March 11, 2014

Regulatory Analysis and Development, PPD, APHIS
Station 3A-03.8
4700 River Road, Unit 118
Riverdale, MD 20737- 1238

RE: Docket No. APHIS-2013-0042

Comments to USDA APHIS on Dow AgroSciences LLC; Draft Environmental Impact Statement for Determination of Nonregulated Status of Herbicide Resistant Corn and Soybeans

Center for Food Safety, Science Comments I
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Introduction

These comments submitted by Center for Food Safety are one of two sets of science comments from our organization. Legal comments are also being submitted. The references cited have been uploaded as supporting materials. The filenames for these documents match the citations in the text, and are all incorporated as (e.g. Benbrook 2012). Full citations are included at the end.

These comments supplement and incorporate by reference our earlier two rounds of comments on the draft Environmental Assessments for event DAS-68416-4 (Enlist soybeans) and event DAS-40278-9 (Enlist corn), as well as all the references submitted previously. The previous CFS science comments on the draft EAs have been resubmitted as Appendix B, and will be cited in the text as "CFS Science Soy", "CFS Science Corn I", and "CFS Science Corn II."

References to the Appendix of the EIS cite the Appendix number followed by a hyphen then the page number (e.g. 4-29). Only references that are new to these draft EIS comments are listed in the References section at the end.

Executive Summary

The growing unsustainability of U.S. agriculture

U.S. agriculture is becoming progressively less sustainable. Unhealthy monoculture corn is on the rise over space (more acres) and time (continuous corn). Farm size is increasing even as family farmers decline in number, weakening the economic and social fabric of rural communities. Millions of tons of precious topsoil continue to wash into our waterways each year, with the impressive reductions in soil erosion that took place in the 1980s and early 1990s coming to a halt in the Heartland since 1997. In major field crops, fertilizer use is at or near all-time highs, and American farmers are becoming ever more dependent on all classes of toxic pesticide, with attendant harm to the human health and the natural world. One major way in which agriculture is becoming less sustainable is through the introduction of genetically engineered (GE) herbicide-resistant (HR) crops such as Enlist corn and soybeans.

Enlist crops would likely increase corn plantings in American agriculture

Enlist crops would increase the prevalence of weeds resistant to 2,4-D, which would force nearby wheat growers (who depend heavily on 2,4-D) to utilize more expensive alternatives. Higher wheat production costs would incentivize wheat growers to switch to corn. This transition from wheat to corn would be most pronounced in Ecoregions G and I (the Northern Plains states of ND, SD, NE and KS). Over the past two decades, wheat growers in the western parts of these states have responded to high corn prices by transitioning to corn. Under the Preferred Alternative, Enlist crops would exacerbate this trend by generating 2,4-D-resistant weeds, thus making wheat more expensive to grow and corn an even more profitable alternative. Corn cultivation is already at historic levels, exceeding 95 million acres in 2012 and 2013. It utilizes far more fertilizer and herbicide than any other crop, resulting in runoff and environmental degradation. Corn is also more water-intensive than wheat, and would accelerate depletion of scarce water resources (the Ogallala Aquifer) in the Northern Plains states.

Enlist crops would also be accompanied by greatly increased 2,4-D drift damage to neighboring crops. This would provide an incentive to growers of 2,4-D-sensitive crops (e.g. vegetables and fruits, grapes, sunflower, cotton and soybeans) to transition to crops, like corn, that tolerate 2,4-D drift without damage.

Enlist crops would substantially increase use of herbicides

2,4-D is one of the oldest herbicides, introduced in the 1940s. Once widely used in corn, it has been largely displaced by other herbicides (most of them less toxic) and today is little used in either corn or soybean production. Dow projects that deregulation of Enlist corn and soybeans would increase annual agricultural use of 2,4-D from 25.6 million lbs. at present to 77.8-176 million lbs. by 2020 – a three-fold to seven-fold increase. Estimates made by other scientists support somewhat more than the high-end of Dow's 2,4-D use projection, but based on somewhat differing assumptions: lesser adoption of Enlist crops, but higher rates and/or more frequent applications. Glyphosate use is projected to continue unchanged, as Enlist crops will be offered in versions resistant to glyphosate, and 2,4-D would not displace glyphosate use. As Enlist soybeans are also resistant to glufosinate, and Enlist corn to quizalofop, use of these herbicides would also increase, though to a lesser extent than 2,4-D. The Preferred Alternative would lead to an unprecedented level of herbicide use and dependence in American agriculture. The No Action Alternative would likely lead to only a modest rise in 2,4-D use.

Noxious weed and plant pest threats posed by Enlist crops

APHIS made herbicide-resistant weeds the centerpiece of the EIS, but paradoxically asserts that the impacts of herbicide use that triggers their emergence is "outside the scope of this EIS" (EIS at v). Enlist crops pose three distinct threats that require assessment under the authority conferred upon USDA by the Plant Protection Act.

First, Enlist crops themselves would become weeds when they sprout as volunteers in the next year's crop. Corn volunteers in particular are often problematic weeds. Because difficulty of control is a major factor in assessing a weed's relative weediness, and herbicides are major control options, the weediness of corn volunteers increases with the number of herbicide-resistance (HR) traits they possess. Enlist corn would be sold with at least three, and perhaps four or more, herbicide resistance traits, making its volunteers in follow-on crops a clear weed threat that reduces yield, interferes with harvest, or greatly increases control costs. Control measures to eliminate Enlist corn volunteers would include tillage, increasing soil erosion. Enlist soybean volunteers might also become problematic weeds.

Enlist corn volunteers that also express genetically engineered resistance to corn rootworm would also pose a clear plant pest risk. Lower levels of insecticidal toxin in such corn volunteers would accelerate evolution of resistance in rootworm, the most serious pest of corn. The survival and prevalence of such volunteers would be increased by their resistance to multiple herbicides, exacerbating rootworm resistance and thus its threat to U.S. corn production. APHIS has not begun to assess the weediness and plant pest risks posed by Enlist corn in this context.

Enlist crop systems would also foster rapid emergence of weeds with resistance to 2,4-D, as APHIS concedes. Because Enlist crops would be preferentially used where weeds resistant to glyphosate and other herbicides are already rampant, the result would be extremely intractable weeds immune to multiple weed-killers. Some of these would certainly meet USDA's noxious weed criteria, which include difficulty of control as well as invasiveness and reducing productivity of crop fields. Thus, herbicide resistance has the potential to transform a merely troublesome weed into a noxious one. Indeed, several glyphosate-resistant (GR) weeds already rate noxious designation. For instance, GR Palmer amaranth and GR horseweed are already regarded as more damaging than a federally listed noxious weed – Benghal dayflower – in part due to their immunity to glyphosate. They have dramatically increased weed control costs and in some cases led to abandonment of cropland, among other harms. Waterhemp and kochia are two other prevalent GR weeds. Certain biotypes of these species have evolved resistance to synthetic auxin herbicides such as 2,4-D. 2,4-D resistance would in many cases evolve in weeds already resistant to glyphosate and other herbicides, a cumulative impact that APHIS failed to assess. While weed resistance is not unique to herbicide use with HR crops, it evolves much more readily in this context. The ability of established HR weeds to spread long distances via pollen flow and seed dispersal leads to area or region-wide harms, undermines the efficacy of "best management practices," and increases the need for USDA action. Just as APHIS regulates or prohibits the import of certain plants as pathways for the introduction of noxious weed seeds they commonly harbor, so HR crop systems must be regulated as pathways to emergence of herbicide-resistant noxious weeds.

Enlist crops, soil erosion and tillage

APHIS claims throughout the EIS that Roundup Ready crops have reduced soil erosion by promoting farmer adoption of soil-sparing conservation tillage systems, and that Enlist crops would do likewise. These claims are without foundation. While soil erosion rates declined in the 15 years prior to Roundup Ready crop introduction, they have ***not*** declined since 1997, matching the period when these crops were massively adopted. Neither would Enlist crops reduce soil erosion. Federal farm policy enacted in 1985 has been the major driver of reduced soil erosion in American agriculture. Since Roundup Ready crops have not promoted an increase in conservation tillage, they are not responsible for the many benefits (e.g. improved air, water and soil quality) attributed to this practice. On the contrary, the epidemic of glyphosate-resistant weeds fostered by Roundup Ready crop systems has increased soil-eroding tillage, as APHIS concedes. Since Enlist crops will promote still more intractable weed resistance, their effect would be to further increase soil erosion via greater use of tillage for weed control. APHIS's assessment of these issues is fundamentally flawed.

Sustainable Action Alternative

APHIS should have considered an alternative to Enlist crops that encourages agroecological weed control methods that minimize reliance on herbicides and reduce soil erosion. Organic farmers have developed and refined such techniques, which include complex crop rotations, cover crops, judicious use of tillage and other management options. APHIS concedes that such beneficial, techniques would likely increase under the No Action alternative, while the Preferred Alternative would "delay the adoption of non-chemical management strategies" for weeds. Just as agricultural policy is chiefly responsible for driving adoption of soil-conserving farming methods, so similar policy instruments are needed to promote sustainable weed management practices.

Human health and environmental impacts of increased 2,4-D use

The vastly increased use under the Preferred Alternative would have substantial adverse human health and environmental impacts.

Flawed Assumptions and Faulty Analysis

These include inconsistent and biased assessment of herbicide use impacts, the false contention that herbicide resistant weeds are inevitable, inconsistent valuation of simplicity versus diversity in weed control, and failure to assess short-term vs. long-term risks and benefits of the Alternatives.

The growing unsustainability of U.S. agriculture
Sustainability is an often-claimed attribute or goal of American agriculture, yet it is easy to lose sight of what it actually means. Sustainable farming systems are "capable of maintaining their productivity and usefulness to society indefinitely. Such systems ... must be resource-conserving, socially supportive, commercially competitive, and environmentally sound."[1] By these measures, U.S. agriculture is becoming progressively less sustainable, and genetically engineered, herbicide-resistant crops have contributed substantially to this deteriorating trend.

"Socially supportive" farming systems must provide a decent income and employment for farm families, a prerequisite to healthy rural communities. Technologies that facilitate increasing scale of production through reducing labor needs have been the rule in U.S. agriculture for at least a century. They have been a major factor leading to continual consolidation of farmland in ever fewer hands, accompanied by the exit of small and mid-size producers from farming (MacDonald et al 2013) and the decline of rural communities. Many now believe it is time to switch course, and implement agricultural systems such as organic farming that do a better job of providing employment rather than saving labor.

Weed control has traditionally been one of the more labor-intensive tasks in farming. Roundup Ready (RR) soybeans have been estimated to reduce labor needs for weed control by 15% (EIS at 75). USDA economists agree that: "HT [herbicide-tolerant] seeds reduce labor requirements per acre" (MacDonald et al 2013, p. 28). APHIS regards this as a "benefit" of RR crops, in that it frees up time for off-farm employment (EIS at 75). However, it is unclear whether working two jobs rather than one is a benefit, since it may be an undesired consequence of insufficient income from farming. In any case, farmers may choose to employ their "saved labor" in other ways that APHIS fails to consider. For instance, RR crop growers may seek to farm more acres rather than seek off-farm employment, bidding up prices for land (including leases). Larger growers are generally in a better position to absorb these added costs, and so outcompete small and medium-size growers, who are thereby put at a competitive disadvantage and potentially put out of business. As USDA economists have concluded: "GE seeds may partly explain increased consolidation among field crop farmers since 1995" (MacDonald et al 2013, p. 27). APHIS has failed to assess the negative socioeconomic impacts of RR crops, and the potential for similarly adverse impacts of the Enlist crop systems designed to partially replace them.

Sustainable farming should also conserve resources and be environmentally sound. As detailed below, Enlist crop systems would contribute to the unsustainability of U.S. agriculture in these respects as well.

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[1] John Ikerd, as quoted by Richard Duesterhaus in "Sustainability's Promise," *Journal of Soil and Water Conservation* (Jan.-Feb. 1990) 45(1): p.4. NAL Call # 56.8 J822.

Enlist crops would likely increase overall corn plantings in American agriculture

As APHIS concedes, Enlist crop systems would increase selection pressure for 2,4-D-resistant weeds (EIS at ix), and thereby increase their prevalence in American agriculture. Farmers of wheat, oats and barley (small grains) commonly use 2,4-D, one of the most inexpensive herbicides on the market. 2,4-D-resistant weeds from Enlist fields could easily spread to nearby small grains farms, which explains why APHIS chose to assess the impact of 2,4-D-resistant weeds on farmers in proximity to Enlist fields (EIS at 121: "Proximity of Corn and Soybean to Other 2,4-D Treated Crops"). APHIS determined that 2,4-D-resistant weeds would increase management costs for such small grains farmers by forcing them to use more expensive alternative herbicides (EIS at 125-128). In fact, the costs might rise to such an extent that these farmers "may choose not to grow small grains" (EIS at 121), but presumably transition to more profitable crops instead.

Many would switch from wheat to corn, which is more profitable and regarded as "an important competing crop for wheat" (USDA ERS Wheat 2014). Wheat growers in North Dakota, South Dakota, Nebraska and Kansas have transitioned many of their wheat acres to corn over the past two decades (EIS at 120[2]; USDA ERS Wheat 2014). Under the Preferred Alternative, the Enlist-driven spread of 2,4-D-resistant weeds could well make wheat growing less profitable and spur still further abandonment of wheat in favor of corn.

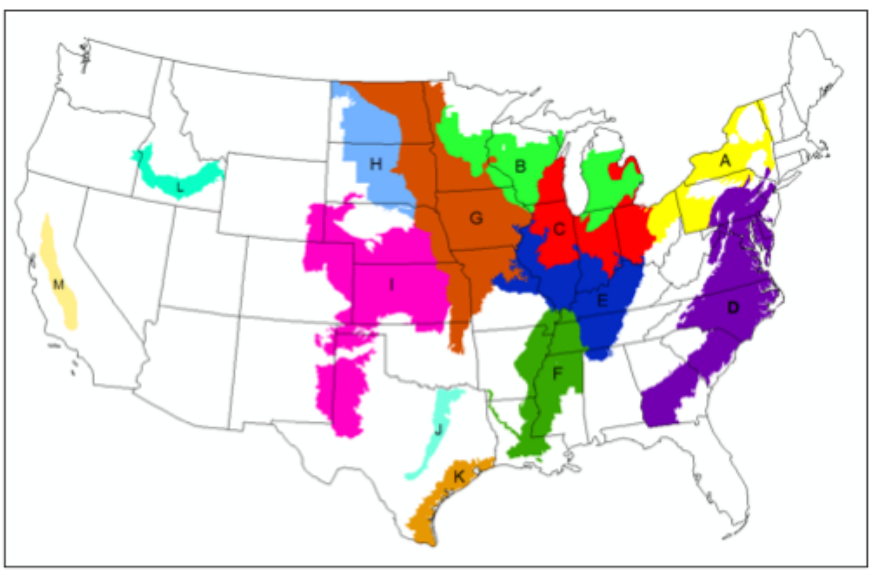

Figure 1. Major Corn and Soybean Cultivation Regions in the U.S.

Source: EIS at 24.

[2] APHIS refers to the northern and western parts of region G and the northeastern section of region I, which correspond to the western portion of the named states; see Figure 1 portrayed above, from EIS at 24.

Corn is a "high-impact" and wheat a "low-impact" crop (Wallander et al 2011, p. 1), meaning that replacing wheat with corn acres would put greater stress on natural resources and degrade the environment. Corn is more water-intensive than wheat, and is heavily irrigated in parts of the Northern Plains, especially Nebraska and Kansas (region I, EIS at 37-38), where the Ogallala aquifer is a major source of irrigation water and is being depleted at an alarming rate (EIS at 40: "Withdrawals from this aquifer greatly exceed recharge from surface waters.").

Corn utilizes roughly four times as much nitrogen and phosphorous fertilizer as wheat,[3] and in 2010 was treated with an historical high of 140 lbs./acre of nitrogen.[4] Nitrogen and phosphate runoff cause eutrophication of rivers and bays, creating "dead zones" devoid of oxygen and bottom-dwelling aquatic life. Nitrogen fertilizer is a major source of nitrous oxide global warming gases (EIS at 41). Mineral nitrogen fertilizer stimulates decomposition of soil organic matter by microbes, leading to a decline in soil nitrogen and overall soil quality that in turn lowers productivity (Mulvaney et al 2010). Corn production also involves roughly seven-fold more herbicide use than wheat, including the great majority of the endocrine-disrupting weed-killer atrazine, which is a common contaminant of surface and drinking water contaminant, and banned in the European Union.

By generating 2,4-D-resistant weeds that spread to wheat fields, Enlist crop systems would likely exacerbate the water-depleting and environmentally-damaging replacement of low-impact wheat acres with high-impact corn. APHIS must assess these impacts in the EIS.

The few sentences APHIS devotes to this issue are illogical and inconsistent. First, APHIS maintains that the Preferred Alternative would not lead to displacement of wheat by corn and soybeans in regions G and I (Northern Plains states) "unless this [Enlist] strategy for weed control ***reduces costs*** compared to the No Action Alternative" (EIS at 120). On the contrary, ***more expensive*** wheat production due to 2,4-D-resistant weeds would have the same effect, since what matters to the farmer is the relative profitability of his/her options. APHIS itself concedes that farmers might stop growing small grains due to resistant weeds (EIS at 121), and profitable corn would then be the most attractive alternative.

While APHIS fails to draw the logical conclusion described above for the Preferred Alternative, it baselessly asserts precisely this outcome (wheat to corn) for the No Action Alternative, mangling a number of basic facts in the process (EIS at 60).

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[3] For N and P, see "Fertilizer use and price" data from USDA's Economic Research Service, Table 2, at http://www.ers.usda.gov/data-products/fertilizer-use-and-price.aspx#.UdQpqRaGi5Q.

[4] See "Fertilizer use and price" data from USDA's Economic Research Service, Table 10 at http://www.ers.usda.gov/data-products/fertilizer-use-and-price.aspx#.UdQpqRaGi5Q. The per acre fertilizer use figures that APHIS reports for corn (EIS at 79) are wrong because they represent average ***single*** application rates, not ***annual*** rates that take account of multiple applications. APHIS reports per acre figures of N: 78 lbs.; P: 52 lbs.; K: 73; and sulfur: 11 lbs., while the correct annual per acre rates are: N: 140 lbs.; P: 60 lbs.' K: 79 lbs.; and sulfur: 13 lbs.

Directly after noting the historically high acreage planted to corn in 2012 and 2013 (97.2 and 97.4 million acres, respectively), APHIS states:

"Under the No Action Alternative two to four million acres of land ***currently used for other crops*** are expected to be converted to corn cultivation in the next decade. (USDA-OCE 2011a)." (EIS at 60, emphasis added)

The reference cited – USDA-OCE (2011a) – says no such thing, and certainly does not project 99-101 million acres of corn (97 + 2 to 4) in the next decade.[5] APHIS then cites a paper showing that grasslands and retired farmlands – ***not*** "land currently used for other crops" – ***have recently been*** (not "are expected to be") converted to corn and soy production. APHIS's conclusion – "Under the No Action alternative, this continued demand for corn is likely to cause [sic] the cultivation of corn in lieu of alternative crops such as wheat…" – is completely illogical and does not follow from the facts it (mis)-cites (EIS at 60). As argued above, the relevant (and actual) facts – some noted by APHIS itself – show that it is the Preferred Alternative that is likely to lead to conversion of wheat to corn.

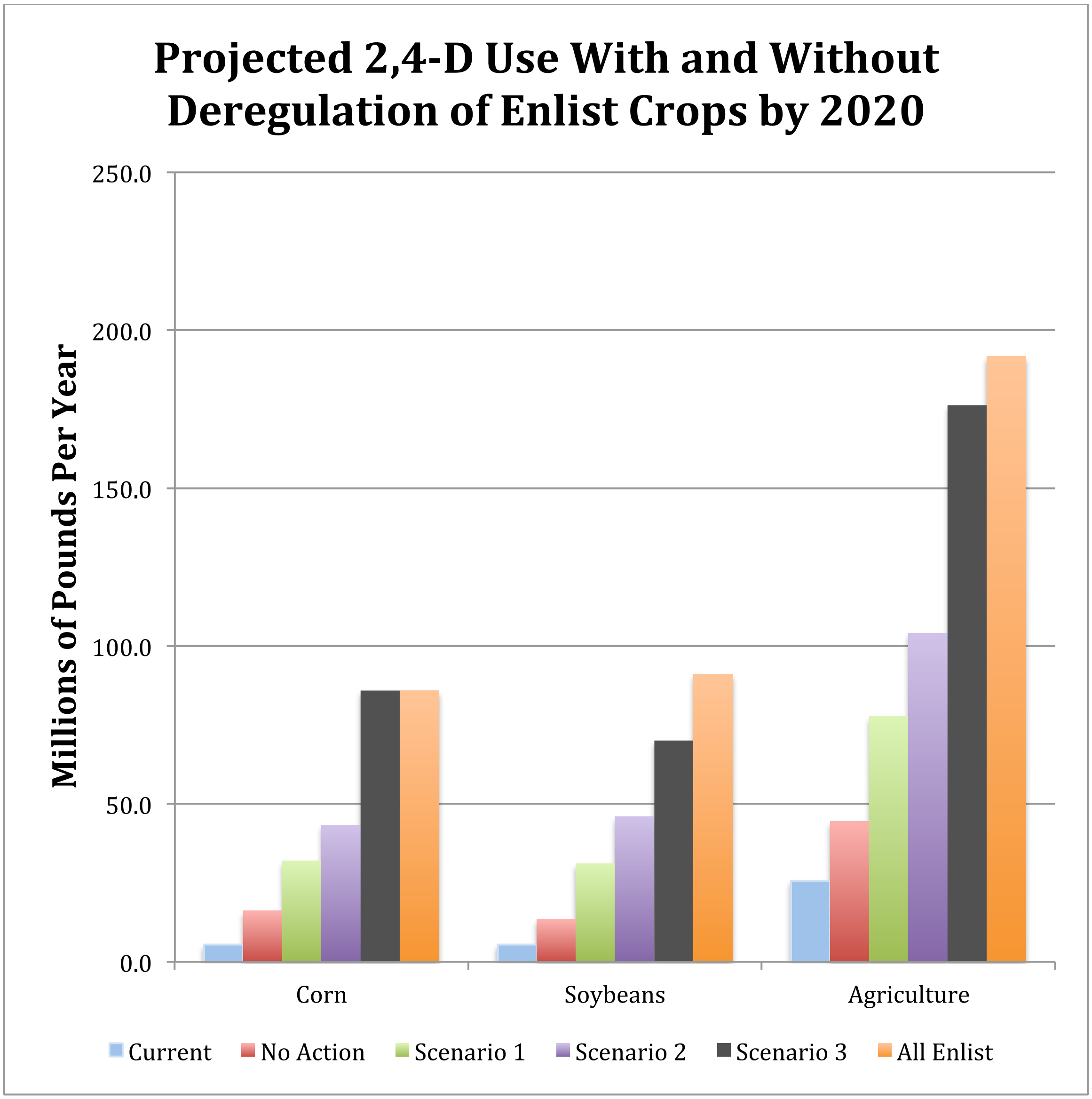
Enlist crops would substantially increase use of herbicides in American agriculture

2,4-D Use

Dow projects[6] that deregulation of Enlist corn and soybeans would increase annual agricultural use of 2,4-D from 25.6 million lbs. at present to somewhere between 77.8 and 176 million lbs. by 2020 – a three-fold to seven-fold (200% to nearly 600%) increase. In contrast, 2,4-D use on crops is projected to increase only 74% to 44.5 million lbs. under the No Action Alternative (EIS at 134). Dow's range for the Preferred Alternative represents the lower- and upper-bound estimates of three scenarios that are based on differing assumptions (EIS, 4-29 to 4-33). Figure __ portrays 2,4-D use under the various scenarios based on Dow's figures.

[5] The cited document is "USDA Agricultural Projections to 2020," published in February 2011; and its projections of corn acreage through 2020 never rise above 92.0 million acres (Table 19).

[6] "DAS [Dow AgroSciences] provided to APHIS three projections of 2,4-D use in corn and soybeans." (EIS, Appendix 4 at 4-30).



Source: Dow's 2,4-D estimates as reproduced by APHIS (EIS, Appendix 4, Table 4-12 at 4-34). CFS added the "All Enlist" scenario, a variant of Scenario 3 (see "All Enlist" below for explanation).

Scenario 1: Dow assumes that 30% of corn and soybean acres will be infested with GR weeds by 2020, and that these growers will plant Enlist crops. This scenario results in a six-fold increase in 2,4-D use on both corn and soybeans over current (2011) usage.

Scenario 2: Based on market share estimates, Dow finds it "reasonably possible" that 45% of corn and soybean acres could be planted with the Enlist trait by 2018 to 2023. Under this scenario, 2,4-D use would rise by 8-fold on corn and by 9-fold on soybeans.

Scenario 3: Dow assumes that Enlist corn would displace all currently grown glyphosate-resistant (GR) corn and 68% of soybeans by 2020. Under this scenario, there would be a 16-fold increase in 2,4-D used on corn and a 14-fold increase on soybeans.

All Enlist: A variant of Scenario 3[7] in which all currently grown GR soybeans (89% of total soybean acreage) and all GR corn are converted to Enlist. 2,4-D use increases 16-fold and 17-fold on corn and soybeans, respectively.

All four scenarios assume that 2,4-D will be sprayed at the rate of 0.875 lbs/acre/application, and applied an average of 1.33 times per season on corn and 1.54 times per season on soybeans, corresponding to 1.16 and 1.35 lbs/acre per season. These projected seasonal application rates represent just 38% to 45% of the proposed maximum label rate of 3 lbs/acre per season or both crops.

Other projections suggest that the upper range of Dow's estimates is more likely, though on the basis of somewhat different assumptions. For instance, Benbrook (2012) projects that 2,4-D use on Enlist corn would rise to 104 million lbs./year by 2019, similar to Dow's Scenario 3, but based on a lower Enlist corn adoption rate (55% of corn acres) and a higher average number of applications per season (2.3). Benbrook's projection is more nuanced than Dow's, in that Benbrook projects that both average number and rate of application will gradually increase over time in response to weeds increasingly tolerant of 2,4-D. This would match the experience of increasing number and rate of glyphosate applications with Roundup Ready crops as glyphosate-resistant weeds became more prevalent (NRC 2010).

Mortensen et al (2012) projected increased aggregate use of 2,4-D and dicamba with introduction of Dow's Enlist and Monsanto's dicamba-resistant soybeans. Based on Mortensen's projection, CFS estimated that by 2025, 2,4-D use would increase to somewhere between 67 and 135 million lbs./year, similar to Scenario 3. This projection assumes 2 lbs./acre 2,4-D are used per season (two-thirds of the maximum proposed label rate of 3 lbs./acre), and that Enlist soybeans are planted on from 45% to 91% of U.S. soybean acres by 2025 (CFS Science Soy, 6-10).

Glyphosate use

Enlist crops are also resistant to glyphosate.[8] Dow assumes that glyphosate will continue to be applied to Enlist crops at levels currently used on Roundup Ready crops (0.875 lbs/acre/application). In fact, Dow plans to promote a 1:1 premix of glyphosate + 2,4-D (Enlist Duo) for use on Enlist crops. For growers who make use of Enlist Duo, this would have the effect of ensuring little or no glyphosate reduction

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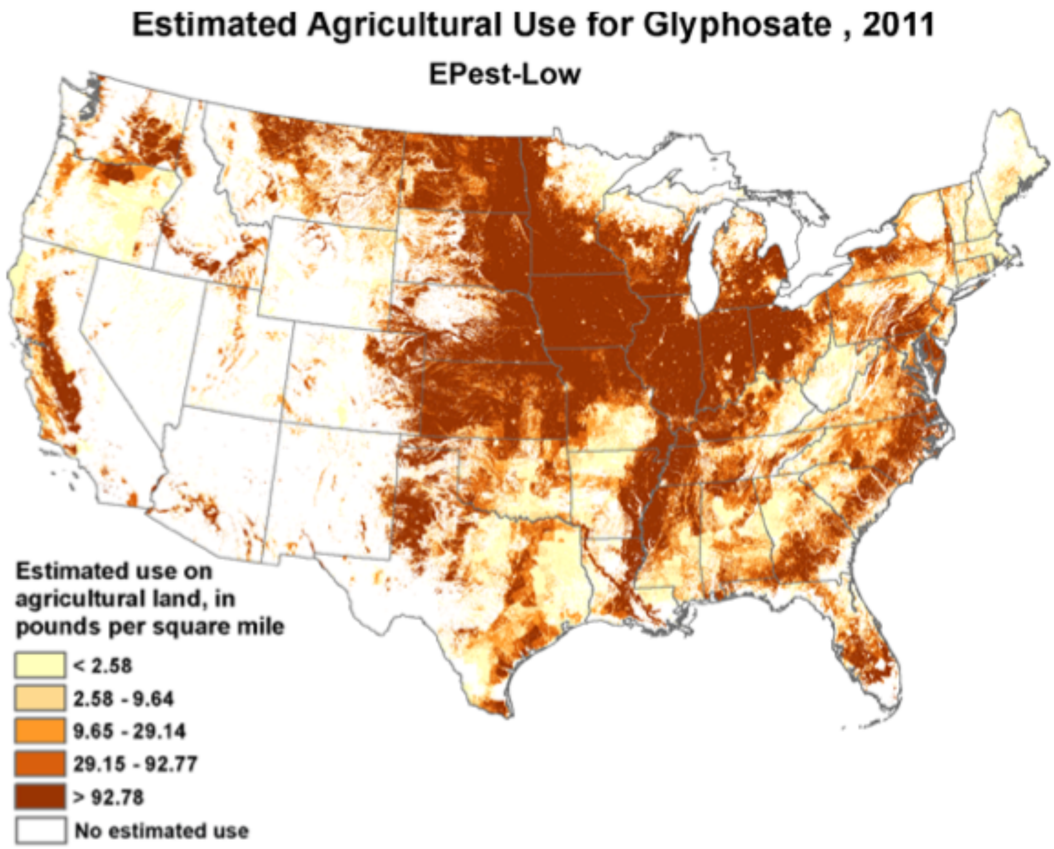
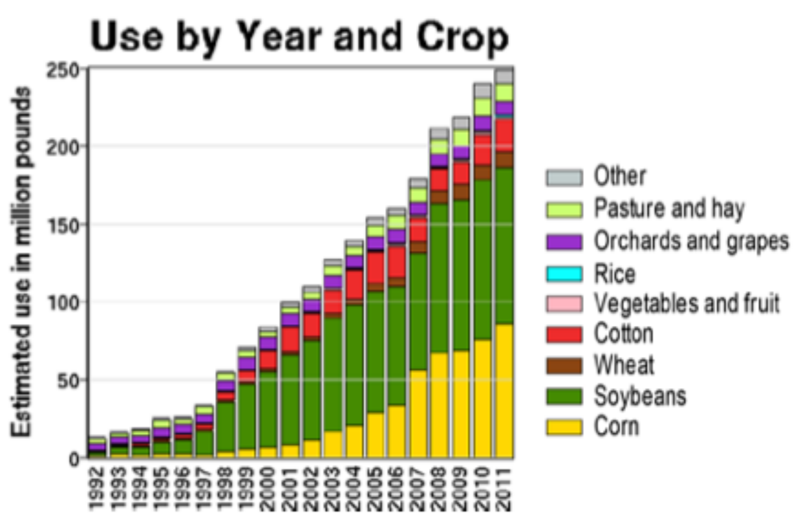
[7] Scenario 3 was initially described as projecting the impact of displacing ***all*** glyphosate-resistant soybeans as well as all GR corn with Enlist crops, but was changed in mid-stream to exclude 32% of soybean acres that Dow assumes will be planted "to one developing technology that will be a direct competitor to the Enlist Weed Control System" (EIS, Appendix 4 at 4-32). Dow is likely referring to Monsanto's dicamba-resistant soybeans, which have not been deregulated by APHIS. The "All Enlist" scenario has been added to project 2,4-D use under the original assumption of full displacement of GR corn and GR soybeans with Enlist crops.

[8] DAS-44406-6 soybeans are not engineered for resistance to glyphosate like Enlist corn and DAS-68416-4 soybeans, but Dow intends to stack in glyphosate resistance in varieties sold to farmers (EIS at 4).

with Enlist crops, and an enormous increase in overall herbicide use. This is because 2,4-D would not displace glyphosate, but rather be used at equal quantities on top of glyphosate. APHIS projects unchanged use of glyphosate in agriculture by 2020 under all Alternatives, assuming 225 million lbs./year (2011), based on third party proprietary data supplied by Dow (EIS at 4-33 and Table 4-13 at 4-35). However, the U.S. Geological Survey finds 250 million lbs. of glyphosate are used agriculturally, and that the long-term increase has not shown any signs of slowing (see figure below). APHIS reproduces a USGS map that portrays glyphosate use a decade ago (EIS at 4-27). Since that time, glyphosate use on corn has risen dramatically from 7.5 million lbs. to roughly 80 million lbs., while soybean use has increased from 70 million to roughly 100 million lbs. (see bar graph on USGS chart below). APHIS should replace that map with an up-to-date version that gives a true picture of glyphosate use today.





Source: U.S. Geological Survey Pesticide National Synthesis Project, Epest-Low, https://water.usgs.gov/nawqa/pnsp/usage/maps/show_map.php?year=2011&map=GLYPHOSATE&hilo=L&disp=Glyphosate, last accessed 3/8/`4. USGS notes that the 2011 map is preliminary until updated with data from the 2012 Census of Agriculture.

Glufosinate use

Both Enlist soybean events (DAS-68416-4 and DAS-44406-6) are also engineered for resistance to glufosinate herbicide (EIS at 3-4, 152). Dow has also put the Enlist corn trait into SmartStax corn (Scherder et al 2012), which has resistance to glufosinate as well as glyphosate. This may well indicate plans to introduce Enlist corn varieties with additional resistance to glufosinate. At the very least, Dow clearly foresees that some growers will apply glufosinate to Enlist soybeans:

> "DAS-68416-4 soybeans confers [sic] tolerance to the herbicides 2,4-D and glufosinate, both of which will provide expanded weed management options in soybeans. …. Post-emergence applications of glufosinate will control a broad spectrum of grass and broadleaf weeds" (Dow Enlist Soybean Petition, p. 122).

Thus, it is not surprising that APHIS found that "glufosinate use on soybean could increase" in its draft Environmental Assessment of DAS-68416-4 soybeans (APHIS DEA at 80). What is surprising is APHIS's entirely new and unfounded assumption in the EIS:

> "Glufosinate use is expected to increase under the No Action Alternative ***but is expected to decrease under the Preferred Alternative*** based on the expectation that 2,4-D is considered a more favorable option for glyphosate resistant weed control compared to glufosinate."[9] (emphasis added, EIS at 119)

There are a number of good reasons to expect a substantial increase in glufosinate use with deregulation Enlist soybeans, besides the obvious fact that Dow anticipates it. First, APHIS's assumption that growers will choose 2,4-D ***instead of*** glufosinate for control of glyphosate-resistant and other weeds is agronomically naïve, and likely to be false in many cases where combined use is preferable. Weed scientists have found that using a combination of glufosinate and 2,4-D is more effective than using either one alone in controlling glyphosate-resistant Palmer amaranth (EIS at 2-25) as well as GR common waterhemp, barnyardgrass and Asiatic dayflower (Craigmyle 2013). Combined use of 2,4-D and glufosinate would not preclude use of glyphosate as well, especially a few years down the line as more weeds evolve resistance to 2,4-D and/or glufosinate. Second, a growing number of grass weeds have evolved resistance to glyphosate (EIS at 4-38). Because 2,4-D does not control grass weeds, a 2,4-D/glyphosate combination would be ineffective, and in such cases glufosinate (which does kill grass weeds) would be a logical choice. Third, there has been a tremendous rise in glufosinate use on both cotton and soybeans over the past few years by growers battling GR weeds. In fact, adoption of glufosinate-resistant soybeans (Bayer's LibertyLink varieties) and glufosinate use have both tripled from just 2011 to 2012 (see table below). These developments show increasing receptivity to use of this herbicide by a growing number of farmers

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[9] In Appendix 4 on Herbicide Use Trends and Predicted Use on Enlist Corn and Soybean, APHIS presents a conflicting assessment, namely, that "the use of glufosinate would not increase under the Action Alternatives ***relative to the No Action Alternative***" (EIS at 4-39, emphasis added), suggesting that 2,4-D use would increase in both scenarios. No estimate of 2,4-D use is offered anywhere in the EIS for either Action or No Action Alternatives.

plagued by glyphosate-resistant weeds, especially in the Southeast. This trend would likely continue with introduction of Enlist soybeans.

Postemergent Glufosinate Use on Glufosinate Tolerant Soybeans

Year	Total Acres	Glu-Tol Acres	Glu-Tol as % of Total Acres	Total Lbs of Glufosinate	Lbs Glu/Acre	Total Applications/ Acre
2008	74,404,953					
2009	77,584,979	208,577	0.3	68,751	0.46	1.12*
2010	78,725,007	892,476	1.1	452,163	0.52	1.25
2011	74,835,007	997,423	1.3	521,200	0.53	1.18
2012	75,939,995	2,989,410	3.9	1,536,000	0.51	1.19

*Revised from previous submission. From third party proprietary data

Source: Docket material provided by Dow

CFS estimated that glufosinate use on soybeans could rise to 19.2 million lbs. by 2025, based on current glufosinate usage rates and 45% adoption of Enlist soybeans by that time (CFS Science Soy, 10-11). This would represent a more than 12-fold increase in use over the 1.536 million lbs. used in 2012.

Elsewhere in the EIS, APHIS concedes indirectly that Enlist soybeans would lead to increased glufosinate use, in direct contradiction to its statements quoted above. For instance, APHIS admits that: "Selection of weeds resistant to glyphosate, auxins, chloroacetamides, ALS inhibitors, ***and glufosinate*** will still occur under the Preferred Alternative" (emphasis added, EIS at 139), which implies glufosinate use on Enlist soybeans. Similarly, APHIS admits that such weeds will erode the utility of Enlist soybeans: "weeds resistant to glyphosate, 2,4-D, ***and glufosinate*** will limit the use of this product [Enlist soybeans] and any benefit to soil that may arise" (emphasis added, EIS at 144), which would not be the case if glufosinate were not applied.

APHIS must revisit the issue of glufosinate use with Enlist crops, and provide a projection of its increased use that accords with known facts and trends.

Use of quizalofop

In its draft Environmental Assessment for Enlist corn, APHIS found that DAS-40278-9 "is expected to result in an increase in the use of the herbicide 2,4-D in corn, as well as the new use of quizalofop on corn" (DEA at 42). As with glufosinate, APHIS has made an about face in the EIS and projects declining use of quizalofop under the Preferred Alternative (EIS at 119) where it had earlier projected increasing use. APHIS assessment is wrong here as well.

Enlist corn is endowed with resistance to grass "fops" herbicides like quizalofop and cyhalofop by virtue of the same AAD-1 gene that confers 2,4-D resistance. Quizalofop is not currently applied to corn, because, as a grass-family crop, quizalofop would kill it. Enlist corn provides a new option for corn growers seeking to control grass weeds, especially but not only those with glyphosate-resistance. While most GR weeds are broadleaf plants, a growing number are grasses. APHIS notes that six grass weeds that have evolved glyphosate-resistance in the U.S.: junglerice, goosegrass, Italian ryegrass, rigid ryegrass, annual bluegrass[10] and Johnsongrass (EIS at 4-38). In fact, there are 17 distinct populations of these glyphosate-resistant grass weeds in eight states, and nine of them are found in corn, soybeans and/or cotton, and of course corn and soybeans are very frequently rotated on the same fields.[11] APHIS assumes that quizalofop will not be used "in the near future" to control such weeds because "the affected area is still small," without however providing any documentation (EIS at 4-38).[12] In any case, a "near future" assessment is not adequate in an agricultural landscape with continuing rapid evolution of glyphosate-resistance. For instance, Dow projects that two serious corn weeds will evolve resistance to glyphosate within five years (barnyardgrass and foxtail).[13] Clearly, one can expect some corn growers to make use of quizalofop to control GR grass weeds of the present or near future. Others would choose it to control one or more of the 16 grass weed species that APHIS notes are problematic in corn and soybeans (9) or just corn (7), whether glyphosate-resistant or not (EIS at 5-10, Table 5-2).

CFS projects that Enlist corn could reasonably lead to 868,000 lbs./year quizalofop use on corn (versus zero at present), assuming that Enlist corn is grown on 55% of overall corn acres, and that just 20% of those growers use quizalofop at the proposed annual label rate of 0.082 lbs./acre (CFS Corn I, p. 9).

APHIS's argument for a reduction of quizalofop use is speculative and illogical (EIS at 4-38 and 4-39), and rests primarily on assuming no use on Enlist corn, which as argued above is highly unlikely. APHIS asserts (without documentation) that soybean growers who presently use quizalofop on soybeans employ it mainly to eliminate volunteer corn in their soybean fields, and that if those same growers ***also*** adopt Enlist corn, they would no longer be able to use it for this purpose. However, only 2% of soybean acres are presently treated with 120,000 lbs. of quizalofop.[14] Even if some of this current usage were eliminated, it would not come near to counterbalancing the increased use of quizalofop on Enlist field corn.

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[10] APHIS mistakenly calls this weed "annual ryegrass." See entries under weed species 24 of the list of glyphosate-resistant weeds at http://www.weedscience.org/Summary/MOA.aspx?MOAID=12, last visited 3/8/14.

[11] Compiled from reports at http://www.weedscience.org/Summary/MOA.aspx?MOAID=12.

[12] It is a general and serious deficiency of the EIS that APHIS nowhere provides even rough quantitative estimates of acres infested with any particular GR weed species or population, and does even provide a consistent figure for national GR weed-infested acres.

[13] DAS (2011f). Supplemental Information for Petition for Determination of Nonregulated Status for Herbicide Tolerant DAS-68416-4 Soybeans: Economic and Agronomic Impacts of the Introduction of DAS-68416-4 soybeans on Glyphosate Resistant Weeds in the U.S. Cropping System. June 27, 2011. Dow AgroSciences, June 27, 2011, p. 23. Submitted to APHIS with Petition.

[14] USDA NASS (2012). Agricultural Chemical Use data for soybeans, 2012. Accessible at http://www.nass.usda.gov/Data_and_Statistics/Pre-Defined_Queries/2012_Soybeans_and_Wheat/index.asp.

Potential use of triclopyr and fluroxypyr
The AAD-12 enzyme that makes both Enlist soybean events resistant to 2,4-D and related chlorophenoxy herbicides also confers resistance to pyridyloxyacetate herbicides such as triclopyr and fluroxypyr (Dow Petition at 116; EIS at 4). However, APHIS fails to specify that DAS-68416-4 and DAS-44406-6 soybeans are in fact resistant to these herbicides (EIS at 2, 152), perhaps because (to our knowledge) Dow has not explicitly proposed their use with Enlist soybeans at this time, or petitioned EPA for the needed registrations.

However, Dow scientists clearly envision at least the potential for such use. In a scientific paper, they demonstrated that a model plant (*Arabidopsis*) genetically engineered to contain the AAD-12 enzyme found in Enlist soybeans survives high rates of triclopyr and fluroxypyr (2.24 kg ae/ha = 2 lbs./acre). Based on the activity of the AAD-12 enzyme in "degrading the synthetic auxin herbicides triclopyr and fluroxypyr…" , they stated: "This activity gives AAD-12 potential utility for providing resistance to a wider repertoire of synthetic auxins beyond 2,4-D and thus enables expanded broadleaf weed control" (Wright et al 2010).

APHIS should amend the EIS to include pyridyloxyacetate herbicides such as triclopyr and fluroxypyr among the herbicides to which Enlist soybeans are resistant (e.g. EIS at 2, 152). CFS concedes that it would be difficult to model potential use of these herbicides under the Preferred Alternative. However, because farmers have in the past made use of an undisclosed herbicide-resistance trait in a GE crop by applying the corresponding herbicide post-emergence against the advice of both crop and herbicide developers (Golden 2010), it is important that the EIS be amended to reflect the biological possibility of applying these herbicides to Enlist soybeans.

Overall herbicide use
Enlist crops would clearly trigger a massive increase in the use of herbicides on corn and soybeans, given even modest adoption rates, driven primarily by sharply rising use of 2,4-D and lesser increases in the use of glufosinate and "fops" herbicides like quizalofop. Enlist crops would thus have a very different effect than their major predecessor HR crop system, Roundup Ready. While Roundup Ready soybeans, corn and cotton did in fact lead to a substantial increase in overall herbicide use, the increase was tempered by glyphosate's partial displacement of other herbicides used on these crops (Benbrook 2012). As a result, glyphosate today thoroughly dominates herbicide use on soybeans and cotton, and in 2010 surpassed atrazine to become the number one herbicide on corn.

The fact that 2,4-D would ***not*** displace glyphosate or most other herbicides applied to these three major crops would mean an unprecedented increase in herbicidal intensity under the Preferred Alternative. For instance, APHIS/Dow concede that 2,4-D use on Enlist corn would not displace any atrazine, the 2nd-leading corn herbicide that is a potent and persistent endocrine-disrupting compound that contaminates the drinking supplies of millions of Americans and is banned in the European Union (EIS at 4-35, Table 4-13).

As discussed above, independent assessments strongly support increases in 2,4-D use on the order of Dow's Scenario 3 and the "All Enlist" variant portrayed in Figure __ above, though based on somewhat different assumptions than Dow's (lower adoption rates, higher number and rates of application).

Under the Preferred Alternative, 2,4-D use on corn and on soybeans would likely increase to 80 to 100 million lbs./year, for 160 to 200 million lbs. combined use on the two crops, by 2020. This compares to combined corn/soybean use of just 11 million lbs. per year at present, and thus a 14-fold to 18-fold increase in 2,4-D use. Overall agricultural 2,4-D use would rise from 25.6 million lbs./year at present to 185 to 215 million lbs./year (adding the 15 million lbs. per year of non-corn and non-soybean agricultural use at present, projected to continue unchanged), for a seven- to eight-fold rise in agricultural use of 2,4-D. In these projections, we have conservatively excluded our projected increases in the use of glufosinate and quizalofop.

Other issues with APHIS's herbicide use assessments
APHIS relies excessively on "third party proprietary" herbicide use data provided to it by Dow, which did not even give the name of the firm that provided it with the data. APHIS merely assumes that these data were "reported correctly" by the unnamed firm to Dow, and by Dow to APHIS. APHIS's justification for reliance on these data – "In recent years, herbicide use data has generally not been publically available" (EIS at 4-2) – is entirely inadequate. APHIS is referring here to gold-standard pesticide (including herbicide) usage data collected periodically by USDA's National Agricultural Statistics Service. While USDA NASS does not collect data for all crops every year, it has collected pesticide use data for all of the years in many of the tables and graphs in Appendix 4 of the EIS (e.g. EIS at 4-5). APHIS could have made use of NASS data if for no other purpose than to check the veracity of the proprietary data in years where the former were available, especially recent NASS data for corn (2010) and soybeans (2012), to which APHIS makes no reference.

Weed and plant pest threats posed by Enlist crops
APHIS's authority under the Plant Protection Act gives it authority over plant pest and noxious weed risks that may be posed by genetically engineered crops. Herbicide-resistant crop systems such as the "Enlist Weed Control System" (EIS at 4-32) are explicitly designed for weed management purposes. Enlist crops present three distinct risks that fall under the USDA's Plant Protection Act authority.

First, Enlist crops would become difficult to control weeds when they sprout as volunteers in the next year's crop. Second, Enlist volunteers that also contain genetically engineered insecticidal toxins would in certain cases lead to more rapid evolution of resistance to these toxins in serious insect pests, posing a clear plant pest risk. Finally, Enlist crop systems would foster rapid evolution of 2,4-D resistance in weeds, which in combination with pre-existing resistance would in some cases give rise to noxious herbicide-resistant weeds.

Crop volunteers as weeds
It is important to understand that the term "weed" does not denote any biological class in the taxonomy of nature. It is an anthropocentric term used to denote ***any*** plant that humans find undesirable for ***any*** reason. As APHIS notes: "Weeds are simply plants growing in areas where their presence is undesired by humans" (EIS at 5-2). This anthropocentric definition implies that a plant can be a weed at some times and in some situations but not others.

For instance, crop plants desired as food in most contexts are often called weeds when they sprout as undesirable "volunteers." A volunteer is a crop plant that sprouts from unharvested seed that fell to the ground in the previous season. For example, a farmer who grows corn one year and soybeans the next on the same field will often have volunteer corn growing amidst his/her soybeans. Like other weeds, volunteers compete with the crop for nutrients, water and sunlight, and can thus reduce yields, and can also make harvest more difficult. Grain escapes harvest and is left in the field for several reasons. Disease or pests can weaken the crop's stalk or roots, causing the plant to fall over (lodge) such that the grain lies on or near the ground and is missed by the harvester. Storms and drought can also cause lodging. Harvesting equipment is imperfect, and always scatters a certain amount of grain to the ground. In corn, it is estimated that lodging and harvest losses leave 3-6% of the kernels behind in the field after harvest (Shay et al 1993), each a potential volunteer the next season.

Many studies show that volunteers reduce yield (EIS at 94-95). Volunteer corn populations of 3,5000 to 7,000 plants per acre were shown to reduce soybean yields by 10% and 27%, respectively, in Nebraska. In South Dakota, 13,000 plants per acre reduced soybean yield by 54% (Stahl 2013). Just two to four volunteer corn plants per square meter reduced yields in soybeans by 20% (Morrison 2012). Corn volunteers can be a troublesome weed in other crops as well, including dry beans, sugar beets and subsequent corn crops (Bernards et al, 2010; Davis, 2009; Johnson et al, 2010; Stewart, 2011). As discussed below, volunteers can also exacerbate plant pests.

Enlist crop volunteers as weeds
Volunteer corn becomes much more of a weed threat when it is herbicide-resistant, because difficulty of control is a prime attribute of weediness and herbicides are major weed control options. In 2007, volunteer glyphosate-resistant corn (Roundup Ready) was rated as one of the top five weeds in Midwest soybean fields (Morrison 2012). Things have become worse with adoption of SmartStax corn, which is resistant to two herbicides – in this case glyphosate and glufosinate (Brooks 2012, Morrison 2012).

Enlist corn volunteers would be still more persistent by virtue of "improved fitness … which translates into fewer options for the removal of volunteer plants" (Enlist Corn PPRA[15] at 9). When volunteer corn emerges in soybeans, one tactic is to apply "grass" herbicides like quizalofop to kill it (effective on corn since corn is a grass family crop, EIS at 4-38). This tactic would no longer be effective on Enlist corn volunteers, since they would be resistant to quizalofop and other "fops" herbicides like cyhalofop (Enlist Corn PPRA at 10). In addition, Dow has already "stacked" 2,4-D and quizalofop resistance into SmartStax corn (Scherder et al 2012), which as noted above is resistant to glyphosate and glufosinate. Glufosinate – otherwise an effective means to control volunteer corn – would also be ineffective. Contrary to APHIS, neither glyphosate nor glufosinate would be effective control options (Enlist Corn PPRA at 10). Such volunteer corn plants would be resistant to four major modes of action, and would present still more serious control problems, leading to use of additional herbicides specifically to control volunteer corn that would otherwise not be needed, or to increased use of soil-eroding tillage. As APHIS concedes: "If the volunteer corn is stacked to express both glyphosate and glufosinate resistance, inter-row cultivation [a form of tillage] is the only option for post-emergence control within corn." (EIS at 95). APHIS did not assess increased use of toxic herbicides or soil erosion resulting from cultivation to control Enlist volunteer corn.

Even if additional herbicides are used, they are often not very effective. APHIS initially found that "dim" (e.g. clethodim) and ALS inhibitor herbicides would effectively control Enlist corn volunteers (Enlist Corn PPRA at 10), but in the EIS concedes that neither provides control adequate to prevent yield losses in soybeans under some circumstances (EIS at 95).

It is reasonably foreseeable under the Preferred Alternative that Enlist corn varieties would be offered with resistance to additional herbicides. In Dow's 2009 patent on the 2,4-D resistance trait, the company envisions crops with combined resistance to not only 2,4-D, glyphosate, "fops" herbicides like quizalofop and glufosinate – but also to one or more additional classes of herbicide, including: ALS inhibitors, bromoxynil, HPPD inhibitors, PDS inhibitors, photosystem II inhibitors (e.g. atrazine), photosystem I inhibitors (e.g. paraquat), PPO inhibitors, phenylurea herbicides, dicamba and others (DAS Patent 2009, paragraph 0082). Thus, Enlist corn or soybean volunteers could be offered in varieties resistant to most or potentially all major classes of herbicide on the market today. The more herbicide resistance traits are stacked into Enlist crops, the less likely it is that they would be susceptible to effective control; and the more damage they would cause in terms of reduced yield and harvesting problems. The time, expense, toxicity and natural resource impacts of weed control would also increase, as farmers apply herbicides specifically to control crop volunteers that they would otherwise not utilize, or employ soil-eroding tillage.

[15] PPRA = APHIS's Plant Pest Risk Assessment

While the discussion above focuses on Enlist corn volunteers, Enlist soybean volunteers would also be weedier and negatively impact crop production (CFS Science Soy, 39-40).

Enlist corn volunteers would exacerbate a serious plant pest, corn rootworm
Enlist corn volunteers would also exacerbate one of the most serious plant pest issues facing American farmers today: the rapidly evolving resistance of corn's worst pest, corn rootworm, to the genetically engineered toxins found in most corn varieties.

The majority of GE herbicide-resistant corn on the market today is sold in "stacked" versions with genetically engineered resistance to corn rootworm and above-ground pests like European corn borer. Insect resistance is conferred by various toxins (e.g. Cry3Bb1) derived from the soil bacterium *Bacillus thuringiensis* (Bt). According to USDA, these "stacked" gene varieties that combine herbicide- and insect-resistance were planted on 71 % of U.S. corn acres in 2013, versus just 14% with herbicide-resistance alone.[16] APHIS assumes in the EIS that under the Preferred Alternative: "Enlist crops could be crossed with any currently available variety including GE varieties no longer regulated by APHIS" (EIS at 119). Enlist corn would thus be offered primarily in versions stacked with "Bt" resistance to corn rootworm.

Bt-resistant corn rootworm is already becoming a full-blown problem in up to 11 states (CFS Rootworm 2013), in part because the corn produces low levels of Bt toxin that tends to foster evolution of resistance (Gray 2011, Porter et al 2012). Krupke et al (2009) have found that ***volunteer*** corn produces ***still less*** of the insect-resistance toxin. The lower-level Bt toxin expression of volunteer corn relative to parent corn allows many corn rootworm to persist into the next season, and also fosters rapid evolution of resistance in them (Stahl 2013, Morrison 2012).

As noted above, Bt corn is usually stacked with glyphosate resistance; because glyphosate is often the only herbicide used in soybean fields, stacked volunteer corn is more likely to persist, which makes the problem worse. Krupke et al (2009) conclude that "weedy volunteer corn plants stacked with GR [glyphosate-resistance] and Bt traits may accelerate the development of Bt-resistant WCR [western corn rootworm] populations, circumventing the current [Bt insect-resistance] management plans." In continuous stacked corn managed with glyphosate, corn volunteers producing lower, resistance-promoting levels of rootworm toxin would be still more likely to escape control than in soybeans, since harder to distinguish as volunteers in a field of corn.

Enlist corn would exacerbate the plant pest risk presented by stacked glyphosate-resistant/Bt volunteer corn. Combined resistance to 2,4-D, quizalofop, glyphosate

[16] http://www.ers.usda.gov/data-products/adoption-of-genetically-engineered-crops-in-the-us.aspx#.Ux_KE_2wya4

and likely other herbicides would diminish control options, and thus Enlist volunteer corn would be more likely to survive to foster resistant corn rootworm. This is still more likely to be true given that recommended control practices for Enlist volunteer corn are not very effective (as discussed above), and so in many cases may not be utilized. Thus, many growers would likely leave such volunteers uncontrolled.

CFS requested that APHIS address this serious plant pest issue in scoping comments for the EIS (EIS at 2-8, 2-47), yet APHIS completely failed to assess it.

Enlist crop systems would foster rapid emergence of multiple herbicide-resistant and noxious weeds

Summary
Herbicide-resistant crop systems like Enlist are pathways for rapid emergence of herbicide-resistant weeds. Some existing populations of weeds resistant to glyphosate and other herbicides, such as Palmer amaranth, horseweed and common waterhemp, already meet USDA's noxious weed criteria, which include difficulty of control as well as invasiveness and reducing productivity of crop fields. Enlist crop systems would be preferentially grown where such herbicide-resistant (HR) weeds are already rampant. APHIS concedes that Enlist crop systems would foster emergence of weeds with resistance to 2,4-D, but fails to assess the cumulative impacts of multiple resistance. ***Additional*** 2,4-D resistance would transform troublesome HR weeds into noxious ones, and exacerbate the noxious character of already noxious weeds such as resistant Palmer amaranth by making them still more recalcitrant to control. Because 2,4-D is an important control option for resistant weeds, and because its existing uses have not resulted in widespread 2,4-D resistance, the No Action Alternative would largely preserve 2,4-D's efficacy for its important role of controlling weeds already resistant to glyphosate and other herbicides. Under the Preferred Alternative, Enlist crop systems would foster additional 2,4-D resistance in these same weeds. Because HR weeds spread, the negative impacts of Enlist would not be confined to Enlist crop users, but would rather become area-wide impacts that impact non-Enlist growers as well. APHIS failed to assess the multiple herbicide-resistant and noxious weed threats posed by Enlist crop systems in its Plant Protection Act assessments.

Enlist crop systems are pathways for rapid emergence of 2,4-D and multiple-herbicide resistant weeds
Herbicides do not automatically trigger weed resistance, as APHIS falsely assumes (EIS at 148). Much depends upon how they are used. Experience shows clearly that herbicide-resistant crop systems are particularly prone to promote rapid evolution of weed resistance by fostering repeated, exclusive and late post-emergence application of the HR crop-associated herbicide(s) (CFS Science Soy at 21-24). This explains why no glyphosate-resistant weeds emerged over the first 20 years of glyphosate's commercial use, but rather only emerged to reach epidemic proportions in step with the adoption of Roundup Ready crops (CFS Science Soy at

24-27). A modeling study by UK weed scientist Paul Neve (2008) (frequently cited by APHIS in past regulatory documents) concurs:

"Glyphosate use for weed control prior to crop emergence is associated with low risks of resistance. … Post-emergence glyphosate use, associated with glyphosate-resistant crops, very significantly increases risks of resistance evolution."

This also explains why APHIS projects that Enlist crop systems under the Preferred Alternative would increase selection pressure for 2,4-D resistance in weeds, but does not similarly project increased 2,4-D weed resistance under the No Action Alternative. APHIS in fact notes that 60 years of 2,4-D use have resulted in relatively few and small resistant populations.

Acting under the noxious weed provisions of the Plant Protection Act, APHIS prohibits and/or regulates introduction from overseas of seed from plants that are ***not*** noxious weeds if such seed is potentially admixed with noxious weed seed. The seed thus prohibited or regulated is regarded as a potential "pathway" for introduction of noxious weeds into the United States. APHIS has the authority and the duty to regulate herbicide-resistant crops as potential pathways for emergence of noxious, herbicide-resistant weeds.

APHIS's dereliction of duty
APHIS has both the authority and the duty under the Plant Protection Act to assess genetically engineered (GE) crops for the plant pest and noxious weed risks they may pose (EIS at v). Yet remarkably, APHIS makes only five references to the term "noxious weed" in the entire collection of Plant Protection Act assessments of Enlist crops that it has drafted to date (EIS at v and 161, Enlist Corn PPRA at 9, Enlist Soybeans PPRA at 7, Enlist Soybeans draft EA at 142), and in each case only to make the trivial point that neither corn nor soybean appears on the list of federal noxious weeds. This assessment failure is completely unacceptable in light of existing (if unlisted) noxious weeds spawned by the major predecessor herbicide-resistant crop system, and the inevitable emergence of still more intractable noxious weeds under the Preferred Alternative.

APHIS's criteria for noxious weeds
In 2008, APHIS issued a proposed rule (never finalized) to implement its authority under the Plant Protection Act of 2000 to regulate the noxious weed risks that may be posed by GE crops. APHIS described various impacts of noxious weeds, which include:

> "Lost productivity of crop fields: Noxious weeds may directly compete with crop plants for limited resources, dramatically reducing yields." (FR Vol. 73, No. 179, pp. 60008-60048 at 60013).

One example of a federally listed noxious weed in this category is Benghal dayflower (*Commelina benghalensis*)." (Ibid)

Difficulty of control is a key attribute of noxious weeds:

> "In general, federally listed noxious weeds are plants that are likely to be aggressively invasive, have significant negative impacts, and are ***extremely difficult to manage or control once established.***" (Ibid, emphasis added)

And herbicides are major control options. While only certain problematic weeds "are considered to be so invasive, so harmful and so difficult to control" as to rate designation as noxious, "significant negative consequences" of all weeds, including noxious ones, include "lost yields, ***changes in management practices, altered herbicide use***, etc." (Ibid, emphasis added)

Thus, noxious weeds include those that cause dramatic yield reductions, resulting in lost productivity of crop fields; are extremely difficult to control; and have significant negative consequences by forcing substantial and adverse changes in management practices, including those involving toxic herbicide use.

Glyphosate-resistant weeds most likely candidates for noxious weed status
Glyphosate-resistant, Roundup Ready crops as grown in U.S. agriculture have proven to be potent promoters of glyphosate-resistant (GR) weeds that would never have evolved absent the widespread introduction of this cropping system (CFS Science Soy at 24-27). Nearly half of U.S. farmers surveyed in 2012 said they had GR weeds in their fields, up from 34% in 2011 (Stratus 2013). The same survey found 61 million acres infested with GR weeds in the U.S. alone (EIS at 136), an area the size of Wyoming. CFS Science Soy (29-36) provide a documented discussion of the severe impacts of four of the worst GR weeds as of 2012, which include reduced yields, large increases in the number, quantity and toxicity of herbicidal control responses, increased use of soil–eroding tillage, hand-weeding across hundreds of thousands of acres, abandoned cropland, and several-fold increases in weed control expenditures. According to eminent weed scientist Dr. Stephen Powles, writing in the Proceedings of the National Academy of Sciences on the topic of GR weeds: "It is not an exaggeration to state that the potential loss of glyphosate to significant areas of world cropping is a threat to global food production" (Powles 2010). The discussion below focuses on GR weeds because: 1) Enlist crops would be preferentially grown in areas where GR weeds are rampant (EIS at iii); and 2) Additional resistance to 2,4-D in weeds already resistant to glyphosate (and often other herbicides) would be both likely and most conducive to generation of noxious HR weeds.

Existing herbicide-resistant noxious weeds: Palmer amaranth and horseweed
Several GR weeds are already noxious by USDA's standards, for instance Palmer amaranth (Ward et al 2013). Webster and Nichols (2012) provide a comprehensive review of changes in prevalence of the most problematic weed species in 14 Southern states from 1994/95 to 2008/09. This review is based on comprehensive

weed surveys, and breaks down the most problematic weeds in cotton, soybeans, corn and wheat over this time period. The ranking system used by Webster and Nichols "provides measures of the most difficult to control weed species…."

Two of the most prevalent and damaging glyphosate-resistant weeds nationally – Palmer amaranth and horseweed – are ranked as the second and fourth worst weeds in southern soybeans. Both are more damaging than the federally listed noxious weed, Benghal dayflower (*Commelina benghalensis*),[17] which is ranked ninth (Webster and Nichols 2012, Table 4). Prior to the introduction of glyphosate-resistant crops in 1995, Palmer amaranth and horseweed ranked just 23rd and 38th, respectively. Similarly, two glyphosate-tolerant species – Florida pusley and Benghal dayflower – rose from 39th and 40th, respectively, to the 5th and 9th positions over the same period. Thus, the already noxious weed Benghal dayflower has become still more problematic by virtue of its glyphosate tolerance in combination with ubiquitous use of glyphosate. In cotton, which is sometimes rotated with soybeans, glyphosate-resistant Palmer amaranth was the worst weed in 2009, up from the 10th position in 1995 (Ibid, Table 3).

Palmer amaranth and other glyphosate-resistant weeds expanding, treated as noxious weeds

Glyphosate-resistant Palmer amaranth was once a noxious weed that primarily plagued cotton and soybeans in the South, but over the past few years it has emerged rapidly in Midwestern, Eastern and Western states, where it infests now corn as well as soybeans and cotton. It is now found in Missouri, Illinois, Ohio, Kansas, Michigan, Indiana, Iowa, Pennsylvania and Delaware, as well as Arizona and California. Since the year 2010, there have been 17 new populations reported of GR Palmer amaranth, eight of GR tall waterhemp, six of GR kochia, and five of GR horseweed,[18] to name only a few of the more problematic GR weeds.

In Iowa, glyphosate-resistant Palmer amaranth populations are being treated like federally listed noxious weeds. Agronomists recommend that farmers who identify this weed in their fields should remove them by hand prior to harvest, put them in a bag and burn the bags to prevent spread (Ellis 2013). In Minnesota, where the weed has not even yet appeared, agronomists are urging vigilance to enable "rapid early detection and eradication before any permanent population can become established" (Stahl & Gunsolas 2013).

Long- and short-distance spread of herbicide-resistant weeds

Once established, an herbicide-resistant weed population can spread via cross-pollination or long-distance seed transport. In Indiana, researchers believe that glyphosate-resistant Palmer amaranth was introduced to northern Indiana in dairy or beef manure from animals that were fed cotton seed hulls or other feed stocks from the South that were contaminated with Palmer amaranth seed (Leglieter &

[17] See FR Vol. 73, No. 179, p. 60013, cited above.

[18] See http://www.weedscience.org/Summary/MOA.aspx?MOAID=12, last visited March 10, 2014.

Johnson 2013). Other modes of transport include combines and other agricultural equipment as well as birds and other animals (Ellis 2013). Certain weeds (e.g. horseweed) can send pollen on the wind over long distances, while seeds washed into rivers can also spread [herbicide-resistant] seed long distances (see CFS Science Soy, 38-39). Thus, HR weeds cannot be effectively prevented or controlled by approaches that rely solely on individual growers following "best management practices" (BMPs) reputed to slow or prevent HR weed emergence. Likewise, because implementation of BMPs can be costly, any individual grower has less incentive to implement them if he/she can expect his/her field to be invaded by resistant weeds from those of a less diligent farmer anyway (see Webster & Sosnoskie 2010 and CFS Science Soy at 38-39). If a noxious, herbicide-resistant weed were always confined to the field of the farmer whose farming practices fostered its emergence, there might be less need for USDA action. Since this is not the case, and spread can cause area- or region-wide harm, action is essential.

Multiple herbicide-resistant weeds

Many GR weeds are also resistant to other herbicides, making them more difficult to control and hence problematic (see CFS Science Soy at 29-36). In Indiana, Palmer amaranth was identified in 51 fields across five northwestern counties in 2012, and in many fields survived multiple applications of both glyphosate and PPO-inhibiting herbicides (Legleiter and Johnson 2013). Most GR Palmer amaranth is also resistant to ALS inhibitors, which is thought to be due to pre-existing ALS inhibitor-resistant populations being selected for additional resistance to glyphosate; or to cross-pollination between glyphosate-resistant and ALS inhibitor-resistant individuals (Ward et al 2013). Palmer amaranth populations have evolved resistance to five different classes of herbicide: dinitroanilines, triazines (e.g. atrazine) and HPPD inhibitors as well as glyphosate and ALS inhibitors (Ward et al 2013). In Nebraska, scientists recently discovered a population of Palmer amaranth resistant to both atrazine and HPPD inhibitors, and with reduced sensitivity to ALS inhibitors, bromoxynil and a PPO inhibiting herbicide (Jhala et al 2014). Waterhemp biotypes have evolved resistance to six different classes of herbicide (Rosenbaum & Bradley 2013).

Synthetic auxin-resistant weeds

2,4-D is the most widely used member of the synthetic auxin class of herbicides. Weed populations or biotypes that evolve resistance to one member of this group may have cross-resistance to other members. APHIS falsely states that "relatively few weeds have developed resistance to 2,4-D" (EIS at 16). In fact, biotypes of 31 weed species around the world have evolved resistance to synthetic auxins (Synthetic Auxin Resistance 2014). There are 22 herbicide groups. Synthetic auxins are tied for 4th in number of weed species that have evolved to them (Weed Resistance by SOA 2014). This fact suggests that many weed species of the genetic capacity to evolve resistance to 2,4-D, even if at present it is true that 2,4-D-resistant populations are not anywhere near as prevalent as for instance GR weeds. Enlist crop systems would dramatically increase selection pressure for 2,4-D-resistant weeds, and thus the fact that existing populations are small means nothing. After all, there were practically no GR weeds prior to the dramatically increased selection pressure for resistance that accompanied massive use of glyphosate with Roundup Ready crop systems.

Waterhemp is one serious GR weed that has a biotype resistant to 2,4-D. Several kochia biotypes are resistant to dicamba, and so potentially 2,4-D as well, since the two herbicides share a common site of action (CFS Science Soy at 35). APHIS notes that a biotype of one of the most troublesome corn/soybean weeds, common lambsquarter, is resistant to dicamba, but falsely concludes that it is ***not*** resistant to 2,4-D (EIS at 4-4), when in fact the report cited for that weed states that it "may be cross-resistant to other Group O/4 herbicides," the class of synthetic auxins which includes 2,4-D.[19] Less than one month ago, scientists identified a wild radish population resistant to both glyphosate and 2,4-D (WeedSmart 2014). Such dual-resistant weeds would increase dramatically under the Preferred Alternative. CFS Science Soy (27-29) provide further discussion of synthetic auxin-resistant weeds.

The prevalence and adverse impacts of glyphosate- and multiple herbicide-resistant Palmer amaranth, horseweed, common waterhemp, kochia and other weeds are discussed extensively in CFS Science Soy (17-41). This discussion also includes a comprehensive assessment of the potential for these weeds to evolve additional resistance to 2,4-D and/or glufosinate with Enlist crops.

Additional resistance to 2,4-D under the No Action versus Preferred Alternatives
Under the No Action alternative, 2,4-D use on corn and soybeans is projected to rise modestly through 2020 (much less than under the Preferred Alternative), continuing a trend of gradually increasing use over the past few years. 2,4-D use is gradually rising because it has proven to be an effective control option for farmers battling glyphosate-resistant weeds. There is very little risk of 2,4-D-resistant weeds under the No Action Alternative, for several reasons. First, 2,4-D has been used for over 60 years, and while a number of weed species have shown the genetic capacity to evolve resistance to this herbicide (which is concerning, as discussed above), as APHIS notes the few populations that exist tend to be small and are not regarded as especially problematic. This indicates that current 2,4-D use patterns are not resistance-promoting. Second, the volume of 2,4-D use would not increase much under the No Action Alternative; it would continue to be used just once per season as at present; and it would be used mainly in combination with other herbicides – all factors which are said to impede resistance evolution. Finally, under the No Action Alternative there would be greater use of beneficial non-chemical weed control tactics like cover crops and crop rotations, which suppress weeds without exerting any selection pressure for resistance to any herbicide. These factors explain why APHIS projects little or no additional 2,4-D resistance under the No Action Alternative.

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[19] See http://www.weedscience.org/Details/Case.aspx?ResistID=5389, last visited 3/11/14.

Under the Preferred Alternative, growers would rely excessively on resistance-promoting, post-emergence applications of 2,4-D, often in conjunction with glyphosate. However, glyphosate would have no impact on the glyphosate-resistant weeds that are rampant where Enlist crops are most likely to be grown. GR weeds are estimated to infest a massive 61 million acres (area of the state of Wyoming). These GR weeds (especially in Enlist soybeans) would thus often be treated with just one effective mode of action, which weed scientists agree offers ideal conditions for rapid evolution of resistance. Dow projects an average of 1.54 and 1.33 applications of 2,4-D per season with Enlist soybeans and corn, respectively, while others project 2 applications per season (as discussed above). Rates and overall volume would also increase. Increased frequency, rate and volume of use all promote resistance. APHIS also projects declining use of glufosinate and quizalofop under the Preferred Alternative; while a questionable assumption, if it holds true it would mean still greater reliance on and more resistance to 2,4-D. Finally, non-chemical weed control tactics like cover crops and crop rotation are less likely to be employed under the Preferred Alternative. These factors underlie APHIS's projection of increased selection pressure for 2,4-D-resistant weeds with Enlist crops.

Resistance to other herbicides in the No Action vs. Preferred Alternatives
APHIS states that weeds resistant to glyphosate and other non-2,4-D herbicides would increase more in the No Action than in the Preferred Alternative, but it is entirely unclear why this should be so. APHIS maintains that using a diversity of herbicide classes with different "modes of action" (aka "sites of action") is the key to preventing resistance from emerging to any one class of herbicide. APHIS also describes, based on data provided by Dow, how soybean and corn farmers have been increasing the diversity of herbicides they employ in response to glyphosate-resistant weeds for several years now (EIS, Appendix 4). As this trend would continue under the No Action Alternative, it would seem to suggest lesser, not more, emergence of weeds resistant to non-2,4-D herbicides.

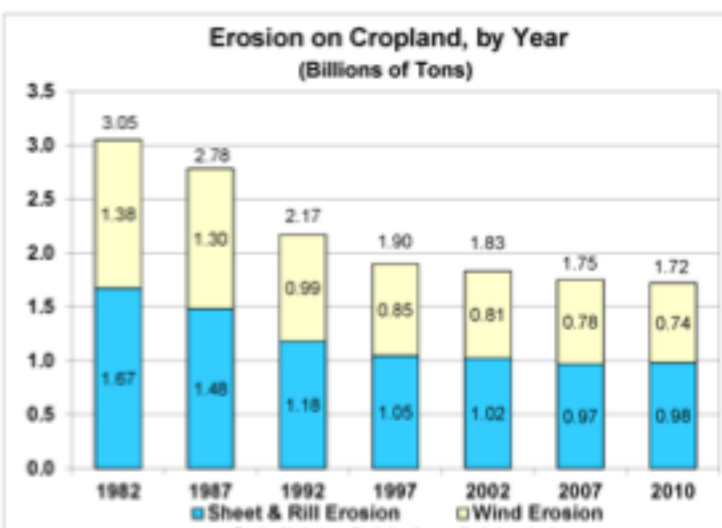
Conversely, the growing diversity in types of herbicide used would be reversed under the Preferred Alternative, as farmers revert to the simplicity and convenience of the total post-emergence weed control paradigm that would be offered by Enlist crops, and to which farmers have grown accustomed through 15 years of Roundup Ready crops. Indeed, there is evidence to support this assessment from trends in the use of another HR crop system, glufosinate-resistant, LibertyLink (LL) soybeans. Tennessee weed scientist Larry Steckel reports that in his state, a survey showed that "60 percent of our Liberty Link soybeans got nothing but Liberty on them." University of Arkansas weed scientist Jason Norsworthy, reporting a similar trend in Arkansas, said: "Folks, we're going to run Liberty into ground if that's the case. We've got to use other modes of action if we're going to protect it and keep it around for any length of time" (Bennett 2014). The implication is clear. Enlist crop systems would similarly "run 2,4-D into the ground" by generating 2,4-D-resistant weeds under the Preferred Alternative.

Enlist crops, soil erosion and tillage
Throughout the draft EIS, APHIS repeatedly asserts that under the Preferred Alternative, Enlist crops would enable farmers to utilize post-emergence 2,4-D applications to control glyphosate-resistant weeds, and thereby avoid soil-eroding tillage operations that would otherwise, under the No Action Alternative, become necessary to control these GR weeds. APHIS accordingly attributes to Enlist crops a whole host of benefits commonly associated with reduced soil erosion, including improved air, water and soil quality; and claims as well that soil erosion and the associated impacts would increase under the No Action Alternative.

These assertions, in turn, are based on the assumption that Roundup Ready crops have driven a reduction in soil erosion by facilitating less soil-eroding tillage practices, known collectively as "conservation tillage." APHIS argues by analogy that Enlist crops would preserve and further the benefits of reduced soil erosion purportedly conferred by Roundup Ready crops.

CFS provides a fully documented discussion that debunks the purported linkage between glyphosate-resistant and Enlist crops, adoption of conservation tillage practices, and reduced soil erosion in CFS Science Soy (62-76). We will not repeat that discussion here, but rather present new information that further supports the falsity of APHIS's view that Roundup Ready crops have, and Enlist crops would, reduce soil erosion.

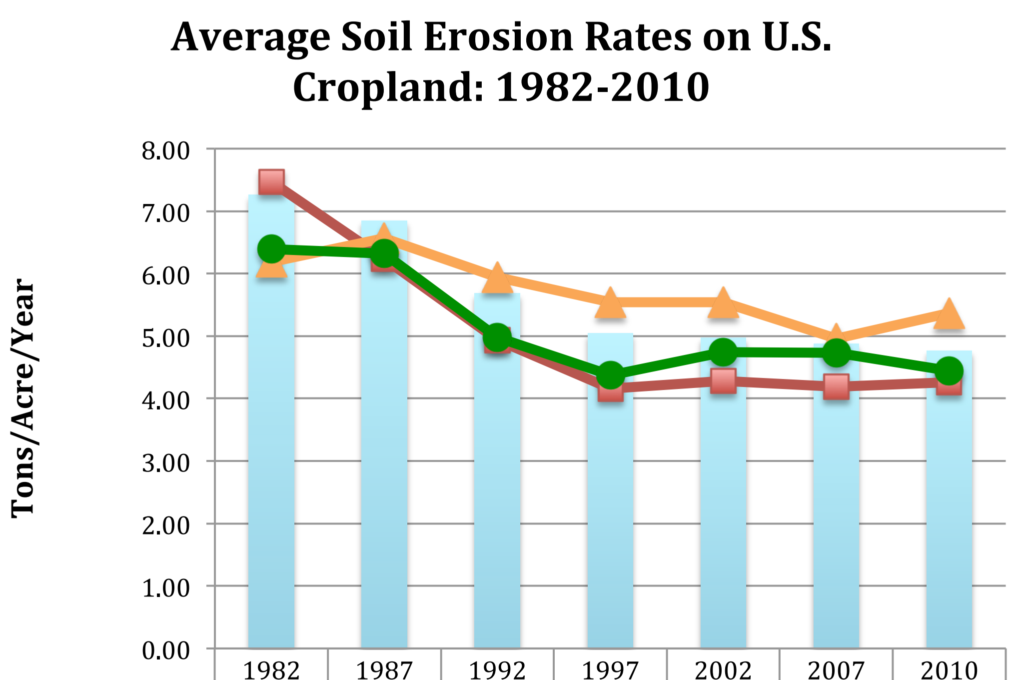
The most recent data from USDA's experts at the National Resources Conservation Service (formerly the Soil Conservation Service) show that the massive reductions in soil erosion that occurred in the 15 years before Roundup Ready crops came to a virtual halt in the Roundup Ready crop era (see figure below).



Source: USDA NRCS (2013). Summary Report: 2010 National Resources Inventory. National Resources Conservation Service, USDA, September 2013, p. 7. NRCS notes that "[t]he estimate of the change in erosion from 2007 to 2010 was not statistically different from zero."

On a national level, soil erosion declined by 38% from 1982 to 1997, but by just 9% from 1997 to 2010. Roundup Ready crops were introduced in 1996, and RR varieties now comprise the overwhelming majority of corn, soybeans and cotton in America, planted on over 150 million acres. If Roundup Ready crops planted on such a massive scale truly reduced soil erosion, it would be certainly be reflected in greater reductions in soil erosion post 1997 than have in fact occurred.

However, the evidence at the regional level is still more revealing. The majority of American corn and soybeans are grown in three Farm Production regions: the Corn Belt (Iowa, Missouri, Illinois, Indiana and Ohio); the Lake States (Wisconsin, Minnesota and Michigan); and the Northern Plains states (North and South Dakota, Nebraska and Kansas) (see map below). ***Soil erosion rates were entirely flat in corn and soybean country over the period of massive Roundup Ready crop adoption post 1997*** (see figure below).



	1982	1987	1992	1997	2002	2007	2010
NATIONAL	7.26	6.85	5.68	5.05	4.97	4.87	4.77
Corn Belt	7.47	6.24	4.94	4.16	4.28	4.19	4.26
Lake States	6.19	6.57	5.94	5.54	5.54	4.96	5.37
Northern Plains	6.39	6.32	4.98	4.37	4.74	4.73	4.45

NATIONAL Corn Belt Lake States Northern Plains

Source: USDA NRCS (2013) dataset. Data represent combined sheet/rill and wind erosion. Data not yet compiled in the report cited above. Kindly provided to CFS by Patrick Flanagan, National Statistician, NRCS, on 2/27/14.

It is simply impossible to reconcile no reduction in soil erosion with massive adoption of crops (Roundup Ready) that save soil. Either NRCS is wrong or RR crops have not saved soil (and Enlist crops would not). APHIS does not question NRCS soil erosion figures. Indeed, APHIS concedes in a single isolated passage that: "it is important to note that much of the reduction in soil erosion occurred prior to the adoption of GE herbicide resistant crops…" (EIS at 97), consistent with NRCS data. However, APHIS nowhere concedes the crucial fact that soil erosion has ***not*** declined in the Midwest since 1997.[20]

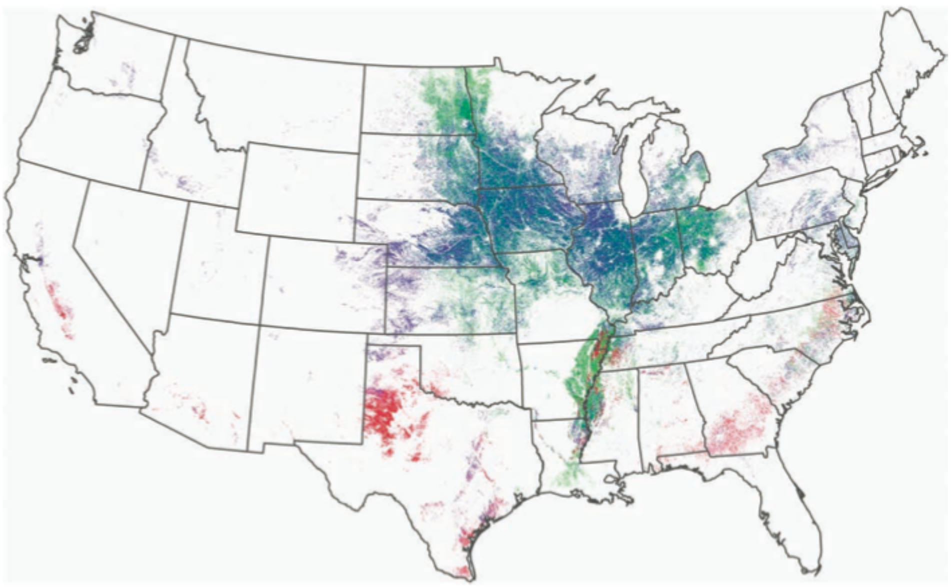


Figure 1. In 2011, approximately 26% of the land surface (558,000 square kilometers) in 12 Midwestern states (Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin) was planted almost exclusively with two plant species: corn and soybean, both of which are genetically modified for weed and insect pest management. In the map, red marks cotton fields, green is corn, and blue is soybean. The data, from 2011, were generated using the US Department of Agriculture National Agriculture Statistics Service's Cropland Data Layer Program data set.

USDA NASS map showing where corn (green), soybeans (blue) and cotton (red) are grown. The majority are in the 12 states of the Corn Belt, Northern Plains and Lake States as described in text.

It is extremely important to note that ***this purported but illusory reduction in soil erosion is the sole pretext for Enlist crops, a pretext that APHIS repeats*** **ad nauseum** ***throughout he EIS to make the enormous increase in herbicide use and increased weed resistance under the Preferred Alternative more palatable, and to create the false negative impression of increased soil erosion under the No Action Alternative.***

[20] Indeed, the passage just cited is preceded by a description of soil erosion reductions from 1982 to 2007 (EIS at 97) to buttress, in the eyes of readers not familiar with the data, the false linkage of RR/Enlist crops and reduced soil erosion that pervades the EIS.

Rather than analyze this issue, of such importance to APHIS's central thesis in the EIS, APHIS merely alludes to the major factor driving reduced soil erosion in American agriculture, the 1985 Farm Bill (EIS at 67, 97), without however acknowledging the enormous impact it had in reducing soil erosion, or the mechanism that made it so successful – namely, providing farmers with extremely strong financial incentives to adopt soil-saving techniques by making their subsidies dependent on implementation of conservation tillage. CFS Science Soy (62-76) provide a full discussion of the issue.

In conclusion, it should be noted that reducing soil erosion has for three decades and longer been a leading goal of U.S. agricultural policy - deservedly so, for rich topsoil is one of the most important factors that makes American agriculture so productive; and its loss through soil erosion was the major cause of one of our country's worst agricultural and human disasters – the Great Dust Bowl of the 1930s. Topsoil once lost is not readily restored, and thus preservation of this invaluable resource is of crucial importance to America's long-term well-being. Thus, the misconception that HR crop systems like Enlist and Roundup Ready serve this laudable goal represents much more than deceptive pleading for deregulation of Enlist crops. It also obfuscates the true causes of soil erosion, which lie more in the policy arena, and thereby diverts attention and political will from enacting the policies needed to effectively address it.

Sustainable Action Alternative

Summary

APHIS did not consider an alternative to Enlist crops for weed control that encourages use of agroecological weed control methods that minimize reliance on herbicides and as well as soil erosion. For instance, USDA researchers have studied and developed successful agroecological weed management methods. Such methods include complex crop rotations, cover cropping, limited tillage, changes in timing of planting, and other management options. Organic farmers have also developed a rich repertoire of ingenious techniques for managing weeds and others pests while conserving soil, without resort to toxic herbicides. Many cultural techniques for weed management provide additional benefits, for instance increasing soil organic matter content, and reducing soil erosion and agrichemical runoff. While the No Action Alternative would be more consistent with such a path (relative to the Preferred Alternative), there are numerous policy instruments that would more vigorously promote sustainable weed management, which APHIS must consider in the context of a Sustainable Action Alternative.

A third choice

While the No Action Alternative is certainly the lesser of two evils, in that it would result in lesser toxic herbicide use and also greater adoption of beneficial practices such as cover crops (EIS at 83) relative to the Preferred Alternative, it is not in itself sufficient to move agriculture onto a more sustainable path. Below, we sketch the outlines of a Sustainable Action Alternative that APHIS should consider in the EIS.

Weed management vs. weed eradication

Weeds can compete with crop plants for nutrients, water and sunlight, and thereby inhibit crop growth and potentially reduce yield. While less dramatic than the ravages of insect pests or disease agents, weeds nevertheless present farmers with a more consistent challenge from year to year. However, properly managed weeds need not interfere with crop growth. For instance, organically managed corn has been shown to yield as well as conventionally grown varieties despite several-fold higher weed densities (Ryan et al. 2010). Long-term cropping trials at the Rodale Institute reveal that average yields of organically grown soybean were equivalent to those of conventionally grown soybean, despite six times greater weed biomass in the organic system (Ryan et al. 2009). Weeds can even benefit crops – by providing ground cover that inhibits soil erosion and attendant loss of soil nutrients, habitat for beneficial organisms such as ground beetles that consume weed seeds, and organic matter that when returned to the soil increases fertility and soil tilth (Liebman 1993). These complex interrelationships between crops and weeds would seem to call for an approach characterized by careful management rather than indiscriminate eradication of weeds.

Non-chemical weed management

Farmers have developed many non-chemical weed management techniques, techniques that often provide multiple benefits, and which might not be utilized specifically or primarily for weed control (see generally Liebman-Davis 2009). For instance, crop rotation has been shown to significantly reduce weed densities versus monoculture situations where the same crop is grown each year (Liebman 1993). Cover crops – plants other than the main cash crop that are usually seeded in the fall and killed off in the spring – provide weed suppression benefits through exudation of allelopathic compounds into the soil that inhibit weed germination, and when terminated in the spring provide a weed-suppressive mat for the follow-on main crop. Common cover crops include cereals (rye, oats, wheat, barley), grasses (ryegrass, sudangrass), and legumes (hairy vetch and various clovers. Intercropping – seeding an additional crop amidst the main crop – suppresses weeds by acting as a living mulch that competes with and crowds out weeds, and can provide additional income as well (Liebman 1993). One common example is intercropping oats with alfalfa. Higher planting densities can result in more rapid closure of the crop "canopy," which shades out and so inhibits the growth of weeds. Fertilization practices that favor crop over weeds include injection of manure below the soil surface rather than broadcast application over the surface. Techniques that conserve weed seed predators, such as ground beetles, can reduce the "weed seed bank" and so lower weed pressure. In addition, judicious use of tillage in a manner that does not contribute to soil erosion is also a useful means to control weeds. While APHIS makes occasional passing references to such non-chemical techniques, for the most part it equates "non-chemical weed control" with intensive tillage, and gives decidedly short shrift to cultural weed control techniques. For instance, the 14-page Appendix 3 on "Weed Management and Herbicide Use" focuses almost exclusively on herbicides and tillage, and devotes barely more than one page to “cultural weed control,” and even this section discusses only crop rotation (EIS at 3-9 to 3-11).

Organic agriculture

Many of the non-chemical weed management methods discussed above were pioneered by organic farmers, or represent refined and improved versions of agricultural practices more common in the era before industrial agriculture, with its near exclusive focus on herbicides and tillage. Surprisingly, APHIS's treatment of agronomic practices utilized in organic farming (EIS at 64-66) lacks any discussion of the many well-known benefits it provides in terms of increasing soil quality and eliminating synthetic chemical use, and deals exclusively with GE contamination prevention measures. USDA Agricultural Research Service scientists have found that “organic farming can build soil organic matter better than conventional no-till farming can” (USDA ARS 2007). APHIS acknowledges that “[s]oil organic matter (SOM) is probably the most vital component in maintaining quality soil; it is instrumental in maintaining soil stability and structure, reducing the potential for erosion, providing energy for microorganisms, improving infiltration and water holding capacity” … as well as “nutrient cycling, cation exchange capacity, and the breakdown of pesticides,” among other benefits (EIS at 96). Yet while APHIS credits conservation-tillage with these benefits, it fails to acknowledge the superior performance of organic methods in delivering these same boons. APHIS also fails to discuss the science that casts grave doubt on some of the purported benefits of conservation tillage, or shows its negative impacts (CFS Science Soy at 73-76). Meanwhile, the problems generated by the prevailing chemical-intensive weed eradication paradigm fostered by herbicide-resistant crop systems such as Enlist are becoming ever more serious, and will only be greatly exacerbated if the Preferred Alternative is adopted. APHIS provides no coherent assessment of sustainable, non-chemical, cultural weed control practices, as practiced for instance in organic agriculture and low-input systems.

Promising trends

There is increasing interest in and practice of such sustainable, non-chemical weed management techniques among farmers and agronomists. For instance, Purdue agronomist Eileen Kladivko reports that “interest in cover crops has skyrocketed over the past few years in the eastern corn belt” and that “cover crops are getting a fresh look as part of modern sustainable agricultural systems” (Kladivko 2011). Cover crops can be usefully integrated into no-till systems (Hoorman et al 2009). There has even been promising research on the use of cover crops, with or without tillage, to suppress problematic glyphosate-resistant weeds, such as Palmer amaranth, which can also “lessen dependence on chemical weed control (e.g. Price et al 2012, DeVore et al 2013). Arkansas corn and soybean growers who adopted cover crops to inhibit soil erosion are finding that they also help suppress glyphosate-resistant Palmer amaranth (Robinson 2013). However, the seductive convenience of the Enlist crop system would likely inhibit further adoption of cover crops and other sustainable techniques, at the cost of increased weed resistance, more herbicide use and tillage a few years down the line. As APHIS concedes, the

Preferred Alternative would "delay the adoption of non-chemical management strategies" (EIS at xi, 139). Conversely, APHIS also concedes that "cover cropping and crop rotation, both of which have shown promise in reducing weed pressure…." would likely increase under the No Action Alternative (EIS at 83).

Policy measures
Just as strong policy initiatives were the major force driving adoption of soil-conserving farming methods (see above under "Enlist crops, soil erosion and tillage"), so appropriate policy instruments could increase the use of more sustainable weed management techniques (Robinson 2013). Policy measures that could promote less chemical intensive and more sustainable weed management include education and outreach by extension officers, financial incentives to adopt improved practices, and regulatory requirements that prioritize non-chemical tactics (Mortensen et al. 2012).

Human health and environmental impacts of increased 2,4-D use
As discussed in CFS Science Soy (45-59), the vastly increased use of 2,4-D will have adverse health impacts that represent an additional reason to adopt the No Action Alternative.

Farmers are on the front line. While generally healthier than other Americans, farmers suffer higher rates of certain cancers, such as non-Hodgkin's lymphoma (NHL), a cancer of the lymph nodes that kills 30 percent of those afflicted. Numerous studies in Sweden, Canada and by scientists at the U.S. National Cancer Institute have found that farmers who use 2,4-D and related herbicides are more likely to contract deadly NHL While Sweden, Norway and Denmark have banned 2,4-D based on such studies, the U.S. Environmental Protection Agency (EPA) refuses to act. Other studies link farmer 2,4-D exposure to greater risk of Parkinson's Disease.

Children of pesticide applicators in areas of Minnesota with heavy use of chlorophenoxy herbicides like 2,4-D have a disproportionately higher incidence of birth anomalies than in non-crop regions or where these herbicides were less used. Meanwhile, the latest available data show that 2,4-D is still contaminated with low levels of extremely toxic dioxins, which may or may not be the cause of 2,4-D's toxicity. There are numerous reports of neurological and neuromuscular impacts (e.g. dizziness, expand list) in 2,4-D exposed farmers. Exposure to both 2,4-D and glyphosate is associated with increased incidence of fatal injuries to farmers, perhaps in consequence of the neurological impacts noted above (Waggoner et al 2013). Dow plans to market a mix of 2,4-D and glyphosate (Enlist Duo) for use on Enlist crops. APHIS provided no assessment of the human health impacts of increased 2,4-D use.

Environmental impacts of increased 2,4-D use
As discussed in CFS Science Soy and the second set of science comments on this draft EIS, the massive increase in 2,4-D applications will take a heavy toll on the

environment as well.

Flawed Assumptions and Faulty Analysis

Inconsistent and biased assessment of herbicide use impacts
APHIS begins by placing herbicide use impacts "outside the scope of this EIS" (EIS at v). However, it is obviously impossible to assess an herbicide-resistant crop without considering the very purpose for which it was developed.

APHIS purports to address the combined impact of deregulating Enlist crops and EPA approval of Enlist Duo (2,4-D-choline + glyphosate) in the cumulative impacts section of the EIS (Section 5). However, APHIS's treatment of 2,4-D in this section is almost entirely limited to its supposed effect of reducing soil erosion and associated harms (though as argued above increased soil erosion is more likely). There is no corresponding assessment of the direct human health and environmental harms that would ensue from this massively increased use of 2,4-D, a clear example of bias.[21]

In contrast, Section 4 of the EIS addresses an imaginary and entirely unrealistic scenario in which APHIS deregulates Enlist crops but EPA does not approve 2,4-D choline for use on them. Here, APHIS reaches the entirely trivial conclusion that when Enlist crops cannot be used for their sole intended purpose (heavy application of 2,4-D and other herbicides they are engineered to resist), their impacts would be similar to those of other corn and soybean varieties.

This pervasively biased treatment of herbicide use generates a falsely positive picture of the Preferred Alternative and a falsely negative impression of No Action. APHIS's original contention – that herbicide impacts are "outside the scope of this EIS" (EIS at v) – is also belied by past assessments of HR crops. In the EIS for Roundup Ready alfalfa, for instance, APHIS devoted hundreds of pages to assessing the impacts of herbicide use. Apparently, herbicide use impacts are addressable by APHIS when they can be used to make the case for an HR crop; and outside the scope of assessment when they reflect badly on it.

Are herbicide-resistant (HR) weeds avoidable or inevitable?
APHIS describes HR weeds as an "unavoidable impact" wherever herbicides are used in corn/soybean production (Section 6, EIS). This is false. Weed control strategies that prioritize non-chemical tactics and make sparing use of herbicides can reduce selection pressure sufficiently to prevent HR weed emergence. Even where herbicides are the primary means used to control weeds, resistance can be prevented (Neve 2008). Indeed, preventing weed resistance is the whole point of

[21] APHIS concedes only that 2,4-D use with Enlist crops would increase selection pressure for 2,4-D resistant weeds, and thereby increase weed control costs for some 2,4-D-using growers of wheat and other crops. However, there is absolutely no attempt to provide even rough estimates of the magnitude of these harms. And the treatments are in any case flawed, as discussed below.

"best management practices" cited by APHIS and promoted by weed scientists. In a paper often cited by APHIS in past assessments, weed scientist Paul Neve modeled GR weed emergence under different herbicidal weed control regimes, finding that "the low mutation rates for glyphosate resistance means that resistance need not be an inevitable outcome of glyphosate use" (Neve 2008). Neve found that post-emergence glyphosate use patterns typical of RR crops have a much higher likelihood of fostering GR weeds than other uses of glyphosate. This finding is consistent with the complete lack of glyphosate-resistant weeds in the 20-year history of glyphosate use prior to Roundup Ready crop introduction. Likewise, Enlist crop systems will rapidly foster weeds resistant to 2,4-D, which have been relatively infrequent over the herbicide's nearly 70-year history.[22]

Simplicity vs. complexity (diversity) in weed control

HR crop systems like Roundup Ready and Enlist foster simplified weed control practices that rapidly generate HR weeds. APHIS credits this "simplicity" of RR crop systems as an unmitigated boon in some contexts [EIS at iii), yet concedes that it gives rise to GR weeds and all the harms they entail in others. In similar fashion, APHIS views "diversity" or complexity of weed control as a negative attribute in some contexts, while acknowledging that this very diversity is the only way to slow or prevent weed resistance in others. APHIS's inconsistent valuation of "simplicity" and "diversity" in weed control undermines its assessment of the costs and benefits of both the Preferred and No Action alternatives, and is closely related to the issue of short-term and long-term impacts.

Weighing short-term "benefits" against longer-term costs

APHIS describes at great length the presumed short-term "benefits" of the Preferred Alternative, but heavily discounts the medium- to long-term costs. As discussed further below, APHIS could and should have projected these countervailing costs and "benefits." To this end, APHIS must first explicitly define time frames (e.g. short-term = five years; medium-term 5-10 years; long-term > 10 years after introduction of Enlist crops). Second, quantitative or semi-quantitative estimates of various parameters are needed to provide a basis for balancing costs and "benefits." For instance, of what short-term value is the "convenience" of Enlist crop weed control? What are the medium- and long-term costs in terms of 2,4-D-resistant weeds? APHIS must assess the short-, medium- and long-term costs and benefits (worker safety, environmental, socioeconomic) of Enlist crops versus the No Action alternative. APHIS's projections of 2,4-D use provide the beginnings of such an assessment, and could be used as the basis for estimating the evolution and prevalence of 2,4-D and multiple herbicide-resistant weeds over time. The costs and environmental impacts of controlling these Enlist-generated weeds should also be modeled. Several scenarios could be constructed based on differing assumptions (as for projections of 2,4-D use). In the draft EIS, APHIS does little more than note

[22] To be precise, there have been a considerable number of weeds that have evolved resistance to 2,4-D, demonstrating the genetic capacity for 2,4-D resistance to evolve. But they are relatively infrequent in that they do not (yet) infest substantial areas of cropland.

that 2,4-D-resistant weeds generated by the Enlist system would impose financial costs on 2,4-D-using growers of certain crops, but gives no estimate, however rough, of their magnitude, much less estimate other adverse impacts.

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