*, ſhew a Portion of the wooden Spindle (of an Inch and an half Diameter) coming out of the hollow Cylinder, on each Side of the Brafs Box.

The Spindle is kept from moving end-ways, by Wreaths, in the fame manner as the Axis of a Wheelbarrow is; which Wreaths fhall be defcribed together with the Hopper. *k* is the Hole by which the Fore-end of the Seed-box is held up to the Bottom of the Hopper, by a Screw and Nut. *l* is the Hole where the Hinder-end of the Box is held up, in the fame manner as the Fore-end is. *m n o p* fhew where the Two Halves of the Seed-box are joined together.

Fig. 10. fhews the Outfide of One Half of the Brafs Seed-box. A A A fhew the Thicknefs of the projecting Bafe of the hollow Cylinder, which is made the thicker, to the end that the Hole may be bored large, and made an Inch and Three Quarters Diameter, when a Spindle that is to go therein is required to be of that Bignefs, by reafon of its extraordinary Length, as it is in the Fore-hopper of the Wheat-drill. B C fhews the Thicknefs of the Ends of the Seed-box, whereby it is held up to the Bottom of the Hopper; if they are not quite a quarter of an Inch thick, they will be ftrong enough; efpecially C, which is the hindermoft, and which is never pull'd down by the Turning of the Spindle, but is rather raifed up by it.

D is the Head of the Counter-fcrew, to be turn'd by the Fingers, to prefs againft the Side of the Setting-fcrew, to keep it from turning of itfelf, when it is worn loofe.

E is the Hole for the Axis of the Tongue. F is the Hole of an Iron Screw-pin, which both holds the Cover to its Place, and alfo the Two Halves of the Box together. G is the Hole for another Screw-pin, which holds the Two Sides of the Box together. H and I are Holes for Two other Screw-pins, which likewife hold the Two Halves of the Box together, and

and are placed one above, and the other below, the Setting-ſcrew; for otherwiſe that Screw, and its Counter-ſcrew, might force open the Joining of the Box, and then the Setting-ſcrew might be looſe, and the Bevel of the Box might be altered; but theſe Screws, being one on each Side of it, prevent this Inconvenience.

Fig. 8. in *Plate* 2. is one Half of a Braſs Turnep Seed-box, lying with its Inſide uppermoſt, which ſhews the left Side of the Mortiſe, and half the Fore-end, and half the Hinder-end, of the Mortiſe, and half of each Screw-pin Hole, by which it is held up to the Bottom of the Hopper. A is half the Hole of the Setting-ſcrew, ſhewing in the Middle of it the End of the Counter-ſcrew. B is half the Hole, by which the Steel Spring-cover is held in with a Screw. All the other Holes are for the ſame Purpoſes, as have been ſhewn in the Wheat Seed-box.

Fig. 9. is the whole Turnep Seed-box, ſtanding upon its Bottom; Part of its Steel Spring-tongue appears in its Place, as alſo ſome of the Notches of the Spindle; but more eſpecially the Cover A, which differs from the Cover of the Wheat Mortiſe, this being a very thin Spring, whoſe lower End juſt reaches to touch (but not to bear upon) the Spindle at the upper End of the tranſverſe *Axes* of the Ellipſes; the Mortiſe being filed away at the End, in order that the upper End of this Spring, and the Screw which holds it, may not lie above the upper Surface of the Box. This Spring is made very weak, to the end that, if by any Chance a ſoft Seed ſhould ſtick in a Notch, and be turned round, this Spring might ſuffer it to paſs by without breaking it. B, C, are the Two Flanks or Sides, made neceſſarily of this Breadth, for bearing againſt the Wood of the Bottom of the Hopper, to prevent the Seed from falling out betwixt the Wood and the Braſs, and that the Hole in the Hopper may be broader than this narrow Mortiſe of the Seed-box. The left Flank B, being next the wide Side of the Hopper, lies all open, except on the outſide of the pricked Lines, where it is covered by the Wood of the End of the Hopper, when it is ſcrewed on to its Place; but the Flanch C, on the right Side, will be all covered by the End of the Box, that will ſtand upon it, and will reach to the pricked Line that touches the Edge of the Mortiſe. D is the End of the Setting-ſcrew, appearing in its Place with a Notch, whereby it is to be turned by a Knife; but I think it better to have an End like a T, to be turned with the Fingers. E is one End of the hollow Cylinder, which projects beyond the Flanch, that there may be more Room for the Crank to turn (without ſtriking againſt the End of the Hopper, or againſt the Flanch) on the Outſide of the Box or Hopper; and for that, the longer this Cylinder is, the better the Braſs Spindle will turn in it.

Fig. 11. is the Spring-cover, with its Hole, whereby it is ſcrewed into its Place, as it is ſeen marked A, in *Fig.* 9.

Fig. 12. is the Setting-ſcrew pointing againſt its Hole, its Head being flat, that it may be turned by the Finger and Thumb.

Fig. 13. is the Counter-ſcrew, to be turned in the ſame manner.

Fig. 5. ſhews the Braſs Spindle of the Turnep Seed-box, and the Manner of turning it againſt its Steel Tongue, or Spring; which Manner is different from that of turning the larger Spindles for Boxes of a larger Size, ſuch as the Wheat Seed-box.

This Spindle *(a)*, being but half an Inch Diameter, is too ſmall to be turned by the Two Wheels, as the

(a) I believe, if it were leſs by a Fourth or Third of its Diameter, it might be better, as being more proportionable to the Smalneſs of the Turnep-ſeed. I have had the Mortiſe much wider; but it cannot well be made much narrower, whilſt the Tongue

the larger Spindles are; not only becauſe it would be in Danger of breaking by the Weight of the Hopper, and by the Twiſting (or Wrenching) of the Wheels; but alſo becauſe it would ſoon become looſe, by wearing the hollow Cylinder thro' which it paſſes; and it would be apt to open the Braſs Flanches from the Bottom of the Hopper, whereby the Seed might run out, beſide ſeveral other Inconveniencies; all which are prevented by turning the Spindle in the manner ſhewn in this Figure; for here the Spindle never preſſes againſt the hollow Cylinder, with any greater Force than that of its own Weight, which is ſo very little, that the Friction made by it is next to nothing.

A the Spindle, exactly fitting the Bore of the hollow Cylinder; which, when it enters the ſaid Cylinder at its left End, in *Fig.* 9. will be ſtopped by the Wreath B B B; which Wreath, being circular, is caſt on the Spindle, and is Part of it; the other End of the Spindle will then appear without the right-hand End of the ſaid hollow Cylinder, at E in *Fig.* 9. and is kept there by the Wreath *Fig.* 14. which is to be put on upon the End of the Spindle, until it come to the Shoulder at *a*, which Shoulder is exactly even with the End of the hollow Cylinder; ſo that this Wreath will touch the End of the ſaid Cylinder by its whole Surface. Then, to fix in this Wreath from coming off, we make uſe of the Slider, *Fig.* 15. whoſe Two Claws A, B, being thruſt down by the Two Notches of the Spindle, at *b* and *c*, until its other Part

Tongue is of this Faſhion; for this Steel Tongue, if narrower, would either be too ſtiff, or elſe apt to break, nor would there be Room in the Mortiſe for a ſufficient Setting-ſcrew to follow it. But there is another Faſhion, wherein a narrower Braſs Tongue has a broad Spring behind it; and when it is in this Manner, the Mortiſe may be a Fourth of the Breadth of this. I have had many of theſe when I made my Boxes in Wood; but cannot deſcribe them by theſe Cuts; neither are ſuch narrow Mortiſes neceſſary, unleſs it were for drilling Tobacco ſeed, Thyme-ſeed, or ſome other Sort of an extraordinary Smalneſs.

C 2

C, which is perpendicular to its Claws, comes down to the Flat of the Spindle, and environs one half of the Hole, covering the Part of the Flat which appears of a darker Colour; and then the upper Part of C, in *Fig.* 15. makes one level Surface with the Flat D of the Spindle; and then the Iron Fork E, being ſcrewed into the Hole F, holds down the Slider faſt, ſo that it cannot riſe up; and then the Spindle, being in its Place, will run round without moving endways, being confined by theſe Wreaths.

The Spindle being thus placed, ſo that it may turn eaſily, we place the Seed-box upon its Flanches with its Bottom upwards; and then ſetting one ſharp Point of a Pair of Compaſſes, or ſome ſuch Inſtrument, upon the Spindle, within the Mortiſe, cloſe to the Edge of the Hole or Ellipſe at the End of the tranſverſe Ax, turn round the Spindle, until the ſaid Point makes a Mark round the Spindle, which will be a Circle; by the ſame means make ſuch another Mark at the oppoſite Ax; then unſcrew the Fork, and take out the Slider, pull off the Wreath, and take out the Spindle, and cut the Notches between the Two ſaid Circles and Marks; the Edges of the Ends of the Notches muſt be Arches of theſe Circles. Theſe Notches ſhould differ from thoſe already deſcribed in the Wheat-drill, in nothing but the Smalneſs of their Dimenſions; their Depth ſhould be about the Thickneſs of a Turnep-ſeed, or ſomething deeper. The Breadth of their Bottoms is uncertain, and muſt be greater or leſs according to their greater or leſs Number; but we commonly have Seven or Eight Notches, and make them about the Breadth in which they appear in this Figure; but whatever their Number be, they muſt be all equal, and ſo muſt all their Interſtices.

G is the End of a wooden Spindle, thro' which paſſes the Iron Crank H. and is faſtened to it by its Screw and Nut, at *d*; Part of which Crank enters

the

the Wood at *e*, which prevents its Turning in the Spindle.

This Crank, by its other End, paſſing thro' the Two Legs of the Fork E, and equally diſtant from the Top and Bottom of it, turns the Spindle by the Motion of the Wheel which is fixed on the other End of the wooden Spindle. If this Crank were to turn the Spindle by a ſingle Pin, inſtead of this Fork, the Seed could never be delivered out equally to the Ground; for as ſoon as the Pin began to deſcend, and decline from being perpendicular to the Horizon, it would, by its own Weight falling down, turn the Spindle half round in a Moment, and there remain with its other End downwards perpendicular to the Horizon under the Spindle, until the Crank reached it there, and ſo no Seed would be turned out by one Semicircle of the Wheel, and a double Proportion would be turned out to the Land that was meaſured by the other Semicircle; but the hinder Leg of the Fork, bearing againſt the hinder Part of the Crank, prevents this Inconvenience.

The Line *f g* is Part of the Surface of a Board, thro' which the wooden Spindle paſſes, and by which it is held in its Place; as ſhall be ſhewn hereafter.

The Axis of this wooden Spindle ought to fall into a Line with the Axis of this Braſs Spindle; but, unleſs Care be taken to prevent it, the wooden Spindle will ſo much wear the Hole thro' which it paſſes, and be worn by it, as to have Room in the Hole to deviate from this Exactneſs, and may deſcend ſo low, that the Crank may come out of the Ends of the Fork; and for this Reaſon it is, that the Fork is made ſo long as it is; but when this wooden Spindle does, by the Contrivances hereafter ſhewn, keep its Axis in a Line with the Axis of the Braſs Spindle, or very nearly ſo, then the Legs of the Fork need be no longer than half an Inch; and in that Caſe, the Joint of the Crank, which is perpendicular to the Spindle,

Spindle, muſt be ſhorter, or elſe deſcend deeper into the Wood, ſo that its End, which turns the Fork, may be in the Middle betwixt its Bottom and the End of its Legs.

The Uſe of the other End of the Spindle is this: When we have a mind that it ſhould be turned by the left Wheel inſtead of the right, we ſcrew in the Fork into the Hole I, and place a ſhort Screw in the room of the Fork, to hold down the Slider.

Note, It is not abſolutely neceſſary, that the hollow Cylinder, which appears on the Sides of the Seed-box, ſhould both, or either of them, project farther than the Flanches; but I think it better that it ſhould do ſo, at leaſt, on that Side which is next to the Fork.

This Cylinder ſhould be bored as true, and as even, as the Barrel of a Fuſil is bored: and the Edges and Surfaces of its Ends muſt be ſmooth, and without Jaggs, to the end that the Wreaths may turn glibly againſt them.

The Figure or Shape of all Sorts of Seeds diſpoſes them, more or leſs, to form an Arch, when they are preſſed from above, and confined on all Sides.

The moſt effectual Way to prevent this is, to take care, whenever many Seeds are to deſcend together by their own Gravity thro' a narrow Paſſage, that ſuch Paſſage be never narrower downwards than upwards; but, on the contrary, that it be wider downwards, on ſome or one of its Sides; in which Caſe, if the Surfaces of all the Sides of this Paſſage be ſmooth, it is impoſſible, that Seeds ſhould of themſelves form an Arch therein.

On this Maxim depends the infallible Performance of a Drill, and from hence are derived the Uſes of the Bevel of the Mortiſe: What I mean by the Word Bevel, in general, has been already defined.

The Bevel of the Mortiſe of the Seed-box is that Inclination of its Sides, whereby it is wider downwards,

wards, and narrower upwards; by which means the Seed is prevented from arching in the Mortiſe before it deſcends to the Notches of the Spindle. And this is the Firſt Uſe of our Bevel; for this Arching might happen in the Mortiſe, if the Planes of its Sides were parallel to each other; and would be unavoidable, if their Inclination were downwards, as it is upwards; but theſe Planes opening downwards, the lower the Seed deſcends, the more Room it has to expand; ſo that the very Weight, which would otherwiſe cauſe it to arch and ſtop, does by means of this Bevel force it to deſcend to the Notches, and then it is ſafe from all manner of Danger of ſtopping. The Ends of the Mortiſe are at ſuch a great Diſtance from each other, and the Cover ſo very thin, as to lie almoſt even with the upper Part of the Spindle, that the Seed can never form an Arch that way; or, if it did, the continual Motion of the Tongue would immediately break it down at the Fore-end of the Mortiſe.

The Second Uſe of this Bevel is, that it gives room for the Tongue to be in the ſame manner bevel, tho' in a leſs Degree: By this means, the Seed cannot by any Impediment be ſtopped in its oblique Deſcent to the Notches, from the Fore-end, and all that other Length of the Mortiſe, along and upon the Surface of the Tongue.

But if the Mortiſe had not this Bevel, the Tongue could not have it; for then either the upper Surface of the Tongue muſt have no Bevel at all, which would deſtroy the Two empty Triangles which ought to be on its Sides; or elſe it muſt have a Bevel the contrary Way (*i. e.* a Bevel reverſed), and be narrower downwards than upwards, which would cauſe the Seed to arch thereon, and hinder its free Deſcent to the Notches.

A Third great Uſe of this Bevel is, that, beſides the Bevel of the Tongue aforementioned, it gives place for Two empty Triangles, one on each Side the Tongue,

Tongue, which have each its vertical Angle extremely acute at the Axis of the Tongue, and have their Bafes at the Bottom of the Mortife, and of the Tongue: Thefe Triangles are alfo Bevels, which confift of the Difference, or Complement, of the Bevel of the Tongue, and that of the Mortife, the latter being about One-third greater than the former; *i. e.* One-third of the whole Bevel of the Mortife is divided between thefe Two Triangles, to each a Sixth Part; fo that if the Angle of Inclination of the Sides of the Mortife were Nine Degrees, then the vertical Angle of each of thefe empty Triangles would be of One Degree and Thirty Minutes, and Six Degrees, would be left for the Bevel of the Tongue. And thefe triangular Spaces help to fecure the free Motion of the Tongue, and free Defcent of the Seed down its Surface; becaufe they permit no Impediment to lodge in them, they being, by means of the Bevel of the Mortife, wider downwards, both obliquely and perpendicularly, fo that no Duft, nor whatever elfe happens to get in betwixt the Tongue and the Side of the Mortife, can reft there; for it will be immediately removed thence by the Motion of the Tongue, and its own Gravity, and either thrown perpendicularly down, or elfe obliquely to the Notches, and the firft Notch that takes it will carry it out at the Seed-paffage.

The Fourth Ufe of the Bevel is, that thereby the Sections of the hollow Cylinder (before defcribed) do form Ellipfes inftead of Circles; which they muft have been, if cut parallel to the Bafes of that Cylinder; and the Sections muft have been thus parallel, had the Mortife been without any Bevel.

Now the Two Semi-ellipfes, which are on the Fore-fides of their longeft Axes or Diameters, and next to the Tongue, are oppofite to, and do ftill uniformly depart from each other, even from the upper End of their faid longeft Axis, until they arrive

arrive at the lower End of the ſame Axis, which is below the Seed-paſſage, as its upper End is very near the Cover.

This Opening of theſe oppoſite Semi-ellipſes makes it impoſſible for any thing, of itſelf, to get into the remaining Parts of this hollow Cylinder, betwixt them and the ſolid Cylinder, call'd the Spindle, which turns continually therein, when the Wheels are going: For you will ſee, that if you make a Mark on the Spindle, cloſe to the Side of the Mortiſe, at the upper End of the longeſt Ax of the Ellipſe; and then turn the Spindle until this Mark come againſt the lower End of the ſame Ax; and there make another Mark on the Spindle, cloſe to the Side of the Mortiſe; and draw a Line from one Mark to the other, parallel to the Ax of the Spindle, which will be the Meaſure of that Part of the Bevel of the Diameter of the Hole; every Point in this Line will, by an intire Revolution of the Spindle, generate a Circle, which will cut the Ellipſe in Two Places, once on the Foreſide of its longeſt Axis, and once on the Back-ſide or hinder Half of it; and that all theſe Points, in this Surface of the Spindle, deſcribed by theſe Circles, will enter the Hole, by the ſaid hinder Semi-ellipſe, as the Spindle there turns upwards (as it always does); and they will all again come out on the fore Semi-ellipſe, as they deſcend towards the lower End of the ſaid Ax of the Ellipſe.

As theſe Points thus come out of the Hole, or (if I may uſe the Expreſſion) as they emerge, they oppoſe every thing that would enter the Hole, they ſtill moving from the Hole, and puſh away from it whatever they meet; nay, if any thing were in the Hole, theſe Points (whereof this Surface conſiſts) would bring it out by this Semi-ellipſe, which is always preſs'd by the Seed when the Drill is at Work; but as theſe Points immerge by the other Semi-ellipſis which is behind the Spindle, they can carry with them into the Hole nothing but Air, becaufe the Cover never fuffers any thing elfe to come there from above; and the Seed falls out of the Notches by its own Gravity, juft before it reaches the lower End of the tranfverfe Ax, being the Place where the oppofite Ellipfes are fartheft afunder; and none of it is ever carried fo far back as the hinder Semi-ellipfes; and therefore nothing can be carried into the Hole from below.

Thus that Part of the Surface of the Spindle will keep the Hole empty and clear, before ever any Notches are cut; but when the Notches are made on the Spindle, they have yet a much greater Force to drive and expel whatever would enter the Hole, their Shape being fuch as nothing can enter againft their bevel Ends; but what is at their Ends will be thrown prefently into the Mortife; infomuch that when a Spindle has been too little for the Hole by a Quarter of an Inch, that is, a fixth Part of the Diameter of the Hole, it will perform very well in drilling large Species of Seeds; and when the Mortife is run empty, nothing at all is found in the Hole, it being thus kept void and clean by the Notches.

Note, That what is here, and elfewhere, faid of the Ellipfe of the one Side of the Mortife, muft be underftood the fame of its oppofite Ellipfe, on the oppofite Side of the Mortife.

All thefe Advantages accruing from this Bevel of the Mortife, I believe that, without it, all Attempts of making a Machine to perform the Work, which this does, would have been vain.

There is alfo within the Mortife unavoidably another Bevel, which is as the Reverfe of the former, and notwithftanding is as ufeful; and this Bevel is, the Inclination which Part of the curvilineal Surface of the Spindle, beginning a little above the fore End of the fhorteft Diameter of the Ellipfes, and defcending down to the Seed-paffage, has to the lower Part of the

the Surface of the Tongue oppofite againft it. Thefe Two Surfaces meeting one another below, when the Tongue is fet up clofe to the Spindle, form a mix'd Angle, which ftops up the Seed-paffage, except when a Notch comes againft it.

When the Tongue is fet from the Spindle, to the Diftance of feveral Diameters of one of the Seeds that are to be drill'd, this revers'd Bevel caufes the Seed to arch at the Seed-paffage, and ftop there, till the Notches force it thro', which would, without this Arching, fall out by its own Gravity, without the Turning of the Wheels.

The Seed arches here the more firmly, the more it is prefs'd upon by the incumbent Seed from above it; and the former Bevel (which I call the Bevel of the Mortife) permits the incumbent Weight to prefs the harder on the Seed that is near the Seed-paffage; and this might be reckon'd a fifth Ufe of the former Bevel: For as it prevents the Seed from arching in any other Part of the Mortife, fo it does, by the fame means, caufe it to arch the more ftrongly at the Seed-paffage, which is fometimes (*viz.* when the Tongue muft be fet wide) as neceffary, as it is for it to efcape arching before it comes thither. And the more ftrongly this Arch preffes againft the Tongue, the more the Tongue by its Spring preffes againft it; and this Preffure being reciprocal and equal, the Seed cannot fall out fpontaneoufly; for when the Paffage is thus wide, if you throw into the Mortife a few Seeds, fuppofe Five or Six at a time only, they will all pafs through immediately, without any Motion of the Wheels; but if you throw in a large Quantity together, there will only a few of the lowermoft fall through, unlefs the Wheels do turn and throw them down by the Force of the Notches.

Indeed we do not care to fet the Tongue fo very wide from the Spindle, unlefs it be when we are obliged to plant a very much larger Proportion of Seed than the Notches are deſign'd for, and when we have no Opportunity of changing the Wheels for ſuch as are lower, nor of changing the Spindle for another that has greater or more Notches in it.

Four-and-twenty Gallons of large Peas are as proper a Proportion to drill on an Acre, as Six Gallons of Wheat are.

There are divers Ways to vary (*i. e.* increaſe or diminiſh) the Proportion of Seed; as, Firſt, by the Setting-ſcrew, with which we can, without any Inconveniency, ſet the Tongue ſo far from the Spindle, as to permit one Round of the Notches to turn out Four times the Quantity, as it will do when the Tongue is ſet cloſe up to the Spindle; and thus we can vary the Proportion by innumerable intermediate Degrees.

Next, if we would increaſe the Proportion yet farther, we can inlarge the Notches; but we cannot add to their Number, unleſs there be room to double it, by making a new Notch between every Two; but we cannot diminiſh the Proportion of Seed by the ſame Notches, becauſe they cannot be made leſſer or fewer.

If we would make any other Alteration in the Proportion of Seed by the Notches, it muſt be done by making another Set of them; which we may do, becauſe the wooden Spindle may have Three Rows of Notches in it, of which we may uſe either, by moveing the Wreaths and Wheels towards one End or the other of the wooden Spindle; as ſhall be ſhewn in the Deſcriptions of the Hoppers.

But as for the Braſs Spindle of the Turnep-drill, we can have but one Set of Notches in it *(a)*: And there-

(a) But by putting on a Wreath (that is a little broader than the Mortiſe) upon the Spindle (made longer for that Purpoſe) we can, by changing this Wreath from one End of the Spindle to the other, have Two ſets of Notches of different Sizes, and of different

therefore, tho' we can increaſe the Proportion of Seed by enlarging the Notches, or perhaps by doubling their

different Numbers in it: Or if we would have Three Sets, we need only make Uſe of Two ſuch Wreaths, and let the Spindle be long enough to receive them. So we may uſe which Set we pleaſe.

Tho' ſeveral Sets of Notches may be uſeful to thoſe who drill many Sorts of fine Seeds different in Magnitude in a very great Degree; yet I never found more than one Set of Notches neceſſary in this Spindle.

Nor have I uſed any more than one Set of Notches in one Mortiſe of any Sort; but in a wide Mortiſe, there may be made a double Set of Notches, conſiſting of Two Rows, all of equal Bigneſs, and half of the Length, and double the Number of a ſingle Row, one End of each Notch reaching to the Middle of the Mortiſe, and pointing againſt the End of an Interſtice, that is between Two of its oppoſite Notches.

If ever there ſhall be Occaſion for this Sort of Notches, it muſt be when a great Proportion of Seed is to be drill'd by a ſmall Spindle, and low Wheels: The Smalneſs of the Spindle may not, by a ſingle Set, admit of a ſufficient Number of Notches (of a proper Bigneſs) in its Circumference; not that a double Set, by its double Number, will throw down a greater Quantity of Seed than a ſingle Set of the ſame Width and Depth, but a leſs Quantity: But it may be feared, that a very ſmall Number of Notches might not ſpread the Seed ſo much as to cauſe it to lie even in the Chanels, one Notchful falling all to the Ground, before any of the next Notchful reaches it, which would make Chaſms or Gaps in the Row of Corn or Legumes: This, ſuch a double Number of Notches will certainly prevent.

It would ſeem, that the higher the Wheels, the more need there ſhould be for this double Set of Notches: But it appears to be otherwiſe; for the greater Diſtance the Seed has to fall, the more it ſpreads, and ſtrikes oftener againſt the Funnel and Trunk; and by that means a Notch from high Wheels will, with the ſame Quantity of Seed, ſupply a greater Length of the Chanel (or Furrow) than a Notch will from low Wheels.

In all my Practice I never had any Occaſion for ſuch a double Set of Notches, either with high or low Wheels, or even when I drilled into open Chanels, without Funnels or Trunks to my Drill-plough; and yet my Rows of St. Foin, and of Corn, were always free from Gaps, being equally ſupply'd with Seed from one End to the other.

If ever there is Occaſion for more than a ſingle Set, it muſt be for Beans, for which alſo I think a large Spindle is better than a

 double

their Number; yet we cannot leſſen the Proportion of Seed by the Notches, unleſs we have a new Set of them, and that will occaſion a Neceſſity of having another Spindle; but, as to the Setting-ſcrew of the Turnep-drill, it will increaſe the Proportion of Seed with the ſame Notches, much more than the Setting-ſcrew of the Wheat-drill will do.

The other Way of varying the Proportion of Seed in the ſame Boxes, is by the Diameter of the Wheels, when we can alter them; for Wheels, of what Diameter ſoever they are, muſt turn round all the Notches at one Revolution; ſo that Wheels of Twenty Inches Diameter will deliver out a third Part more Seed than Wheels of Thirty Inches Diameter, into the ſame Length of the Chanels; but we ſeldom have any Occaſion to alter the Wheels, unleſs it be on account of planting a Species of Seed of a different Magnitude, as the largeſt Sort of Peas, and ſmall-grain'd Wheat, or St. Foin Seed are.

Theſe are all the Ways we have to alter the Proportion of Seed, we drill with the ſame Seed-boxes;

double Set of Notches in a ſmall one one. The largeſt Spindle I have known made, is of Two Inches and an half Diameter, and that only for Horſe-Beans.

The beſt Sort of Notches for a double Set are thoſe which have convex Bottoms; becauſe ſuch are leſs liable to drop their Seeds without the turning of the Wheels, than any other Sort: And a double Set muſt be in greater Danger of this, as the Tongue is always hindered from preſſing ſo cloſely againſt any Notch, being held open by the Seeds on the oppoſite Interſtice; which is contrary to a ſingle Set, where no Seed can lodge at either End of a Notch, to hold open the Tongue, or hinder its preſſing againſt it.

Note, When I made my Boxes of Wood, I had double Boxes, with a Partition between ſuch a double Set of Notches; but never made ſuch in Braſs, not knowing whether that Partition, by its Thinneſs of hard Metal, might not cut the Spindle: Yet I never found any Occaſion for a double Row of Notches. I made thoſe double Boxes only for drilling Two Sorts of Seeds at once into the ſame Chanel.

theſe

5

these Two Sizes, already described, being sufficient for all Sorts of Corn and Seeds which we commonly sow, from Marrow-peas to Turnep-seed; but, for drilling of Beans, the Boxes must be larger, and are commonly made of Wood, the Spindle Two Inches Diameter, or more, and the Boxes Two Inches wide: Where note, That this Increasing of the Width of the Mortise, from an Inch and an half, to Two Inches, increases the Quantity of Seed to almost double; because this Half Inch is all added to the Middle of the Notches, where they are deeper than their Ends; the Bevel of which takes up a considerable Part of the Length of the Notches. For Beans, they also contrive to have their Wheels as low as conveniently they can. These Wooden Drills are now become common in many Places.

The Wooden and Brass Seed-boxes differ not in any of the most essential Parts of them; only the Wooden Box must be thicker, as the Wood is not so strong as Brass; the Spring is made strait instead of crooked; and, being let into the Back of the Wooden Tongue, bears against it at each End; and the Chanel, into which it is placed, being made hollow in the Middle, the Spring has its Play there, and must be stiffer and have a little more Play in the Bean-drill, than in any lesser Seed-box.

I, at first, made all my Seed-boxes of dry Box-tree Wood, which performed very well, and are still used: But, a few Years ago, a Gentleman advised me to make them in Brass; the doing of which has put me to a great deal of Trouble and Expence, for want of understanding the Founder's Art: Yet this I do not repent, because they are, in some respect, better than those made in Wood; especially to those who do not well understand their Fabric; for, to such, the Swelling and Shrinking of the Wood was inconvenient in small Boxes: And I now am told, that they are cast in *London* of the best Brass, at the Price of One

Shilling *per* Pound, and ſo ſmooth as to require very little filing. And theſe Braſs Boxes being alſo more laſting than Wood, and not much more expenſive, when Workmen know how to make them, I think it not worth while to give any particular Directions for making them in Wood.

As to the Spindles of the Turnep-boxes, I have often made them with a mix'd Metal, of half Pewter, and half Spelter, which perform very well, and are eaſily made; becauſe this Metal will melt, almoſt as ſoon as Lead, in a Fire-ſhovel, to be caſt in a Mould; but Braſs will not melt without a Crucible.

The firſt Idea that I form'd of this Machine, was thus: I imagin'd the Mortiſe, or Groove, brought from the Sound-board of an Organ, together with the Tongue and Spring, all of them much alter'd; the Mortiſe having an Hole therein, and put on upon one of the Iron Gudgeons of the Wheelbarrow; which Gudgeon being enlarg'd to an Inch and an half Diameter, having on it the Notches of the Cylinder of a Cyder-mill, on that Part of it which ſhould be within the Mortiſe, and this Mortiſe made in the Ear of the Wheelbarrow (thro' which the Gudgeon uſually paſſes), made broad enough for the Purpoſe; this I hoped, for any thing I ſaw to the contrary, might perform this Work of Drilling; and herein I was not deceived.

As for placing a Box over this Mortiſe to carry a ſufficient Quantity of Seed, it was a thing ſo obvious, that it occaſion'd very little Thought; and an Inſtrument for making the Chanels, not much more; neither for applying Two Wheels, one at each End of the Axis, inſtead of the ſingle Wheel in the Middle of the Axis of the Wheelbarrow.

At firſt my Plough made open Chanels, and was very rude, being compoſed of Four rough Pieces of Planks, of little Value, held together by Three Shoots, or Pieces of Wood, which held them at a Foot Di-

ſtance

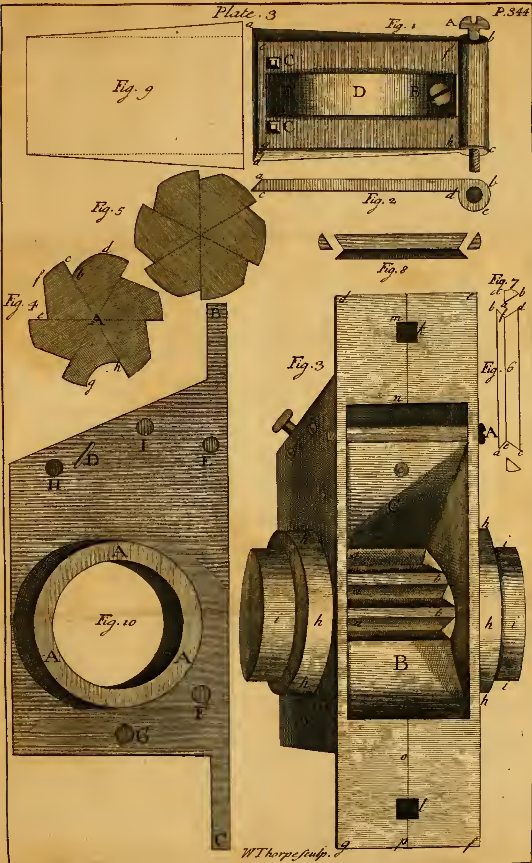


Fig. 1
Fig. 2
Fig. 3
Fig. 4
Fig. 5
Fig. 6
Fig. 7
Fig. 8
Fig. 9
Fig. 10
W Thorpe sculp.

ſtance one from the other: Theſe Pieces, being cut ſharp at Bottom, made the Chanels tolerably well in fine Ground. But I ſoon contrived a Plough with Four Iron Shares, to make Chanels in any Ground: This drew a Hopper after it, having Four Seed-boxes at its Bottom, carried on a Spindle by Two low Wheels, which had Liberty to riſe and ſink by the Clods that they paſs'd over: The Seed-boxes delivered their Seed immediately into the open Chanels.

This Plough and Hopper were drawn by an Horſe, and the Seed, lying open in the Chanels, was covered ſometimes by a very light Harrow, and ſometimes by an Hurdle ſtuck with Buſhes underneath it.

I ſoon improv'd this Plough to perform better, and to make Six Chanels at once, and ſometimes a great many more.

This Plough and Hopper, with their Improvements and Alterations, are ſhewn in *Plates* 4. and 5.

CHAP. XXI.

Of the *Wheat-Drill.*

FIG. 1. in *Plate* 4. is the Drill-plough, which makes the Chanels for a treble Row of Wheat, at Seven-inch Partitions, and covers the Seed by the Harrow which moves on its Beams. A, is the Plank, Three Feet and an half long, Eight Inches and an half broad, one Inch and a quarter thick; its upper and under Surfaces are true Planes. B, B, the Two Beams, each Two Feet Four Inches long, Two Inches Three quarters broad, and Two Inches and a quarter deep, ſtanding under the Plank at right Angles with it, and held up to it by the Four Screws and Nuts *a*, *a*, *a*, *a*, the one being at the ſame Diſtance from the

the right, as the other is from the left End of the Plank.

This Plough makes its Chanels by Three Sheats, and their Shares and Trunks; the Firſt or Foremoſt of which Sheats ſtands under the Middle of the Plank, with Part of it appearing at *b*; and is fully deſcrib'd in *Fig.* 2, where A is the Tenon, of a convenient Size, Two Inches broad between Shoulder and Shoulder, Three quarters of an Inch thick: It is driven into the Plank thro' a Mortiſe, and pinn'd up by its Hole: It ſtands thus obliquely, and pointing forwards, that it may ſtand the more out of the Way of the Funnel. The Shoulder at *a* is a quarter of an Inch. The hinder Shoulder, from the Tenon to the Angle at *b*, is Three quarters of an Inch. The Depth of the Back of the Sheat, and Thickneſs of the Share, when it is on, from *b* to *c*, is Nine Inches and a quarter; and the Angle at *c* muſt be a right Angle, contrary to the Opinion of ſome, who fanſy it ought to be acute, ſuppoſing that when this Angle is right, whilſt the Seed is deſcending by the Back of the Sheat, the Plough, as it moves forwards, would get before the Seed, and ſo it might fall to the Ground behind the Trunk; but this Miſtake is for want of conſidering the vaſt Diſproportion between the Celerity of the Seed's deſcending near the Earth, and the ſlow Progreſs of the Plough; the Seed deſcending at the Rate of Sixteen Feet in a Second of Time, and the Plough proceeding but about Three Miles an Hour, does not advance the Thickneſs of a Seed, whilſt it is falling to the Gtound by the whole Depth of the Sheat.

The Thickneſs of the Sheat is an Inch, at its upper Part. The reſt of it is to be no thicker than the Breadth of the Share.

Fig. 3. is the Share, lying Bottom upwards. *a* is its Point. *b* the Socket, Three Inches long, Seven Sixteenths of an Inch broad. *c* is the Hole, by which it is faſtened up to the Sheat. *d* is another Hole, which is never made uſe of, except when the Share, being

being faſten'd up by the other Hole, inclines to either Side; then we draw it right by a Nail driven into this Hole. *e*, *e*, are Two very ſmall Notches, into which the Sides of the Trunk are jointed, to protect them from being torn out by the Earth or Stones that might rub againſt them. *f* is the Tail of the Share, which, when it is in its Place, will make the right Angle before deſcribed in *Fig.* 2. and from which Tail, to the Fore-part of the Socket, is the Length of the Bottom of the Sheat, *viz.* Six Inches and an half. The Breadth of the Share Three quarters of an Inch.

Fig. 4. ſhews one Side of the Share. The prick'd Line *a e* ſhews the Bevel of the Fore-end of the Socket, the upper Edge of which muſt bear upon the Fore-part of the Sheat below *f* in *Fig.* 2. and the other Part of the Share will bear againſt the Bottom of the Sheat, from *d* to *c*, and will be faſtened up by a flat Nail, paſſing thro' the foremoſt Hole of the Share, and entering the Hole *g* in the Sheat; which Nail being bended in the ſaid Hole (which Hole ſhould be at leaſt an Inch Diameter) will hold the Share faſt to the Sheat; and, by unbending this Nail, the Share may be eaſily taken off, upon Occaſion, without damaging the Sheat. *Note*, This Hole in the Share ought to be wider below than above, and the Head of the Nail of the ſame Shape; or elſe, as the Share wears thinner, it might come off. The prick'd Line, near the Fore-part of the Sheat, ſhews where a Shoulder muſt be cut on each Side of it, becauſe otherwiſe the Sheat, being thicker than the Breadth of the Socket of the Share, could not enter it: But take care, that the Share do not bear againſt theſe Shoulders.

Fig. 5. is one Side of the Trunk, being a thin Plate of Iron, and is often made of the Blade of an old Scythe: It is to be riveted on to one Side of the Sheat, to another of the ſame on the oppoſite Side, by Three Rivets paſſing thro' them both, with the Sheat in the Middle of them; which Holes appear

both

both in the Plate and in the Sheat. Theſe thus riveted on do form the Trunk at the Back of the Sheat. The whole Breadth of this Plate is an Inch and Three quarters; but Three-eighths of an Inch being riveted on to the Sheat, there remains but an Inch and Three-eighths for the Trunk. The Length of the Plate is the ſame with the Depth of the Sheat and Share, except that it ſhould not reach to the Bottom of the Share, by about the Thickneſs of a Barley-corn, to the end that it may not bear againſt the Ground, as the Share doth. The Notch at the Bottom of the Plate is that which anſwers the Notch in the Tail of the Share: The Corner of the Plate at *a* we make a little roundiſh, that it may not wear againſt the Ground.

This Plate thus riveted on the Sheat, and another of the ſame Form on the other Side oppoſite to it, compoſe the Trunk, which is *Fig.* 6. *a d* is the Edge *a b* of the Plate *Fig.* 5. *b c* is the like Edge of the oppoſite Side of the Trunk. A is the Back of the Sheat, which, together with the Tail of the Share when in its Place, makes the Fore-part or Length of the Trunk. The Thickneſs of this Back of the Sheat is the Width of the Trunk; and from this Back of the Sheat to the ſaid Edges of the Plates, may be call'd the Depth of the Trunk. The upper Ends of theſe Two Plates *a* and *b* we ſpread open a quarter of an Inch wider, for half an Inch down, than the reſt of the Trunk, for the more free Reception of the Seed from the Hole of the Funnel: We likewiſe take care, that the Two lower hinder Concerns of the Trunk do not incline to one another, to make the Trunk narrower than the Back of the Sheat, leſt the Earth ſhould be held in by them, and fill the Bottom of the Trunk.

Fig. 7. is one of the hinder Sheats, and appears, in part, at *c* in *Fig.* 1. It is faſtened into one of the Beams by its Tenon, which, being driven into a Mortiſe, is pinn'd in by a Pin paſſing thro' the Beam, and the

the Tenon cut off even with the upper Surface of the Beam: This Tenon ſtands more oblique than that of the fore Sheat, that there may be the more Wood between its Mortiſe and the Funnel, its hinder Shoulder being ſhort: Its fore Shoulder at *a* muſt be very ſhort, not above the Eighth of an Inch; but its Shoulder *b* Three quarters of an Inch. The Tenon is alſo ſhoulder'd on each Side, as well as before and behind. The Thickneſs of this Sheat ſhould be greater than that of the Fore-ſheat, becauſe it is much narrower. The Depth of this Sheat, is leſs than the Fore-ſheat, by the Depth of the Beam: It is, in all other reſpects, the ſame with the Fore-ſheat, except that it and its Share are ſhorter. The Socket of this Share is but an Inch and One-eighth long, its Breadth half an Inch, and from the Fore-part of the Bottom of the Socket to the End of its Tail, but three Inches. Its Point from the Socket at Bottom is but Three quarters of an Inch, whereas the Point of the Fore-ſhare is an Inch and Three quarters: There is but one Hole whereby the Share is faſtened up to the Sheat. Its Trunk is no wider than the other; for we cut a Rabbet on each Side of the Sheat, that the Plates, which are the Sides of the Trunk, may come within Three quarters of an Inch of one another. Its Tenon, being narrower than the Tenon of the Fore-ſheat, muſt be thicker than it.

The other Hinder-ſheat, and all its Accoutrements, muſt be the ſame as this of *Fig.* 7.

The Workman muſt take care, that the Tenons of the Sheats be not made croſs the Grain of the Wood; and therefore muſt make them of crooked Timber.

Fig. 8. ſhews how the Share is made of Four Pieces; of which *a* is a Piece of Steel for the Point, its larger End being cut bevel for the Shape of the Fore-end of the Socket. *b* is a Piece of Iron for the other End of the Share, from the Socket to the Tail: The other Two Pieces *c* and *d* are the Iron Sides, which, being welded

welded on to the other Two Pieces, and cut off to the Length, form the Share, with its Socket, more exact than it can be made out of one Piece of Iron.

Now we return to the firſt Figure; where the Fore-ſheat being fix'd up at equal Diſtance from each End of the Plank, and as near to the hinder Edges of it as can be, allowing room for the Funnel C to ſtand with the Fore-ſide of its Hole, to make one Surface with the Back of the Sheat, and for the hinder Part of the Trunk not to reach the Edge of the Plank, there muſt be alſo room for the Fore-ſtandard D to ſtand perpendicular to the Plank, acroſs the Tenon of the Sheat.

This Standard being cloſe to the Fore-ſide of the fore Hopper, there muſt be ſo much room between it and the Hole of the Funnel, that the Seed may drop from the Seed-box into the Middle of this Hole. Thus much for placing the Fore-ſheat.

Next, for the Two hinder Sheats; they muſt be placed at equal Diſtance from the Sides of the Beams, and ſo near to the hinder Ends of the Beams, that there may be room to make the Funnels in them, and their Tenons to come up between their reſpective Funnels E and F, and their reſpective Standards G and H, which Standards muſt be ſet perpendicular to the Beams.

The Diſtance of theſe Sheats from the Plank muſt be ſuch, that the Wheels of the hinder Hopper may not ſtrike againſt the Plank, nor againſt the Spindle of the fore Hopper; and the Semidiameters of theſe Wheels being Eleven Inches, there ought to be a Foot between the Centre of each Wheel and the Plank; but we ſometimes cut Notches in the Plank, to prevent the Circle of the Wheels from coming too near the Plank.

For the nearer the hinder Sheats ſtand to the Plank, the better; but theſe Beams may be placed nearer to, or farther from the Plank, by their Screws and Nuts, at Pleaſure.

Theſe

Theſe Beams muſt be ſet at ſuch a Diſtance from one another, that the Shares may be Fifteen Inches aſunder from the Inſide of one to the Outſide of the other.

To try whether all theſe Sheats and Shares are truly placed, ſet the Plough upon a level Surface; and then, if they be right, the Fore-ſhare will touch the Surface by its Point and Tail, and likewiſe the hinder Sheats will do the ſame; except that ſome Workmen will have it, that the Plough goes better, when the Tails of the hinder Sheats are a Barley-corn's Thickneſs higher than their Points; and then their Tails will want ſo much of touching the Surface.

The Shares muſt be all of them parallel to the Beams, and conſequently to one another.

The Chanel made by the fore Share and Sheat for the middle Row, being at equal Diſtance between the Two hinder Sheats, is cover'd by them, they raiſing the Mould over the Seed from each Side of this Chanel.

The Harrow I is drawn by the Beams, to which it is faſtened to their Inſides at *d* and *e*, having each a ſmall Iron Pin, paſſing thro' each End of the Legs of the Harrow, and thro' the Beams; each having a Nut on the Outſides of the Beams, and being ſquare in the Beams, that they may not turn therein to looſen their Nuts; but are round near their Heads, that the Harrow may eaſily move thereon.

The round Ends of the Legs of the Harrow are put thro' its Head I, at the round Holes *f* and *g*; and pinned in behind it, to the end that either Tine of the Harrow may deſcend at the ſame time that the other riſes, where the Ground is uneven.

The Two wooden Tines K and L are pinned in above the Head, and have each of them a Shoulder underneath. They ſtand ſloping; ſo that if they take hold of any Clods, they do not drive them before them, but riſe over them. They are of a convenient Length,

Length, to give room for the Harrow to ſink and riſe, without raiſing up the Shares; and to give them the more room to move: The Legs of the Harrow are crook'd downwards in the Middle.

The Diſtance of theſe Tines from each other is Twenty-two Inches; ſo that each Tine going Three Inches and an half on the Outſide of each Chanel that is next it, fills it up with Earth upon the Seed, from the Outſides of it; which cauſes the Rows to come up ſomething nearer the inner Sides of the Chanels, than to the outer Sides, from whence the Earth is brought into them by the Tines; and the Two outer Rows by this means come up at Fourteen Inches aſunder, tho' the Chanels were Fifteen Inches aſunder.

This way of covering adds more Mould to the Top of a Ridge; whereas, if the Chanels were covered by Tines going within or between them, the Mould would be thrown down from the Top of the Ridge: And theſe Tines ſtand with their Edges and Points inclining outwards, by which means they bring in the more Earth to the Chanels.

If we find, that the Harrow is too light, we tie a Stone upon it, to make it heavier; and ſometimes we fix a ſmall Box of Board on the Middle of it, to hold Clods of Earth for that Purpoſe.

The fore Funnel C has its upper Edges Two Inches high above the Surface of the Plank. It is Five Inches Square at Top; its Four oppoſite Sides being Planes equally inclin'd to each other downwards, until they end at the Hole in the Bottom of the Funnel, which Hole is continued quite thro' the Plank into the Trunk. The Shape of this Hole is ſhewn in *Fig.* 9. where the Four Lines *a b*, *b c*, *c d*, and *d a*, each Line being Three quarters of an Inch, make a true Square, and are the upper Edges of the Hole. The Three prick'd Lines *e f*, *f g*, and *g h*, being each of them longer than the former, tho' as little as poſſible, make the Three lower Edges of the Hole; which being

ing thus wider below than above, and having all its Sides true Planes and ſmooth, it is impoſſible for the Seed to arch therein. The fore Side of this Hole is perpendicular to the upper and lower Surfaces of the Plank, and, together with the Back of the Sheat, makes one Plane Surface.

When we drill a large Species of Seed, as Peas or Oats, we can make this Hole a full Inch ſquare at Top, and of the ſame Shape wider at Bottom; which tho' it be wider than the Trunk, except at its Top, the Seed will not arch there, becauſe there is room behind, the Plates being broader than the Sides of the Hole; for there can be no Arching in the Trunk, unleſs the Seed were confin'd behind as well as on each Side.

The Holes of our Funnels ought to be of the ſame Shape with this deſcribed; tho', as I am inform'd, the Pretenders to the making of this Plough make the Holes of their Funnels the Reverſe of this; which being wrong-way upwards, the Seed is apt to arch in them, except the Holes are very large.

Of this Plough, *Fig.* 1. the Two hinder Funnels E and F differ from the fore Funnel (which has been deſcribed), firſt, in Dimenſions; theſe not being ſo deep, becauſe they being made in the very Beams, their upper Edges are in the upper Surface of the Beams, and their Holes at the Bottom, being about the Eighth of an Inch deep. The Depth of the Funnels muſt want the Eighth of an Inch of the Thickneſs of the Beams; but we make each Funnel an Inch and a quarter broader at Top than its Beam, by adding a Piece of Wood to each Side of its Beam, which reaches down about half-way its Thickneſs; and theſe Pieces being firmly fix'd on by Nails, to the Sides of each Beam, the Legs of the Harrow take hold of theſe Pieces, which are in the Inſide of theſe Beams. When the Plough is taken up to be turn'd, the Man who turns it takes hold of the

Head of the Harrow with one Hand, and lays the other upon the Hopper, or Spindle, to keep it level, and to prevent either of the fore Wheels from ſtriking againſt the Ground, whilſt the Plough is turning round.

Another Difference there is between the Shape of theſe hinder Funnels from that of the former, to wit, That each fore Side of the hinder Trunks muſt not be quite ſo oblique as the reſt; becauſe then the upper Edge of theſe fore Sides might be too near the Tenons of the Sheats, and there might not be ſufficient Wood betwixt them, to prevent the Sheats from being torn out; a thing which has never happen'd, that I know of. We ſometimes make theſe hinder Funnels of a roundiſh Shape, like a Cone inverted; except that the Part which is next the Sheat, is not ſo oblique as the reſt, for the Reaſon already given.

The only Advantage propoſed by this roundiſh Shape is, that there is leſs Wood taken out than from the ſquare Corners, and therefore more Wood for the added Pieces to be faſtened to the Beams, than in the ſquare Funnels.

M and N are Two Pieces of Wood, each Eleven Inches long, Two Inches broad, and Two Inches thick: Theſe are ſcrew'd on near each End of the Plank, by Two Screws and Nuts each: They ſtand parallel to the other Beams, and have each a double Standard or Fork, O and P, in them, perpendicular to the Plank; by which Standards the fore Hopper is drawn and guided, in the manner as is ſeen in *Fig.* 21.

Theſe Standards ought to be braced (or ſpurr'd) before and behind, and on their Outſides; they never being preſs'd inwards, have no occaſion of Braces there: Theſe are to be ſo placed, that when the Spindle is in their Forks, it may be exactly over the Hole of the Funnel, ſo that the Seed may drop into the Middle of it, when the Plough ſtands upon an horizontal

Surface, the Spindle being alſo exactly parallel to the fore Edge of the Plank.

Fig. 10. is D in the Plough *Fig.* 1. It is Two Feet long, Two Inches broad in its narroweſt Part, and half an Inch thick in the thinneſt Part, and Two Inches at its Shoulders above the Plank. It is pinn'd thro' the Plank before the Funnel, having one of its Legs on each Side the Tenon of the Sheat: It ſtands perpendicular to the Plank: Its only Uſe is to hold the fore Hopper from turning upon the Spindle, being put thro' a thing (*Fig.* 22.) like the Carrier of a Latch, nail'd on to the upper Part of the fore Side of the fore Hopper, in which thing this Standard has room to play, or move ſide-ways, to the end that either Wheel may riſe up.

Fig. 11. is one of the hinder Standards, which being placed in the Beam, as G or H, perpendicular to it, is driven into a Mortiſe, and pinn'd into the Beam. It has a Shoulder behind, and another before, and a Third on its Outſide; which Shoulders ſerve inſtead of Braces, to keep it from moving backwards, forwards, or outwards: It is Two Feet Four Inches long, Two Inches broad, and an Inch thick: It is placed with its broad or flat Sides towards the Sides of the Beams. It is made ſo thin, becauſe it ſhould have the more room for the Hopper to play on it; and therefore muſt have its Strength in its Breadth. The Part at *a* muſt ſtand foremoſt.

The Standards G and H are both alike, except as they are oppoſite: Their Uſe is to draw, guide, and hold up the hinder Hopper: They are to be placed perpendicular to the Beams, and at equal Diſtance from each Side of thoſe Beams, and at ſuch a Diſtance before the Funnels, that when the fore Side of the Hopper by its whole Length bears againſt the hinder Surface of the Standards, the Seed may drop into the Middle of both Funnels, the Plough ſtanding upon an horizontal Surface.

Be ſure to take care, that the Sheats, Funnels, and Standards, be ſo placed, that the Spindle of the Hopper may be at right Angles with the Beams.

Q and R Part of the Limbers, which are alſo called Shafts, Sharps, and Thills; from whence the Horſe that goes in them is call'd a Thiller. Theſe Limbers are ſcrew'd down to the Plank, by Two Screws and Nuts each. The Limbers are kept at their due Diſtance by the Bar S; near each End of which Bar, there is a Staple with a Crook underneath each Limber, to which is hitch'd, or faſtened, a Link of each Trace, for drawing the Plough. This Bar is parallel to the Plank, and Seven Inches and an half before its fore Edge.

The Limbers muſt be mounted higher or lower at their fore Ends, according to the Height of the Horſe that draws in them; and this may be done by the Screws that hold them to the Plank, and by cutting away the Wood at the Two hinder Screws, or at the Two foremoſt Screws, or by Wedges.

Every Workman knows how to team the Limbers; that is, to place them ſo on the Plank, that the Path of the Horſe, which goes in the Middle betwixt them, may be parallel to all the Shares, and ſo that a Line, drawn in the Middle of this Path, might fall into a ſtrait Line with the fore Share, ſtanding on the ſame even Surface with the Path; for otherwiſe the Plough will not follow directly after the Horſe, but will incline to one Side.

The Uſe of the Trunks of this Plough is for makeing the Chanels narrow, of whatſoever Depth they are: But, without Trunks, the Chanels muſt be made wide by Ground-wriſts, which ſpread the Sides of the Chanels wide aſunder, to the end that they may lie open for receiving of the Seed; and the deeper they are, the wider they muſt be: By this Width of a Chanel, the Seed in it is with more Difficulty cover'd, and the Chanel fill'd with the largeſt Clods, and the

Seed

Seed comes up of a great Breadth, perhaps Three or Four Inches wide, ſo that the Weeds coming therein are hard to be gotten out.

To avoid theſe Inconveniences of wide Chanels, I contrived Trunks like thoſe deſcribed, except that they were but Five or Six Inches high; and the Tops of their Plates, bending outwards from each other, form'd Two Sides of a Funnel; and the Wood between the Two Plates, being cut bevel at the Top, was as the fore Side of a Funnel to this Trunk: It was open behind from Top to Bottom: The Wheels were low, and the Seed-boxes narrow: The Seed in theſe Chanels was eaſily cover'd, eſpecially thoſe Sorts which were ſown in dry Weather; for then the fineſt Mould would run in, and cover the Seed, as ſoon as the Trunks were paſt it.

The Seed in ſuch a narrow Chanel comes up in a Line, where the Row not being above a Quarter of an Inch broad, ſcarce any Weeds come in it; and when the Weather is dry, the Earth of the Chanel not lying open to be dry'd, the Seed comes up the ſooner.

I had Two Reaſons for making of theſe Trunks higher, as they are now uſed: The one was, to avoid the too great Length of the Shares; and my other Reaſon was, that with thoſe low Trunks, and long Shares, there could not be Two Ranks of Shares, and their Hoppers in the Plough, which are neceſſary for making very narrow Partitions, and abſolutely neceſſary for planting this treble Row of Wheat; for if Three Shares for making the Seven-inch Partitions were placed in one Rank, the Mould (which is always moiſt or wet, when we plant Wheat) would be driven before the Shares, there not being room for it to paſs betwixt them.

Fig. 12. is one End of the hinder Hopper laid open. I call it one End (altho' it be an intire Box by itſelf) becauſe this Hopper is ſuppoſed to have its middle Part cut out, to have a clearer Sight of the

Plough, and fore Hopper; as is ſeen in *Fig.* 15. which is the whole Hopper in Two Parts. In this *Fig.* 12, A is the Inſide of one End of the Hopper, made with ſeveral Pieces of half-inch Elm-board nail'd on to the Poſt *c a*, on the fore Side; which Poſt is a little more than half an Inch ſquare, and Seventeen Inches and Three quarters long, being the Depth of that Part of the Hopper which holds the Seed. B is the fore Side of this Hopper; which muſt be nail'd on to the ſaid Poſt, being of the ſame Length with it, and Four Inches broad, and half an Inch thick; and this is the Part which on its Outſide goes againſt the right-hand Standard of the Plough, when it is at Work. The other Poſt *b d*, of the ſame Thickneſs with the former, is nail'd in within half an Inch of the oppoſite Edge of this End; to which Poſt alſo C being nail'd, makes the hinder Side of this Part of the Hopper. C is Four Inches broad, and half an Inch thick; and both it, and the Poſt to which it is to be nail'd, are ſomething longer than its oppoſite Side, becauſe the Side B makes right Angles with the Top and Bottom of the Hopper; but the hinder Side C makes oblique Angles with the Top and Bottom of the Hopper; and the Reaſon of this is, becauſe when the Hopper is full of Seed, it may be equally pois'd on the Spindle; which it could not be without this Bevel, unleſs the Bottom of the Hopper did come as much behind the Spindle as before it; and that would hinder the Perſon that follows the Drill, from ſeeing the Seed fall out of the Seed-box into the Funnel; and that Part of the Bottom which is before the Spindle cannot be made ſhorter, becauſe that Part of the Seed-box which is before the Spindle, is (upon account of its Tongue) much longer than the Part of it which is behind the Spindle. 'Tis true that when the Hopper is empty of Seed, it cannot be thus pois'd; but then, being ſo light, it does not require it. *e f g h* is a Piece of a Board, nail'd on to that Part of the End

A,

A, which is below the Bottom of the Cavity which holds the Seed, and is commonly plac'd a little croſs the Grain of the Board to which it is nail'd, and ſerves to ſtrengthen it, and keeps the Hole *i* from ſplitting. The upper Edge *e f* of this added Piece of Board is exactly the Length of the Bottom of the Hopper, whereto the Braſs Seed-box is faſtened; and this Bottom, together with its Seed-box under it, being put into its Place, bears upon this Piece from *e* to *f*, which holds up the right Side of the Bottom, and keeps it from ſinking downwards; as the lower Ends of the Two mention'd Poſts, and the fore and hinder Side B and C nail'd to them, prevent its riſing upwards.

The Manner of making the Hole *i* is as follows: Place the Seed-box with its fore End at *e*, and hinder End at *f*, with the Baſe of its Cylinder (or great Hole) againſt this added Piece of Board, and its upper Edge exactly the Height of the Edge *e f*; then, with a Pair of Compaſſes put thro' the Cylinder of the Seed-box, mark round the inner Edge of its Baſe upon the added Board; then take off the Seed-box, and find the Centre of the mark'd Circle; and then with a Tool call'd a Centre-bit, of the right Size, bore the Hole quite thro' the double Board; and this Hole will be in the right Place, and of the ſame Diameter with the Spindle; but in caſe there is to be a Braſs Wreath on that Part of the Spindle which is to turn in this Hole, then the Hole muſt be bor'd of the ſame Diameter with that Part of the Wreath which is to enter it; and that may be perhaps near a quarter of an Inch longer than the Diameter of the Spindle, upon which it is faſtened.

This End A, thus bor'd and ſhap'd, is a Pattern for its Oppoſite, and for the other Two Oppoſites of the other Cavity, which holds the Seed at the other End of the Hopper.

When the Oppoſite of A (with the Two Poſts whereto the fore Side B, and the hinder Side C, are nail'd, and having a like Piece of Board in its lower Part with a like Hole in it) is added, and when the Bottom (Four Inches broad), with its Seed-box under it, is thruſt in at *f* by the prick'd Lines, until it reach *e*, bearing on one Side upon the Piece of Board *e f g h*, and the other Edge of the Bottom bearing in like manner upon the oppoſite Piece, then this Cavity of the Hopper, which will contain about Two Gallons of Seeds, will be finiſh'd.

Note, The Bottom muſt make a right Angle with the Two fore Poſts, having the Side B perpendicular to it.

D is a Part of the Board which comes out farther than the Hopper, in order to hold a Bar at *k*; which being faſtened there, and in like manner to the Oppoſite of this Board, this Bar bearing againſt the fore Part of the Standard, the Hopper and its Wheels are in part drawn by it.

Into the Notch *l* is faſtened one End of a long Bar, which paſſes the whole Length of the Hopper, and holds the upper Part of its Two Cavities in their Places, as is ſeen mark'd D, in *Fig.* 15.

E is Part of the Board which comes before the Hopper, and whereto one End of a Piece of Wood is faſtened by Nails or Screws, which bearing againſt the fore Part of the Standard, and againſt its Inſide, the Hopper is in part drawn and guided by it, as ſhall be ſhewn in *Fig.* 15.

Fig. 13. ſhews the Outſide of the Figure laſt deſcrib'd. A is the Standard by which this End of the Hopper is drawn, in the manner as it is here placed. B is one End of the Spindle paſſing thro' the Hopper and Seed-box. C the Bottom, having the Seed-box faſtened on to it, with one Screw before, and another behind, with their Nuts underneath, and the Heads of their Screws very thin, and the Pins ſquare at Top,

Top, that they may not turn in the Wood; and their Heads muſt either be let into the Wood, even with the Surface, or elſe the Sides B C of the Hopper muſt be cut for theſe Heads of the Screws to paſs in under them.

This bottom Board, which holds the braſs Seed-box, is Four Inches broad, and full half an Inch thick, and at each End a quarter of an Inch longer than the Seed-box: This Piece is firſt thruſt in ſliding upon the Two added Pieces of Board, until its fore End comes under the fore Side of the Hopper, and its hinder End under the hinder Side; then ſetting the Hopper with its Bottom upwards, the Spindle being thro' the Seed-box, and Holes of the Hopper, we hold the Seed-box hard upon the Bottom, at equal Diſtance from each End of it, whilſt the Holes are bored thro' the Bottom, by the Holes at each End of the Seed-box; and then the Screws, being put thro', ſcrew on the Box; and when that is done, we make a Mark upon the bottom Board, with the Compaſſes, on each Side of the Braſs Box, beginning from the Ends of the Axis of the Tongue, reaching as far backwards as is the Length of the Mortiſe: Theſe Two Lines or Marks are a Direction for cutting the Hole in the Bottom of the Hopper, thro' which the Seed deſcends into the Seed-box; then we pull out the Spindle, then draw out the Bottom, take off the Seed-box, and cut the Hole in the Bottom in the manner I will now deſcribe in *Fig.* 14. where the Two pricked Lines *a b* and *c d* are the lower Edges of the Hole, and the ſame with the Two Lines mentioned to be marked by the Sides of the Seed-box. The pricked Line *a d*, being at right Angles with the Two former, is the lower Edge of the fore End of the Hole, and exactly over the Axis of the Tongue, and parallel to it. The pricked Line *b c* is the lower Edge of the hinder End of the Hole, which is juſt over the hinder End of the Mortiſe, and parallel and equal

to

to the laſt-mentioned pricked Line: Theſe Four pricked Lines are the lower Edges of this Hole, contiguous to the Seed-box. The Two Lines *e f* and *g h* are the upper Edges of the Sides of the Hole, which, being farther aſunder than the lower Edges, make the reverſe Bevel of this Hole; which may be determined by this, that the Surface between theſe Two upper and lower Edges, being Planes, are inclined to one another downwards, in an Angle of about One hundred and Thirty Degrees. The Two Lines *e h* and *f g*, at right Angles with the Two laſt-mentioned Lines, make the upper Edges of the Ends of this Hole; and, being nearer together, than the pricked Lines under them, the plane Surfaces, betwixt theſe Two Lines and thoſe Two pricked Lines, ſhew the Bevel of the Ends of theſe, which are inclined to each other upwards in an Angle of about Sixty-five Degrees.

This double Bevel effectually prevents the Seed from arching in the Hole, before it gets into the Mortiſe of the Seed-box; and alſo, the Two upper Edges of the Ends of the Hole being nearer together than the lower, there is the more Wood left between theſe Edges and the Screws, which hold the Box to the Bottom, whereby the Board is leſs apt to ſplit.

Then the Box being ſcrewed on to the Bottom, and thruſt again into its Place, the Spindle, paſſing thro' both the Hopper and the Box, keeps the Bottom in its Place: Then D, in *Fig.* 13. is the imaginary Plane of the Top or Mouth of the Hopper, being a rectangled Parallelogram, and parallel to the Bottom, to which the fore End is perpendicular, and a rectangled Parallelogram of the ſame Breadth.

Fig. 15. ſhews the fore Side of the whole hinder Hopper, with its Two Cavities, and all its Accoutrements, except the Wheels; the Two Ends A and B being exactly alike, having each of them its Seed-box at the Bottom, in the ſame manner as in the one has been deſcribed. The Bar D holds together the upper

Parts

Parts of this double Hopper at a right Diſtance, which is, when there is Ten Inches clear room betwixt the Two ſingle ones. The Spindle E, paſſing thro' the Whole, holds the Two ſingle Hoppers by Four Wreaths, at the ſame Diſtance below, as they are held by the Bar above.

Theſe Four Wreaths are ſcrewed on to the Spindle, to keep it from moving towards either End, as well as to hold the Hoppers in their Places: Two of which Wreaths are ſeen at *a* and *b*; and the other Two are placed on the Outſides, as theſe Two are on the Inſides. Before we proceed any farther in this Figure, it will be proper to ſhew the Wreaths, which are of Two Sorts.

The one in *Fig.* 16. where A is its Hollow, which is circular, and muſt be of the ſame Diameter with the Spindle; and, being thruſt on upon the Spindle, till it touch the Board, is faſtened to the Spindle by a ſmall Screw thro' each of its oppoſite Holes. *a b* ſhews the Breadth of this Wreath, whether it be made of Braſs or Wood: It is little more than half an Inch. *b c d* is the Part of it that goes againſt the Board: The Thickneſs of the Surface of this End which goes againſt the Board, is a quarter of an Inch, if made with Braſs; but if with Wood, half an Inch; but the Thickneſs of its other End *a e f* is leſs than its End *b c d*, by which means the Screws are the more eaſily turned in.

Fig. 17. ſhews the other Sort of Wreath, which is always made in Braſs: Its Cavity is a hollow Cylinder like the former: When it is on the Spindle, its End *a b c* is thruſt into the Hole of the Board (made wider for the Purpoſe) until *d e f* come cloſe to the Board, and ſtop it from entering any farther; then we ſcrew it on to the Spindle by the Holes, as the other Sort of Wreath is deſcribed to be ſcrewed.

This is the beſt Sort of Wreath; becauſe it keeps the Spindle from wearing againſt the Edges of the Hole,

Hole, and then the Spindle never has any Friction against the Wood in any Part of it; but the other Sort are more easily made (especially of Wood), and the Spindle will last a great while in them; or if it be worn out, the Expence of Three-pence or Four-pence will purchase a new Spindle.

Now I must return to *Fig.* 15. where the Spindle E having its Four Wreaths fixt on it, we turn it round with our Hand, to see whether the Wreaths are put on true; and when they are so, neither the Spindle, nor the Hoppers, can move end-ways: Tho' the Spindle be pretty hard to turn round, the Wheels will soon cause it to turn easily. Whilst the Spindle is in this Posture, we turn the Hopper Bottom upwards, and mark the Spindle for cutting the Notches in the manner before directed; and then we take off the Spindle, and cut the Notches, and also cut each End of the Spindle square, up to a Shoulder at each End, so that the Wheels may come easily on without knocking or thrusting; and then we return the Spindle to its Place, and put on the Wheels, pinning them on with each a long Nail, which being crooked at the Ends, prevent it from falling out, but may be very easily pulled out with the Claws of a Hammer; but we must take care, that neither the square Ends of the Spindle, nor the square Holes in the Naves (or Hubs) of the Wheels (into which they enter), be taper; for, if they are taper, the Wheels will be apt to work themselves off.

The Piece of Wood, *Fig.* 18. is that which goes over the Standard, and, being placed in the Hopper, as F. in *Fig.* 15. draws that Part of the Hopper by its Inside *a b* bearing against the fore Part of the Standard; and that Part of it from *b* to *c*, being the Breadth of the Standard, bears against its inner Inside, to prevent the Hopper from going any farther towards that End. This Piece of Wood is fastened to the Boards of the Hopper, either by Screws or Nails:

This

This Piece, from *d* to *e*, muſt be of ſuch a Thickneſs, that the Standard, bearing againſt its Inſide *b c*, may be equidiſtant from each Board, to which this Piece is faſtened. The Part, or fore Side of this Piece *f g*, muſt be the Length of the Diſtance between Board and Board, to which it is faſtened; and that is exactly Four Inches. Its Thickneſs and Depth muſt be ſuch as may make it ſtrong enough for the Purpoſes intended.

The Piece marked *Fig.* 19. is the Oppoſite of the former, and to be placed in the ſame manner, and as it is ſeen marked G in *Fig.* 15. obſerving always, that the Part of it, which holds the Hopper from moving end-ways, muſt always be on the Inſide of the Standard; for, if theſe Pieces ſhould bear againſt the Outſides of the Standards, the Hopper could have no Play upon them, nor could either of the Wheels riſe up without raiſing the Share (that was next to it) out of the Ground; but, being thus placed, either Wheel may riſe without the other, and without raiſing the Share.

I ſay more of this, becauſe it is a Point wherein young Workmen are apt to miſtake.

Thus having ſhewn, in *Fig.* 15. how the Hopper is guided and drawn at the lower Part, I come next to ſhew how it is held and drawn at its upper Part; for which the Piece of Wood, *Fig.* 20. being a competent Breadth and Thickneſs, Four Inches long, is fixt in between the Boards with Nails or Screws; and is H in *Fig.* 15. The Standard paſſing up betwixt this and the fore Side of the Hopper, its fore Surface bearing againſt this Bar, and its hinder Surface againſt the Hopper; ſo that the Hopper may riſe and ſink eaſily upon the Standard at Top, being in the Middle on the fore Side of the Hopper; there will be an equal Diſtance of each Side, for either Wheel to riſe, without the Standard ſtriking againſt the Sides of the Hopper to hinder its riſing. There is another Bar

equal

equal to this, and has the ſame Office, at the other End of the Hopper, marked I. Likewiſe the Bar D is of the ſame Uſe with theſe mentioned ſhort Bars, and they help to ſtrengthen one another.

When the Wheels are put on till they reach near to the Wreaths, they will ſtand with their Rings, or Circles, Two Feet Three Inches aſunder.

We ſet them as near together as conveniently we can; becauſe when they are too wide, they are apt to draw the Plough towards one Side of the Ridge; and ſometimes, when the Ridge is high, the Hopper might bear upon the Funnels; and then the Wheels, being carried above the Ground, would not turn to bring out the Seed: And that theſe Wheels may come the nearer together, their Spokes are ſet almoſt perpendicular; ſo that the Wheels are not concave, as other Wheels are. This Hopper is ſhewn, put on upon its Standards, in its Place, in *Fig.* 21. where the mentioned Bar D, which holds the Hopper together at Top, is ſeen, as alſo the Four Wreaths, and likewiſe the hinder End of the Seed-boxes ſtanding over the Funnels, with their Trunks underneath them. Here alſo the back Part of the fore Hopper is ſeen, with its Seed-box ſtanding over the fore Funnel: Its Mouth alſo is ſeen at A; as alſo the Top of its fore Side held up by the thing *(Fig.* 22.*)* like the Carrier of a Latch, with the Nails in it, which faſten it to the Top of the fore Side of the Hopper, and give room for either of its Wheels to riſe.

This fore Hopper may eaſily be deſcribed by the Figure of a Box, like the other already deſcribed, at its Ends, which are of the ſame Shape with the Inſide of the Box, *Fig.* 12. but much lower, being Seven Inches and an half deep, and Sixteen Inches long; and the Breadth of its Bottom is determined by the Length of the Seed-box, and a little wider at Top, on account of the Bevel which poiſes it: It carries no more Seed than one End of the hinder Hopper; but

but it is capable of holding more; but we do not fill it quite, left ſome of the Seed ſhould fly over in jolting, its Mouth being ſo much longer than the other.

This Hopper is kept in its Place, from moving end-ways upon the Spindle, by a Wreath fixed to the Spindle at each End of the Box, in the ſame manner as has been deſcribed for holding the other Hopper. The Wreaths moſt proper for this Purpoſe are the Sort deſcribed in *Fig.* 17. but the other Sort deſcribed in *Fig.* 16. and even made with Wood, will ſuffice; but then we muſt take care to make the Hole at the End of the Hopper of a conſiderable Thickneſs, that it may not wear the Spindle, which, by reaſon of its great Length, is the more liable to bend, and be cut by the Edges of the Holes; which Cutting cannot be prevented but by the Thickneſs of the Holes, or by ſuch Wreaths as that of *Fig.* 17.

We ſometimes make this Hopper exactly like a common Box, without any Part of its Ends deſcending below the Bottom; and, in that Caſe, we place a narrower Piece of Board at each End of the Hopper, like that of *Fig.* 23. in which Figure, the Hole A being put on upon the Spindle, the Piece of Board is faſtened on by a Screw and Nut thro' the Hole B, near the Top of the End of the Hopper, and by another Screw and Nut thro' the Hole C, near the Bottom of the Hopper. Another ſuch a Piece of Board, fixed on in the ſame manner to the oppoſite End of the Hopper, holds this long Hopper parallel to its Spindle, that paſſes thro' the Holes of theſe Two Pieces, and thro' the Braſs Seed-box, which is fixed up to the Bottom, in the Middle betwixt them.

There are Two Methods for letting the Seed paſs from a long Hopper into the Seed-box. The firſt is that of cutting the Hole through its Bottom, in the manner that has been ſhewn in *Fig.* 14. The other is that which cannot be uſed in a Hopper ſo ſhort as the

the Boxes of our hinder Hoppers are; but in the fore Hopper, or any other long Hopper, we can place the Braſs Seed-box to a Bottom made for the Purpoſe, like that in *Fig.* 24. where there is a Piece of Board on the fore Part of the Hopper from End to End, as *a b*, and another on the hinder Part of the Hopper, as *c d*. Then the fore Part of the Braſs Seed-box, being placed under the Piece *a b*, is ſcrewed up to it at *e*, and the hinder Part of the Seed-box under *c d* ſcrewed up to it at *f*; then the Bottom of the Hopper, being open in the Middle, is ſhut by very thin Boards, *g* and *h*, fixed up to the mentioned Pieces: Theſe Boards having their upper Surface even with the upper Edges of the Braſs Box, the Seed can no way arch in coming into the Mortiſe of the Seed-box. Whichever of theſe Two Methods be made uſe of, in a long Hopper, the Bottom muſt be fixed to the Two Sides, by ſmall Bars of Wood of about Three quarters of an Inch ſquare, to which the Bottom and Sides are faſtened by Nails, in the manner that the Ends and Sides of the hinder Hoppers are faſtened to their Poſts, which ſtand in their Corners.

We take the ſame Method for cutting the Notches in this Spindle, as has been deſcribed for cutting the Notches in the other Spindle.

But obſerve, That the great Length of this Spindle requires it to be the larger; and we make it of an Inch and Three quarters Diameter, the other being only an Inch and an half: We therefore bore the great Hole or Cylinder of its Braſs Seed-box a quarter of an Inch in Diameter larger than of the Braſs Seed-boxes of the hinder Hoppers; and we commonly make a Notch more in the Circumference of this Spindle, becauſe the Semidiameters of its Wheels muſt be as much greater than of the hinder Wheels, as is the Thickneſs of the Plank, and the Ends of the Limbers which are betwixt this Spindle and the upper Surface of the Two Beams.

We

We make all our Spindles of clear-quarter'd Aſh, without Knots or Crooks; and when they are well dry'd, and made perfectly round, and of equal Diameter from one End to the other, by the Prong-maker, we pay a Peny *per* Foot for them at the firſt Hand, and they will now-and-then have ſomething more for the largeſt Size; but we are only curious to have the middle Part of this long Spindle exact; for we graft on a Piece at each End, which does not require any Exactneſs: The Graftings are ſeen at *a a* at one End, and *b b* at the other End of the Spindle (in this *Fig.* 21.) by Four flattiſh Iron Rings driven on upon the grafted Parts, as they appear under thoſe Letters in the Middle. Between each Pair of theſe Rings, we drive a ſmall Iron Pin thro' the Joints at *c* and at *d*, to keep the Grafts from ſeparating end-ways; and if they are not tight enough, we make them ſo, by Wedges driven in betwixt them and the Spindle.

This fore Hopper is drawn by the Spindle, and the Spindle is drawn by the Two double Standards B and C, betwixt whoſe Forks it is placed, as appears in this Figure; the Diſtance between each Fork, or double Standard, being exactly the Diameter of the Spindle, ſo that the Spindle may have juſt room to riſe and ſink there, and no more.

The Hopper and Spindle are guided, or kept in their Place, from moving end-ways, by Two Wreaths ſcrew'd on to the Spindle, the one at *e*, and the other at *f*; each of which Wreaths, bearing againſt the Surfaces of both the Legs of each double Standard, on the Sides next to the Hopper, prevent the Spindle and Hopper from moving towards either End; and yet admit the Wheels, or either of them, to riſe and ſink without raiſing either Side of the Plough, contrary to what would happen, if the Wreaths were placed on the Outſides of the Standards next to the Wheels.

We make theſe Wreaths a little different from the other Sort of Wreaths, which turn againſt the Holes; we make them of a greater Diameter, leſt they ſhould at any time get in betwixt the Legs of the double Standards, in caſe the Standards ſhould be looſe, or bend: Therefore we make the Diameter of each of theſe Wreaths, at leaſt, Two Inches and Three quarters: We always make them of Wood, and of a peculiar Shape, taking off their Edges next the Standards, which Edges would be an Impediment to the Riſing of one End of the Spindle without the other. So that, for making theſe Wreaths, we may form a Piece of Wood of the Shape of a Skittle-bowl (or an oblate Spheroid) having an Inch and Three-quarter Hole bor'd thro' its Middle, and then cut by its Diameter (which is about Three Inches) in Two Halves, each of which will be one of theſe Wreaths; and they muſt be placed on the Spindle, with their convex Sides bearing againſt their reſpective Standards.

The Diameter of the fore Wheels is about Thirty Inches, as the Diameter of the hinder Wheels is about Twenty-two.

The fore Spindle ſhould be of ſuch a Length, that its ſquare Ends, E and F, may come out Three or Four Inches farther than the Hubs (or Stocks) of the Wheels; ſo that there may be room to ſhift the Wheels towards either End, for making ſeveral Sets of Notches, for the Uſe of the Seed-box.

Obſerve, Tho' the fore Hopper is drawn by its Spindle, yet the hinder Spindle is drawn by its Hopper.

The Reaſon of this great Diſtance between the Two fore Wheels is not ſo much for their ſerving as Marking Wheels to this particular Drill; which being drawn only upon a Ridge, its Top is a ſufficient Direction for leading the Horſe to keep the Rows parallel to one another, if the Ridges are ſo; but if the Wheels were much nearer together than they are, and yet more than Six Feet aſunder, the Wheels going on the Sides of the next Ridges would be apt to turn the Drill out of the Horſe-path towards one Side, not permitting the Drill to follow directly after the Horſe; and if the Wheels ſhould ſtand at Six or Seven Feet Diſtance from one another, then they muſt go in the Furrows which are on each Side of the Six-feet Ridge: This would occaſion their Hopper to bear upon the Plank, which would carry the Wheels above the Ground, and no Seed would be turned out of the Hopper, unleſs the Wheels were of an extraordinary Height *(a)*; and the Height requir'd for them would be very uncertain, ſome Furrows being much deeper than others; but the Tops of contiguous Ridges are generally of an equal Height, whether the Furrows betwixt them be deep or ſhallow; for we ſeldom make Ridges of an unequal Height in the ſame Field: Therefore there can be no need to change the Height of our Wheels, that are to go upon the Middle of the Ridges; but if they went in the Furrows they muſt be of a different Height

(a) Notwithſtanding the Reaſons given, and that I have never uſed Wheels of ſuch an Height as might be neceſſary for going in the Furrows, yet it may not be amiſs to try ſuch; becauſe with them the Spindle needeth not to be more than half the Length of one that is carried by low Wheels: And high Wheels will allow the Funnel to be much larger, ſo that altho' the Spindle go higher from it, no Seed will drop beſide a large Funnel; but there is not room for a large one under low Wheels.

I did not think it neceſſary to deſcribe the Manner of making Drill-wheels any otherways than by ſhewing them in the *Plates*; but I will obſerve here, that they are to be made very light: One of mine, that is 30 Inches high, weighs Five Pounds and an half; it has a Circle or Ring of Iron, whoſe Depth is half an Inch, and its Thickneſs a quarter of an Inch; alſo very thin Iron Stock-bands to hold the Nave or Stock from ſplitting. The Circle is held on the Spokes by ſmall flat Iron Pins on each Side; and each Spoke has a Ring of Iron to ſecure its End from being ſplit by driving in of the Pins. We alſo make the Drill-wheels leſs concave than other Wheels are.

when uſed for drilling of high Ridges, from what would be required when uſed for drilling low Ridges.

One Reaſon why the hinder Shares are ſhorter than the fore Share (and conſequently the fore Part of their Sheats leſs oblique) is, that they may be ſet the nearer to the Plank; and I have had a Drill with Five Shares in the Plank, Fourteen Inches aſunder, and Four of theſe hinder Sheats following in another Rank, whoſe Shares were leſs than Three Inches long; ſo that their Beams were ſet ſo far forwards, that one Hopper (by a Contrivance that carried the Seed forwards to the fore Rank, and backwards to the other Rank) ſupply'd the Seed to both Ranks of Trunks, and planted St. Foin in Rows Seven Inches aſunder, when the Ground was too rough to be planted with Rows at that Diſtance by one Rank of Shares.

It may be objected, that the fore Part of theſe hinder Sheats might not be oblique enough to raiſe up the Strings of Roots or Stubble, which might come acroſs them in their Way; but this Inconvenience is remedied by the greater Obliquity of the fore Sheat (or Sheats), which clears the Way for the hinder Sheats, by raiſing out of the Ground ſuch Strings, *&c.* which might annoy them; eſpecially, in this Wheat-drill, where the fore Share ſo clears the way of the hinder Shares, that they can take hold of no String in the Ground, except of the Ends of ſuch which the fore Share has looſen'd; and they hanging faſter in the Ground by their other Ends, the hinder Shares ſlip by them without taking hold of them; and the Harrow-tines, going after ſo near to the Chanels of the hinder Sheats, by the ſame means eſcape alſo from hanging in ſuch Strings.

The Reaſons for placing the One Share and One Hopper before, and the Two behind, in this Wheat-drill, are ſo many, and ſo obvious, that it would be but loſing of Time to mention them.

The

The Limbers G and H, we make of Afpen, Poplar, or Willow, for Lightnefs; we make them as fmall and light as we can, allowing them convenient Strength; and the fhorter they are, the more exactly the Drill will follow the Horfe, without the Hand of him, that follows the Drill, whofe chief Bufinefs is, with the Paddle to keep all the Shares and Tines from being clogged up by the Dirt fticking to them, and alfo to obferve whether the Seed be delivered equally and juftly to all the Chanels.

Thefe Limbers fhould approach fo near together at their fore Parts, near the Chain, that there may be none or very little room betwixt the Limbers and the Horfe; and therefore muft be nearer together for a very little Horfe than for a great one: The Horfe, which I have ufed in all my Drills for thefe many Years paft, is a little one, about Thirteen Hands high; and the fore Part of my Drill-limbers are Twenty Inches wide afunder at the Chain.

At *g* on the Outfide of the Limber G, is a fmall Staple driven in, having one Link on it, which holds a fmall Hook, which, taking hold of different Links of the very fmall Chain I, raifes or finks the fore Part of the Plough to different Heights. But take care to fet it at fuch a Degree, that the fore and hinder Share may go equally deep in the Ground; and when they do fo, the fore Part of the Limbers ought to be higher than the Traces which draw them.

At *h* in the Limber H, is driven another Staple, which holds the other End of the Chain; or elfe, inftead of a Chain, we may make ufe of a Piece of Cord, one End of which put thro' this Staple, and ty'd to the Limber, and a Piece of Chain of half a dozen Links, faften'd to the other End of fuch a Cord, will ferve as well as a whole Chain, for raifing and finking the Limbers.

He who can by thefe Directions make this Wheat-drill, may very eafily make any other Sort of Drill, for planting any Sort of Corn, or other Seeds that are near about the Bignefs of Seeds of Corn: He may make it with a fingle Row of Sheats, by placing as many of thefe fore Sheats as he pleafes in the Plank, which may be longer or fhorter, as he thinks fit; and he may add a Beam betwixt every Two of them, with a Sheat in it, like thefe hinder Sheats; and then the Drill will be double, having Two Ranks of Shares. But I muft advife him never to make a Drill with more Shares than will be contain'd in Four Feet Breadth, that is, from the outermoft on the right Hand, to the outermoft on the left Hand; for fhould the Drill be broader, fome of the Shares might pafs over hollow Places of the Ground without reaching them, and then the Seed falling on the Ground would be uncover'd in fuch low Places.

To a Drill that plants upon the Level, Marking-wheels are neceffary, to the End that every Row may be at its due Diftance: As in a Drill with Five Shares, for planting Rows Eight Inches afunder, Four of the Five cannot err, becaufe Four equal Spaces are included betwixt the Five Shares; but the Fifth (which we call the parting Space) being on the Outfide unconfin'd, would fcarce ever be equal, were it not kept equal by the Help of the Marking-wheels. The Rule for fetting of thefe is thus: We compute altogether the Five Spaces belonging to the Five Rows; which being in all Forty Inches, we fet the Marking-wheels Eighty Inches afunder, that is, double the Diftance of all the Spaces, each Wheel being equidiftant to the Middle of the Drill, which Middle being exactly over the Horfe-path, when the Drill is turn'd, the Horfe goes back upon the Track of one of thefe Wheels, making his Path exactly Forty Inches diftant from his laft Path: By this means alfo the Rows of the whole Field may be kept equidiftant, and parallel to one another; fo that it would be difficu t for an Eye to diftinguifh the parting Rows from the reft.

But

But when Two different Sorts of Seed are planted, ſuppoſe a Row of St. Foin betwixt every Row of Barley, the Rows of which being Eight Inches aſunder, and the Barley drill'd by the fore Hopper into the Chanels made by the five Shares, and the St. Foin drill'd from the hinder Hopper into the Chanels made by Six Shares, the Marking-wheels muſt be at no greater Diſtance than thoſe above-mention'd, where there are only Five Shares; becauſe one of the Six, which are for the St. Foin, muſt always return in the ſame Chanel, going twice therein; for One Row of Barley would be miſſing, in caſe the parting Space ſhould be made by this Sixth Share; and that parting Space would have no Barley in it. Therefore it is a Rule, that whenſoever Two Sorts of Seeds are drill'd, the Rows of one Sort betwixt the Rows of the other there muſt be an odd Share in the Drill, which muſt go twice in one Chanel, and the Diſtance of the Marking-wheels muſt be accounted from that Rank of Shares which are the feweſt: It muſt alſo be contriv'd in this Caſe, that each outermoſt Seed-box muſt deliver but half the Quantity of Seed that each of the inner Seed-boxes do; becauſe the outer ones going twice in a Place, their Chanels would otherwiſe have a Quantity of Seed double to the reſt.

In a Drill that has Two Spindles, we place the Marking-wheels on the foremoſt, which upon their Account is the longeſt; but if we ſhould uſe the Wheels of the hinder Spindle as Marking-wheels, then that muſt be the longeſt, and ſo the fore Wheels (their Semidiameters being much longer than the Semidiameters of the hinder Wheels, and their Spindles ſhorter) would ſtrike againſt the hinder Spindle, unleſs it were ſet farther back than is convenient.

When Ground is harrow'd the laſt time before it is to be drill'd, we contrive that the Harrows may not go directly towards the ſame Point that the Drill is to go, leſt the Track of the Marking-wheel ſhould be exactly parallel with the Track of the Harrow-tines, which might make it difficult to distinguish the Track of the Wheel from that of the Harrow-tine.

He that has not a great Quantity of Ground to plant with St. Foin, and does not plant it betwixt Rows of Corn, will have occasion for no other Drill than this Wheat-drill, describ'd in *Fig.* 21. He may plant his Rows at Fifteen Inches asunder, by the hinder Hopper, and its Shares, without removing them, the fore Hopper being taken off; or else you may plant Three Rows at Sixteen Inches asnnder, by setting the Beams, and their Seed-boxes and Hoppers, at Thirty-two Inches asunder instead of Fifteen, equidistant from the fore Share: and then the Marking-wheels, which are those of the fore Spindle, must be Eight Feet asunder; to wit, double to the Spaces of the Three Shares, which are Three times Sixteen Inches (or Four Feet); or you may set the Two hinder Beams, *&c.* at what Distance you please, setting the Marking-wheels to correspond with them; but then the Harrow must be alter'd, and both its Legs and Tines must change their Places in the Head, the Legs for guiding it exactly, and the Tines to follow in all the Three Rows, which will require a third Tine to be added in the Middle, between the other Two. But without any other Alteration than that of taking off the fore Hopper, and that of lessening the Seed-passages of the hinder Hopper by the Setting-screws; my Man planted me several Acres of St. Foin with my Wheat-drill Two Years ago, the Rows being all Fourteen Inches asunder: It is now an extraordinary good Crop.

In case the Shares, being only Three, should in fine Ground go so deep as to endanger the Burying of the Seed, the best Remedy to prevent this fatal Misfortune is, to place a triangular Piece of Wood, like those in *Figures* 25. and 26. the first of which shews one Side thereof, with the Nail by which it is

to

to be nail'd into the lower Part of the Trunk, with its moſt acute Angle uppermoſt; the other in *Fig.* 26. ſhews the ſame, and its Back-ſide *a b*, that is to be nail'd to the Back of the Sheat, being of the ſame Breadth with it; its Bottom *b c* being the Breadth of the Plates, on their Inſide, the Angle *c* coming out backwards, juſt as far as the Plates: The Depth of this Piece from *a* to *c* is uncertain, becauſe the Plates of ſome Trunks are broader than of others. The Uſe of this Piece is, to fill up the lower Part of the Trunk; ſo that the Seed, dropping upon the oblique Side of this Piece of Wood, may by it be turn'd into the Chanel, after ſo much Mould is fallen in it, as will ſufficiently leſſen its Depth, whereby the Danger of burying the Seed is avoided: And ſuch a Piece of Wood placed into each Trunk, I think, is preferable to Ground-wriſts, which are commonly uſed for this Purpoſe; becauſe the Ground-wriſts leave the Chanels too wide and open.

But when only the Two hinder Sheats are uſed for St. Foin, we can make their Chanels the ſhallower, by ſinking the Limbers by their Chain, ſo much as that, the Plough bearing moſt upon the fore Share, the hinder Shares will go the ſhallower.

When we drill hilly Ground, both up and down, we cover the hinder Parts of all the Trunks, from their Tops, to within Two or Three Inches of the Ground, to prevent the Seed's falling out far behind the Trunk, in going up Hill; and this we do either by a Piece of Leather nail'd to each Side of a Sheat, the Middle of the Leather bearing againſt the hinder Part of the Plates (or Trunk); or ſometimes, inſtead of Leather, we uſe Tin.

Every Trunk being thus inclos'd behind, we can drill up and down an hill of a moderate Aſcent; but when it is very ſteep, we never drill any thing but St. Foin on it, and that by a Drill made for the Purpoſe, ſo very light, that a Man may carry it up the

Hill

Hill on his Back, and draw it down after him: This Drill has Five or Six Sheats in one Row (with the Harrow behind them). Their Shares being extremely ſhort, the Standards which draw the Hopper muſt be ſet perpendicular to the Horizon, when the Drill is coming down, rather than to the Surface of the Side of the Hill: The Funnels muſt alſo correſpond with the Standards.

Some, inſtead of theſe Sheats, make uſe of hollow wooden Harrow-tines, thro' which the Seed deſcends: But theſe I do not approve of; becauſe where the Ground is hard, and not fine, they riſe up, and make no Chanels for the Seed; and then it lying uncover'd will be malted.

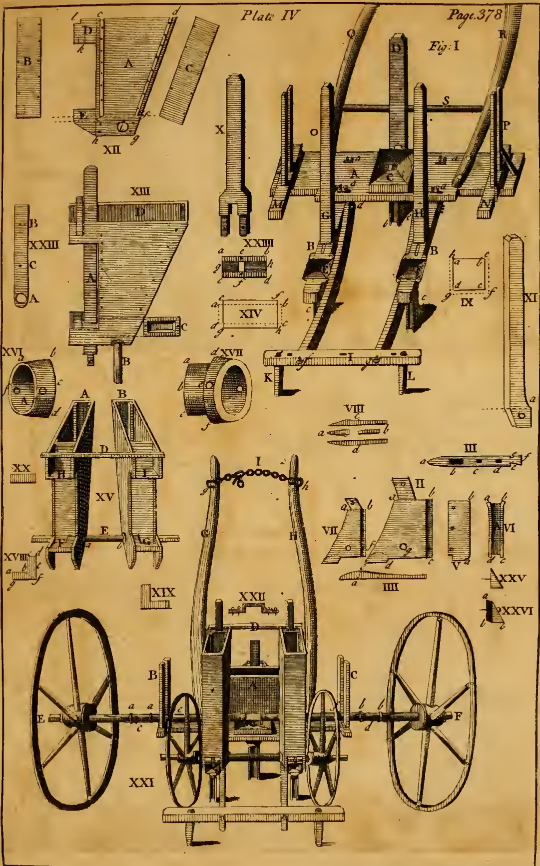
When a Drill has only one Rank of Shares, we ſcrew on the Harrow by its Legs, to the Inſide of the Two outſide Sheats, as near as we can to their fore Shoulders, leaving ſufficient room for the Harrow to riſe and ſink, in the ſame manner as when it is drawn by the Beams.

C H A P. XXII.

Of the Turnep-Drill.

PLATE 5. ſhews the whole Mounting of a Turnep-drill. *Fig.* 1. is a Plough, but little differing from the Drill-plough laſt mentioned. A, A, are the Two Limbers, differing in nothing from the other, except that they are lighter, not being above Two Inches Diameter, behind the Bar: They are drawn in the ſame manner as the other. Their Bar B is diſtant from the Plank Three Inches, being ſhoulder'd at each End, with a very thin flat Tenon, paſſing thro' each Limber, and pinn'd on their Outſides, as at *a a*. We do not pin in this Bar thro' the Limbers, leſt the Holes

Plate IV



B. Cole sculp.

Holes ſhould make theſe very ſmall Limbers the weaker in that Part. C, the Plank, Two Feet and an Inch long, Five Inches broad, and an Inch and a quarter thick. D, D, the Two double Standards, or Two Pair of Standards, placed into the Plank with Shoulders above, and Tenons pinn'd underneath the Plank, and are Thirteen Inches high above it: Theſe ſerve for a Pair of Marking-wheels, when Turneps are drill'd on the Level, to keep the Rows all parallel, and at what Diſtance you pleaſe, by ſetting them according to the Rule already laid down.

Sometimes we place the double Standards into the Plank of the Wheat-drill, in the ſame manner that theſe are placed.

We take off the inner Edge of each Standard at the Top, as at *b b* and *b b*, for the more eaſy Admiſſion of the Spindle of the Marking-wheels into the Forks: This Spindle is kept in its Place by Two of the ſame ſort of Wreaths, and placed in the ſame manner as thoſe deſcrib'd for the fore Hopper of the Wheat-drill.

Such Marking-wheels are neceſſary for drilling upon the Level; but not for drilling upon Ridges.

E is the Beam, Two Feet Two Inches and an half long, Four Inches broad, and Two Inches thick: It is thus broad, that the Screws which hold on the croſs Piece F, may be farther aſunder: The Screws muſt be placed as near as may be to the Outſides of the Beam, and at equal Diſtance from each Side of the croſs Piece; by which means the Standards are kept the firmer from Turning.

The Diſtance between the Plank and the croſs Piece is Eleven Inches. The Bteadth of the croſs Piece is Two Inches and a quarter. This croſs Piece is ſhewn apart in *Fig.* 2. where its Two Standards A B, are each Seventeen Inches long (or high), and each on its fore Side and hinder Side One Inch and a quarter broad, and nearly Three quarters of an Inch thick: They are ſhoulder'd ſhoulder'd and pinn'd into the croſs Piece at *a b*. The croſs Piece is Thirteen Inches and an half long, and one Inch and a quarter thick in the Middle from *c* to *d*; but for about an Inch on the Inſide of each Standard is Two Inches and an half thick, that the Standards may have the more Wood to ſupport them, and that the Hopper, bearing upon the thicker Parts of the croſs Piece, may be held up above the Funnel, that the Fork of the braſs Spindle may not ſtrike againſt it, when the Plough is taken up to be turn'd, there being a little more than a quarter of an Inch of the Breadth of the croſs Piece behind the Standard, for the Hopper to reſt on.

The whole Diſtance between the Standards is Nine Inches and a quarter. The Standards muſt be exactly perpendicular to their croſs Piece: Their Tops are drawn up each to a Point, as at *e* and *f*, by which the Hopper is the more eaſily put on upon them.

The Funnel, Sheat, Share, and Trunk, are the ſame as thoſe in the Wheat-drill, except a few Differences: As G in *Fig.* 1. is the ſame as the fore Sheat of the Wheat-drill, with its Accoutrements; only it is lower, being but Eight Inches high from the Bottom of the Share up to the Beam; and the Plates of the Trunk are ſomewhat narrower: Its Tenon paſſes thro' the Beam, and comes up above it, betwixt the Funnel and the croſs Piece; and there is pinn'd in thro' its Hole above the Beam. There is no want of Wood behind the Sheat, the Funnel not being cut in the Beam, but placed upon it.

The Funnel is ſhewn apart in *Fig.* 3. and is Two Inches deep, Four Inches ſquare at Top; its Four Sides terminating at an Hole in the Bottom, half an Inch broad from *a* to *b*, and near an Inch long from *c* to *d*; which Length is divided in the Middle, by the upper Edge of a Braſs Spout, which divides the Hole into Two equal Parts (or Holes), each of which

is

is about half an Inch ſquare; this Funnel being ſcrew'd on upon the Beam by Two Wood Screws, entering at Two oppoſite Corners of the Funnel, as at *c d* in *Fig.* 1. ſo that the Seed may drop from the Seed-box upon the right Side of the Funnel at *e*, which being about half an Inch diſtant from the Partition, and equidiſtant from both Holes, the Seed rebounding is pretty equally diſtributed to each of the Holes.

The fore Part of the foremoſt Hole being equal with the Back of the Sheat, the Beam being cut thro'; ſo that the Back of the Sheat, and the fore Part of the Hole thro' the Beam, and the fore Part of this Hole, make one plain Surface, whereby the Seed that falls into this foremoſt Hole, deſcends to the Ground, near the Back of the Sheat, thro' the Trunk.

And the Seed which falls into the hinder Hole, is convey'd obliquely backwards thro' Part of the Beam, by a ſhort thin Braſs Spout, whoſe Diameter in the Inſide is ſomewhat more than half an Inch; but the fore Part of it, which divides the Two Holes, deſcends firſt perpendicularly half an Inch, and then turns off backwards, and there the Spout begins to be round: Its joining is on its hinder Part, to the end that the Seed, never running upon it, cannot be ſtopp'd by it. The lower End of this Spout ends at the lower Surface of the Beam, a little behind the Plates of the Trunk, which Hole is ſeen at *a* in *Fig.* 4. where this Hole delivers the Seed down into the Spout A, when it is drawn up into its Place by the String B drawn thro' the Hole at *b* in the End of the Beam, and there tied until it ſtand in the Poſture in which it is ſeen at *f* in *Fig.* 1.

The Shape of this Spout is better ſeen at *Fig.* 5. where A is the Spout, Four Inches long, a full Inch Diameter in the Inſide: Its lower End is circular; but its upper End B is cut at oblique Angles, ſo that when it is drawn up to its Place, its Edges will touch the

lower

lower Surface of the Beam, and inclose the lower End of the other Spout within it: It is made of thin hammer'd Brass (as is the other). The Edges of the Piece of Brass, which make this Spout, are join'd on its hinder Part, for the same Reason that they are so in the other Spout. At *b* there is a Jag cut in one of these Edges, and rais'd upwards, by which Jag the String being tied on the Spout just below, is hindered from slipping upwards.

Joining to the highest Part, and made with Part of the same Piece of Brass, turn'd back from the End of the Spout, is its Hinge C, near Three quarters of an Inch long in its Hollow.

D is a thin Piece of Iron, half an Inch broad, and a little longer than the Top of the Sheat, by which the Spout is held up: This Piece of Iron is riveted by a Rivet passing thro' an Hole at *c*, and thro' the Sheat, just before the Trunk, and thro' another Piece of Iron on the opposite Side; both the Pieces of Iron, with their upper Edges touching the Beam, being thus riveted to the Sheat.

The Spout is pinned in by the Screw E, passing as by the prick'd Line F thro' the Hole G, and also thro' the Hinge C, and screw'd into the Hole of the opposite Piece of Iron, corresponding with the Hole G; and then it will appear as in *Fig.* 4.

Instead of these Pieces of Iron, we sometimes use Pieces of Wood, a little broader and thicker, nail'd on the Sheat.

The Use of this Spout is for carrying half of the Seed backwards, so that it may drop upon the Chanel, after the Earth is fallen into it: By this means the Seed lying very shallow, being only cover'd by a little Earth rais'd by the Harrow, by its Shallowness comes up in moist Weather, sooner than the other half, which lies deeper in the Ground; but if the Weather be dry when planted, the deeper half, by the Moisture of the Earth from the Dews, will come up first,

firſt, and the ſhallow half will not come up till Rain come to moiſten it; ſo that by the ſhallow or deep, the Turnep-fly is generally diſappointed.

Fig. 6. ſhews one of the Tines of a Drill-harrow made of Wood: Its Edge *a b* is made roundiſh at *b*, by which means it raiſes the Earth on its Sides; but does not drive it before: This Edge from *a* to *b* is Six Inches long; from *b* to *c*, being its Bottom, is One Inch and a quarter; from *c* to *d* is the Back, an Inch and an half thick at Top, gradually tapering downwards to *c*, where it is half an Inch thick, being ſhoulder'd all round: It has a flat Tenon A, which paſſes thro' a Mortiſe in the Harrow-head; the Length of which Mortiſe is parallel with the Length of the Harrow-head, into which it is held by a Pin, paſſing thro' the Hole of the Tenon, above the Harrow; as may be ſeen in *Fig.* 7. at *a*; and its Fellow at *b*.

Theſe Two Tines are Eight Inches aſunder at their Points, and Six Inches and a quarter aſunder at their upper Parts, juſt under the Harrow-head. The fore Edge of the Tine A inclines a little to the Left, as the Edge of the Tine B doth to the Right.

Fig. 8. ſhews one of the Legs of the Harrow. At *a* is ſeen the round Tenon, which paſſes thro' the Harrow-head up to its Shoulder, and is pinned in thro' an Hole of the Tenon juſt behind the Harrow-head; upon this Tenon the Harrow-head may turn: The other End has an Hole at *b*, thro' which it is pinned on to the Beam. The Length of the Leg from the Shoulder at *a*, to the Hole at *b*, is Twenty Inches: Its Thickneſs is an Inch and a quarter, and its Breadth an Inch. The Two Legs are ſeen mark'd C, D, in *Fig.* 7. They bend down in the Middle, to give the Harrow the more room for riſing and ſinking; they are parallel to each other, and diſtant a little more than the Breadth of the Beam, that they may have Liberty to move thereon, when one End of the Harrow-head ſinks lower than the other, by the Unevenneſs of the Ground.

The

The Harrow is pinned on to the Beam by the Iron Pin, *Fig.* 9. paſſing thro' the Hole of the Leg at *g*, and thro' the Beam, and alſo thro' the other Leg on the other Side of the Beam, where the Screw at the End of the Pin has a Nut ſcrew'd on it. This Pin is round from its Head all the Way thro' the firſt Harrow-leg, and thro' the Beam; but all that Part of the Pin, which is in that Leg againſt which the Nut is ſcrew'd, muſt be ſquare; whereby that Part being bigger than the round Part of the Pin, and than the Hole in the laſt-mention'd Leg, cannot turn in the Hole of that Leg; for if it did, the Nut would be ſoon unſcrew'd by the Motion of the Harrow; but the Pin muſt have room to turn in the other Leg, and in the Beam. This ſquare Part of the Pin is ſeen at *a*, *Fig.* 9. The whole Length of the Pin, from its Head to the End of the ſquare Part at *a*, where the Screw begins, is of the Thickneſs of the Two Legs, and of the Breadth of the Beam.

We ſometimes ſet the Legs of the Harrow Two Inches wider aſunder, by making them each an Inch thicker at their fore Ends in their Inſide, and reaching Five or Six Inches behind their Iron Pin: Theſe thicker Parts, bearing againſt the Beam, keep the hinder Part of each Harrow-leg an Inch diſtant from the Sides of the Beam, whereby the Harrow-legs are Six Inches aſunder, inſtead of Four, by means of theſe added Thickneſſes.

When a Drill is taken up to be turn'd, the Perſon that does it, takes hold of the Harrow-head, and lifts it up: The Legs of the Harrow, bearing againſt the croſs Piece, ſupport the whole Weight of the Drill.

When the Harrow does not go deep enough, we tie a Stone upon the Middle of the Harrow-head, by a String that paſſes thro' the Holes at *h*. All the Wood of this Plough and Harrow is Aſh, except the Limbers.

The

The Hopper of the Turnep-drill is very different from those already described: It consists of a Box placed into the Middle of a Carriage; which Box is described in all its Parts, lying open with their Insides upwards in *Fig.* 10. A is the fore Side of the Box, Five Inches and an half deep, and Six Inches and an half long. B, the hinder Side of the Box, opposite to the former, and of equal Dimensions.

Each End of the Box is made with Three Pieces of Board, of which C the uppermost is Three Inches and a quarter deep, and Five Inches long; which Length is the Breadth of the Inside of the Box. The End of the Piece C, when in its Place, stands against the prick'd Line *a b* in the fore Side A; the other End standing against the prick'd Lines in B, which is opposite to, and corresponds with, the prick'd Line *a b*; the fore Side, and hinder Side, being screw'd to the Ends of this Piece by Four Screws.

The Piece D is Two Inches and a quarter broad, and of the same Length with the Piece C, and screw'd up to the Bottom of it with Two Screws, and then its End will bear against the prick'd Line *b c*, and that which is opposite to it in the Side B.

E is the lower Piece of this End, and an Inch and a quarter broad: Its End is to stand against the prick'd Line *c d*, and its other End at the opposite prick'd Line in B. The Piece D must be screw'd upon the upper Edge of the Piece E, as the Bottom F must be screw'd up to its under Edge, which will stand upon the prick'd Line *e f*. The Three Pieces G, H, I, being opposite to C, D, E, and of the same Dimensions with them, placed in the same manner, make the other End of this Box. At *g* in the Bottom F, appears the Hole which is over the Mortise of the Brass Seed-box, the Shape and Size of which Hole may be seen by the prick'd Lines upon the Flanches B, C, of *Fig.* 9. in *Plate* 2. The foremost End of which Hole reaches almost as far forwards as the

End of the Axis of the Tongue of the Braſs Seed-box, and its hinder End almoſt as far as the hinder End of its Cover *(a)*. The Bottom F, being of the ſame Length, with C, D, E, and their Oppoſites, bears againſt the prick'd Line *d b* of the fore Side A, and againſt the oppoſite prick'd Line of B. The Length of this Bottom F is the Breadth of the Inſide of the Box, and its Breadth reaches to the outer Edges of the Pieces E and I, being Three Inches and an half.

All the Jointings of theſe Pieces muſt be at right Angles, and ſo cloſe, that no Seed may run out at them. All the Pieces are of Board, full half-inch thick, except the Bottom, which is thinner.

Fig. 11. ſhews the Bottom of the Box with its under Side uppermoſt, where the light Part A is the Bottom-board, covering the Two End-boards, E and I, in *Fig.* 10. The dark Parts B and C are the under Sides of D and H, in *Fig.* 10. At *a* is the fore End of the Braſs Seed-box ſcrew'd up to this Bottom-board. At *b* is the hinder End of the Braſs Seed-box ſcrew'd up in like manner, the outer Edge of the Flanch of the Seed-box being even with the Edge of the Bottom-board. The End of the Braſs Spindle, with its Fork, appears at C.

Fig. 12. ſhews this Box ſtanding upon its Bottom, with its hinder Side laid open. At *a* is the Hole in the Bottom, under which the Braſs Seed-box is faſten'd, with ſmall Iron Screws, ſquare near the Heads, paſſing thro' the Bottom, and thro' the Holes at each End of the Braſs Box, with their Nuts underneath.

(a) Commonly it reaches within half a quarter of an Inch; but if it ſhould only reach within a quarter of an Inch of them, it would not have that ill Conſequence at that Diſtance, as the ſame Poſition would have in the large Seed-boxes; for, in them, the Seed would, in ſuch Caſe, be apt to bear againſt the Bottom of the Hopper, and obſtruct the Motion of the Braſs Tongue, which ſmall Seeds cannot do in the Turnep-ſeed Box.

The Pins muſt touch all the Sides of the Holes in the Braſs, to prevent the Seed-box from moving any Way.

A is the fore Side of the Box. B the hinder Side lying down. C is the Piece H of *Fig.* 10. which makes a ſort of Shelf in the Box at its left End. D at the right End makes another like Shelf, underneath which, the Fork of the Braſs Spindle is turn'd by the Crank in the End of the wooden (falſe) Spindle. By means of theſe Shelves, there is room for the Two wooden falſe Spindles to come the further into the Carriage, without leſſening the upper Part of the Box. E and F are the Two Ends of the upper Part of the Box, made by the Two Pieces G and C of *Fig.* 10. When the hinder Side B is rais'd up, and ſcrew'd to theſe Ends, the Box is complete.

We put a Lid upon this Box, which is hing'd on to its right or left End. This Box (having the Braſs Seed-box at its Bottom) is to be placed into the Middle of a Frame or Carriage.

Fig. 13. ſhews the Inſide of the Carriage lying down. A is the hinder Side, Eighteen Inches long, Dove-tails and all, and Six Inches broad. B the fore Side of the ſame Length with the hinder Side, and Eleven Inches broad. This Five Inches greater Breadth than the hinder Part is, becauſe a greater Height is required on the fore Side, on account of the Hopper's being drawn, and the Plough held up by that and the Pieces that muſt be fix'd to it. C, D, are its Two Ends, Six Inches long, beſide their Dove-tails, and Six Inches broad. E and F are Two Pieces each Six Inches long, whoſe Ends are to ſtand againſt the prick'd Lines *a b* and *c d* of the hinder Side, and their other Ends againſt the prick'd Lines in the fore Side, which are oppoſite to theſe. The Breadth of each of theſe Pieces is Four Inches: When they are in their Places, their lower Edges come even with the Bottom of the Carriage. Their Uſe is to ſupport the Ends of the Spindles which come juſt thro' their Holes, after each of them have paſſed their Hole at its reſpective End of the Carriage.

All this Carriage is made of Board full half-inch thick; The Ends C and D are made of double Thickneſs by another Piece of Board added to each, that covers all their Inſides, except their Dove-tails. Theſe Boards with which they are lin'd, are nail'd to them, with their Grain going a different Way, and croſſing the Grain of the Board at the End, either at right or oblique Angles. This prevents the Holes from ſplitting out, and makes the Holes of a double Thickneſs; whereby the Spindle is the leſs worn by them, in caſe there are no Braſs Wreaths to enter them.

The middle Pieces E and F are lin'd by their whole Surfaces, in the ſame Manner as the Inſides of the Ends are lin'd.

When theſe Ends and middle Pieces are in their Places, a wooden Cylinder, of the exact Diameter of the Holes, is thruſt thro' all Four, to hold them exactly true, whilſt the Ends and middle Pieces are all ſcrew'd faſt into their Places.

The prick'd Lines are drawn all round the Carriage, thro' the Centres of the Holes, and at equal Diſtance from the Bottom of the Carriage, which is an Inch and Three quarters, and the One-eighth of an Inch. This prick'd Line is a Direction how high to nail on the Ledgers G and H, whereon the Box is to ſtand; and the Diſtance the upper Surface of the Ledger muſt be above the prick'd Line, is the Semidiameter of the Braſs Spindle; and the Thickneſs of the Braſs Box above the Spindle, or which is the ſame thing, the Diſtance between the Centre of the great Hole of the Braſs Seed-box, and the Plane of the Top of its Mortiſe, being half an Inch and half a quarter, ſtrike a Line above the prick'd Line parallel to it, at this Diſtance above, and then nail on the Ledger, with

with its upper Edge at this Line. This, with its oppoſite Ledger plac'd in the ſame manner, will ſupport the Box with the Axis of the Spindle of the Seed-box, at equal Height with the Centres of the Holes of the Carriage; ſo that if thoſe Holes are parallel to, and equidiſtant from the fore Side and hinder Side of the Carriage, and the Axis of the Braſs Spindle be placed in the like manner parallel to, and equidiſtant from the fore Side and hinder Side of the Box; then when the Box is thruſt down in its Place, upon theſe Ledgers, and the wooden (falſe) Spindles are placed into their Holes, their Axis will fall into a ſtrait Line with the Axis of the Braſs Spindle, as they ought.

Fig. 14. ſhews the Carriage laid open. A is its back Side lying down. B is its fore Side ſtanding up. C is the ſquare End of the left (falſe) Spindle, whereon a Wheel is to be put up to the Shoulders of the Spindle, quite cloſe to the Ends of the Carriage. This Spindle, being an Inch and an half Diameter, is held in its Place, and kept from moving end-ways, by Two Wreaths; the one at *a*, bearing againſt the Inſide of the End of the Carriage, the other Wreath at *b*, bearing againſt the left Side of the middle Piece; which Wreath keeps the Spindle from moving towards the right Hand, as the other does from moving towards the left. D is the ſquare End of the other wooden Spindle, whereon a Wheel muſt be placed in the ſame manner as the other Wheel. This Spindle is kept from moving end-ways by Two Wreaths, in the ſame manner as the other Spindle is; but this right-hand Spindle, being that which turns the Braſs Spindle by its Crank, which enters the Fork, ſhould have its Wreaths of Braſs, like thoſe deſcrib'd in *Fig.* 17. *Plate* 4. Part of which Wreaths entering about Three quarters of an Inch into the Hole of the End and middle Part of the Carriage, being firmly ſcrew'd on to the Spindle, prevent the Friction that would otherwiſe be betwixt the Wood of the Spindle, and the

Wood of the Holes; which Friction wearing the Wood of both, would in time cauſe the Spindle to be looſe in its Holes, whereby its Axis would deviate from the ſtrait Line it ſhould make with the Axis of the Braſs Spindle, and make an Angle with it; and then the Crank would change its Place in the Fork at every Revolution of the Wheels; and if the Hole ſhould be worn very wide, and the Spindle worn much leſs, the Crank might let go the Fork; but when the Wood is of this Thickneſs, and each Hole has Wood in it, with its Grains pointing different ways, it would be many Years before the Holes would become large enough for this to happen, tho' only wooden Wreaths were uſed; and as to the Two Wreaths of the left Spindle, they may be of Wood, becauſe tho' that Spindle ſhould grow looſe, it is no Damage; for it only ſerves to bear up that End of the Carriage; but he that has this Sort of Braſs Wreaths for the hinder Hopper of a Wheat-drill, may take them thence, and place them upon theſe Spindles, and remove them again to the Wheat-drill when that is uſed; for that and the Turnep-drill are very rarely, or never, uſed at the ſame time.

E is the Iron Crank, plac'd into the falſe Spindle, in the manner ſhewn at H in *Fig.* 5. of *Plate* 2. for turning the Braſs Spindle by its Fork; but take care that the End of this wooden Spindle do not approach nearer to the End of the Braſs Spindle than the Diſtance of half an Inch, leſt, if the inner Wreath ſhould grow looſe, the wooden Spindle might bear ſo hard againſt the Braſs one, as to wrench the Seed-box down from the Wood, and then the Seed might run out betwixt the Seed-box and the Bottom to which it is ſcrew'd.

When the hinder Side A is ſcrew'd up againſt the Ends and middle Pieces, then the Box deſcrib'd, being thruſt down into the Carriage, and ſtanding upon the deſcrib'd Ledgers, and at that Diſtance from each

End of the Carriage, that the Seed may drop on the Side of the Funnel, as is before deſcrib'd; the Box is kept in its Place by one Screw paſſing thro' its Back, and the back Side of the Carriage.

The Notch F is cut in the Bottom of the hinder Side of the Carriage, up to the Bottom of the Ledger, for the Convenience of ſeeing the Seed drop into the Funnel.

The round Notch G is made in the Bottom of the fore Side of the Carriage, to make room for one's Hand to go in there, and turn the Setting-ſcrew without taking off the Hopper from the Standards.

This Box and Carriage, ſo fix'd together, compoſe the Turnep-hopper, which is drawn and guided, and alſo holds up the Plough, by Two hollow Pieces of Wood ſcrew'd on to the Outſide of the fore Part of the Carriage; their Ends H and I appearing a little above the Carriage.

One of theſe hollow Pieces of Wood is ſhewn in *Fig*. 15. The Breadth of its Hollow muſt conform to the Breadth of the Standards, which are One Inch and a quarter broad; but we muſt allow about a quarter of an Inch more in the Hollow for the Swelling of the Wood. The Depth of the Hollow muſt be the Thickneſs of the Standard that is to go in it, allowing about the Eighth of an Inch for the Swelling of the Wood. The Hollow ſhould be a little deeper in the Middle than at each End; becauſe the Standard ought not to bear againſt any thing, except at or near the upper and lower Part of the Carriage. Altho' the End of theſe Pieces come a little higher than the Carriage in this Hopper, yet I think it is better that theſe hollow Pieces come no higher than even with the Top, nor deſcend any lower than even with the Bottom of the Carriage; and then the Length of each of theſe Pieces need be no more than Eleven Inches, which is the whole Depth of the Carriage.

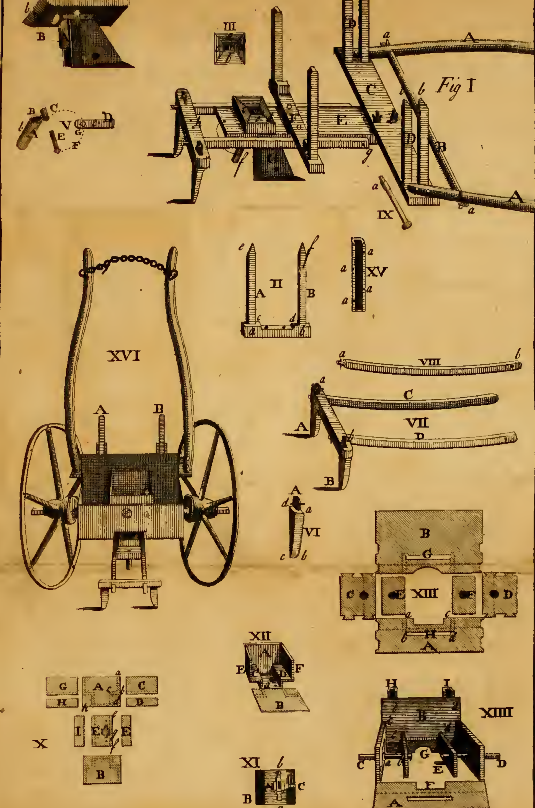
The Wood on each Side of the Hollow, sufficient for the Holes *a*, *a*, *a*, *a*, must be about half an Inch broad. The best way for fixing them on, is whilst the Standards are in them, placing a small Piece of Wood at each Corner of the Hollow, betwixt the Standard and the Wood, to the end that there may be no more room on one Side of a Standard than on the other Side; then screw them on (parallel to and equidistant from their respective Ends of the Carriage) by Four small Screws each, the one at *c*, *c*, *c*, *c*, and the other at *d*, *d*, with Two below; the Heads of these Screws being on the Inside of the Carriage, and their Nuts on the Outsides of the hollow Pieces; then pull out those little Pieces of Wood, that were to keep the Standards in the Middle of the Hollows, whilst the Holes for the Screws were bored, and then the Turnep-Hopper is finished, and being put on upon the Standards A, B, in *Fig.* 16. is ready to go to Work; and in this Figure the whole Turnep-drill may be seen as in the Prospect of a Person following it at Work, except that this Figure has not the double Standard, nor Marking-wheels; because we never use them for drilling-Turneps, except it be on the Level, which we very rarely do.

The Circles of the Wheels of this Hopper go Twenty five Inches asunder; were they farther asunder, they would not go so well upon the Ridges; or were they nearer together, they might not hold up the Plough so steadily, but that one Wheel might happen to be rais'd from the Ground, by the descending of the opposite Limber; and if it should happen to be the Wheel that turns the Crank, no Seed would be deliver'd out whilst the Wheel was rais'd above the Ground; sometimes we use Wheels of Twenty-six Inches Diameter, sometimes Thirty, and at intermediate Diameters, with this Hopper.

The best Wood for making all Sorts of Hoppers is Walnut-tree or Elm; our Beams and Standards we make of Ash.

What

Plate V. P.392



B. Cole Delin et Sculp

What is meant by Wood-ſcrews, are taper Screws made with Iron, having very deep Threads, whereby they hold-faſt when ſcrewed into Wood, and their Points will enter into ſoft Wood without boring any Hole for them into the Wood they are to take hold of; but near their Heads they are round, and have no Thread, and that Part of them muſt always be in a bored Hole thro' that Part of a Board that is to be drawn cloſe.

If the Standards ſhould be much ſwollen by being wet, it may be proper to anoint them with Soap.

In drilling, when the Wind is very ſtrong, and the Hopper goes high above the Funnel, the Seed might be blown over it, if we did not take care to guard it from the Force of the Wind; and for doing this there are many Ways: Sometimes we nail a Piece of Linen Cloth round the Ends, and the fore Side of the Hopper; or elſe we nail on a Piece of old Hat, or Shoe-leather, round the Edges of the Funnel, to raiſe it higher; or if the Hopper go a great deal above the Trunk, we nail up a Pipe of Leather to the wooden Bottom of the Box, which Pipe, being about an Inch wide at Bottom, protects the Seed from the Wind, till it arrives ſo near the Funnel, that the Wind cannot blow it over.

If we would have a long Hopper, to plant many Rows at once, of Clover or other fine Seeds, it is eaſy to make each of theſe wooden (falſe) Spindles turn Two or Three Braſs or Iron Spindles; but then, as in all other Caſes; where the ſame Hopper is to ſupply more than one Chanel with Seed, each of its Wheels muſt have Liberty to riſe without the other, as thoſe of the hinder Hopper of the Wheat-drill do.

CHAP.

CHAP. XXIII.

Of the HOE-PLOUGH, *&c.*

PLATE 6. *Fig.* 1. is the Hoe-Plough in a ſide View. A is the Beam and Plough-tail, being much the ſame with that of the common Plough deſcribed in *Fig.* 1. of *Plate* 1. The Beam of ſuch a common Plough, being cut off, and ſcrewed up to this Plank, and its Limbers, might make a Hoe-Plough. The Share of this, from its Tail to the fore Part of its Socket, is Two Feet One Inch long, and from thence to the End of the Point, Ten Inches and an half: This is the Meaſure of the under Side of the Share. B is the Plank, Two Feet Seven Inches and an half long, Two Inches and an half thick, and Nine Inches broad. C, D, are the Nuts of the Two Screw-pins, which hold up the Beam to the Plank. E is the Nut of the Draw-pin, which Pin has a Crook underneath, whereto one of the Links of the ſhort Chain of the Whipper is faſtened for drawing the Plough; the only Uſe of this Nut is, to hold the Pin from dropping out by its own Weight, and that of the Chain and Whipper; but often, to avoid the Trouble of ſcrewing and unſcrewing the Nut, we ſupply its Uſe by a ſquare Pin a little bigger than the Hole, which we drive up by an Hammer, ſo tight, that it may not drop out of itſelf; but can eaſily be driven out by a few Blows of the Hammer, as often as it is neceſſary to remove it into another Hole. F, G, are the Two Limbers; they are ſcrewed on to the Plank by Four Screws and Nuts: The under Surface of the Limbers by their whole Length are parallel to the Plank, and to the upper Surface of the fore

End

End of the Beam, contrary to the manner of placing the Limbers of the Drill Ploughs; becauſe their Planks being always parallel to the Bottom of their Shares, if their Limbers were parallel to their Beams, as theſe are, the fore Ends of their Limbers would not be elevated higher than the Plank, but would go within a Foot of the Ground, inſtead of being elevated almoſt as high as the Horſes that draw them; and the upper and under Surfaces of this Plank muſt not be parallel to the Share, but muſt make the ſame Angle with it as its Limbers and Beam do.

Theſe Limbers ought to crook outwards from each other all the Way, till they come within about a Foot of the Chain, much more than the Drill-Limbers need to do; becauſe the Middle of the Plank of the Drill follows directly after the Horſe, but the Middle of the Plank of the Hoe-Plough very ſeldom does; and therefore there muſt be the more room betwixt theſe Limbers. Likewiſe there muſt be the more room betwixt the fore Part of the Limbers, becauſe oftentimes the right Limber muſt be raiſed, and the left depreſſed, in holding the Plough towards the left Side (for if it ſhould be held towards the right Side, the Share would go upon the Fin, and its Point be raiſed out of the Ground, unleſs it were on a Surface that had a Declivity towards the Right). The Diſtance between the fore Ends of theſe Limbers is Two Feet Eight Inches.

The Strength and Stiffneſs of theſe Limbers muſt be ſuch, that there may be no Bending betwixt their fore Ends and the Tail of the Beam; for if they be too weak, ſo as to yield to the Weight of the Furrow, the Point of the Share will deſcend into the Ground, and its Tail will riſe up, and then the Plough cannot go well. The ſhorter they are, the ſtronger and ſtiffer will they be, of the ſame Thickneſs. We may make them juſt of ſuch a Length, that there may be room for the Horſe before the Bar H (which holds the Limbers at their due Diſtance). Theſe are from

their

their Ends to the Bar, Four Feet Ten Inches long and from thence to the Plank Ten Inches, and Three Inches and an half ſquare at the Bar.

I is the Whipper. K, L, are its Notches, whereunto the Traces both of the Thiller, and of the Horſe next before him, are faſtened. The Length of the Whipper is uncertain; but when we hoe betwixt Rows, when the Plants are grown high, we make it as ſhort as it can be, without galling the Horſe's Legs by the Traces.

We ſet this Plough to go deeper or ſhallower by the Chain of the Limbers; the changing of whoſe Links to the Crook M has the ſame Effect as changeing the Pins to different Holes of the Crow-ſtaves of a common Plough.

Fig. 2. is the Beam with its Mortiſe and Holes; its Crooking down at the Tail is not very material; but it cauſes the hinder Sheat to be a little the ſhorter below the Beam, whereby it may be ſomething the lighter, and yet of the ſame Strength as if it were longer. Its whole Length is Four Feet Ten Inches: We make its Breadth and Thickneſs ſuch, that it may be as light as it can be without Bending. A is the Mortiſe thro' which the hinder Sheat paſſes. B is the Mortiſe for the fore Sheat, upon which it is pinned up. C is a Hole in the Beam, into which the End of the left Handle being driven, holds it from moving, and is the beſt Manner of faſtening this Handle of a Plough. D, E, are the Holes, thro' which the Two Legs of the double Retch paſs, and are there held up by their Nuts. F is the Coulter-hole. G is the hinder Hole, by which the Plough is held up to the Plank. H and I are the Two foremoſt Holes of the Beam, thro' one or the other of which paſſes the Pin which holds the Beam to the fore Part of the Plank. Theſe Holes muſt be made as near together as they can be, without Danger of ſplitting them one into another; to prevent which there are ſeveral Ways: The one is by driving in Two ſquare Pins croſs the Beam, under the

the pricked Line *a b*, before the Holes are bored, which will prevent the Grain of the Wood from being forced out of one Hole into the other; or theſe Holes may be plated with Iron above and below, which will have the ſame Effect, and then there need not be more than One Inch between Hole and Hole.

Fig. 3. is the Plank apart, which by its Holes, and pricked Lines, ſhews the different Manner of placing the Beam. *a*, *a*, *a*, *a*, are the Four Holes for ſcrewing down the Limbers to the Plank.

Suppoſing the Path of the Horſe to be a ſtrait Line, and the pricked Line *h i* (which is at right Angles with the Plank, and equidiſtant from each Limber) to go exactly over it, without making any Angle on either Side of it; then the Beam muſt be placed at right Angles with the Plank, to the End that the Share may go parallel to the Horſe-path, excepting that very ſmall Inclination that its Point has to the left, ſhewn by the pricked Lines in *Fig.* 1. of *Plate* 1. But this Plough ſeldom follows the Horſe in that manner. The ſaid pricked Line *h i* generally makes Angles with the Horſe-path; elſe when the Beam ſtood near the left Limber, and the Draw-pin near the right Limber in the Hole 9. (which it muſt do to keep the Share parallel to the Horſe-path) the Weight of the right End of the Plank and its Limber would be too heavy for the right Hand of the Holder to manage; and if the Draw-pin be removed (ſuppoſe) to Hole 7. the Paralleliſm of the Share with the Horſe-path will be loſt, and the Point of the Share may be inclined too much towards the Left; and when a Furrow is to be plowed on the right Side of the Horſe-path, the Beam muſt be removed nearer to the Middle of the Plank, and the Draw-pin muſt be placed on the left Side of the Beam, ſuppoſe to the Hole 2. This will bring the greateſt Part of the Plank to the right Side of the Horſe-path; and then the Share, ſtanding at right Angles with the Plank, will make a very large Angle

Angle with the Horſe-path, and then the Plough will not perform at all. Therefore it being neceſſary, that the Share always go parallel to the Horſe-path, and often as neceſſary that the Plank go at oblique Angles to the Horſe-path; it follows then that the Beam ſtand at oblique Angles with the Plank, to preſerve the Parallelism to the Horſe-path; and this cannot be done but by the Holes which are ſhewn under the pricked Lines which croſs the Plank.

The Holes A, B, C, are thoſe to one of which the Beam is ſcrewed up by its Hole G, in *Fig.* 2. Theſe Holes are made as near to the hinder Edge of the Plank, as they can ſafely be, without Danger of tearing out; which is generally about an Inch diſtant from the ſaid Edge.

Every one of theſe Holes are anſwered by Three others, near the fore Edge of the Plank, as the Hole B has, at the fore Edge of the Plank, the Holes D, E, F. D, E belong to the Hole I of the Beam *Fig.* 2. Theſe Two Holes are made as near together as they can be without breaking into one another. F anſwers the Hole H in *Fig.* 2. and is made between D and E, as near them as ſafely it can.

When the Beam is ſcrewed up at B and F, and makes the ſame Angles with the Plank, as the pricked Line *b c* doth; then the Draw-pin ſtanding in the Hole 8 or 9, will bring the Plough ſo much to the Left, that the Share will point too much towards the Right; then remove the fore End of the Beam to the Hole D, and then the Beam will make the ſame Angle with the Plank as the pricked Line *c d*, which may bring the Share to be parallel to the Horſe-path nearly enough: But if the Draw-pin ſhould be placed in the Hole 1. then the Plank would go ſo much on the Right of the Horſe-path, that the Share would point vaſtly too much towards the Left, ſtanding in either of theſe Two Poſitions: Therefore the foremoſt Pin muſt be removed to the Hole E, and then the Beam being

being at the ſame Angles with the Plank as the pricked Line *f g*, it may be parallel to the Horſe-path, or ſo nearly, that by removing the Draw-pin one Hole, it may be made perfectly ſo.

Note, That tho' here are but Nine Holes for the Draw-pin; yet we uſually make many more in our Planks: And ſometimes by changing the Draw-pin either Way into another Hole, tho' that Hole be but an Inch diſtant from the former, the Share is brought right without any Inconvenience.

The Holes A and C have each of them their oppoſite Holes, which (when the Beam is placed into either of the Two) have the ſame Effect, for keeping the Share parallel to the Horſe-path, as the Hole B and its Three oppoſite Holes have; and if either of the Holes belonging to A, B, or C, ſhould not bring the Beam ſufficiently oblique to the Plank, for the Share to be parallel to the Horſe-path, when the Draw-pin is in ſome one particular Hole, then there may be another Hole bored before, on the Right or Left, for the fore Pin to paſs thro' by the Hole H of the Beam *Fig.* 2. which will incline the Beam a little more to the Right or Left, as occaſion requires; and if none of all theſe be ſufficient, the Plank may be turned the other Side upwards; and the Beam being faſtened there by the hinder Screw into any one of thoſe Holes, which were next to the fore Edge of the Plank before it was reverſed, there may be a new Set of Holes to anſwer the fore Pin, of which that which was an hinder Hole before the Plank was reverſed, may be one. Theſe may ſet the Beam at different Angles from any of the firſt Holes; ſo that there may be at one End of the Plank Six Syſtems of Holes, Three on the one Side, and Three on the other; and if we have a mind to make yet more various Poſitions of the Plough, we may turn the Plank, End for End, and there make Six different Syſtems of Holes.

But,

But, inſtead of turning the Plank, it would be better to have a Fourth Hole in the Beam, ſtanding as near to the hinder Hole as H doth to the fore Hole; to anſwer which Fourth Hole, there may be Two Holes in the Plank, one at each Side of the hinder Hole of every Syſtem at proper Diſtances, to ſet the Plough ſtill at more different Angles with the Plank; and theſe, I believe, will be more convenient for the Purpoſe than the different Holes in the fore Part of the Plank, it being eaſier to remove the hinder Screw than the fore Screw; becauſe if the Plank and Limbers are not held up by ſomebody, whilſt the fore Pin is out, their Weight will wrench out the hinder Hole of the Plank by that Screw; but whilſt the hinder Screw is out, there is no need of holding up the Plank, becauſe its Weight, bearing upon the Beam, cannot injure the foremoſt Hole, whilſt the Limbers bear upon the Horſe. Upon this account, I wonder we had not made the Holes, for changing the Poſition of the Beam, at the hinder Part of the Plank rather than the fore Part; which convinces me, that new Inſtruments are ſeldom perfect in the Beginning.

We can alſo alter the Standing of the Beam, by cutting away the Wood on one Side of an Hole, and placing a Wedge on the oppoſite Side of the Pin.

The Holder may make ſome Alteration in the Going of the Plough by the Handles.

The Reaſon we never ſet the Beam on the right Half of the Plank is, that the Plough always turns its Furrow towards the Right-hand; and the ſtrait Side of the Share and the Coulter never go ſo near to a Row on the Right-hand, by the Breadth of Two Furrows, as it does to a Row on the Left-hand.

If by the Drawing of the fore Horſe or Horſes, the Plough ſhould bear too hard upon the Thiller, it may be helped by making a Row of Holes near the hinder Side of the Plank, for the Draw-pin, inſtead of of thoſe in the Middle; for the farther backwards the Draw-pin is plac'd, the leſs will the Limbers bear on the Thiller, eſpecially when drawn by more Horſes than one; becauſe the fore Horſes draw the Limbers more downwards than the Thiller doth, as may be ſeen in *Fig.* 4.

Fig. 4. ſhews the manner how the Hoe-plough is drawn, and how the Traces are fix'd to it. The Traces of both Horſes are faſtened to the Notches of the Ends of the Whipper at *a* and *b*. The Traces of the Thiller by their fore Part are faſtened to an Hook, or Ring, on the Wood of the Collar, as is uſual for other Thillers; and the fore Part of the next Horſe's Traces is faſtened to his Collar in like manner; but theſe Traces, being twice as long as thoſe of the Thiller, muſt be held up in the Middle by a Piece of Cord or Chain, as at *c*, where one End of it is faſtened to the Trace, and paſſes over the Top of the Collar, behind one of the Hames, and before the other to keep it from ſlipping backwards or forwards; its other End is faſtened to the opoſite Trace on the other Side, as this End is at *c:* This prevents the Chain from falling down, and getting under the Horſe's Legs in turning; but beware that this String or Chain be not ſo ſhort as to hold up the Traces higher than their ſtrait Line; for that would preſs upon the Collar, and gall the Thiller, beſides occaſioning the Plough to be drawn too much upwards; for this drawing of the fore Horſe by a different Line from that of the Thiller, is a great Advantage for keeping the Plough the firmer into the Ground.

If there is another Horſe, his Traces are faſtened at the Collar of the Second, in the ſame manner as in drawing of a Waggon.

When we hoe betwixt Rows, where the Plants are very high, as thoſe of Turnep-ſeed, which are much higher than the Horſes, to turn a new Furrow up to the Row, when there is a Trench in the Middle of the Interval, where the Horſes muſt go, we find it beſt to place the Beam by the Holes B and E, in *Fig.* 3. and the Draw-pin near the left Limber, which brings the Tail of the Plough to the Right-hand, and the fore Ends of the Limbers being towards the Left, the End of the right Limber (by turning the Handles a little to the Left) bears againſt the wooden Saddle at *d*, and cannot hitch into or take hold of any of the Plants to tear them. And that no Part of the Limber may take hold of any Plant, we make it very ſmooth from one End to the other; and cut off the Corner of the Plank equal with the Limber, that the Plants may ſlip by it without hanging in it, or being broken by it. The Whipper ſtanding towards the left End of the Plank, its End *b* does not reach ſo far towards the right as to take hold of the Plants, its End *a* being over the Interval, where no Plants are; and to keep its right End the more out of Danger of hurting the Plants, we place the Hook of its Chain nearer towards this End, by which means the left End, becoming heavier, ſinks lower, and raiſes the right End higher; and the higher it is, the more ſecure the Plants will be from it; becauſe they are held off by the Limber above.

This way my Turnep-ſeed has been ho'd, when one would have thought it impoſſible for a Plough and Horſes to go betwixt the Rows without deſtroying the Crop. Almoſt in this manner we give our Wheat the laſt Hoeing, to turn the Furrow a Second time towards the Row. When the Plants of the Rows are very high, the Driver muſt go in the next Interval, on the Left of the Plough; and the Holder has a Cord, like the Reins of a Bridle, which he lays over the End of the Draw-pin, which keeps it from falling down, until he has occaſion to uſe it for guiding or turning the Thiller.

When we turn the Furrow from the Row (which will then be ever on the left Side of the Plough), the Plough muſt be ſet in a very different and contrary

Poſture;

Posture; but then the Plants commonly being low, there is no Danger of the Whipper's or Limber's hitching or taking hold of them; but the Driver must take care, that he does not tread on them, nor suffer any of the Horses to do so; and they of themselves, when they are not blind, take all the Care they can to avoid it; and I observe, that the Plants are oftener injured by the Driver, than by the Horses.

'Tis in this last-mentioned manner of Hoeing, when we go very near to the young Plants, the First or Second time, that we must take care of burying them with the Earth, which (especially when dry and fine) is apt to run over to the left Side of the Plough; this we can in great measure prevent, when the Ground is clean, by nailing with Three or Four Nails a very thin square Piece of Board to the Sheat, with one Corner bearing at, or below, *a*, in *Fig.* 1. and its other lower Corner bearing on the Back of the Coulter on its left Side at *b*, its upper Corner reaching to *c* or higher; its fore End is ty'd on to the Coulter by a leathern Thong passing thro' an Hole very near the End of the Board. The lower Edge of the Board must come no lower than the prick'd Line *a*, *b*, which, at *b*, is just even with the Surface of the Ground, before it is rais'd by the Share; for if this Board should be set down too near the Share, the Plough would not go; but, being set in this manner, it prevents the Earth (when never so much pulveriz'd in the driest Weather) from running over upon the Plants to bury them, tho' the Plough go very near them; except in this case, we never use a Board, the Earth running over to the left Side, being often advantageous in Hoeing; for it changes more Surface of the Ground, than if it went all to the right; and when in Summer we hoe from the Wheat-rows, not going very near to the grown Plants, this Earth that runs over the Share to the Left, helps to mend such Places where the Furrow was not thrown up close enough to the Row by the precedent Hoeing.

The first time we turn a Furrow towards the Row, the Horses go in the Trench near to it, and the Plough stands on the left Side of the Horse-path, almost in the same manner as when the Furrow is turn'd from the Row; but we very often make use of a common Plough, for throwing down the Ridge, which has lain all the Winter in the Middle of the Interval. One Wheel, going on each Side of that Ridge, holds that Plough to a great Exactness for splitting this Ridge into Halves, which the Earth-board, being set out for that Purpose, throws up to the Row on each Side of the Interval.

We also very often make use of the Two-wheel'd Plough, for raising up the Ridges, whereon we drill the Rows; not but that the Hoe-Plough will do every thing that is necessary to our Husbandry: Yet the common Ploughs being heavier than we usually make our Hoe-Ploughs, they by their Weight, and Help of their Wheels go a little steadier: and besides the Ploughmen, being more accustom'd to them, prefer them before all other, where their Wheels are of no Prejudice.

I never saw neater Ridges rais'd by any Plough, than by the Hoe-Plough, nor finer Plowing; and I believe that were it made as heavy, and as strong, it would outdo the Swing-Plough, in plowing miry Clays, where Plough-wheels cannot go; but I, haveing no such Land, have never made any Hoe-Plough heavy enough for it. However, I am convinc'd, by the many Trials which I have seen, that no other Plough can be used for every Horse-hoeing Operation, so effectually as this I have now describ'd.

The making the Hoe-plough is not difficult for a good Workman; and a few of the Holes for setting the Beam are sufficient, provided they are made in their proper Places, which is impossible for me to describe exactly in a Number that is no more than necessary;

neceſſary; becauſe the Diſtance the Plough muſt go from the Horſe-path on either Side, is uncertain, as the Largeneſs or the Depth of the Furrow is; and for that Reaſon, it is as impoſſible for me direct the Ploughman to the particular Angles, at which his Beam muſt be ſet with the Plank, to keep the Share parallel to the Horſe-path, as it is to direct a Fidler, how far he muſt turn his Pegs to give his Strings their due Tenſion for bringing them all in Tune, which without a Peg to each String could never be done; but when he has his juſt Number of Pegs, his Ear will direct him in turning them, till his Fiddle is in Tune; ſo the Ploughman by his Eyes, his Feeling, and his Reaſon, muſt be directed in the ſetting his Plough; but without a competent Number of Holes, he can no more do it than a Muſician can tune Four Strings upon one Peg. And I am told, that ſome Pretenders to making the Hoe-Plough have fix'd its Beam to the Plank immoveable, which makes it as uſeleſs for hoeing betwixt Rows, as a Violin with but one Peg to its Four Strings would be for playing a *Sonata*.

Fig. 5. ſhews the Sort of Yoke, that is us'd on every Ox that draws in a ſingle File, as they always muſt when they work with the Hoe-plough; but after they have been accuſtom'd to draw double (*i. e.* Two abreaſt) they muſt be practis'd for about a Week to draw ſingle, before they are ſet to Hoeing; for otherwiſe they will be apt to demoliſh the Rows, one running off to the right-hand, expecting his Fellow to come up with him on the Left, and another will run off on the Left to make room for his Companion to go abreaſt with him on the Right, endeavouring to go in the manner in which they us'd to be placed for drawing in Pairs.

I ſuppoſe I need not give any Caution about muzling the Oxen when they hoe; becauſe they will eat the Plants as ſoon as they come an Inch above the

 Ground,

Ground, and that will ſhew the Neceſſity of it; but there is no occaſion to muzzle the Horſes until the Plants are grown as high as their Noſes, when rein'd up, as in *Fig.* 4.

Fig. 6. is an Inſtrument of Pulveration, which might have been ſufficiently deſcrib'd by its Matter, Weight and Dimenſions, without any Portrait, were it not to ſhew the particular Manner of drawing it, being very different from that of a common Roller, whoſe Frame is difficult to make, and coſtly; but this, being only Three Feet long, is drawn by a ſimple Pair of Limbers, held together, by the Two Bars A and B, firmly pinn'd in at their Ends.

Its Gudgeons muſt not come out beyond the outer Surface of the Limbers, leſt they ſhould take hold of the Plants, when drawn in the Intervals; alſo the hinder Ends of the Limbers, behind the Gudgeon, ſhould crook a little upwards, for the ſame Reaſon.

This Stone Cylinder is Two Feet and an half Diameter, and weighs Eleven hundred Weight beſides the Limbers. It muſt never be us'd but in the drieſt Weather, when neither the Plough nor Harrow can break the Clods; and then being ſo very ponderous and ſhort, it cruſhes them to Powder, or into ſuch very ſmall Pieces, that a very little Rain, or even the Dews (if plentiful), will diſſolve them.

I have had great Benefit by this Roller in preparing my Ridges for Turneps. The Weather proving dry at *Midſummer* (which is the beſt Seaſon for planting them), the Land was in Pieces like Horſe-heads, ſo that there was no Hope of reducing them fit for planting with Turneps that Year; the Clods being ſo very large, that they would require ſo many Viciſſitudes of wet and dry Weather to ſlack them; but this Inſtrument cruſh'd them ſmall, and the Plough following it immediately, the Ridges were harrow'd and drill'd with very good Succeſs.

I

I have alſo made uſe of it for the ſame Purpoſe in the Middle of a cloddy Field, where it pulveriz'd the Clods ſo effectually, that the Benefit of it might be plainly diſtinguiſh'd by the Colour and Strength of the Two following Crops, different from the other Parts of the Field adjoining on both Sides, whereon the Roller was not drawn.

But cruſhing has ſuch a contrary Effect from ſqueezing, that if this Roller ſhould be us'd when the Land is moiſt, it would be very pernicious, by unpulverizing it; of which I am ſo cautious, that ſometimes I let the Roller lie ſtill for a whole Year together.

There is alſo a long triangular Harrow, which is ſometimes uſeful in the Intervals when the Earth is of a right Temper betwixt wet and dry; but there is no need to deſcribe it, and I ſcarce uſe it once in Two or Three Years.

The Diameters of the wooden and iron Pins and Screws, with their Holes, and the Sizes of the Nails to be made uſe of in all the deſcrib'd Inſtruments, I leave to the Diſcretion of the Workmen, who, if they are Maſters of their ſeveral Trades, cannot be ignorant of ſuch Matters.

Fig. 7. and *Fig.* 8. ſhew the Lands of Turneps mention'd at the Beginning of this Work.

AN

APPENDIX

CONCERNING

The making of the DRILL, *and the* HOE-PLOUGH, *&c.*

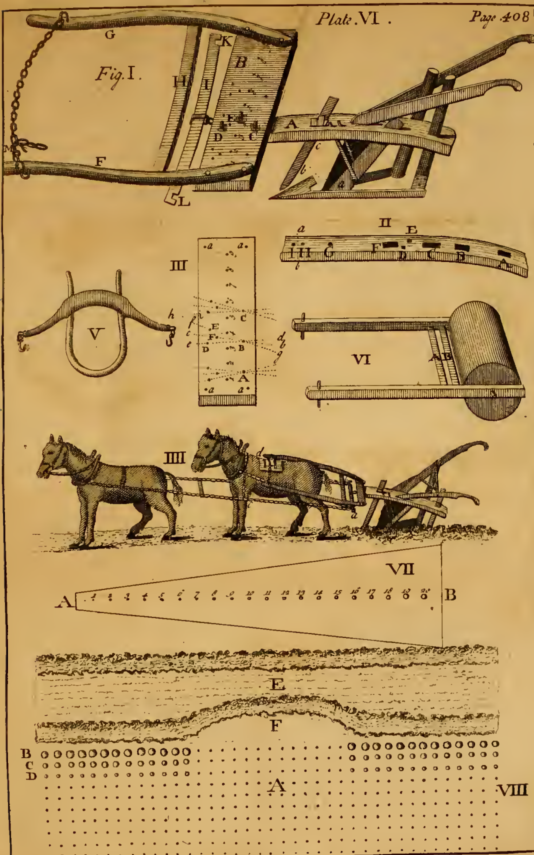
TO a Workman, who would make these Instruments, I would add the following Directions.

The First thing to be done for making the Drill, is to place half a Sheet of Paper to the Back of Plate 2. by pasting it on to its Margin; and likewise another half Sheet to Plate 3. in the same manner.

Then with a Needle prick through all the Out-lines of A, B, C, and D, in *Fig.* 2. which will mark out both Sides, and both Ends of the Mortise of the Turnep Drill-box. Also prick through the Out-lines of the great Hole in the middle of A, and of the elliptical Hole in B. Also prick the little Hole at E, in A; and at F, in B. Prick through the prick'd Line *p q*, in B; which is the Line to which the Setting-screw *Fig.* 6. or *Fig.* 12. that is to pass thorough the Hole in C, must be parallel.

When the Paper is taken off, cut out of it the said A, B, C, and D, by the Pricks made by the Needle.

Then cut the same in Pastboard, by laying these Pieces of Paper thereon (because Pastboard, being stiffer than



B. Cole. Delin. et Sculp.

than Paper, will be more fit for the Uſe). Draw a Line with Ink on the pricked Line, *p q*.

The Hole in C muſt be ſomething larger than in the Cut, becauſe the Setting-ſcrew muſt be ſo, being beſt to be of Braſs, which is leſs apt to ruſt than Iron, of which Metal it was formerly made; but Braſs, being weaker, requires the more of it to equal the Strength of Iron.

The Wreath, *Fig.* 14. is not neceſſary, becauſe the Slider, *Fig.* 15. is ſufficient without it; but then care muſt be taken, that the Edges of its Claws A B, which rub againſt the Cylinder of E, in *Fig.* 9. be taken off, to prevent their cutting it. This Slider is ſometimes made of Braſs, and ſometimes of Iron.

Thus the Workman will have the Sides and Ends of the Turnep-mortiſe, which make the Whole of it, whereby he may make it exactly in ſoft Wood.

Fig. 7. called the inner Cylinder, being put into the Cylinder A, of the Steel Tongue, *Fig.* 4. whereby the Holes for the Axis of the Tongue, being the lower from the Top of the Mortiſe, do not only ſecure the Edges of the Mortiſe from breaking out, but alſo give room for the Flanches B, C, in *Fig.* 9. to be made to reach as far forwards as the Axis of the Tongue, and farther: Hereby the Hole, in the Bottom of the Hopper, may be as wide at the fore End, as at the pricked Line at the Letter B.

The Notches in the Spindle, *Fig.* 5. ſeem to appear deeper than is uſual for Turnep-ſeed; but I remember I have drilled Furze-ſeed with a Turnep-drill without altering the Notches. As for the Shape of theſe Notches, they are ſo fully deſcribed in *Fig.* 6. and *Fig.* 8. of *Plate* 3. that I can add nothing to that Deſcription; only that thoſe being for the Wheat-drill, the Size of Notches for the Turnep-drill muſt be leſſer in ſome proportion to the leſſer Size of the Seed.

For making the Wheat-drill do the ſame as for the Turnep-drill. The *Fig.* 3. in *Plate* 2. is one Side of of the Mortiſe, by which muſt be made Two in Paſtboard. *Fig.* 10. in *Plate* 2. and *Fig.* 9. in *Plate* 3. are the Two Ends of it.

The Cover that prevents the Wheat from falling down on the hinder Side of the Spindle, is one intire Piece of Braſs, which is marked B in *Fig.* 3. of *Plate* 3. but the Shape of it, with its Hole whereby it is held in by a Screw, is only ſeen in the Side, *Fig.* 3. of *Plate* 2. and there deſcribed by pricked Lines; and by pricking through them, the Shape of the End of the Cover may be taken, which Cover is of the ſame Shape from End to End.

The Joyner who cannot by theſe Additions, and the Explanations of the *Plates*, make theſe Drills in Wood, doth not deſerve the Name of a Workman.

When he has once made them whole, he can eaſily make them in Halves like *Fig.* 8. in *Plate* 2.

By theſe Halves the Founder will make his Moulds proper for caſting them in the beſt Braſs. But in theſe Halves for Caſting, there muſt be no other Holes, but the great Holes, and the Hole for the Setting-ſcrew.

The great Hole in the Mould muſt be largeſt at E, in *Fig.* 9. *Plate* 2. and leſſer in the Inſide in *Fig.* 8. for as it muſt be of a conical Shape for making the Core, if it ſhould be caſt bigger within, when the Whiteſmith bores it (as he muſt) to an exact Cylinder, the End E would be in Danger of burſting by the Force of the Boring, as it is much thinner than in the Mortiſe. And beſides this, if there ſhould be any little Flaw in the Edges of the Hole within the Mortiſe (which the Founder muſt avoid as much as poſſible), it may perhaps be bored out by means of the Hole's being leſs there. The Hole muſt be ſomething leſs in the Mould than its proper Size, even where it is largeſt; elſe it may happen, that in boring it to a true Cylinder it may become too big. And I believe, in the Cooling of the Braſs, the Hole grows bigger as the Spindle grows leſs.

For

For the Hole of the Setting-ſcrew, lay on upon the dark Part of *Fig.* 8. one of the Paſtboard-ſides; and from the black Line *p*, *q*, draw a Line coincident to it as on the Braſs, for making the half Hole A by; and the other Half of it on the oppoſite Half-ſide.

Theſe Paſtboards will be very uſeful to the White-ſmith, for directing him to find the Places where the Holes for the Axis of the Tongue, and thoſe for ſcrewing the Two Halves of the Mortiſe together, are to be made. I adviſe againſt boring the great Hole with a Tool (a Bit) with more than Four Edges; for it would be apt to tear the Braſs.

The great Hole of the Turnep-drill is bored with Tools like thoſe wherewith a Gun is bored. But the Wheat-drill is bored with a Screw-ſtock, whoſe Edges are made ſharp for that Purpoſe, and may be ſet wider or narrower at Pleaſure: It is put into the Hole along with an half-round Piece of Wood, the lower End of the Stock being ſet faſt in a Vice: The whole Seed-box (for it muſt always be ſcrewed together before it is bored), being put on the End of the Stock (made taper a little way for entering), is turned round it by a long wooden Spanner, which hath a Notch in the middle of it, to receive the whole Seed-box, in order to bore it by turning it round upon the Stock.

The Braſs ought to be of the beſt Sort, which will be eaſy to file, and yet not mix with baſer Metal.

The Seed-boxes may be caſt whole by theſe Moulds; but I prefer thoſe that are ſcrewed together, for ſeveral Reaſons, which I have not time now to write.

There is a Turnep Seed-box come to my Hands that was made by Pretenders; I wiſh it is the only one made in the ſame manner; for it is uſeleſs; the Notches in the Spindle are much ſhorter than the Breadth of the Mortiſe; at each End of the Notches is a deep Chanel (as deep as the Bottom of the Notches) quite round the Spindle, inſtead of a Mark, which ſhould be but juſt viſible for cutting the Notches;

and inſtead of a tender Steel Spring, there is a ſtrong Piece of Iron without Elaſticity. By means of this Iron, the Machine grinds the Seed, inſtead of drilling it.

What I ſhall here add concerning the Wheat-drill, is ſome Alterations in *Fig.* 21. of *Plate* 4. *viz.* The fore Share and Sheat muſt be left out for drilling Wheat, no more middle Rows being uſed. And the Two Beams B B in the Plough, *Fig.* 1. muſt be ſet to make Chanels Ten Inches aſunder. And the double Hopper, *Fig.* 15. muſt be ſet nearer together, ſo as the Seed may fall into the middle of the Funnels of the Beams.

Tho' there is no Neceſſity of Marking-wheels for guiding the Drill-horſe upon Ridges; yet they are very uſeful for holding the Drill ſteady, and to prevent its tottering, which without the Marking-wheels, and the fore Hopper, it is apt to do, when the Shares ſtand ſo near together as Ten Inches; and on a narrow Ridge one of the hinder Wheels might run off to the Furrow, and draw the Shares after it, if the Drill were not kept ſteady by the Marking-wheels, and by their Hopper, which takes hold of the ſingle Standard by *Fig.* 22. as is ſeen in *Fig.* 21. in *Plate* 4. But there ſhould not be ſo much room in it on each Side of the Standard, leſt the Plough by that means ſhould have too much room to totter, now the Shares are ſo near together.

The Marking-wheels muſt be ſet at the Diſtance of the Breadth of Two Ridges, which, as we now make them, is about Nine Feet and an half from Wheel to Wheel.

The Braſs Box may be taken out of the fore Hopper: And tho' that Hopper be of no Uſe to the double Row, except as is aboveſaid; yet if there ſhould be Occaſion to preſs the Marking-wheels deeper into the Ground for keeping the Plough the more ſteady in its Courſe, it may be uſefully filled with Earth, or other Matter, ſufficient for that Purpoſe. And beſides,

ſides, it may ſerve to plant Three Rows of St. Foin, when the fore Share and Sheat are put in, and the Beams and hinder Hopper ſet a Foot or Eighteen Inches wider, and the Marking-wheels at their due Diſtance, as is directed in the Eſſay. Thus the ſame Drill may plant Wheat and St. Foin.

A Drill for the double Rows might be made with a ſingle hinder Hopper, inſtead of the double one. And there is a Contrivance to ſupply the Uſe of the fore Hopper for keeping the Plough ſteady, and more eaſy to make than that Hopper; but this cannot be deſcribed by Words without Cuts.

The Lime wherewith the brined Wheat is dried, receiving ſome of the Salts from the Brine, will ſtick in the Notches of the Spindle; yet never makes any Stoppage to their Delivery of the Seed; but every Year we clean the Notches from the Lime with a Chiſſel, and, if it were done oftener, it would not be amiſs.

There is an Accident that may poſſibly happen, but never to a careful Driller; *viz.* a large Clod may ſome way be thrown into a Funnel of the Beam of the Plough, either by a Wheel, or by the Paddle that cleanſes the Sheats from the Dirt that ſticks to them when the Earth is wet. This may ſtop the Wheat from falling out of the Funnel into the Trunk; and then, ſo far as the Plough goes thus ſtopped, the Chanel will have no Seed in it; but the Driller that follows may take it out immediately, which if he ſhould neglect to do for never ſo little a Diſtance, he ought to ſtop the Plough whilſt he ſupplies the Chanel with Seed from his Hand as far as it is empty. When there is any Danger of this, as in very rough cloddy Ground, it is beſt to take off the Drill-harrow, to the end that the Chanel may lie open for receiving the Seed from the Hand. But if the Ends of the Hopper reach below the Funnels, and they are otherwiſe defended, as they may be, this Accident can never happen.

When

When the Dtill-harrow is taken off, the beſt way for taking up the Plough to turn it, is to bore a Hole of about half an Inch Diameter in the End of each Beam behind the Funnels, and faſten a Withe into theſe Holes; by which Withe the Driller very conveniently takes hold with one Hand, and lifts up the Plough, laying his other Hand on the Hopper to keep it ſteady. This Method of taking up the Plough hath been often uſed for the Wheat-drill, and for the Turnep-drill; and in the latter the Hole in the one Beam holds the Withe as well as do the Two Holes in the former.

There are new Editions of ſome of theſe Engines, which cannot be fully deſcribed without more *Plates*; but ſince thoſe already deſcribed are found by Experience to be ſufficient for the Purpoſes they were deſigned for, new Editions of them are not neceſſary, tho' convenient in many reſpects.

Reaſon will eaſily make Additions to the Inſtruments when they are neceſſary; as when more than one Braſs Spindle is to be turned by one or each Wheel for planting Clover amongſt Barley after it is come up. 'Tis done by a very light Plough, drawn by a Man: It plants Four Rows at once Eight Inches aſunder: The Shares are very ſhort and narrow, and ſo are the Sheats and Trunks. 'Tis not difficult to put on a Crank at the other End of the Braſs Spindle, in the ſame manner that the Handle that winds up a Jack is put on, and to faſten it at the Hole at I in *Fig.* 5. of *Plate* 2. This Crank muſt, at its firſt turning, before it turns up towards the Letter H, of the ſame *Fig.* be long enough to reach to within an Inch of the Fork of the Second Spindle. Thus each Wheel may turn ſeveral Spindles, and then this Drill may plant many Rows of Seeds at once.

When you plant Rows nearer together than Eight Inches, it is beſt that the Plough have Two Ranks of Shares and Hoppers, elſe the Earth may be driven before

before the Shares; but with Two Ranks of them, they will not be more apt to drive the Earth before them in making Rows at Four Inches asunder, than at Eight, when there is only a single Rank of Shares.

But I think this near Distance of Four Inches cannot be proper for any Sort of Seeds, except Flax-seed; and even for that Seed not necessary. If the Land be made fine, a single Rank of Shares will go very well to plant Rows at Seven Inches asunder.

I had formerly a Drill-Plough for drilling across very high round Ridges for Hand-hoeing, where Horse-hoeing is impracticable: It had no Limbers; but it had little Ground-wrists to make open Chanels, and had Handles behind it, whereby the Driller raised up the Tail of the Plough, when it was passing the Summit of the Ridge. There were neither Funnels nor Trunks; for these would hinder the Seed from falling into the Chanels, both by the Plough's going up and down the Ridge. The Hopper was drawn by the Plough in such a manner, that in passing all Parts of the Ridge the Wheels were not raised from the Ground: The Chanels were equally supplied with Seed throughout: It planted Four Rows at once, at a Foot asunder. I used this Drill-Plough 30 Years ago in *Oxfordshire:* I have no such Ridges here, nor consequently any Occasion of such an Instrument; and did not make Cuts of it, because it is not useful for Horse-hoeing. I only mention it here for the Benefit of those who have a mind to plant such Ridges regularly with an Engine: I hope their own Reason will enable them to contrive such a Plough, especially now they have the manner of making the Drill, Hopper, *&c.* shewn to them.

I have made a very material Addition to the Hoe-Plough, of *Plate* 6. *viz.* At the fore End of the Beam *Fig.* 2. is the Hole I, by which alone let the Plough be drawn, leaving out the Hole H; instead of the Hole G make a Mortise, Three or Four Inches long,

long, and as broad as the Thickneſs of the Iron Pin, the End and Nut of which are ſeen at C, in *Fig.* 1. This Pin ſhould be more than half an Inch Diameter, and ſquare at that End that goes into the Mortiſe; let the hinder End of the Mortiſe juſt appear behind the Plank, when the Beam is at right Angles with it.

By means of this Mortiſe there may be many more Holes through the Plank without Danger of ſplitting into one another the Holes in the Beam, which muſt anſwer thoſe in the Plank.

Draw many Lines from the Middle of the foremoſt Hole of the Plank to the hinder Edge of it, at (ſuppoſe) a quarter of an Inch from one another there; and then bore a Hole in that Part of each Line that is leaſt apt to break into the next Hole to it.

Every Syſtem of Holes in the Plank will have like Benefit of being increaſed in their Number by the Convenience of this Mortiſe; without which it is impoſſible to have ſo great Variety of turning the Point of the Share to make the Share go parallel to the Horſe-path.

The Board deſcribed in *p.* 403. we now uſe very ſeldom in Hoeing of Wheat.

Explanation of Plate VII.

FIG. 1. ſhews the Plank and the Harrow of the lateſt and beſt Drill-plough, moſt ſimple, and accommodated to the preſent Practice of planting double Rows.

A is the Plank, with all its Mortiſes and Holes; *b* is the Mortiſe into which the Tenon of the fore Sheat of the Drill-plough, for planting treble Rows, was faſtened; *d* is the ſquare Hole for receiving the Seed from a Hole of the ſame Shape and Size in the Bottom of the Funnel.

When the Sheat is taken out of the Mortiſe *b*, and another Sheat is made exactly the ſame with that, place them in the Mortiſes *a a*, and make the Two

ſquare

ſquare Holes *c c* behind them, for their Funnels to ſtand on. Make the Mortiſe *e*, which is to hold the ſingle Standard that is to hold up the fore Hopper in the treble Drill, and in this to guide the Wheels alſo, inſtead of Wreaths, that in the treble Drill are put on the Spindle bearing againſt the Inſides of the double Standards; for in this the Shares being but Ten Inches aſunder, and at ſuch a Diſtance from each of the Wheels, that neither of them doth by riſing lift up a Share perceptibly; but if the Shares were wide aſunder, or there were more of them reaching nearer to the Ends of the Plank, a Wheel might riſe up, and lift a Share out of the Ground, if guided by the ſingle Standard and Hopper, as in this. The ſingle Standard is ſhewn in *Plate* 4. *Fig*. 10. but this has no Fork at its Bottom, as that has. This has only a ſingle Tenon, and is ſhouldered before, behind, and on each Side, to hold it the more firm and ſteady, when tightly pinned down by Two Pins underneath the Plank. The Dimenſions of this Standard are the ſame with thoſe of the other; but the Shoulders muſt not increaſe the Thickneſs of the Standard any higher than the Tops of the Funnels.

The Four other ſquare Holes, *viz*. *f* with another behind it, and *g* with one before it, are for the double Standards, which are to be well ſhouldered, or braced on the Side of each that is next to the End of the Plank, and on the Outſide. There is no need of Shoulder or Brace on the Sides where the Spindle is placed, or on the Side next to the Middle of the Plank.

The Four round Holes *h i k l* are thoſe thro' which the Four Pins paſs that hold on the Limbers, and the Piece A, in *Fig*. 2. and the other of the ſame Sort in *Fig*. 4.

Fig. 2. and 4. ſhew how the Harrow's Leg B is held to the Piece A, by the Pin C. The Letters *a b* ſhew the Holes through which the Pins do paſs to ſcrew the Piece A up to the Plank, and the Limbers for guiding the Harrow. This Piece A is ſomewhat longer than the Breadth of the Plank; it is about Two Inches thick, and Two and an half in Depth. The Pin *Fig.* 3. goes through this Piece near the Bottom of its fore End, whereby the Harrow-tines have the more room to riſe up, without being held down by the Legs preſſing againſt the Plank.

Fig. 3. is the Pin C, of *Fig.* 2. *a* is its Head, *b* its round Part, whereon the Harrow moves; *c* is its ſquare Part, that prevents its turning, which by the Motion of the Harrow would unſcrew the Nut *d*, and cauſe it to come off of the Screw *e*, and be loſt.

The Harrow is alſo ſhewn in *Fig.* 1. as it is guided by the Pieces before deſcribed: B is its Head, that holds the Tines D D, drawn by the Legs C C. Tho' theſe Legs *in Plano* ſeem in their Middle to crook ſideways, yet when out of Perſpective, their Middles crook only downwards; which is to give the greater Length to the Tines, and the more room for them to move up.

Fig. 5. is the Spindle in Three Parts. A is the middle Part, wherein are the Notches *b b*. This is beſt to be of Oak, or ſome other hard Wood, in which the Edges of the Notches are leſs apt to wear than in ſofter Wood; but I have had a Set that have laſted the Drilling of 120 Acres, when made of Aſh. B and C are the Two other Parts: D and E are their Ends, whereon the Wheels are put. The Holes *h h h h*, and the ſame in the other End under the Letter E, are for ſetting the Wheels at different Diſtances, in order for making new Notches, or for different-ſized Ridges: The Wheels are held in their Places by long Nails put through ſome of theſe Holes, and clenched upon the Iron Stock-bonds to prevent their falling out. Theſe Ends B and C need not be cut to a Square; except juſt enough to prevent the Wheels from turning on the Spindle.

Theſe Three Parts are grafted together by Help of the hollow Cylinder *Fig.* 6. which, being put on upon the Joint *f*, of the Spindle *Fig.* 5. holds the Parts A and B together by the Two Pins *a a*, paſſing through the Cylinder near its Ends, and through the Holes *k* and *g*.

This Joint may be in another manner; *viz.* One Part of the Spindle may enter into the other by cutting it to a ſquare Peg of an Inch long, and 3-4ths Diameter, entering an Hole that fits it, at the End of the other Part.

Theſe Pins will be beſt to have Screws at their Ends with Nuts to them; and then they need not be ſo tight in the Holes, and may be the more eaſily taken out, when the Part B is to be taken off for avoiding Obſtructions in drilling an outſide Ridge.

The Cylinder is a Foot long, and about half an Inch thick, bound with an Iron Ferrel at each End; and if there were another in the Middle, it might be the ſtronger.

Place the Cylinder on the Outſide of the Spindle, the Joint *f* being exactly againſt the Middle of the Cylinder; and mark at each End of it, in order to ſee when it is in its right Place; and after it is put on and pinned, mark likewiſe on the Spindle the exact Places of the Holes, for the more eaſy finding them every Time the Cylinder is put on.

Another Cylinder muſt be on the Joint *c*, held together by Pins paſſing thro' the Holes *i* and *d*, in the ſame manner, and for the ſame Purpoſe, as the other Joint already deſcribed.

The Spindle ought to be of equal Diameter with the Bore of the Seed-boxes, thro' which it is to paſs; but this I find, needs not be quite an Inch and 3-4ths; it may want an 8th of it, even in this long Spindle.

Fig. 7. is one of the Pins which hold the Cylinder in its Place, as has been ſaid; *a* is its Head; *b* the Stalk, which would be better to be a Screw at its

 lower

lower End, whereon to ſcrew a Nut; but then the Stalk muſt be ſquare at the Head.

Fig. 8. is a Sheat with its Trunk and Share of the Drill-plough, which has been deſcribed in *Plates* 4. and 5. but the Shape of the Share, as it riſes at the Socket, is more plainly ſeen in this Figure.

Fig. 9. is the whole Wheat-drill, which at preſent I uſe for planting the double Row. A is the Hopper, riſing and ſinking on the ſingle Standard B, which holds it up. C is the thing like the Carrier of a Latch, deſcribed by *Fig.* 22. in *Plate* 4. I need ſay no more for deſcribing this Drill, than to ſhew how it differs from that deſcribed in *Plate* 4. *viz.* This Hopper has Two of theſe Carriers, the one near its Top, like the other; and another near its Bottom, which keeps the Plough from riſing at either End, without the riſing of either End of the Hopper, which is no Inconvenience here; becauſe the Two Shares, being but Ten Inches aſunder, are almoſt the ſame as one; ſo that at the Diſtance the Wheels ſtand from each other, the riſing of one Wheel doth not lift up the Share that is next to it perceptibly; as it would do if the Shares were farther aſunder, or the Wheels nearer together.

This Hopper holds twice as much Seed as the ſingle fore Hopper did, *viz.* half a Buſhel; and is divided into Two equal Parts by the Partition *e*, whereby the Driller ſees whether the Seed is diſcharged equally; and if he perceives that one Part of the Hopper runs out faſter than the other, he muſt adjuſt them by the Setting-ſcrews.

The Funnels *a a*, which receive the Seed from the Hopper, and convey it down into the Trunks *c c*, appear under the Hopper, as doth alſo Part of the Hole *d*, whereon the Funnel ſtood when the fore Hopper was ſingle. D ſhews the Cylinder upon the grafted Spindle at one End, as F ſhews where the other End with its Cylinder and Wheel is taken off.

 The

The Ends of the Piece A, which guide the Harrow, appear behind the Plank at *f f*. At *g* in the Harrow-head is a Hole exactly in the Middle between the Tines, for tying on a Stone when the Harrow is too light for the Soil. *Note*, This Hole muft follow exactly after the Middle of the Plank, *i. e.* between the Two Shares at an equal Diftance from each.

Obferve, that the Legs of this Harrow go thro' the Head on the Outfides of the Tines, as in the treble Drill they go thro' on the Infide of the Tines. Inftead of the wooden Tines, may be put in common Iron Tines of a proper Length.

The Two Hooks whereby the Plough is drawn are at *h h*. 'Tis beft for the Ends of the Hooks to turn upwards, fo that the Links of the Chain-traces, that are to be put on them, may not be apt to drop off. Take care that thefe Traces be of an equal Length, which may be eafily made even by the Links that are put on thefe Hooks.

Note, The Links of the Piece of Chain, whereby the Plough is made to go deeper or fhallower, may be very fmall, and by no means in the Proportion they bear to the Limbers in the Cut. There need not be above Four or Five Links. If there be occafion to raife or fink the Limbers more than that Number will reach, the Cord may be tied longer or fhorter on the other Limber. And when there is not the Convenience of Chain-traces, they may be fupplied by a few Iron Links at the Ends of Hempen Traces.

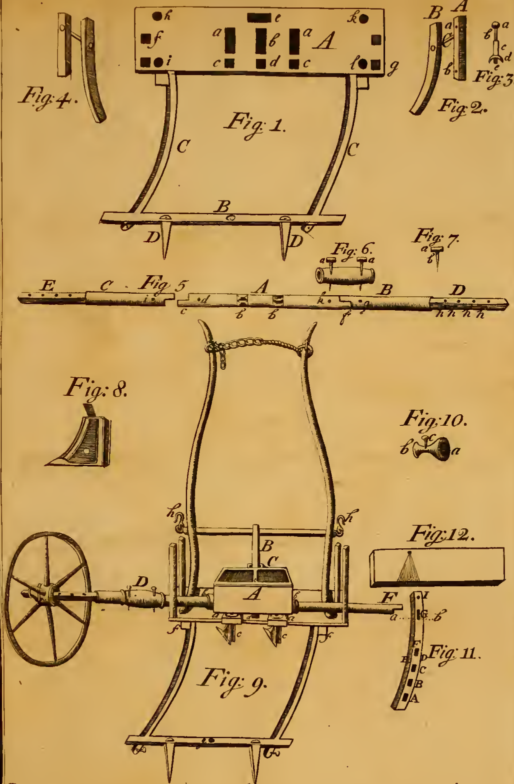
Fig. 10. is the Shape of a wooden Wreath, which (when the Shares ftand wider afunder, or when there are more than Two of them, fo that they come nearer to the Ends of the Plank, this Wreath) is neceffary to be put on the Spindle, the End *a* bearing againft the Infide of the double Standards, and the End *b* being towards the Hopper. 'Tis fixt to the Spindle by the Screw *c*, which fhould not enter the Spindle above half an Inch deep. There may be another like Screw to enter in the ſame manner on the oppoſite Side of this Wreath There muſt be in this caſe another Wreath the ſame of this to bear againſt the other double Standards. And when theſe Wreaths are uſed, the Hopper muſt have only the upper Carrier C; the lower one muſt be taken off. But in this our Drill for planting Wheat, no Wreaths muſt be on the Spindle, except thoſe at *b b*, which are to hold the Hopper from moving endways. And theſe may be of the Sort above deſcribed, the End *a* bearing againſt the Hopper.

Fig. 11. is the Beam of the Hoe-plough deſcribed in *Plate* VI. *Fig.* 2. with no other Alteration than leaving out the Hole H, and the pricked Line between it and the Hole I; and changing the Hole G into a Mortiſe. The pricked Line *a b* repreſents the hinder Edge of the Plank, behind which appears a very ſmall Part of a Mortiſe. See *p.* 415, 416.

Fig. 12. is the Plank, which is *Fig.* 3. in *Plate* VI. The Improvement of it in this Figure is deſcribed in *p.* 415, 416.

An Appendix *to Chap.* IX. *of* Wheat, *p.* 138. *containing* Memoranda *for the Practiſers of this* Huſbandry.

AT the Second Hoeing the Plough goes in the Furrow of the Firſt, making it deeper, and nearer to the Wheat. The Third Hoeing fills up this Furrow; and then, at the Fourth Hoeing, the Plough goes in the ſame Place as the Second, turning the Mould into the Interval. 'Tis remarkable that though the Furrows of the Second and Fourth Hoeings be deep, and near to the Rows, ſeeming to deprive the Wheat of the Mould which ſhould nouriſh it, whereby one would imagine, that theſe Furrows lying long open ſhould weaken or ſtarve it; yet it is juſt the contrary; for it grows the more vigorous: And it is the Obſervation of my Ploughmen, that they



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they cannot at these Hoeings go too near to the Rows, unless the Plough should tear out the Plants.

If I may presume to assign the Cause of this surprising Effect, it is, in my Opinion, the following; *viz.* This open Furrow has a double Surface of Earth, which by the *Nitre* of the contiguous *Atmosphere*, is pulverized to a great Degree of Minuteness near the Row. The Roots that the Plough cuts off on the perpendicular Side of the Furrow, send out new Fibres to receive the *Pabulum* from this new-made Pasture; and also Part of this superfine Powder is continually falling down into the Bottom of the Furrow, and there gives a very quick Growth to those Roots that are next it, and a quick Passage through it into the Earth of the Interval, where they take likewise the Benefit of the other Side of this pulverized Furrow. When it is said, that Air kills Roots, it must not be understood, that it kills a Plant, unless all, or almost all, its Root is exposed to it, as it is not in this Case. Some think there are Roots that run horizontally below the Plough into the Interval; but of this I am not convinced.

'Tis not often that we hoe above Four times; and then the Furrow is turned towards the Row at the Third time only.

There being no Danger from these Furrows lying long open, we are not confined to any precise Distance between the times of Hoeing, for which we need only regard the Weather, the Weeds, and our own Convenience of Opportunity and Leisure.

'Tis an Advantage when these Furrows lie open on each Side of the double Row till Harvest; for then there need only Two Furrows to be plowed on a Ridge to throw down the Partition in order for planting the next Crop; but if at the last Hoeing the Furrows are turned towards the Row, they must be plowed back again after Harvest before the Partition can be plowed: This requires double the time of the other; and the ſooner the Partitions are plowed, the more time they will have to be pulverized before they are replanted. Indeed this Advantage is only when the Rows are to be planted where they were the Year before; for this is rather a Diſadvantage when they are to be planted in the Intervals. Whether theſe Furrows lying long open next the Rows in very hot dry Climates may be prejudicial, cannot be known, but by Trials.

As from the external Superficies of an Acre of Paſture on a rich Soil, Animals take more *Pabulum* than of an Acre on a poor Soil; ſo Vegetables take more *Pabulum* from the internal Superficies of a rich Acre than of a poor one; the Pulveration, or Superficies of Parts, being equal. *See* p. 44, 45. From whence there is no Encouragement for making Trials on very poor Land.

'Tis no great Matter whether the Rows are drilled on the Partitions, or the Intervals; for the Crops of a Field, Four Years ſucceſſively drilled on the Partitions, were very good. After the Partitions had been plowed, and lain open till the Weather made them pulverizable by the Harrows, and then turned together by Furrows larger than thoſe which opened them, much Earth of the Intervals was mixed with them. This is the ſtrongeſt and loweſt Ground I have; and if there ſhould be much wet Weather after Harveſt, it is ſo long in drying, that we take the firſt Opportunity the Weather allows for planting the Wheat, which is generally done in the above manner, becauſe it is the ſhorteſt; but, without ſome ſuch Reaſon to the contrary, I prefer planting the Rows on the precedent Intervals.

My Field, whereon is now the Thirteenth Crop of Wheat, has ſhewn that the Rows may ſucceſsfully ſtand upon any Part of the Ground. The Ridges of this Field were for the Twelfth Crop, changed from Six Feet to Four Feet Six Inches: In order for this Alteration,

Alteration, the Ridges were plowed down, and the whole Field was plowed crofs-ways of the Ridges for making them level; and then the next Ridges were laid out the fame way as the former, but One Foot Four Inches narrower; and the double Rows drilled on their Tops, whereby of confequence there muft be fome Rows ftanding on every Part of the Ground, both on the former Partitions, and on every Part of the Intervals: Notwithftanding this, there was no manner of Difference in the Goodnefs of the Rows, and the whole Field was in every Part of it equal, and the beft, I believe, that ever grew on it. It has now the Thirteenth Crop, likely to be very good, tho' the Land was not plowed crofs-ways.

The proper Times for Plowings and Hoeings depending upon the Weather, and other Circumftances, cannot be directed but by the Reafon and Experience of the Practifer, as has been faid.

The Number of Ridges being increafed, as their Breadth is now diminifhed, occafions fomewhat the more Plough-work; we likewife ufe more Handwork than formerly; but the Profit of this increafed Labour is more than double to the Expence of it.

The Decline of the Woolen Manufacture furnifhes us at this time with Plenty of Hand-hoers and Weeders; becaufe they can earn much more by working in the Field than by Spinning at home.

'Tis better to make Fifteen Ridges on an Acre, than to leave any Earth unmoved by the Hoe-plough in the Middle of the Intervals; but when Ploughmen, by Practice, underftand well to ufe the Hoeplough, they will plow the Intervals clean, tho' the Ridges are only Fourteen on an Acre.

Bearded Wheat is in this Country called *Cone*, and that which has no Beard *Lammas*. I obferved formerly the Bread of *White-cone* had a little yellowifh Caft, which I now fufpect was from the Mill-ftones; for I have feen it be very white thefe many Years, fince the

the Millers know better how to grind this Wheat. Cone-wheat Weſtwards yields Six-pence a Buſhel more than *Lammas*; but towards *London* the contrary.

The Reaſons why a whole Field of Wheat doth not produce a Crop equal in proportion to a Yard or Perch cut, rubbed out, and weighed immediately upon the Spot, may be, becauſe the Grain of the Field lying to ſweat in the Mow, loſes conſiderably of its Weight and Meaſure. There is alſo ſome loſt in the Field by Reapers, and by Leaſers; and ſome is by Threſhers thrown out of the Barn; and ſome of them are found to have Contrivances to carry home with them at Night, Part of the Wheat they threſh in the Day. I ſay nothing of thoſe Thieves, who in Harveſt rob the Field in the Dark; tho' they are not very uncommon.

I miſſed of making my propoſed Experiment of the ſingle Row, after I had prepared for it by plowing out one of the double in ſeveral Places for that Purpoſe; but, in the Hurry of Harveſt, they were cut together with the reſt, without making any Trial; as ſhould have been made, if my Illneſs had not prevented my Attendance in the Field at the time of Reaping.

The Practice and Inſtruments that are left off for better in their room, as the Quadruple and Treble Rows, &c. are ſtill uſeful to be ſhewn, in order to deter others from going into an inferior Method that is now exploded; for ſome might think it an Improvement of the double Rows, &c. by their own Invention, if they ſhould not know it had been already tried.

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