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Pesticide Re-Evaluation Division
Office of Pesticide Programs
Environmental Protection Agency
1200 Pennsylvania Ave. NW
Washington, DC 20460-0001

RE: Pesticide Registration Review: Atrazine; Proposed Revisions to the Interim Registration Review Decision Memorandum; Docket No. EPA-HQ-OPP-2013-0266

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Introduction

The Weed Science Society of America (WSSA) appreciates the opportunity to provide comments to The U.S. Environmental Protection Agency's (EPA) proposed revisions to the atrazine interim decision released on June 30, 2022 (EPA, 2022b).

The WSSA is a non-profit professional society consisting of approximately 1,200 members from 46 U.S. states and 37 countries. Our organization promotes research, education, and extension outreach for the management of weedy plants. This includes providing science-based information to the public and to policy makers while fostering awareness of weeds and their impacts on managed and natural ecosystems. Our scientists publish their research in many journals, but the three journals published by the WSSA include Invasive Plant Science and Management, Weed Science, and Weed Technology.

The WSSA respects the challenges the Agency faces under the current registration and re-registration environment. Ample non-scientific court decisions coupled with the loss of Agency personnel is a monumental task to overcome, but one that can be addressed through partnering with science-based organizations such as the WSSA. The WSSA is committed to working with the agency to 1) generate accurate and usable science-based data to improve the regulatory process and 2) provide a direct connection to weed science research and extension experts working with herbicides across a range of environments. Furthermore, the WSSA is requesting the Agency consider the many benefits of developing WSSA-EPA working groups to cooperatively and more effectively address issues facing herbicides, including atrazine.

Although this document is focused on atrazine use in corn (field, sweet, etc.), sorghum, sugarcane, ornamentals, and turf, our ultimate objective is to develop a cooperative long-term strategy between the EPA and the WSSA facilitating more accurate regulatory <u>and</u> on-farm decisions based on a robust scientific data set.

Literature Review of Atrazine Movement from the Treated Area and Mitigation Practices

Extensive research and analysis of the physiological properties of atrazine have identified its potential for off-field movement. Due to its weak soil sorption, water solubility, and persistence in the environment, atrazine movement through surface water runoff from treated fields to watersheds, groundwater, and other bodies of water has been documented (Develin et al. 2000; Isensee 1988; Mueller et al. 2020; Ritter et al. 1974; Ryberg et al. 2020; Toccalino at al. 2014). This movement is known to be influenced by not only the chemical properties of atrazine, but also soil characteristics (soil type, pH, organic matter, etc.), field properties (slope), tillage practices, rainfall duration, intensity, and timing relative to application (DeLaune et al. 1997; Issa and Wood 2005; Kelly and Wilson 2000; Krutz et al. 2010). With these complex interactions, potential atrazine runoff is highly influenced by production practices and regions in which the product is utilized (Brecke et al. 1981; Burnside and Wicks 1980; Devlin et al. 2000; Gallaher and Mueller 1996; Krutz et al. 2009).

Scientists have invested significant efforts in understanding atrazine off-field movement, persistence in waterbodies, and how to minimize this contamination to preserve herbicide utility, while protecting sensitive environments (Doizer et al. 2007; Mueller et al. 2020; Toccalino at al. 2014; Wantanabe et al. 2007). Currently there are programs in place, or are being implemented, that educate and/or incentivize practices that reduce the potential for atrazine movement off-field through runoff. For example, in Kansas, an atrazine management program provides a flexible approach to implementing best management practices (BMPs) that are both suitable for the production region while also reducing atrazine runoff into the Little Ark Watershed. Producers who participate in the program receive an incentive payment based on the practice, helping offset implementation costs. Since the program was initiated in 2006, these BMPs have been implemented on 281,115 acres, with a 50.2% reduction in atrazine runoff from treated areas (KSU 2022). Additionally, in Nebraska, a cooperative effort between the Nebraska Department of Agriculture, the USDA, and the University of Nebraska has supplied educational resources for growers on regionally recommended atrazine BMPs for surface water quality, in an effort to help farmers identify and implement practices that are effective and suitable for their operation (Nebraska Department of Agriculture et al. 2019).

Thus, there is great potential to implement programs around the country where needed, that cooperatively work towards a common goal of understanding and preventing runoff on a local level. Mitigation that is tailored to practices that growers are familiar and comfortable with will promote adoption and acceptance. Therefore, the WSSA is committed to cooperating with the US EPA to address the concern of off-field atrazine movement, and identifying practical but effective practices that are sustainable, economical, and achievable for the many growers who utilize atrazine around the country.

Atrazine in US Agriculture

During the last five years, atrazine was applied to an estimated 65% of corn (60.7 million acres; USDA NASS 2022a) and nearly 71% of sorghum (3.7 million acres; USDA NASS 2020) acres in the US. In sugarcane, approximately 90% of the crop accounting for an average of 800,000 acres was treated with atrazine between 2012-2016 (EPA 2019a). Through consistent performance, low cost, residual and postemergence control of numerous weeds, flexibility in time and method of application, compatibility with other herbicides, and crop safety, atrazine has become deeply ingrained in US corn and sorghum production (Bridges 2008, 2011; Mitchell 2014; Swanton et al. 2007). In a study evaluating 449 combined university research trials from 2006 to 2010, results indicated that corn, on average, yielded 307.3 kg ha^{-1} more when atrazine was included in herbicide programs, compared to similar programs lacking atrazine (Fawcett 2012). Following atrazine's introduction, newer herbicides have entered the marketplace, but no true replacement to atrazine has been identified for integration into weed management programs by farmers around the country (Bridges 2008; LeBaron et al. 2008; Mitchell 2011). In fact, herbicides entering the market place after the commercialization of atrazine rely on being applied in mixture with atrazine for effective weed management (Bridges 2011; Jha 2022; Johnson et al. 2022; Lancaster et al 2022; LeBaron et al. 2008; Loux et al. 2022; Swanton et al. 2007; Warren 1998).

The loss of atrazine or restrictions limiting its use rate or application pattern would not only challenge farmers' ability to control weeds in labeled crops, but would likely rapidly exacerbate the development herbicide resistance. Also, of great importance, the use of atrazine not only positively influences the production of that crop, but has the same impact on crops grown in rotation as a result of seedbank dynamics (Schwartz et al. 2015; Schweizer and Zimdahl 1984). Currently, no alternative herbicides are available that provide equal economic and agronomic attributes when compared to atrazine (Bridges 2011; Carlson 1998; Carlson 2008; Gianessi and Reigner 2007; LeBaron et al. 2008; Mitchell 2011; Mitchell 2014; Swanton et al. 2007; Warren 1998). Even more concerning is the very limited potential for new registered herbicides (Davis and Frisvold 2017; Qu et al. 2021).

Atrazine in Turf

The use of atrazine, both preemergence and postemergence is a critical, cost effective component of turfgrass management programs. Atrazine provides control of numerous problematic broadleaf and grassy weeds for both homeowners and professional users, is safe on turfgrass species, and is a valuable resistance management tool (Askew 2022; Billeisen et al. 2022; Brosnan et al 2020a; Brosnan et al. 2020b; McCullough 2022; Stephenson et al. 2020). The spectrum of weeds controlled by atrazine lends to a simplified, effective weed management program in warm-season grasses.

Management of weeds in turfgrasses can be challenging, as species sensitivity directly influences herbicide selection. Atrazine products offer flexibility across numerous grass species, including St. Augustinegrass, and centipedegrass (Unruh and Brecke 2006; Reicher et al. 2013). For example, atrazine alternatives for control of dollarweed, dichondria, and doveweed in St. Augustinegrass can be more expensive, lead to erratic and unpredictable weed control, and may cause injury to the grass (Johnson 1973; McCarty et al. 1995; Yu and McCullough 2016). Similarly, centipedegrass is highly tolerant to atrazine. Atrazine controls winter annual weeds during the spring transition and reduces injury potential from alternative herbicides, which may delay greenup in the spring (Ferrell et al. 2006; Gannon et al. 2004; McElroy and Walker 2009). Additionally, atrazine is an essential resistance management tool in turfgrass production. Often combined with other herbicides such a *S*-metolachlor or mesotrione to enhance the efficacy of preemergence and postemergence weed control programs, atrazine used alone or in rotations can help control troublesome weeds where resistance is challenging sustainable management (Askew 2022; Billeisen et al. 2022; Brosnan et al. 2020b; McCullough 2022; Stephenson et al. 2020).

Ultimately, restrictions on the application rate of atrazine in turfgrass will likely: 1) increase the cost of weed control in lawns, sod production, and recreational turf; 2) compromise weed control efficacy; 3) increase problems with weeds that have limited control options available; and 4) impact the sustainability of turf weed management programs in warm-season grasses.

Atrazine in Guava and Macadamia Nut Crops (Ornamental Crops)

While acreage is minimal compared to agronomic crops and turf, atrazine is a critical herbicide in several ornamental crops, including macadamia nuts and guava. In 2017, macadamia nuts were grown on over 18,000 acres of land, accounting for nearly $54 million in total production (USDA NASS 2022 b,c). While the majority of macadamia nut acreage is in Hawaii where atrazine is no longer available, suitable production sites have been identified in Florida and California (Kawate and Tarutani 2006). As a crop with few efficacious registered herbicides, and diuron as its most suitable alternative being challenged through the regulatory process, atrazine provides excellent control of troublesome weeds when applied preemergence and postemergence (Kawate and Tarutani 2006). Maintaining the option of atrazine use in macadamia nuts is critical to ensure sustainable, economical production.

For guava, the most recent survey accounted for nearly 1,100 acres in the US, with production valued at $306,000 (USDA NASS 2022 d,e). Nearly 90% of this production occurs in South Florida, with suitable sites also identified in California (Mossler and Crane 2002). Weeds including grasses, sedges, and pigweed species directly compete with guava trees for water and nutrients, and as few herbicide options are currently registered, it is essential that atrazine is available for these production systems (Mossler and Crane 2002).

Atrazine as a Component of an Integrated Weed Management Program

The most valuable attribute of atrazine is its contribution to integrated weed management programs and conservation efforts. Atrazine is rare among herbicides because it controls many of the nation's most problematic weeds in two ways. The herbicide has preemergence utility by controlling small emerging seedlings through effective residual activity, while also having the added benefit of foliar activity to control small, emerged weeds when applied postemergence (Brecke et al. 1981; Bridges 2011 Buhler et al. 1994; Bulcke et al. 2005; LeBaron et al. 2008). This flexibility and extended control through the season allows farmers a greater chance at success of controlling weeds such as Palmer amaranth and waterhemp (Bridges 2008; Jha 2022; Johnson et al. 2022; Lancaster et al 2022; Loux et al. 2022). Atrazine is an excellent tank-mix partner with other herbicide modes of action offering farmers the ability to utilize multiple mechanisms of action simultaneously, which can provide season-long weed control and delay the selection of herbicide-resistant weeds (Norsworthy et al. 2012).

Conservation tillage systems (including no-till, strip-till, and other reduced tillage methods) are widely accepted and utilized by farmers in many US cropping systems (Derpsch et al. 2010; Fawcett 2008; Vitale et al. 2011). Advantages of conservation tillage are numerous, and result in both environmental and agronomic benefits and have even been promoted as a key avenue for agriculture to positively influence climate change (Derpsch et al. 2010; Hussain et al. 2021; Langdale 1994; Tilman et al. 2002). Because atrazine controls emerged weeds, provides soil residual activity, and exhibits weak adsorption to crop residue, the herbicide is uniquely suited to conservation tillage systems (Fawcett 2008; Langdale 1994; Tilman et al. 2002; Triplett and Dick 2008).

The inability to use atrazine at optimum rates to control troublesome weeds in these production systems threatens to mitigate the following benefits of conservation tillage: 1) protection from soil erosion due to wind and water; 2) increased water infiltration which reduces runoff; 3) improved biodiversity in soil and surrounding land; 4) increased soil organic matter content; and 5) sequestration of atmospheric carbon dioxide in the soil which reduces the release of greenhouse gas (Bridges 2008; Fawcett 2008; Harker and O'Donovan 2017; Hebblethwaite and Somody 2008). Ultimately, the combination of conservation tillage and atrazine as a weed management tool at scientifically established use rates and application parameters fosters the ability to keep agricultural inputs in the treated area, thereby preventing movement out of the field into water (Bridges 2008; Dong et al. 2013; Hebblethwaite and Somody 2008; Potter et al. 2004, 2011; Swanton et al. 2007).

Agriculture is Threatened by the Lack of Weed Management Tools

The importance of diversified weed management programs that focus on reducing the weed seed bank through planting into fields free of weeds, rotating crops, maximizing crop competitiveness, integrating non-chemical practices, removing weed escapes, and using diverse herbicide chemistries within and across years has been promoted for decades (Beckie 2006; Beckie and Harker 2017; Harker and O'Donovan 2017; Walsh and Powles 2007; Zimdahl 2018). As supported by abundant research, these methods of herbicide resistance management remain the building blocks for future programs, but farmers must have tools available if they are to remain sustainable. The U.S. EPA is very knowledgeable of this concern and the agency promotes the use of diversified herbicide mode of action programs toward weed management (U.S. EPA 2017). The introduction of new conventional herbicides has been slowing since the mid-1980's, indicating that new herbicides will not be available to replace existing herbicides (Phillips McDougall 2018). Thus, the approach of removing effective tools available at optimum rates and use patterns from a grower's toolbox must be taken very seriously. Decisions must be made, 1) using sound science, 2) considering practical pesticide use patterns, 3) evaluating the most recent data, and 4) developing a more transparent approach of weighing benefits verses risks when a tool is being registered or reregistered.

The loss of atrazine's effectiveness by reducing rates below optimum levels or having overly conservative regulations limiting herbicide use (e.g., requiring a set of mitigation practices from a picklist that may not be suitable for some growers), would challenge integrated weed management systems. As regulations cause the loss of tools or restrict them to the point where they can't be used effectively, then the risk of herbicide resistance increases (Bulcke and Desmet 2005; Gressel and Segel 1990; Renton et al. 2011). As herbicide resistance increases, research suggests there will be a correlated increase in inputs and associated costs, whether through additional herbicide applications or cultural practices, increased equipment costs, more trips across the field, higher fuel expenses, or hand labor to manually remove weeds (Culpepper et al. 2010; Legleiter et al. 2009; Mueller et al. 2005; Norsworthy et al. 2007, 2012). If these additional weed control practices are not effective, crop loss will result with negative economic impact. Additionally, as changes in agronomic practices are likely to arise without the ability to use atrazine, practical use patterns of other herbicides and changes in weed populations (species shifts, community composition, etc.) will likely occur to the detriment of the farmer (Buhler et al. 1994; Derksen et al. 1993; Johnson et al. 2009; Swanton et al. 1993). The loss of atrazine as an effective weed management tool would not only increase the potential for resistance development for atrazine but also for other herbicide active ingredients used in respective crops.

Proposed Revisions to the Atrazine Interim Decision

WSSA Extension Committee Members were surveyed seeking input on the EPA's proposed mitigation measures and proposed picklist conservation practices for atrazine, as a result of the WSSA-EPA atrazine webinar discussion. ***Comments below are guided by the survey and may reflect the opinion of individual weed scientists and not that of WSSA. The WSSA welcomes the opportunity to foster a connection between experts making these comments and scientists from the agency.***

Proposed Mitigation Measures

1. *Soil Saturation Restriction:*
    - Prohibiting applications to saturated soil is a reasonable mitigation, especially when considering equipment would get stuck or destroy soil structure if applicators attempted to drive over the field.
2. *Prohibiting aerial applications:*
    - Eliminating the ability for farmers to apply atrazine through aerial applications would essentially eliminate its use in some scenarios. Many corn and sorghum regions experience short windows of time to treat numerous acres during adverse weather conditions. Aerial applications would provide a greater opportunity to treat more land quickly, while avoiding saturated soil conditions, and improving the potential of making timely and effective applications related to weed size.
    - The EPA (2022c) has indicated that prohibiting aerial applications will not reduce atrazine runoff and that the offsite movement due to drift is much less than the environmental loading due to runoff. It would be helpful to scientists if there was a description of how much the environmental risks will be reduced by prohibiting aerial applications.
    - By limiting the maximum use rate to 2.0 lb ai/acre, and specifying a maximum windspeed restrictions and a 50% swath displacement on the downwind side of the field, the risks posed by aerial application should be similar to ground applications of atrazine.
3. *Prohibiting application during periods of active rainfall, when a storm is even likely to produce runoff events is forecasted to occur within 48 hours following application:*

- Avoiding an application within 48 hours of rainfall events that cause runoff of herbicides is supported by the literature and advised (Potter et al. 2014, 2016). However more guidance to growers on following this requirement would be beneficial.
- The pesticide runoff models are influenced by the soil curve number, which are heavily influenced by the hydrologic soil groups (HSG Groups A, B, C, and D). The calculated final infiltration rates of the HSG Group C and D soils are two to ten times lower than the HSG type A & B soils. Given this large difference in infiltration rates, would it be possible to link the 48 hours prohibition on spraying only to HSG soil groups C & D?

4. *Atrazine use rate restriction:*
    - *For corn:* Although some data exists with current atrazine use rates (USDA 2022a), it is currently unknown what percent of acres are using more than 2 lb ai/A to manage weeds. For example, in Georgia and Kentucky between 2014 and 2021 the two highest rates on average were 1.92 and 1.87 lb ai/A per year, respectively. Based on results of our survey coupled with the current data available by the USDA (USDA 2022a), we believe the number of acres being treated with over 2 lb ai/A per year may be minimal. A working group could be developed to determine specific geographic locations at the local level, identifying the target pest and locations that require higher rates. With potentially minimal areas needing 2.5 lb ai/A of atrazine, a label could be specifically developed to achieve regulatory, environmental, and grower needs effectively. *Although no survey participants mentioned sorghum or sugarcane, this process could also apply to those crops.*
    - *For field corn, sweet corn, and sorghum:* Lowering the approved rate of atrazine from 2.5 lbs to 2 lbs ai/acre prior to having mitigation measures defined is premature, as some mitigation measure may allow continued use of the 2.5 lb ai/A rate.
    - Lowering the rates of atrazine to a level below the scientifically developed recommended use rate will likely increase herbicide resistance development. Identifying areas and key weeds where use rates are needed above the newly proposed maximum rate is essential.
    - Applying multiple modes of action (often premixes) to control problematic weeds is the backbone of a sound weed management program (Norsworthy et al. 2012). If rates of atrazine are reduced in premixes this will cause either: 1) a reduction in the rate of the tank-mix partner thereby promoting herbicide resistance to both chemistries, or 2) an interval of time needed to reformulate the premix by the registrant. Additionally, applications may have to be supplemented with additional herbicide partner products to achieve an acceptable level of weed control, resulting in additional expenses for the farmer and greater volumes of total pesticides applied to a single acre.

Proposed Picklist Mitigation Measures

The WSSA greatly supports the Agency's efforts to allow flexibility for growers and would like the opportunity to assist in developing effective strategies. Simplifying the process, while improving adoptable mitigation practices, is achievable and could be facilitated more effectively through working groups. The WSSA understands that the final picklist on the label will list different point values for the different regions of the country and soil types. Appendix A Table 2 of the atrazine proposed revisions to the PID indicates that depending on the region of the country and the erodibility of the field, users will need to adopt one to four runoff reduction practices for field corn, one to two practices for sweet corn, and one to four practices for sorghum. As described below, the greater the number of runoff reduction practices required, the more farms that will not be able to use atrazine.

1. *No Preemergence (to the crop) Applications*:
    - Although we do value and understand the Agency's approach with this option, it is not a sound scientific practice for weed management (Beckie 2006; Beckie and Harker 2017; Walsh and Powles 2007). If the Agency moves forward with this as an option, we strongly encourage a concise and clear discussion be included, ensuring growers understand this is not advised for a sustainable weed management program.
    - Preemergence applications are the most beneficial timing of atrazine applications as it is needed to control the small, newly emerging weed seedlings. This is the most important use of atrazine for weed management purposes because these applications are made during the critical period for weed control (Ulusoy et al. 2020). Preemergent applications of atrazine account for 60% of total pounds applied (EPA 2019b) and the loss of this application timing would have very large impacts.
    - Atrazine applied preemergence (to the crop) is a valuable tool that allows farmers to control existing weed vegetation prior to planting in no/reduced tillage scenarios. Promoting the removal of this use could lead to a reduction in conservation tillage practices and a concomitant increase in soil erosion and runoff.
    - Since atrazine is heavily utilized in preemergence herbicide weed control programs (especially as a key component of premixes), excluding this use will force farmers to heavily utilize Group 15 (VLCFA) and Group 27 (HPPD) chemistries, which increase herbicide resistance pressure on these products that already have confirmed resistant weed biotypes in the U.S. (Heap 2022)
    - Limiting atrazine to postemergence crop applications creates a logistical challenge for farmers and applicators. Applicators will be faced with a "compressed" application window, where millions of acres of cropland must be sprayed in a very short period of time, creating an unequal distribution of time,

resources, and equipment amongst all crops grown by that producer. This scenario increases stress on the farmer, potentially causing untimely applications.

- Atrazine is an important component of many herbicide premixes that include multiple modes of actions. Precluding preemergence use of atrazine may eliminate a practice documented to slow the evolution of weed resistance to herbicides.
- Ultimately, eliminating the ability to utilize atrazine preemergence to the crop increases the potential for crop yield loss due to weed interference. This will reduce the per-acre productivity of crops in which atrazine is used for weed control. If yield losses are high enough, the farmer may not be profitable with the crop, and could be forced to grow an alternative crop with less profit potential. The EPA (2022b) estimates that net revenue will decrease by 61% in field corn, a complete net revenue loss in sweet corn, a decrease of 67% of net revenue in sorghum, and a 17% decrease in net revenue for sugarcane. These levels of reduction in net revenue would not be sustainable. ***In addition, mitigation practices are expected to be most burdensome for small and lower income farmers (EPA 2022b).***
- If prohibiting preemergence applications is designed to reduce runoff due to early season (spring) rainfall, could a mitigation option allow preemergence use if the corn is planted after the early spring rainfall season?
- Seasonal rainfall patterns and crop planting dates vary widely across the country and by year. Thus, prohibiting preemergence atrazine applications is no more of a guarantee that atrazine runoff will be reduced compared to postemergence applications.

2. *Vegetative Filter Strips, ≥30 ft for Hydrological Soil Groups A & B or ≥ 100ft for Hydrological Soil Groups C & D:*
    - Offering vegetative filter strips is a valid option, but not one that can be used by most growers. Several reasons this practice cannot be considered a widely adoptable practice are as follows:
        i. Implementing in-field vegetative filter strips will require installation on millions of acres of farmland where atrazine is utilized.
        ii. Vegetative filter strips are costly measures to implement and maintain, with no clear understanding of who will be responsible for expenses (landowner, renter, farmer, applicator, etc.).
        iii. Farmland will likely be removed from production to adopt this method.
        iv. The practice is not an option for small fields, or those with little slope and runoff, as undesirable effects surrounding runoff may occur (i.e. ponding).
        v. Significant maintenance programs will be required to ensure vegetative field strips are maintained properly, which will be added costs of equipment and time. For example, maintenance could involve extra costs due to regular mowing, applications of herbicides to control unwanted weeds, or fire to control all of the species.
        vi. This approach should be unified with NRCS and their conservation plans.

3. *Cover Crop (on-field):*
    - Using cover crops are an extremely effective management tool for mitigating the movement of pesticides from treated fields and is an excellent option for many growers (Potter et al. 2004, 2011, 2015, 2016). Potter et al. (2016) noted that after four years of sampling, aggregated total fomesafen runoff losses from conventional plots was 2.7 g ha^{-1} compared to 0.05 g ha^{-1} from conservation plots with a rye cover crop.
    - *To simplify the pick list approach and to mitigate the movement of herbicides from the field, it appears scientifically feasible that the use of a cover crop following NRCS protocols would be an effective stand-alone procedure without the need of any additional mitigation measure for at least some regions of the country (Potter et al. 2004, 2011, 2016).*
    - This practice should support atrazine rates of 2.5 lb ai/A for corn and sorghum in areas needing this use rate.
    - Cover crops are typically not feasible is some western geographic regions due to limited moisture availability.
    - Some growers in the Northeast US have had problems with slugs in their cover crops and the available molluscicides do not effectively control this problem.
4. *Contour Buffer Strips (on-field), Contour Farming (on-field), and Terrace Farming (on-field):*
    - These approaches are valid options and should be included on the list, but these practices will not be adoptable by many growers. Several reason this practice cannot be considered to be a widely adoptable practice are as follows:
        i. The use of contour and terrace-based mitigation options are limited to fields with measurable slope producing runoff. These mitigation practices do not provide benefit to fields with flat topography, as is found in many U.S. field corn, sorghum, sugarcane, and sweetcorn producing regions.
        ii. These mitigation measures are extremely costly to implement and difficult to maintain, therefore are not feasible for many farmers.
        iii. Implementing contour and terrace-based mitigation measures will take significant arable land out of agronomic production, impacting food supplies.
        iv. This approach should be unified with NRCS and their conservation plans.
5. *Grassed waterways and field borders:*
    - Both practices are sound approaches that should be included as options, however both have significant limitations.
        i. Implementing field borders and grassed waterways will require installation on millions of acres of farmland where atrazine is utilized.
        ii. Field borders and grassed waterways are costly measures to implement and maintain, with no clear understanding of who will be responsible for expenses (landowner, renter, farmer, applicator, etc.).
        iii. Farmland will likely be removed from production to adopt this method.

iv. Not an option for small fields, or those with little slope and runoff, as undesirable effects surrounding runoff may occur (i.e. ponding).
v. Significant maintenance programs will be required to ensure these areas are maintained properly which will be added costs of equipment and time. For example, maintenance could involve extra costs due to regular mowing, applications of herbicides to control unwanted weeds, or fire to control all of the species.
vi. This approach should be unified with NRCS and their conservation plans.

6. *Irrigation Water Management:*
   - Overhead irrigation is an excellent approach to reduce pesticide runoff and should be a clearly defined and approved mitigation measure. Potter et al. (2016) noted that less than 1% of applied fomesafen left the field through runoff in their study making the following conclusion: "relatively low runoff rate was linked to post-application irrigation incorporation". This was observed even though there was a runoff event on the day of application, a worst-case scenario. One likely explanation of the relatively small amount of fomesafen lost in runoff was that the herbicide was incorporated with 12.5 mm of irrigation following applications. During rainfall simulations conducted at the same location, irrigation incorporation on conventional plots reduced fomesafen runoff nearly 2-fold (Potter et al. 2011).
   - *To simplify the pick list approach and to mitigate the movement of herbicides from the field, it appears scientifically feasible that the use of irrigation would be an effective stand-alone procedure without the need of additional mitigation measures, at least within some regions of the country (Potter et al. 2011, 2016).*
   - The volume of water and time of irrigation should be that recommended by state Extension Services or state-led pesticide agency.
   - The current description as "Irrigation Water Management" inherently lacks much detail as noted below by many of our weed scientists.
     i. Further clarification is needed regarding irrigation water management
     ii. Every farm with irrigation makes different management decisions.
     iii. Will this mitigation require the use of certain irrigation equipment?
     iv. Will this mitigation practice limit the amount of water that could be applied to the crop at one time?
     v. Will this mitigation practice be based on the use of irrigation modeling? Historically, the use of irrigation modeling has not been effective in meeting crop/water demands in certain regions of the U.S., such as the Southern Great Plains.
     vi. Will this mitigation practice be linked to soil type?
7. *Strip Cropping:*
   - The approach of planting mixes of crops in strips has the potential to be valid depending on how it is implemented. However, this practice will not be largely

implemented. There are several reasons why this practice cannot be considered to be a widely adoptable practice:

i. The use of strip cropping is not feasible for implementation on large amounts of acres.
ii. Avoiding pesticide contamination across crops is often not achievable. Many newer herbicide labels have very large infield buffers next to non-labeled crops. This could preclude the use of those herbicides in a strip cropping system unless all of the crops are on the herbicide label.
iii. Harboring of insects and diseases are often problematic with this production scenario.

8. *Soil Incorporation to a Depth of 2.5 cm (1 in):*
    - This mitigation measure can be an effective approach and should be included as an option (Develin et al. 2000; Johnson et al. 2012; Rector et al. 2003a,b). However, once again this practice will not be largely adopted because of labor and equipment issues, and the desire of farmers to eliminate tillage.
    - Incorporating atrazine will eliminate the ability for producers to implement reduced and no-tillage conservation practices. These tillage practices were designed to mitigate the effects and potential for runoff and soil erosion, therefore their elimination would lead to adverse effects.
9. *No Tillage/Reduced Tillage/Strip-Tillage (on-field):*
    - This practice is one that is extremely effective in mitigating the movement of pesticides from treated fields and is an excellent option for many growers (Potter et al. 2004, 2011, 2016). Potter et al. (2016) noted "Over four years in which samples were collected, aggregated total fomesafen runoff losses from conventional plots was 2.7 g ha^{-1} and from strip-till plots 0.05 g ha^{-1}"; the strip-till system included a rye cover crop. In 2011, Potter et al. noted that after making "seven fluometuron applications" and "measuring 10 years of surface runoff" that the level of surface runoff was 1.2% of the applied fluometuron for conventional systems and 0.31% for strip-till systems.
    - *To simplify the pick list approach and to mitigate the movement of herbicides from the field it appears scientifically feasible that the use of no-till, strip-till, or reduced tillage practices would be an effective stand-alone procedure without the need for additional mitigation measures, at least in some parts of the country (Potter et al. 2004, 2011, 2014, 2015, 2016).*
    - This practice should support atrazine rates of 2.5 lb ai/A for corn and sorghum in areas needing this use rate.

Additional Comments by WSSA Scientists.

Again, *comments below may reflect the opinion of individual weed scientists or a group of scientists but not that of WSSA. The WSSA welcomes the opportunity to foster a connection between experts making these comments and scientists from the agency.*

1. *Interpretation and adherence to guidelines:*
    - Many production acres are rented land, with the land owner not the individual actively farming the land. Additionally, many producers utilize the services of custom pesticide applicators. In these situations, who would be responsible for expenses and for selecting a set of mitigation measures from the picklist, and maintaining, complying, and reporting on those mitigation measures?
2. *Consideration of field history of atrazine use:*
    - It is well documented that cropland with an extensive history of atrazine use have built up **microbial populations in the soil capable of enhanced degradation of atrazine**, which may offer an opportunity for an additional mitigation practice (Krutz et al. 2008; Mueller et al. 2010; Odero and Shaner 2014; Shaner et al. 2014; Yale et al. 2017). In these fields, atrazine is rapidly broken down so the amount of herbicide that could runoff is greatly reduced.
3. *Finding enough suitable/realistic options on the picklist:*
    - With diverse production practices utilized in different regions of the U.S., the ability for growers to implement enough suitable strategies on their operations could be challenging.
    - For field corn or sorghum, some regions will require four runoff reduction practices. This will be very difficult to accomplish and may not be feasible for many farmers.
    - Sites that require one or two runoff reduction practices should be feasible for most farmers, especially if additional options as noted in this document could be adopted.
    - An effective solution to this process, and one to simplify the process, may be to limit the number of mitigation measures required in at least some portions of the country. Examples may include 1) cover crops, 2) no-till, strip-till, or reduced till production, and 3) when irrigating the herbicide into the soil prior to a rainfall event that might cause run-off.
4. *Modeling data*
    - Our members continue to raise questions about decisions based on models, especially the input parameters that are being used.
    - Models are overly conservative.
        i. They are not biologically or statistically tested models. They are physical chemical equations designed by soil scientists that account for the parameters they consider important.
        ii. The models appear to not be supported by statistical analysis from multiple sites and soil types as would be expected with a biological or statistical model.
        iii. Models may be effective within a watershed but not across watersheds.
        iv. In the areas of the country where the models overestimate runoff would it be possible to require fewer mitigation measures?

- The value of agricultural commodities and their importance to human sustainability must have a higher benefit weight in the risk and benefit decision process, especially if models are being used to describe the risk.
- In general, many WSSA scientists continue to struggle understanding the models and the methods used generating outputs. Developing a working group to better understand the process, the calculations, and the input parameters so our members can become better partners in helping regulators make scientific decisions would be beneficial.
- It would be helpful to our members if the list of herbicides used to develop and validate the physical chemical equations of models were available. A better understanding of the chemical and physical input parameters could be used by WSSA members to develop research plans to target mitigation practices that would further reduce pesticide runoff. The list of herbicides used to develop and validate the model could be posted to www.regulations.gov so that all interested parties could see them.

5. *Soil texture*
    - We are aware that soil texture is included in the surface water pesticide runoff predictions; however, we do not understand how the model makes specific calculations for the country. Is the model assuming an average texture classification for the entire country or, is it using the classification that poses the most risk for all acres? Since soil textures vary tremendously across the country this should be considered as a mitigation measure.
    - Table 2 of the Atrazine Proposed Revisions to the PID (EPA 2022b) did include credits for soil type for 30- or 100-foot vegetative filter strips. Since soil texture can have large impact on runoff, it is unclear why this appears to be the only place where it is used to adjust the runoff reduction practices.
6. *Land topography/slope*
    - We are aware that land topography and land slope are included in the surface water pesticide runoff predications; however, we do not understand how the model makes specific calculations for the country. Is the model assuming an average for field slope across the entire country or is it taking the worst-case field slope scenario and placing those values on all fields? Since slope varies for every field and has such a huge influence (Potter et al. 2014), this should be a mitigation measure. For example, soils with minimal slope would have far less runoff than those with a high slope gradient and would not pose the same level of pesticide runoff risk.
7. *Ability to access "Atrazine Concentration List 1: Watersheds with Predicted Concentrations of 3.4-9.8 ppb"*
    - Users will need to access the internet to view the Atrazine Concentration List 1 or 2 to verify how they can use the herbicide on their field. The USDA stated that in 2021 only 67% of farm operations own or use desktop or laptop computers (USDA 2021). Therefore, it may be impossible or prohibitively expensive for atrazine users to make sure they are following current EPA requirements. Could

the EPA make sure that paper copies of these documents are available to the approximately 1/3 of farmer operations that do not own or use desktop computers?

8. *FIFRA is a risk benefit statute*
    - The Proposed Revisions to the Atrazine Interim Registration Review Decision (EPA 2022b) describes the benefits of atrazine and impact to the users if the herbicide is not available. However, the document spends very little time describing the risks to the environment. In fact, the Environmental Fate and Effects Division supporting document (EPA 2022c) lists "potential" impacts of reduced biological diversity, reduced food items, reduction in habitat, increased erodibility, and reduction in water quality, etc. but does not provide any examples of documented impacts.
    - As a risk benefit decision document, it would be helpful to WSSA members if they could see the list of documented environmental impacts that are being weighed against the clearly described benefits. Since the Pesticide Reevaluation Division would have used that same list to make their risk benefit decision, it should not be any additional work to post it to www.regulations.gov where all interested parties could see the information.
9. **Confirm and Schedule a FIFRA Science Advisory Panel (SAP) Review**
    - The EPA needs to seek external peer review of atrazine's risks to aquatic plant communities, including the 3.4 ppb CE-LOC given the scientific complexity.
    - There is a history of different scientific methodologies, models, and weighting of studies that cause different determinations for LOCs.
    - Many of these past ecological and scientific reviews concluded higher LOC's for atrazine (Gonzalez-Valero et al 2003).

As members of the WSSA, we believe that science is the building block of all sustainable weed management programs. We also believe science must be the basis of all regulatory decisions, without being manipulated by unproven pesticide models or overly-conservative model inputs. Our commitment to providing data to support regulatory decisions has never wavered and our willingness to cooperate is strong. Herbicides are critical tools of agriculture and are essential if our farmers and ranchers are to feed and clothe the world. Impacting our growers by limiting a weed management tool must be taken seriously.

The WSSA would like to thank the numerous weed scientists contributing to this document and would like to also thank the EPA for their willingness to accept input from our members.

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