CENTER FOR FOOD SAFETY

October 7, 2022

OPP Docket
Environmental Protection Agency Docket Center (EPA/DC) (28221T)
1200 Pennsylvania Ave. NW.
Washington, DC 20460-0001

Re: Docket EPA-HQ-OPP-2013-0266: Comments on the Proposed Revisions to the Interim Registration Review Decision

Center for Food Safety appreciates the opportunity to comment on EPA's proposed revisions to the interim registration decision for atrazine, on behalf of itself and its 970,000 members and supporters. Center for Food Safety (CFS) is a public interest, nonprofit membership organization with offices in Washington, D.C., San Francisco, California, and Portland, Oregon. CFS's mission is to empower people, support farmers, and protect the earth from the harmful impacts of industrial agriculture. Through groundbreaking legal, scientific, and grassroots action, CFS protects and promotes the public's right to safe food and the environment. CFS has consistently supported comprehensive EPA review of registered pesticides and individual inert ingredients.

CFS incorporates by reference the comments submitted to this docket by the Center for Biological Diversity.

EPA proposes to restore *status quo ante* with revisions to the PID

The Trump Administration's EPA issued an interim registration review decision for atrazine on September 14, 2020. That decision was challenged by Center for Food Safety and other groups for lack of substantial supporting evidence on October 30, 2020. EPA then requested a voluntary remand to reconsider its predecessor's interim decision (ID). In particular, EPA wanted to re-evaluate the ID's establishment of an aquatic safety threshold of 15 µg/liter. This threshold – known as the Concentration Equivalent Level of Concern (CELOC) – is the 60-day average concentration of atrazine above which the structure, function and/or productivity of the aquatic plant community, and by extension the aquatic ecosystem that depends upon it, is likely to be adversely affected (EPA 6/23/22, p. 3). EPA seeks comment on its proposal to set the CELOC at 3.4 µg/liter.

Proposed CELOC is better supported by science

EPA had established the 3.4 µg/liter CELOC for atrazine – nearly 5-fold lower than the Trump EPA's CELOC – in its exhaustive 2016 ecological risk assessment. This science-based determination was grounded in 46 published mesocosm/microcosm studies encompassing 87 endpoints (EPA 4/12/16, p. 197). It was based on multiple rounds of analysis and modeling, incorporation of new studies as they became available, re-analysis in response to the recommendations of several Scientific Advisory Panels, and public comments, including input from atrazine manufacturers and their allies. As such, it represents the culmination of a years-long process that distilled the expertise of hundreds of scientists both within and outside of EPA.

The CELOC of 3.4 µg/liter has far better scientific support than 15 µg/liter, and is itself far from conservative. With regard to the universe of microcosm and mesocosm (cosm) studies referenced above, the effects of atrazine at concentrations below the CELOC of 3.4 µg/l were recorded for 11 endpoints: roughly equal numbers represented adverse effects on the aquatic community (5) as no effect (6) (see Fig. 31 below). Effects on community composition were observed at concentrations up to 34-fold lower than the proposed CELOC. In indoor mesocosm experiments, Pannard et al. (2009) observed sharp declines in multiple phytoplankton populations after seven weeks of exposure to atrazine at 0.1 and 1.0 µg/liter, with clear shifts in community structure at the latter concentration as well as at 10 µg/liter, and no recovery noted (discussed at EPA 4/12/16, p. 203, Appendix G.2). After seven days of exposure to atrazine at 1 µg/l, Lampert et al. (1989) observed declines in oxygen saturation, chlorophyll a and density of multiple zooplanktons; at 0.1 µg/l, they observed reduced photosynthetic rate and reduced oxygen saturation, as well as a die-off of daphnia (EPA 4/12/16, pp. 200-201, Appendix G.2). In the study EPA designates as Seguin et al. (2001b), the authors observed a shift in the structure of the aquatic plant community when exposed to atrazine at 2 µg/liter: namely, an increase in density of golden algae (*Chrysophyceae*) after 40 days exposure, and a decline in abundance of *Chlorophyceae* (a class encompassing many common green algae); these same shifts, but more pronounced, were observed at 30 µg/liter (EPA 4/12/16, pp. 202-203, Appendix G.2).

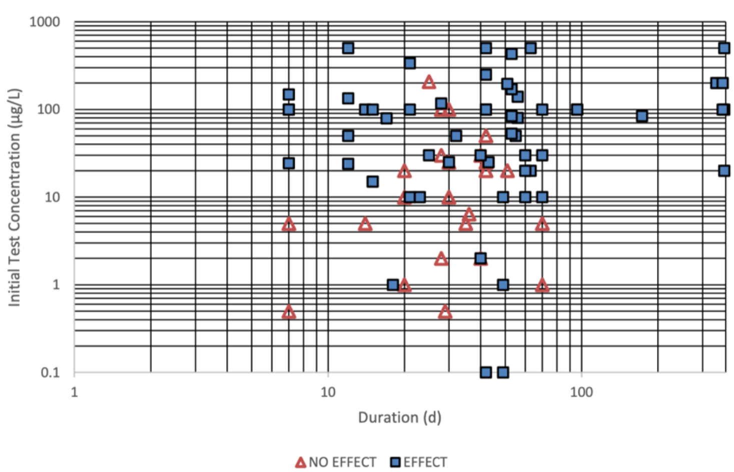

Figure 31. Distribution of Effect and No-Effect endpoints as related to initial study concentration and reported duration.

Source: EPA 4/12/16, p. 191.

In picking 15 µg/l as the CELOC, the Trump Administration's EPA essentially threw out years of careful work by EPA scientists and decades of scientific research on atrazine. As EPA explains, this value "was not determined based on an analytical assessment," is not supported by any "models, calculations or statistics," and hence "was not based in sound science." Rather, it was a politically motivated decision aimed at permitting continued unrestrained use of this toxic herbicide.

Instead of analysis, Trump's EPA rested its case for raising the CELOC to 15 µg/l on vague speculations regarding the potential for aquatic plant communities to recover from the adverse effects of atrazine exposure. But it also conceded that recovery was only rarely observed in the cosm studies, and that "variability in the [cosm] dataset makes it difficult to identify a range of exposure values and exposure durations from which the aquatic plant community would be expected to recover" (EPA 10/22/19, p. 4). However, this did not prevent them from reaching a conclusion entirely unsupported by the cosm data. Dismissing decades of research on atrazine, Trump's EPA cited two papers to support its position that aquatic plant communities have the potential to recover from short exposures to lower concentrations of atrazine: Huber (1993) and Eisler (1989).

Eisler may well have presumed recovery was possible because of his belief that atrazine breaks down quickly in the environment. He stated that "[a]trazine degrades rapidly," with a "[h]alf-time persistence of about 3 days in freshwater" (Eisler 1989, p. 2). If this were so, then it would be easy to believe in rapid recovery of exposed aquatic plants. Today, of course, we understand that atrazine and its degradates are quite persistent. Atrazine has half-lives that range up to 155 days in aerobic river and pond water, and 608 days in anaerobic aquatic environments; field dissipation half-lives vary dramatically in different regions, but range up to 405 days (EPA 4/12/16, pp. 65, 67).[1] Despite his assumption of rapid breakdown, however, and contrary to Trump's EPA, Eisler (1989) actually recommended an atrazine threshold of 5 µg/l to protect sensitive aquatic flora, which is muc closer to the CELOC proposed by EPA.

Huber, whose paper was funded by then-atrazine maker Ciba-Geigy, reviews a considerable number of studies. However, despite discussing results that showed adverse effects on aquatic plants at atrazine levels as low as 1 and even 0.1 µg/liter, he privileges studies that record effects only at higher concentrations. In his advocacy for a 20 µg/l threshold, he simply dismisses those inconvenient findings at lower doses, without in any way demonstrating that recovery of aquatic plant communities from atrazine exposure occurs below his arbitrary threshold.

<u>The proposed CELOC does not protect sensitive fish or amphibians</u>

The proposed CELOC will offer better protection for aquatic plant communities, and also result in less harm to fish and aquatic-stage amphibians, than the current 15 µg/l. However, it must be emphasized that it will not be sufficiently protective, because numerous studies have

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[1] The primitive state of the science on atrazine at that time is also demonstrated by the fact that neither author is aware of atrazine's now well-established ability to disrupt the vertebrate endocrine system, perhaps because the papers were written before the endocrine disruption potential of xenobiotics was widely recognized.

found serious harms to aquatic vertebrates ensuing from exposures below, and often far below, the proposed CELOC.

With regard to fish, two high-quality studies by scientists with the U.S. Geological Survey show that low-level exposure to atrazine reduces the fecundity of two species (see graphs below). In one study, Tillitt et al. (2010) exposed fathead minnows to 0.5, 5 and 50 µg/liter atrazine for 30 days. Cumulative egg production was reduced by 19-39% relative to controls in all treatment groups, reductions that became statistically significant by days 17 to 20. They attributed the result to fewer spawning events and interference with final oocyte maturation in the treatment groups. The same team exposed Japanese medaka to the same three atrazine concentrations for 38 days (Papoulias et al. 2014). Total egg production declined by 36-42% in the three treatment groups, reductions that became significant by day 24. The results were attributed to a reduced number of eggs ovulated by treated females due to interference with the final maturation of oocytes. This striking impairment of fecundity in two fish species occurred at levels as low as 15% of the proposed CELOC.

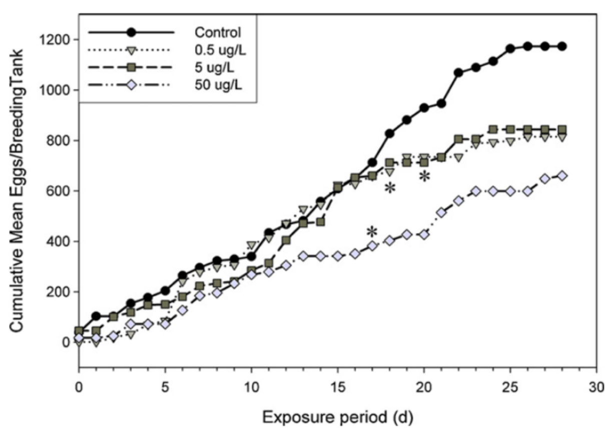


Fig. 1. Mean cumulative egg production (#/tank) of fathead minnow exposed to atrazine. Cumulative egg counts were compared with SAS Statistical Software GLM procedure and least square means ($p = 0.05$). The first day in which cumulative egg numbers were different from controls is designated with an asterisk.

Source: Tillitt et al. (2010)

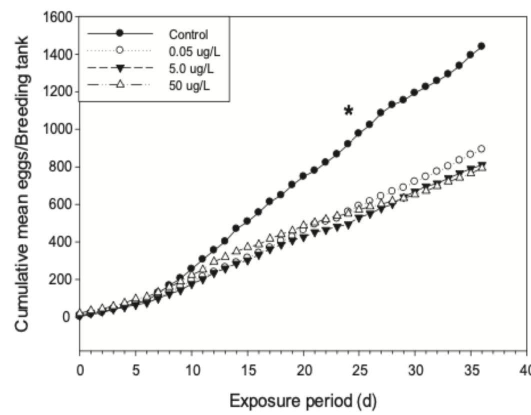


Fig. 1. Mean cumulative egg production (number/tank) of medaka exposed to atrazine. Cumulative egg counts were compared with SAS Statistical Software GLM procedure and least square means ($p = 0.05$). The first day in which cumulative egg numbers were significantly different from controls is designated with an asterisk.

Source: Papoulias et al. (2014.

Amphibians experience a range of deficits from low-level exposure to atrazine. The graph below illustrates endpoints from studies in which atrazine caused death, growth reduction, developmental impairment or reproductive dysfunction in amphibians at concentrations below the proposed CELOC, down to roughly 0.1 µg/liter.

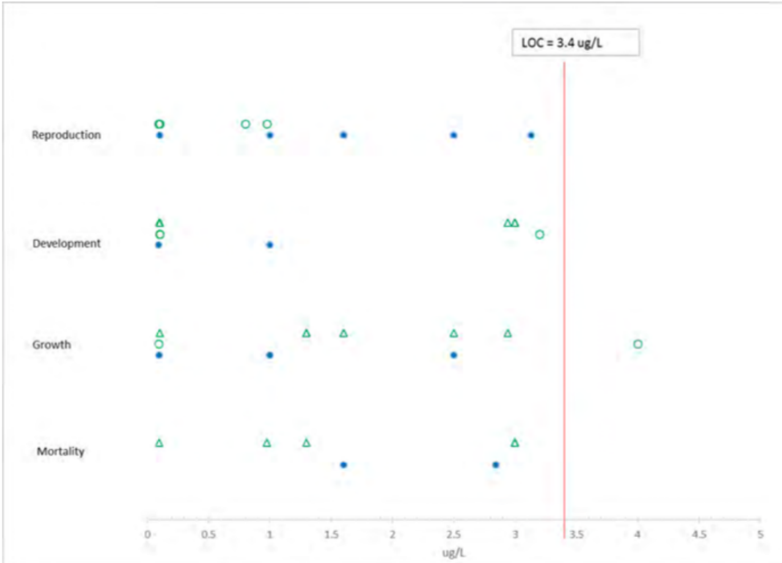


Figure 68. Amphibian effects and no effects endpoints for low level concentrations (0.01 to 5 ug/L) [Effects data are LOAECs (filled blue circles), No effects data are NOAECs (bounded NOAECs - open green circles, unbounded NOAECs - open green triangles)].

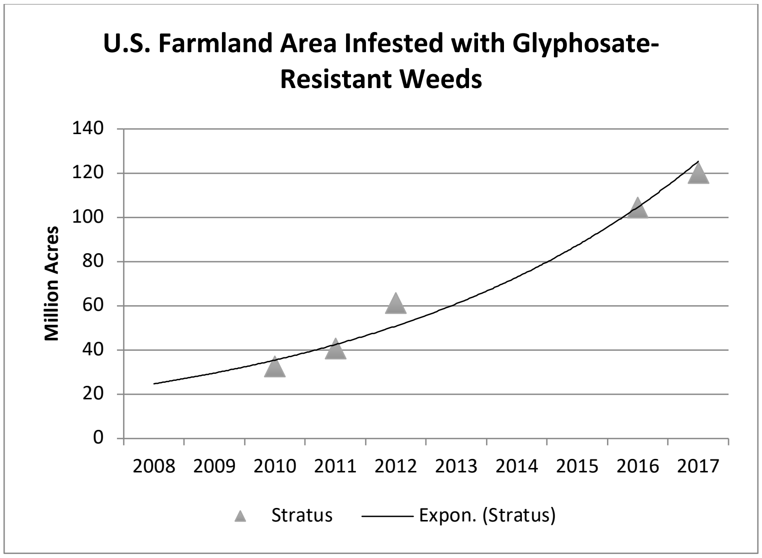
Source: EPA 4/12/16, p. 310.

In short, even if the proposed CELOC of 3.4 µg/l does protect aquatic plant communities, it is still too high to protect sensitive aquatic life from reproductive harm. Atrazine-induced reductions in fish egg production and reproductive dysfunction in amphibians could pose long-term threats to the viability of sensitive fish populations.

<u>Herbicide-intensive cultivation practices do not reduce soil erosion or fight climate change</u>

Herbicide manufacturers and the many advocacy groups and weed scientists they fund have strongly promoted the thesis that herbicides and herbicide-resistant crops are critical to reducing soil erosion by displacing tillage to control weeds. More recently, this messaging has been adapted to claim herbicide-intensive agriculture reduces carbon emissions and thereby helps fight climate change. In essence, the two claims can be treated as one, with tillage serving as the dual-purpose villain that is said to both render soil more prone to being washed away, and accelerate conversion of soil carbon to carbon dioxide. However, neither claim is necessarily true (see Appendix 1).

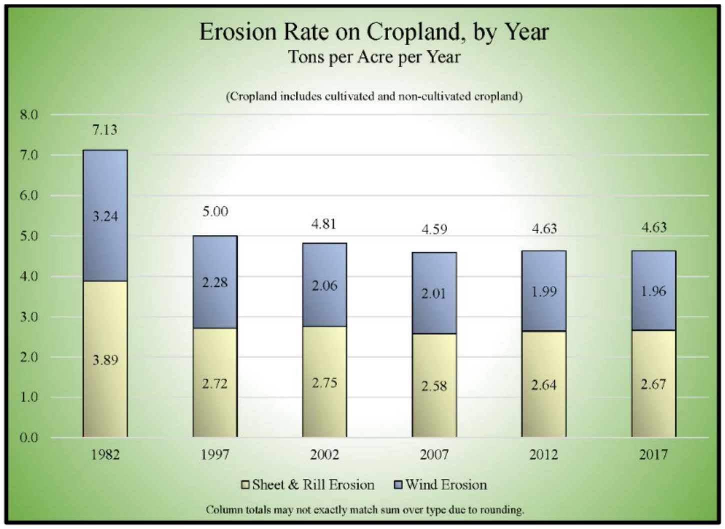
Whatever utility herbicides may have once had to accomplish these goals, it has been negated by their overly intensive use in the herbicide-resistant (HR) crop era, which began in the mid-1990s. Glyphosate-resistant crop systems turned out to be potent promoters of glyphosate-resistant weeds, which until their introduction had been almost entirely unheard of despite two decades of glyphosate use. Glyphosate-resistant weeds now infest at least 120 million acres of U.S. cropland, with 73% of 4,000 surveyed farmers from across the U.S. reporting glyphosate-resistant weeds on their farms in 2017, a 15% increase over 2016 (Pucci 2018; see graph below). Second-generation HR crop systems with additional resistance to dicamba and glufosinate have already begun to foster rapid emergence of dicamba- and glufosinate-resistant weeds. Not surprisingly, weeds resistant to multiple herbicides have also grown dramatically (Mortensen et al. 2012).



Source: Data from Stratus Ag Research in: Fraser (2013) and Pucci (2018).

This explosion in weed resistance has driven a return to tillage (Lu et al. 2022). For instance, the proportion of soybeans under conservation tillage regimes fell from 2006 to 2012 (Appendix 1). In addition, most conservation tillage/no-till is practiced on a rotational basis, with far lower acreage in continuous no-till (Hill 2001, Lu et al. 2022). According to Thaler et al. (2021), less than 15% of the upper Mississippi River watershed – the heart of the Corn Belt – is farmed with no-till practices for at least three consecutive years.

Soil erosion rates have virtually flatlined in the Heartland since the mid-1990s – coincident with widespread adoption of HR crops – and particularly since the resistant weeds they spawned became abundant after 2002 (see graph below). Others have found still greater loss of topsoil in the Corn Belt than is generally shown by conventional measures. Thaler et al. (2021) used satellite and LiDAR data to arrive at their estimate that A-horizon soil (topsoil) has been eroded from roughly one-third of the midwestern Corn Belt, whereas prior estimates suggested none of the Corn Belt had experienced such erosion. Any erosion-reducing impact of herbicide-intensive HR crop systems – which dominate corn, soybean and cotton production – would have been reflected in substantial reductions in soil erosion, which simply has not taken place. In view of these data, a committee of the National Academy of Sciences refuted the widespread myth that HR crop systems somehow promote soil conservation (NAS 2016).



Source: U.S. Department of Agriculture. 2020. *Summary Report: 2017 National Resources Inventory*, Natural Resources Conservation Service, Washington, DC, and Center for Survey Statistics and Methodology, Iowa State University, Ames, Iowa. https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/nra/nri/results/

Atrazine-resistant weeds

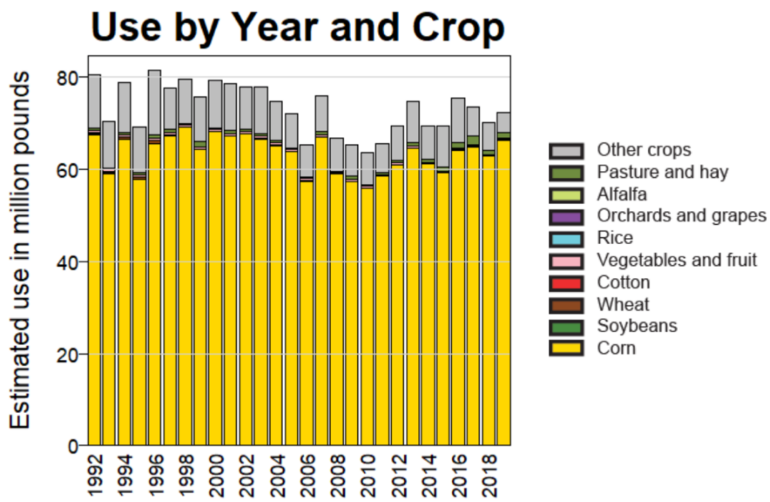
Because weed resistance fosters more tillage as one control option (as well as increased use of a greater array of herbicides), it is instructive to note that more weed species have evolved resistance to atrazine than to any other herbicide active ingredient: 66, to be precise (HRAC 2021). We know of no up-to-date estimate of the acreage infested by atrazine-resistant weeds, or more broadly by those resistant to the class of triazine herbicides. But it is interesting to observe that in 1997, triazine-resistant weeds were estimated to infest three million hectares (7.4 million acres) worldwide, which the author notes made them "the most widespread resistance problem" relative to weeds resistant to other herbicides (Heap 1997). Like all herbicide-resistant weeds, those resistant to atrazine have prompted farmers to employ tillage as one control option.

Atrazine has not forestalled resistance to other herbicides, and will not do so in the future

Has atrazine at least helped stave off resistance to other herbicides? The best test for this claim would be to evaluate atrazine's performance with respect to glyphosate-resistant weeds. Despite relatively constant use of atrazine on corn from 1992 to present (see graph below) – which covers the era before, during and after glyphosate-resistant (GR) crops and weeds became legion – GR weeds skyrocketed from non-existent to infest 120 million acres of farmland.[2] While we know of no breakdown of GR weed-infested acreage by crop, a perusal of the glyphosate-resistant weed reports on www.weedscience.org makes it clear that the majority of GR weeds are found in corn and soybeans; and because these crops are frequently rotated, GR weeds in soybeans will also plague cornfields. Clearly, atrazine has not played any

[2] Thus, GR weeds in the U.S. alone infest over 16-fold more acreage today than the most widespread class of herbicide-resistant weeds (triazine-resistant) infested in the entire world just over two decades ago – one sign of how out of control the weed resistance problem has become.

meaningful role in forestalling GR weeds – likely because many had pre-existing resistance to atrazine, and are now resistant to both herbicides.



Source: Atrazine Use by Year and Crop. US Geological Survey, Epest-Low, https://water.usgs.gov/nawqa/pnsp/usage/maps/show_map.php?year=2019&map=ATRAZINE&hilo=L&disp=Atrazine

It is also instructive to observe that corn is both home to more herbicide-resistant (HR) weed species overall than any other crop aside from wheat: 63 to be exact (HRAC 2021). An increasing number of these HR weeds are extremely aggressive "driver weeds" like Palmer amaranth and waterhemp, and they are increasingly resistant to multiple herbicides rather than atrazine or glyphosate alone.[3] The more problematic the weed and the more resistance traits it bears, the more likely farmers will resort to tillage to control to it.

Atrazine increases mineralization of soil carbon

Atrazine also acts directly upon soil carbon, at least in certain soils. Mahia et al. (2008) incubated two soil types – Humic Cambisol and Gleyic Cambisol – that had been treated with recommended agronomic rates of atrazine, and measured the evolution of carbon dioxide under aerobic conditions over a 12-week period. They found that cumulative evolution of CO_2 was 33-41% higher in the atrazine-treated vs. untreated soil of the same type. The authors note that the increase in CO_2 release was considerably higher than the amount of carbon added as atrazine, and conclude that "atrazine induced an accelerated mineralization of native organic matter, resulting in a 'priming effect'" that they note has been observed by other authors. Thus, atrazine treatments appear to contribute to impoverishment of soil carbon stores in the soil, and directly contribute to industrial agriculture's hefty contribution to climate change.

In short, there is no reason to believe that atrazine plays any meaningful role in either suppressing soil erosion or reducing carbon emissions from cropland. Still less would there be

[3] The majority of recently reported populations of atrazine-resistant Palmer amaranth, waterhemp and kochia are resistant to from two to five classes of herbicide overall. See www.weedscience.org.

any such impacts from the minimal reductions in atrazine use that will likely ensue from the proposed revisions to the interim decision. On the contrary, atrazine is a major component of an increasingly herbicide-intensive field crop agriculture that generates ever more herbicide-resistant weeds, leading to more tillage that in the industrial farming context generates soil erosion and conversion of soil carbon to carbon dioxide. Additionally, there is evidence that atrazine accelerates conversion of soil carbon to CO_2, contributing to climate change.

Observations on the "pick list" of atrazine runoff mitigation measures

EPA has proposed to require atrazine-using farmers of field corn, sweet corn, sorghum and sugarcane to adopt certain atrazine runoff-mitigation measures. Whether they adopt any of these practices, and if so how many, depends on the estimated atrazine concentrations in waterways in their region. In the case of field corn, growers would adopt from zero to four such practices from the following list of 12: "no preemergence applications to the crop, vegetative filter strips, cover crops, contour buffer strips, terrace farming, field borders, grassed waterways, irrigation water management, contour farming, strip cropping, soil incorporation to a depth of 2.5 cm (1 in), or no tillage/reduced tillage" (EPA 6/23/22, p. 15).

These mitigation measures would appear to have some value in reducing atrazine runoff. The primary question is which and how many mitigations need be adopted, and whether they will reduce atrazine runoff sufficiently to make a significant difference for the health of our waterways. We would note that several of these measures represent current practice for large numbers of corn farmers. For instance, many corn growers already apply atrazine early post-emergence, and thus would earn credit for this mitigation despite making no change to their farming practices. The same holds for several other measures. For those farmers using tillage, incorporating atrazine into the soil is a common-sense measure with preplant applications that both reduces runoff and improves weed control if rainfall does not occur with a week of the application. No-till and reduced tillage together are likely very common among corn growers, depending on how the practices are defined. Rotational no-till is more common than continuous no-till, and combined with "reduced tillage" these practices may be regarded as already being practiced on a large percentage of corn acres.

The danger is that if the scoring system is too lax, if credits are too easily earned with current practices, then EPA's pick list will effect little change in inhibiting atrazine runoff and reducing concentrations in waterways.

Filter strips, field borders, grassed waterways and other more structural measures that will likely prevent more atrazine from entering waterways may not have to be adopted by many farmers at all, reducing the benefits of the pick list scheme. EPA should consider requiring more measures that in any case represent good farming practice.

The second major question with the pick list is enforcement. It is not clear that EPA has any means to ensure that farmers actually implement these atrazine run-off mitigations.

Many of these mitigation measures provide benefits beyond reducing atrazine runoff, and EPA should account for these benefits as benefits, not costs. For instance, cover crops are universally recognized to provide multiple significant benefits that include sharp reductions in off-season and early spring soil erosion, reducing the entry of both sediment and other pollutants into our rivers and bays. EPA should also acknowledge that cover crops are an excellent means to increase soil carbon, creating healthier soils that produce higher yields. Finally, cover crops can be managed so as to help control weeds by crimping them into a weed-suppressive mat that inhibits weed germination and reduces herbicide use (SARE 2019).

Bill Freese, Science Director
Center for Food Safety

References

Eisler R (1989). Atrazine hazards to fish, wildlife, and invertebrates: a synoptic review. US Fish and Wildlife Publications, 314.

EPA (6/23/22). Proposed revisions to the atrazine interim registration review decision, case number 0062. EPA-HQ-OPP-2013-0266-1625, Environmental Protection Agency, June 23, 2022

EPA (10/22/19). Regulatory update on the registration review of glyphosate. EPA-HQ-OPP-2013-0266-01260, Environmental Protection Agency, October 22, 2019.

EPA (4/12/16). Refined ecological risk assessment for atrazine. EPA-HQ-OPP-2013-0266-0315, Environmental Protection Agency, April 12, 2016.

Fraser K (2013). Glyphosate-resistant weeds – intensifying. Stratus Ag Research, January 25, 2013. http://www.stratusresearch.com/newsroom/glyphosate-resistant-weeds-intensifying.

Heap IM (1997). The occurrence of herbicide-resistant weeds worldwide. Pesticide Science 51: 235-243.

Hill PR (2001). Use of continuous no-till and rotational tillage systems in the central and northern Corn Belt. Journal of Soil and Water Conservation 56: 286-290.

HRAC (2021). International Herbicide-Resistant Weeds Database, July 2021. See "Download PowerPoint Graphs" at http://www.weedscience.org/Home.aspx. Database funded by pesticide manufacturers under the aegis of the Global Herbicide Resistance Action Committee (HRAC) and CropLife International, maintained by Ian Heap.

Huber W (1993). Ecotoxicological relevance of atrazine in aquatic systems. Environmental Toxicology and Chemistry, 12: 1865-1881.

Lu C et al. (2022). Emerging weed resistance increases tillage intensity and greenhouse gas emissions in the US corn–soybean cropping system. Nature Food 3: 266-274.

Mahia J et al. (2008). Microbial biomass and C mineralization in agricultural soils as affected by atrazine addition. Biol Fertil Soils 45: 99-105.

Mortensen DA et al. (2012). Navigating a critical juncture for sustainable weed management. BioScience 62(1): 75-84.

NAS (2016). Genetically Engineered Crops: Experiences and Prospects. National Academies of Sciences, Engineering, and Medicine, 2016. Washington, DC: The National Academies Press. doi: 10.17226/23395.

Papoulias DM et al. (2014). Atrazine reduces reproduction in Japanese medaka (*Oryzias latipes*). Aquatic Toxicology 154: 230-239.

Pucci J (2018). The war against weeds evolves in 2018. CropLife, March 20, 2018.

SARE (2019). Cover Crop Economics: Opportunities to Improve Your Bottom Line in Row Crops. Sustainable Agriculture Research and Education, U.S. Dept. of Agriculture, June 2019. https://www.sare.org/resources/cover-crop-economics/.

Thaler EA et al. (2021). The extent of soil loss across the US Corn Belt. PNAS 118(8), e1922375118. https://doi.org/10.1073/pnas.1922375118.

Tillitt DE et al. (2010). Atrazine reduces reproduction in fathead minnow (*Pimephales promelas*). Aquatic Toxicology 99: 149-159. https://www.croplife.com/crop-inputs/the-war-against-weeds-evolves-in-2018/.

Appendix 1

Farm Policy, Not Biotechnology, Explains Trends in U.S. Soil Erosion

Bill Freese[1], J. Franklin Egan[2], Craig Cox[3], and Rick Cruse[4]

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It is widely believed that herbicide-resistant crops promote soil conservation

"Herbicide-resistant (HR) crops…[and]…herbicides such as glyphosate minimized the need for tillage as a weed control tactic; the resulting crop production systems have been primary enablers for the success of USDA NRCS [soil conservation] programs."[1]

"… glyphosate-resistant crops (GRCs) … facilitate reduced- or zero-tillage systems, which contribute to reductions in soil erosion from water and wind …"[2]

This belief even frames USDA regulatory decisions on herbicide-resistant crops.[3]

But where's the evidence?

"…there is a remarkable paucity of refereed publications on the influence of glyphosate-resistant crops on tillage practices and associated environmental effects."[2]

New data synthesis refutes this belief

- Corn Belt erosion rates remained entirely flat from 1997 to 2012 despite massive adoption of herbicide-resistant soy and corn (Fig. 1).
- Use of conservation tillage is at best only weakly correlated with adoption of herbicide-resistant crops (Fig. 2).
- Glyphosate-resistant crop systems have generated an epidemic of glyphosate-resistant weeds that farmers often use tillage to control, increasing rather than reducing soil erosion.
- Hence, conservation tillage in soybeans declined for the first time in decades from 2006-2012 (Fig. 2A).
- "Next-generation" crops resistant to combinations of glyphosate and 2,4-D, dicamba, glufosinate and/or other herbicides will lead to more intractable weeds resistant to multiple herbicides, which in turn will make soil-eroding tillage an increasingly attractive control option.

Herbicide-resistant crops have produced little or no reduction in soil erosion

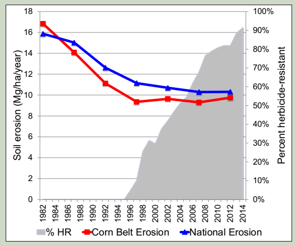

Figure 1: U.S. cropland soil erosion rates vs. percent total corn/soy area planted to herbicide-resistant (HR) corn/soy, 1982-2014.[4]

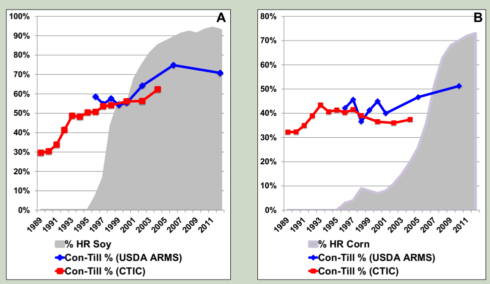

Figure 2: Farmer adoption of conservation tillage practices as percent of total crop area vs. percent adoption of HR soybeans (A) and HR corn (B).[5]

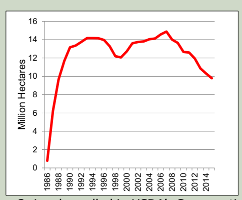

Figure 3: Land enrolled in USDA's Conservation Reserve Program: 1986-2015[6]

Ephemeral gully in Iowa

Past farm policy triggered *massive reductions* in soil erosion

- The 1985 Food Security Act was largely responsible for a 30% reduction in average U.S. soil erosion rates from 1982 to 1997 (Fig. 1).
- Conservation Compliance required farmers to implement conservation practices on erodible cropland in exchange for subsidies, leading to a reduction of **267 million Mg/yr**[7] in soil loss.
- The Conservation Reserve Program (CRP) removed 13.3 million hectares of cropland from production, saving **263 million Mg/yr**[7] of soil.

Soil erosion rates have flat-lined in response to lapses in policy

- Lax enforcement of soil conservation plans suggests that many hectares are only conservation tillage "on paper."
- In response to high crop prices, generous corn ethanol subsidies, and deep cuts in CRP funding, 3.5 million hectares of CRP land have been planted to row crops since 1997 (Fig. 3).

Better farm policy can restore progress in soil conservation

- Reinvigorate enforcement of soil conservation plans.
- Restore funding of the Conservation Reserve Program.
- Create strong incentives for diverse crop-rotations, cover crops, and perennial prairie strips.

References

1. Shaw D.R. et al. 2012. Herbicide-Resistant Weeds Threaten Soil Conservation Gains: Finding a Balance for Soil and Farm Sustainability." CAST Issue Paper No. 49. Council for Agricultural Science and Technology, Feb. 2012.
2. Cerdeira A.L and Duke S.O. 2006. Current Status and Environmental Impacts of Glyphosate-Resistant Crops: A Review. J. Environ. Qual. 35: 1633-1658.
3. U.S. Dept. of Agriculture. 2014. Final Environment Impact Statement for Determinations of Nonregulated Status for 2,4-D-Resistant Corn and Soybean Varieties.
4. U.S. Dept. of Agriculture. 2015. 2012 National Resources Inventory, August 2015.
5. USDA Agricultural Resource Management Surveys (USDA-ARMS); Conservation Tillage Information Center's National Crop Residue Management Surveys (CTIC).
6. U.S. Dept. of Agriculture. 2015. CRP Enrollment and Rental Payments by State, 1986-2014; Conservation Reserve Program: Monthly Summary – Sept. 2015.
7. U.S. Dept. of Agriculture. 2004. Environmental Compliance in U.S. Agricultural Policy: Past Performance and Future Potential, AER-832, June 2004.

B. Freese, J. Franklin Egan, Craig Cox and Rick Cruse (2015). Poster presentation at Synergy in Science, 2015 Annual Meeting of the American Society of Agronomy, Crop Science Society of America and Soil Science Society of America, with the Entomological Society of America, 2015. Available at: https://scisoc.confex.com/crops/2015am/webprogram/Session14265.html.