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Docket No. APHIS-2008-0094
Regulatory Analysis and Development
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Comments to USDA APHIS on Environmental Assessment for the Determination of Nonregulated Status for Corn Genetically Engineered for Tolerance to Glyphosate and Acetolactate Synthase-Inhibiting Herbicides, Pioneer Hi-Bred International, Inc. Event 98140 Corn

February 6, 2009

Docket No. APHIS-2008–0094

Pioneer Hi-Bred International, Inc. has petitioned USDA's Animal and Plant Health Inspection Service (APHIS) for a determination of non-regulated status for Pioneer 98140 corn (Event 98140 or Pioneer 98140 corn), which has been genetically engineered for resistance to two classes of herbicides: glyphosate and ALS-inhibitors. As APHIS notes, this dual herbicide-resistant corn variety will be the first genetically engineered commercial corn product to contain these two traits (EA at 1). Pursuant to the USDA's December 8, 2008 Federal Register notice, the Center for Food Safety (CFS) submits the following comments concerning the inadequacy of the agency's National Environmental Policy Act (NEPA) Environmental Assessment (EA) accompanying the petition for deregulation.

CFS is a non-profit, membership organization that works to protect human health and the environment by curbing the proliferation of harmful food production technologies and by promoting organic and other forms of sustainable agriculture.[1] CFS represents 76,000 members throughout the country that support organic agriculture and regularly purchase organic products. CFS members support the public's right to choose GE-free food and crops. In addition to the comments submitted herein, CFS is concurrently submitting

[1] See generally http://www.centerforfoodsafety.org.

13,251 comments from CFS Food Network members opposing the deregulation of Event 98140 (Docket No. APHIS-2008-0094).[2]

SUMMARY

There are a number of serious inadequacies in APHIS's draft EA that necessitate postponement of any decision on the regulatory status of this corn until a comprehensive Environmental Impact Statement (EIS) has been prepared.

APHIS' analysis of the foreseeable environmental impacts is flawed. Issues that we address in these comments include the likelihood for Event 98140 corn to exacerbate the growing threat to American agriculture posed by the rapid spread of herbicide-resistant weeds, and increase in the use of chemical pesticides, with their attendant adverse impacts on the human environment. Many of the purported environmental benefits that APHIS claims will flow from adoption of Event 98140 corn are unsupported by the record, including promotion of conservation tillage practices, mitigation of agricultural emissions of global warming gases, improved water quality through reduced runoff of fertilizers and pesticides into waterways, and benefits to wildlife. These comments also address the potential for Event 98140 corn to foster increased abundance of invasive earthworms and promote their spread to vulnerable habitats, such as native forests. The EA is similarly flawed regarding the unresolved food safety issues presented by Event 98140 corn. In general, basic factual errors, logical inconsistencies, and faulty analysis belie APHIS' analysis of many of these issues.

The EA fails to comply with NEPA and the Endangered Species Act (ESA). In addition to the above deficiencies, the EA fails to adequately assess biological contamination from Event 98140 to other crops, potentially causing economic harm to organic and conventional farmers, export markets, and endangering the public's right to choose. APHIS does not include any measures of its own to prevent foreseeable contamination, or analyze their potential efficacy, or even include in its analysis an alternative using such measures. In claiming it could not even consider partial deregulation alternatives such as isolation distances, APHIS misconstrues the scope of its NEPA duties. APHIS also fails to adequately address the cumulative impacts of the approval, particularly regarding the foreseeable "stacking" of Event 98140 with other GE crops. Finally, the EA fails to adequately assess the impacts of Event 98140 and its associated herbicide use on protected species and their habitat or consult with the respective expert agencies regarding them.

The proposed APHIS approval is illegal because an EIS is required. Whether there are significant impacts requiring an EIS is determined by a number of enumerated factors (40 C.F.R. § 1508.27), any one of which requires an EIS. Many are present here including, impacts on public health, farmland and whether impacts are cumulatively significant; the

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[2]Letter from Heather Whitehead, Submission of 13,251 comments opposing Docket No. APHIS-2008-0094 from Center for Food Safety True Food Network members, February 6, 2009 (Submitted under separate cover to Docket No. APHIS-2008-0094 with comments attached.).

highly controversial nature of this dual-tolerant crop; the precedent for future actions of this approval; the uncertain, unique, and unknown risks of this unprecedented type of crop and its stacked progeny; and adverse affects on endangered or threatened species.

If APHIS intends to continue to consider approving Event 98140 in any fashion, CFS urges the agency to delay such consideration until after APHIS has completed a rigorous and comprehensive EIS that analyzes and discloses to the public Event 98140's numerous significant potential health, environmental and economic impacts. Approval without an EIS will be arbitrary and capricious agency action that violates NEPA, the ESA and the Plant Protection Act (PPA).

COMMENTS

The following comments illustrate why the proposed deregulation should not be permitted until and unless APHIS prepares an environmental impacts statement ("EIS") to fully review the significant environmental effects of this possible deregulation.

The National Environmental Policy Act

The National Environmental Policy Act (NEPA) requires a federal agency such as USDA APHIS to prepare a detailed EIS for all "major Federal actions significantly affecting the quality of the human environment."[3] NEPA "ensures that the agency ... will have available, and will carefully consider, detailed information concerning significant environmental impacts; it also guarantees that the relevant information will be made available to the larger [public] audience."[4]

If the federal action may significantly affect the environment, APHIS must prepare an EIS.[5] As a preliminary step, an agency may prepare an EA to decide whether the environmental impact of a proposed action is significant enough to warrant preparation of an EIS.[6] If an agency decides not to prepare an EIS, it must supply a "convincing statement of reasons" to explain why a project's impacts are insignificant.[7] "The statement of reasons is crucial to determining whether the agency took a "hard look" at the potential environmental impact of a project."[8] An EA must "provide sufficient evidence and analysis for determining whether to prepare an EIS or a finding of no significant impact."[9] NEPA regulations require the analysis of direct and indirect, as well as cumulative, effects in NEPA documents, including EAs.[10] The assessment must be a

[3] 42 U.S.C. § 4332(2)(C).
[4] *Robertson v. Methow Valley Citizens Council,* 490 U.S. 332, 349(1989).
[5] Steamboaters v. FERC, 759 F.2d 1382, 1392 (9th Cir. 1985); Idaho Sporting Cong. v. Thomas, 137 F.3d 1146, 1150 (9th Cir. 1998) (citation omitted).
[6] 40 C.F.R. § 1508.9.
[7] *Save the Yaak v. Block*, 840 F.2d 714, 717 (9th Cir. 1988).
[8] Id.
[9] *Id.*
[10] See 40 C.F.R. §§ 1508.8, .9, .13, .18.

"hard look" at the potential environmental impacts of its action.[11] APHIS' decisions in the EA must be "complete, reasoned, and adequately explained."[12]

Whether there may be a significant effect on the environment requires consideration of two broad factors: context and intensity. A number of factors should be considered in evaluating intensity, including, "[t]he degree to which the proposed action affects public health or safety," "[t]he degree to which the effects on the quality of the human environment are likely to be highly controversial," "[t]he degree to which the possible effects on the human environment are highly uncertain or involve unique or unknown risks," "[t]he degree to which the action may establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration," "[w]hether the action is related to other actions with individually insignificant but cumulatively significant impacts," and "[t]he degree to which the action may adversely affect an endangered or threatened species or its habitat."[13] An action may be "significant" if one of these factors is met.[14]

The Council on Environmental Quality (CEQ)

NEPA also established the Council on Environmental Quality and charged CEQ with the duty of overseeing the implementation of NEPA.[15] The regulations subsequently promulgated by CEQ, 40 C.F.R. §§ 1500-08, implement the directives and purpose of NEPA, and "[t]he provisions of [NEPA] and [CEQ] regulations must be read together as a whole in order to comply with the spirit and letter of the law."[16] CEQ's regulations are applicable to and binding on all federal agencies.[17] Among other requirements, CEQ's regulations mandate that federal agencies address all "reasonably foreseeable" environmental impacts of their proposed programs, projects, and regulations.[18]

I. The Impacts of Herbicide Resistant Weeds Stemming from the Deregulation of Event 98140 Require Analysis in an EIS.

Background on Herbicide-Tolerant Crops

Pioneer 98140 corn is an herbicide-tolerant genetically engineered (GE) crop. Unlike most herbicide-tolerant varieties currently available, it has been engineered for tolerance to two different classes of herbicide rather than just one: glyphosate and ALS inhibitors.

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[11] *Blue Mountains Biodiversity v. Blackwood*, 161 F.3d 1208, 1211 (9th Cir. 1998). Nat'l Parks & Conservation Ass'n, 241 F.3d at 731 (quoting 40 C.F.R. § 1508.27).
[12] Northwest Coalition for Alternatives to Pesticides v. U.S. E.P.A., 544 F.3d 1043, 1052 n.7 (9th Cir. 2008).
[13] 40 C.F.R. § 1508.27(b)(2), (4), (5), (6), (7), (9).
[14] Ocean Advocates v. U.S. Army Corps of Eng'rs, 361 F.3d 1108, 1125 (9th Cir.2004); see also Nat'l Parks & Conservation Ass'n, 241 F.3d at 731 (either degree of uncertainty or controversy "may be sufficient to require preparation of an EIS in appropriate circumstances.").
[15] <u>See</u> 42 U.S.C. §§ 4321, 4344.
[16] 40 C.F.R. § 1500.3.
[17] 40 C.F.R. §§ 1500.3, 1507.1; see, e.g., Hodges v. Abraham, 300 F.3d 432, 438 (4th Cir. 2002).
[18] See 40 C.F.R. §§ 1502.4, 1508.8, 1508.18, & 1508.25.

The herbicide-tolerance trait allows farmers to apply a specific weed-killing chemical to or near the crop in order to more conveniently kill nearby weeds without damaging the crop itself.

APHIS presents Pioneer 98140 corn as a tool to enhance control of weeds, including weeds that have evolved resistance to herbicides, stating that: "its availability will allow growers a greater ability [sic] to manage weeds and weed resistance."[19] Much of APHIS's analysis rests on the assumption that Pioneer 98140 corn will merely displace existing HT corn varieties, largely glyphosate-tolerant ones.[20] APHIS argues essentially that HT corn varieties in general have not harmed the environment or the interests of agriculture, and have even provided positive benefits, and that Pioneer 98140 corn will not be any different, and should therefore be granted non-regulated status. In one respect, APHIS does claim that Pioneer 98140 will offer advantages over currently grown HT corn: "The availability of this corn will enable growers to control weeds using an ALS-inhibitor herbicide where, for example, glyphosate resistant weeds are present, or conversely, use glyphosate where ALS resistant weeds are present."[21]

This section first provides a brief description of HT crops, and then addresses APHIS' discussion of the purported benefits of HT crops and corn in general with respect to the development of herbicide-resistant weeds and associated increase in pesticide use.

Herbicide-tolerant (HT) crops comprise by far the largest class of GE crops. Crops with HT traits comprised 82% of commercial GE crop acreage worldwide in 2007,[22] more than four of every five acres. GE HT crops are especially prevalent in the U.S, comprising 92% of all soybeans, 63% of all corn, and 93% of all upland cotton planted in 2008.[23] The vast majority of GE HT crops are Monsanto's glyphosate-tolerant, Roundup Ready varieties, which were planted on 148.9 million acres in the U.S. in 2008.[24] A much smaller but unknown acreage is planted to Bayer CropScience's GE glufosinate-tolerant, LibertyLink canola, cotton and corn.[25]

Non-GE herbicide-tolerant varieties of several crops have also been developed, though they have never been very widely planted and have been eclipsed by glyphosate-tolerant

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[19] EA at 14.
[20] EA 14, 20, 23, 29, 31, 32.
[21] EA at 1-2.
[22] ISAAA (2007). "Global Status of Commercialized Biotech/GM Crops: 2007," International Service for Acquisition of Agri-biotech Applications, ISAAA Brief 37-2007. Crops with the HT trait alone = 63% of all acreage, crops with HT plus insect-resistance = 19%.
[23] For soybeans and corn, see USDA-ERS figures at: http://www.ers.usda.gov/Data/BiotechCrops/d_link.htm and http://www.ers.usda.gov/Data/BiotechCrops/. For cotton, USDA-ERS figures greatly underestimate the proportion of HT acres. According to cotton experts consulted by CFS, more accurate accounting (93% HT) is provided by: USDA AMS (2008). "Cotton Varieties Planted: 2008 Crop," USDA Agricultural Marketing Service, Cotton Program, September 2008.
[24] Monsanto (2008). Monsanto Biotechnology Trait Acreage: Fiscal Years 1996-2008, Oct. 8, 2008. http://www.monsanto.com/pdf/investors/2008/q4_biotech_acres.pdf.
[25] For instance, USDA AMS (2008), op. cit., shows that LibertyLink cotton was planted on just 2.7% of upland cotton acreage in 2008, vs. 90% to Roundup Ready varieties.

GE varieties over the past decade. Interestingly, the great majority of these non-GE HT crops are resistant to herbicides of the ALS inhibitor class – imidazolinones and/or sulfonylureas. As noted above, Pioneer 98140 corn is the first variety to combine genetically engineered resistance to both glyphosate and ALS inhibitors.

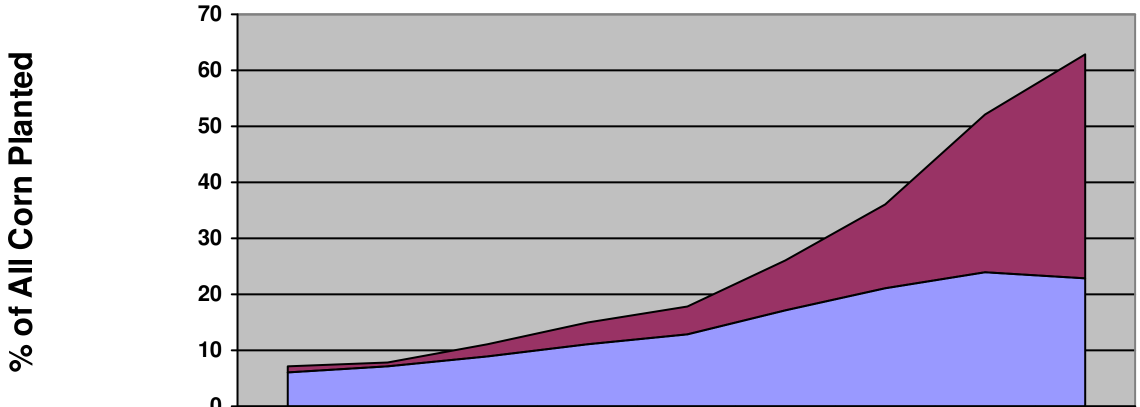
APHIS reports that approximately 7% of U.S. corn was planted to a non-GE HT corn known as Clearfield (tolerant to ALS-inhibiting herbicides of the imidazolinone classs) in 2000,[26] a percentage that dropped by half to 3.5% of corn acres just four years later in 2004.[27] In 2007, research by a private market research firm suggested that the total acreage planted to non-GE HT crops – which include BASF's Clearfield corn, wheat, rice, canola and sunflower, as well as DuPont-Pioneer's STS soybean products (tolerant to sulfonylureas) – totaled over 6 million acres in 2007.[28] In comparison, glyphosate-tolerant GE crops were planted on 128.2 million acres in the U.S. in 2007, or on roughly 20-fold greater acreage, while glyphosate-tolerant corn varieties were planted on 57.9 and 68.3 million acres in 2007 and 2008, respectively.[29] In short, both HT crops overall and HT corn in particular are overwhelmingly GE glyphosate-tolerant varieties.

APHIS vastly understates HT corn acreage

Any analysis of the impacts of HT corn varieties must start with accurate knowledge about how widely they have been and are being planted. In Table 5 of the EA (p. 16), APHIS reports what it believes to be the percentage of U.S. corn planted to GE HT varieties from 2000 to 2008, based on data from USDA's Economic Research Service. APHIS badly misread these data, resulting in a vast understatement of the prevalence of GE HT corn plantings, especially in recent years (see Figure 1).

[26] EA at 28.
[27] Petition at 118.
[28] As cited in APHIS (2008). "Finding of No Significant Impact on Petition for Nonregulated Status for Pioneer Soybean DP-356043-5," July 15, 2008, Response to Comments, p. 26. http://www.aphis.usda.gov/brs/aphisdocs2/06_27101p_com.pdf.
[29] Monsanto (2008), op. cit.

Figure 1: Herbicide-Tolerant Genetically Engineered Corn in the U.S.: 2000-2008



	2000	2001	2002	2003	2004	2005	2006	2007	2008
HT Stacked	1	1	2	4	5	9	15	28	40
HT Alone	6	7	9	11	13	17	21	24	23

Year

HT Alone HT Stacked

Based on USDA-ERS (2008). "Adoption of Genetically Engineered Corn Varieties," updated July 2, 2008, at http://www.ers.usda.gov/Data/BiotechCrops/ExtentofAdoptionTable1.htm, last accessed Feb. 5, 2009. See also: http://www.ers.usda.gov/Data/BiotechCrops/d_link.htm.

Figure 1 presents the percentages of U.S. corn planted to two categories of GE HT corn: varieties with an HT trait alone (lower area); and varieties that have an HT trait "stacked" with one or more insect-resistance traits (upper area). Total percentage planted to HT corn varieties is the sum of the two figures in each year (e.g. 52% in 2007; 63% in 2008). In Table 5 of the EA, however, APHIS reports only the HT alone figures. Thus, APHIS vastly understates the prevalence of HT corn acres, especially in more recent years. Based on USDA figures for acreage of corn planted from 2005 to 2008, APHIS has understated overall HT corn acreage by 7.4 million acres (2005), 11.7 million acres (2006), 26.2 million acres (2007) and 34.4 million acres (2008). APHIS thus understated HT corn acreage by a massive 79.7 million acres over just this four-year period.

APHIS's reliance on these faulty data corrupts its analysis of key issues in the environmental assessment. For instance:

> "Although the percentage of herbicide tolerant corn has been increasing since 2000, the percentage dropped from 24% in 2007 to 23% in 2008. These numbers indicate that the adoption of herbicide tolerant GE corn varieties in the the U.S.

> has not increased to the dramatic extent that it has, for example, for soybean (91% in 2007 and 92% in 2008, out of all soybean acres planted) and that growers have chosen to plant other GE corn available [sic] varieties (e.g. insect resistant corn)."[30]

On the contrary, the percentage of HT corn ***has increased dramatically*** from 2000 to 2008 (7% to 63%) and particularly since 2004, including a sharp spike from 2007 to 2008 (52% to 63%) when APHIS assumes a slight decline. APHIS's false assumption that GE HT corn plantings have leveled out (even slightly fallen) in recent years misleads it into thinking that corn grower interest in HT corn has stagnated, and to the likely false conclusion that availability of Pioneer HT corn will not increase overall HT corn acreage, but rather merely displace existing varieties of HT corn. APHIS similarly relies on these faulty data (lower percentage of GE HT corn in 2008 than 2007) to argue that deregulation of Pioneer HT corn will not increase the range of corn cultivation,[31] and not impact growers of organic corn (17% of GE corn was HT in 2005).[32] Most importantly, APHIS relies on the false assumption of "slowly increasing" adoption of HT corn varieties to argue (albeit in a thoroughly muddled manner) that while deregulation of Pioneer HT corn may lead to an increase in the use of glyphosate, it will only be a "negligible" increase.[33] As discussed further below, CFS has good reason to believe that Pioneer HT corn will lead to substantial increases in glyphosate use.

APHIS's vast understatement of GE HT corn plantings is still more puzzling in light of its citation of Monsanto for the statement that "approximately 30% of total corn acreage" was glyphosate tolerant in 2005. One would think the disparity between this figure and the false one that APHIS reports for that year (HT corn as 17% of all corn for 2005) would have prompted even minimally attentive reviewers to catch the huge errors represented in the Table 5 data. We note that five APHIS Biotechnology Regulatory Services personnel are listed as preparers and reviewers of the draft EA. This makes it difficult to believe that this massive error was inadvertent. In fact, APHIS may well have intentionally understated the prevalence of HT corn plantings as a rationale to avoid discussing the serious threats they pose. After citing the false figure of 24% of corn = HT in 2007, APHIS remarks cryptically that: "This number may actually be higher as not all states were surveyed and it does not include stacked varieties" (EA at 4), suggesting that it knows the truth but prefers not to address its implications.

Herbicide use and development of herbicide-resistant weeds

One huge impact of HT crop systems has been to foster a rapidly escalating epidemic of weeds resistant to the HT crop-associated herbicide (i.e. chiefly glyphosate). Just as bacteria develop resistance to overused antibiotics, so weeds develop resistance to chemicals designed to kill them. While weed resistance to chemical herbicides is not unique to HT crops, it has vastly accelerated with their widespread adoption. Herbicide-

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[30] EA at 16.
[31] EA at 29.
[32] EA at 27.
[33] EA at 23-24.

resistant weeds first emerged in the United States in the 1970s. Since that time, 323 resistant biotypes of 187 different weed species have been documented infesting over 300,000 fields in the world. The U.S. is by far the world leader in herbicide-resistant weeds, by several measures. The U.S. harbors 123 resistant biotypes of 68 different weed species that are documented in up to 200,000 fields covering an estimated 18 million acres.[34] The problem may well be far worse, since these figures include only documented instances of resistant weeds collected in a passive reporting system. As discussed further below, weed scientists have reported many resistant weeds that have not been recorded on the WSSC-HRAC website cited above.

The rapid evolution of herbicide-resistant weeds in the U.S. is attributable to the widespread and intensive use of herbicides, or weed-killers. Herbicides comprise by far the largest category of pesticides, defined as any chemical used to kill plant, insect or disease-causing pests. Agriculture accounts for three-quarters of all chemical pesticide use in the U.S. (Figure 2). In 2001, the last year for which the Environmental Protection Agency has published comprehensive data, 675 million lbs. of chemical pesticides were used in U.S. agriculture.

Herbicides comprise nearly two-thirds of agricultural chemical pesticide use (433 million lbs. in 2001), nearly six-fold more than the insecticides that many associate with the term “pesticide” (Figure 3).

Figure 2: Chemical Pesticide Use in the U.S. by Sector: 2001

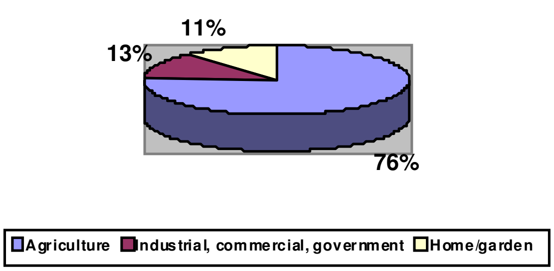
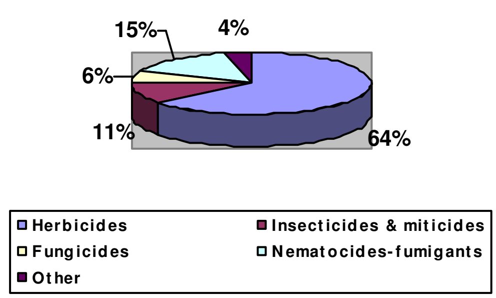


Figure 3: Agricultural Pesticide Use in the U.S. by Type: 2001



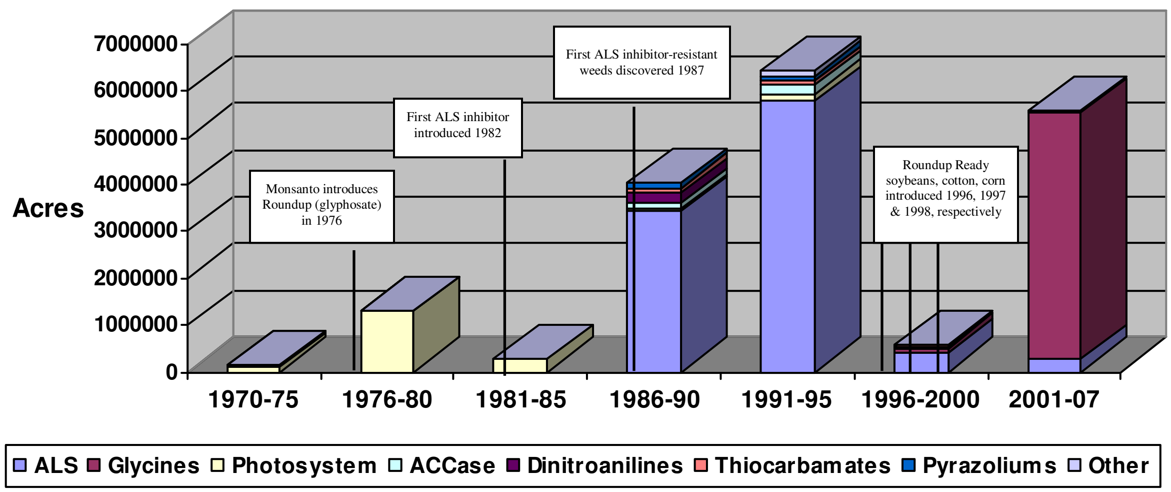
Source: “Pesticides Industry Sales and Usage: 2000 and 2001 Market Estimates,” U.S. Environmental Protection Agency, 2004, Table 3.4. http://www.epa.gov/oppbead1/pestsales/01pestsales/market_estimates2001.pdf.

The first major wave of herbicide resistance that began in the late 1970s involves 23 species of weeds resistant to atrazine and related herbicides of the photosystem II

[34] See WSSA-HRAC (2009). “International Survey of Herbicide-Resistant Weeds,” a project of the Weed Science Society of America (WSSA), funded and supported by the Herbicide Resistance Action Committee (HRAC), a group comprised of pesticide manufacturers. See: www.weedscience.com. These figures are either directly cited on the website, or were compiled by CFS from data available on the website, last accessed Feb. 2, 2009. 200,000 fields and 18 million acres represent upper-bound estimates. Note that Australia is a distant second to the U.S., as measured by number of resistant biotypes, with 53, less than half the number found in the U.S. See: http://www.weedscience.org/summary/CountrySummary.asp.

inhibitor class, which have been reported to infest up to 1.9 million acres of cropland in the U.S. The second major wave began in the 1980s, and involves 37 species of weeds resistant to ALS inhibitors, which have been documented infesting up to 152,000 sites covering 9.9 million acres. The third major wave involves 9 species of glyphosate-resistant weeds, which have been documented in up to 14,261 sites covering 5.4 million acres (see Figure 4).

Figure 4: U.S. Crop Acreage Infested With Herbicide-Resistant Weeds by Class of Herbicide and Year Reported: 1970-2008



Compiled by CFS from WSSC-HRAC (2009), op. cit., last visited Feb. 3, 2009. Note that WSSC-HRAC report "acreage infested" figures in ranges due to the difficulty of determining the extent of a resistant weed population. The figures presented here represent aggregate upper-bound estimates. Note that glyphosate is the only member of the "glycines" class of herbicides.

It is interesting to note that Pioneer 98140 corn has been engineered to be resistant to precisely those two herbicide classes to which weeds have developed the most widespread resistance in the U.S.: ALS inhibitors and glyphosate (aka glycines). In fact, weeds with documented resistance to either ALS inhibitors or glyphosate (occasionally to both) have been reported to infest up to 15.3 million acres, or 85% of the roughly 18 million total acres reported to be infested with resistant weeds since the 1970s.[35] In fact, it is thought that ALS inhibitor-resistant weeds fueled the adoption of glyphosate-tolerant crops,[36] which are now driving an even worse epidemic of resistant weeds that will require, presumably, new chemicals to kill.

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[35] We note that weed resistance is a dynamic affair, and that weeds sometimes lose resistance to an herbicide when its use is stopped, reduced, or effectively managed. Thus, the figures reported above may not represent the current state of weed resistance, particularly for earlier years. On the other hand, WSSC-HRAC is a passive reporting system, and there are many reports of herbicide-resistant weeds that are not recorded on its website.

[36] Owen & Zelaya (2005). "Herbicide-resistant crops and weed resistance to herbicides," *Pest Management Science* 61: 301-311.

Introduction of Pioneer 98140 corn could exacerbate the herbicide resistant weed epidemic and increase associated use of pesticides in several ways. The most likely impact would be to accelerate the already rapid and alarming development of glyphosate-resistant weeds. A second threat is accelerated development of multiple-herbicide resistance in many weed species.

Backround on glyphosate-resistant weeds

As Figure 4 illustrates, glyphosate-resistant (GR) weeds have evolved very rapidly in less than a decade. Today, there are 39 GR biotypes of 9 different weed species in 19 states. These GR weeds infest over 14,000 sites covering 5.4 million acres. The extent of infestation has increased dramatically since just September of 2007, when GR populations of eight weed species were reported on over four-fold fewer sites (roughly 3,000) on less than half the acreage (2.4 million acres).[37]

The nine species of weeds with GR biotypes in the U.S. are: Palmer amaranth, common waterhemp, common ragweed, giant ragweed, horseweed, Italian ryegrass, rigid ryegrass, hairy fleabane and Johnsongrass.[38] Resarchers recently identified glyphosate-resistant lambsquarters in Virginia.[39] Other weeds developing resistance to glyphosate or becoming more prevalent due to glyphosate-induced weed shifts, include velvetleaf,[40] cocklebur and lambsquarters,[41] morning glories,[42] and tropical spiderwort.[43] Annual grasses such as goosegrass (confirmed glyphosate-resistant biotypes in Malaysia), foxtails, crowfootgrass, signal grasses, panicums, and crabgrasses, all have a history of developing resistance to multiple herbicides,[44] making development of glyphosate-resistance more likely in these species.

Glyphosate-resistant horseweed is the most extensive GR weed in the U.S., found in 16 states on up to 3.3 million acres. GR horseweed is considered a “worst-case scenario” for glyphosate-tolerant crop systems because it is well adapted to no-tillage systems popular among GR crop growers, has a high level of fecundity (up to 200,00 seeds per plant), and

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[37] CFS comments on USDA’s Draft Progammatic Environmental Assessment on Introduction of Genetically Engineered Organisms, Sept. 11, 2007.

[38] http://www.weedscience.org/Summary/UspeciesMOA.asp?lstMOAID=12&FmHRACGroup=Go (last visited Feb. 6, 2008.

[39] Hite, G.A. et al (2008). “Differential response of a Virginia common lambsquarters (*Chenopodium album*) collection to glyphosate,” *Weed Science* 56: 203-209.

[40] Owen, M.D.K. (1997). North American Developments in Herbicide-Tolerant Crops. Proceedings of the British Crop Protection Conference, Brighton, UK, BCPC: Brighton, UK. 3:955–963.

[41] Roberson, R. (2006). “Pigweed not only threat to glyphosate resistance,” Southeast Farm Press, Oct. 19, 2006.

[42] UGA (2004). “Morning glories creeping their way around popular herbicide, new UGA research reports,” University of Georgia, August 23, 2004.

[43] USDA ARS (2004). “Little-known weed causing big trouble in Southeast,” USDA ARS News Service, August 24, 2004. The spread of tropical spiderwort resistant to glyphosate, particularly in Georgia, is associated with the dramatic increase in Roundup Ready cotton acreage in recent years.

[44] Robinson, E. (2005). “Will weed shifts hurt glyphosate’s effectiveness?” Delta Farm Press, Feb. 16, 2005.

its seeds disperse long distances in the wind.[45] Up to 1 million acres infested with GR horseweed was recently reported in Illinois, while over 2 million acres are infested with GR horseweed in Tennessee. An Arkansas weed scientist estimated that Arkansas growers would have to spend as much as $9 million to combat glyphosate-resistant horseweed in 2004.[46] The alternative is even more expensive. Left unchecked, horseweed can reduce cotton yields by 40-70%.

Glyphosate-resistant Palmer amaranth is another extremely damaging weed, especially in the cotton-growing areas of the Southeast. Recent reports identified 1 million acres of cotton and soybean field infested with GR Palmer amaranth in Georgia, and another 1 million acres of corn, cotton and soybean acreage in North Carolina.[47] Smaller populations exist in Arkansas and Tennessee. North Carolina State University weed scientist Alan York describes GR Palmer amaranth as an extremely competitive and extremely prolific weed, and as "…potentially the worse threat [to cotton] since the boll weevil."[48] Larry Steckel, weed scientist at the University of Tennessee, estimates that on average, glyphosate-resistant Palmer amaranth will cost cotton growers in the South an extra $40 or more per acre to control.[49] This represents a substantial burden, as cotton farmers' average expenditure on ***all*** pesticides (insecticides and herbicides) was $61 per acre in 2005.[50]

Factors that have promoted the development of glyphosate-resistant weeds include:

1) **Selection pressure:** Ever more frequent and intensive use of glyphosate exerts increasing "selection pressure" fostering the propagation of rare individuals with natural resistance, or fostering shifts in weed species towards those that possess greater levels of natural resistance to glyphosate. Glyphosate use on soybeans, corn and cotton in the U.S. increased by a remarkable 15-fold from 1994 to 2005, from 7.9 million lbs. active ingredient to 119.1 million lbs. USDA data also show that glyphosate intensity on soybeans has increased from an average of 0.52 lbs./acre/year in 1994 to 1.33 lbs./acre/year in 2006, a more than 2.5-fold increase. Application frequency has also risen dramatically, from just 1 application per season in 1994 to an average 1.7 applications in 2006.

2) **Overreliance:** Excessive reliance on a particular herbicide to the exclusion of other weed control methods, including other herbicides. Striking evidence of farmers'

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45 Owen, MDK (2008). "Weed species shifts in glyphosate-resistant crops," *Pest Management Science* 64: 377-387.
46 AP (2003). "Weed could cost farmers millions to fight," *Associated Press*, 6/4/03, http://www.biotech-info.net/millions_to_fight.html
47 WSSC-HRAC (2009), op. cit.
48 Minor, E. (2006). "Herbicide-resistant weed worries farmers," *Associated Press*, 12/18/06. available at http://www.enn.com/top_stories/article/5679 (last visited Sept. 9, 2007).
49 Laws, F. (2006). "Glyphosate-resistant weeds more burden to growers' pocketbooks," *Delta Farm Press*, November 27, 2006, http://deltafarmpress.com/news/061127-glyphosate-weeds/
50 USDA ERS (2007b). Cost and return data for cotton production: 1997-2005. USDA Economic Research Service, last accessed January 12, 2007. http://www.ers.usda.gov/data/CostsandReturns/data/recent/Cott/R-USCott.xls

overreliance on glyphosate to the exclusion of other weed control methods is provided by a recent survey of 400 farmers in the U.S. Midwest conducted by Syngenta. The researchers found that 56% of soybean growers in northern states and 42% in southern states use glyphosate as their sole herbicide. As a result, says USDA plant physiologist Stephen Duke: "the selective pressure for weeds to develop resistance has been huge."[51]

3) **Delayed application:** The longer a weed is allowed to grow, the harder it is to kill, and the more likely it is to reproduce. Delaying application of an herbicide increases the potential for weeds, including resistant individuals, to survive and propagate. Glyphosate-tolerant crop systems allowed growers to switch from the pre-emergence weed control methods common before the advent of GR crops (i.e. application of an herbicide before the crop seeds sprout) to post-emergence weed control. Many growers delay application of glyphosate until many weeds are large in the hope that all weeds will have emerged and only one application would be needed.[52]

4) **Year-in, year out application:** The increasingly common practice of applying heavy doses of glyphosate to GR crops every year is another factor fostering evolution of resistant weeds. This is of particular concern with the popular corn-soybean rotation. 90% of soybeans have been glyphosate-tolerant for the past several years. The rapid increase in percentage of corn planted to HT varieties (the great majority of it glyphosate-tolerant) – from just 18% in 2004 to 63% in 2008 – ensures that ever more cropland will be subjected to glyphosate treatment year in, year out, further increasing selection pressure for resistant weeds.[53]

The potential impact of Pioneer 98140 corn on glyphosate-resistant weeds

As noted above, APHIS anticipates at most a "negligible" increase in glyphosate use from deregulation of Pioneer 98140 corn. This expectation appears to be based on APHIS's faulty assumption that HT corn adoption has leveled out, and that growers are increasingly choosing to grow non-HT corn with only insect-resistant traits. The truth, as Figure 4 clearly shows, is rapidly increasing adoption of HT corn varieties, nearly all glyphosate-tolerant varieties.[54]

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[51] Service, R.F. (2007). "A growing threat down on the farm," *Science*, May 25, 2007, pp. 1114-1117.

[52] Green et al (2007), "New multiple-herbicide crop resistance and formulation technology to augment the utility of glyphosate," Pest Manag Sci 1526-498X/2007.

[53] Owen, M.D.K. (2005). "Update 2005 on Herbicide Resistant Weeds and Weed Population Shifts," 2005 Integrated Crop Management Conference, Iowa State University.

[54] We note that it may well be incorrect to (fully) ascribe this rapidly increasing adoption of HT corn to demand. Monsanto has become the major player in the U.S. corn seed market, reportedly increasing its market share in corn seeds from 43% in 2001 to 61% in 2008, largely through its aggressive acquisition of 25 U.S. regional seed firms since 2004, which are held by its American Seeds, Inc. subsidiary (Goldman Sachs (2008). "Monsanto Co. Company Update," Goldman Sachs Global Investment Research, June 2, 2008, Exhibit 2, p. 2.) With this market power, Monsanto is better able to "force" its Roundup Ready trait into every seed it can, especially corn, part of its profit-maximizing "trait penetration" strategy. Examination of Monsanto's trait acreage figures reveals a surprising trend in support of this hypothesis. Acres planted to non-Roundup Ready corn varieties (i.e. those with one or two insect-resistance traits only) decreased dramatically from 25.3 million acres in 2004 to just 4.9 million acres in 2008. Over the same

For whatever reason, adoption of HT corn varieties is increasing, and to the extent that this does reflect farmer demand for HT corn, the availability of another glyphosate-tolerant corn variety from a major corn seed vendor such as DuPont-Pioneer may spur larger plantings of glyphosate-tolerant corn, increasing selection pressure for glyphosate-resistant weeds. Farmers purchasing Pioneer 98140 corn will make use primarily of its glyphosate-tolerance trait. This is due to the demonstrated popularity of this herbicide and HT corn systems that employ it, as well as to the decreasing corn acreage treated with ALS-inhibiting herbicides. According to a graph provided by DuPont-Pioneer, acres of corn treated with ALS inhibitors have declined from a peak of 30 million in 2000 to just half that in 2006, while over the same period corn acres treated with glyphosate have quadrupled from 11 million to over 40 million.[55]

However, deregulation of Pioneer 98140 corn could easily increase levels of glyphosate usage, and hence selection pressure for still more rapid development of damaging, costly, pesticide-promoting GR weeds, even if APHIS is correct in assuming that Pioneer 98140 corn would merely displace existing HT corn varieties.

First, we note that DuPont-Pioneer scientists reported that maize plants transformed with one version of its glyphosate-resistance GAT enzyme were tolerant to six times the dose of glyphosate normally applied to Roundup Ready corn.[56]

> "Fifth-iteration gat genes also allowed production of glyphosate-tolerant maize plants. T0 plants were sprayed at the four-leaf stage with 104 oz./ac Roundup UltraMAX (4 x field rate, equivalent to 3 lb. ae/ac glyphosate). The regenerants survived the treatment, but exhibited chlorotic banding and growth inhibition (Fig. 4B). Glyphosate tolerance improved with increases in the catalytic efficiency of GAT. With expression of seventh iteration genes, nearly 50% of the maize regenerants showed no chlorotic banding and no growth inhibition (Fig. 4C). **Most transformed plants expressing the best 10th and 11th round gat genes were tolerant to 6 x glyphosate spray and showed no adverse symptoms** (Fig. 4D). Efficacy trials of lines containing genes from several shuffling iterations are under way in the field to evaluate the commercial potential of this glyphosate tolerance trait."

We note that Pioneer 98140 corn incorporates a slightly modified version of an 11th round *gat* gene, designated *gat4621*,[57] which presumably has the enhanced glyphosate tolerance discussed by DuPont-Pioneer scientists in the quote above, which also refers to an 11th round gat gene.

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period, Monsanto dramatically increased sales of GE corn varieties ***with*** the RR trait, from 17 million acres (2004) to 68.3 million acres in 2008. It is unlikely that farmer demand for GE corn varieties with insect-resistance traits alone fell by over 5-fold in this short period of time. The more likely explanation is that Monsanto increasingly supplies its best corn hybrids only in versions that contain the Roundup Ready trait.

[55] Petition, 10/31/07 Addendum to Pioneer Responses of 10/3/07 Regarding USDA's Review of Technical Completeness (9/13/07) 07-152-01p, graph on p. 1.

[56] Castle et al (2004). "Discovery and directed evolution of a glyphosate tolerance gene," *Science* 304: 1151-54.

[57] Petition at 56-57.

Secondly, DuPont-Pioneer has shown interest in developing crops with enhanced glyphosate-tolerance that combine its GAT mechanism of glyphosate tolerance with one or both of the two glyphosate-tolerance traits developed by Monsanto. In its 2005 patent, "Novel Glyphosate-N-Acetyltransferase (GAT) Genes," DuPont-Pioneer claims:

> "A transgenic plant or transgenic plant explant having ***an enhanced tolerance to glyphosate***, wherein the plant or plant explant expresses a polypeptide with glyphosate-N-acetyltransferase activity… and ***at least one polypeptide imparting glyphosate tolerance by an additional mechanism***."[58]

DuPont-Pioneer is clearly interested in such enhanced glyphosate-tolerant crops even without tolerance to ALS inhibitors or other herbicides, and regards them as a legitimate means of controlling glyphosate-resistant weeds:

> "The invention provides methods for controlling weeds in a field and preventing the emergence of glyphosate-resistant weeds in a field containing a crop which involve planting the field with crop seeds or plants that are glyphosate-tolerant as a result of being transformed with a gene encoding a glyphosate-N-acetyltransferase [GAT] and a gene encoding a polypeptide imparting glyphosate tolerance by another mechanism, such as a glyphosate-tolerant 5-enolpyruvylshikimate-3-phosphate synthase and/or a glyphosate-tolerant glyphosate oxido-reductase[59] and applying to the crop and the weeds in the field ***a sufficient amount of glyphosate to control the weeds without significantly affecting the crop.***" (Ibid, par. 0032).

The stacking of up to three mechanisms of glyphosate-tolerance in a single plant would allow for <u>more frequent applications of higher doses</u> of glyphosate, perhaps over the entire growing season of the crop. Such enhanced tolerance would seem to enable <u>vastly increased use</u> of glyphosate (over already exorbitant and growing levels) in an attempt to keep up with the rapidly growing level of glyphosate-resistance found in various weed species. The end result is a vicious circle of rising glyphosate use to control resistant weeds, followed by increased weed resistance, which in turns drives still more chemical use.

DuPont-Pioneer also claims a plant with GAT glyphosate-tolerance and tolerance to one additional herbicide, corresponding to 356043 soybeans (Ibid, claim 112), as well as plants that incorporate enhanced glyphosate tolerance plus tolerance to one of a whole battery of additional herbicides (Ibid, claim 113), described as follows:

> "In a further embodiment the invention provides for …[enhanced glyphosate tolerance as described above] … and a gene encoding a polypeptide imparting tolerance to an additional herbicide, such as a mutated

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[58] DuPont-Pioneer GAT Patent (2005). "Novel Glyphosate-N-Acetyltransferase (GAT) Genes," U.S. Patent 2005/0246798, issued Nov. 3, 2005, assigned to: Verdia, Inc. and Pioneer Hi-Bred International, claim 111, p. 89, emphasis added.

[59] These are two additional mechanisms of glyphosate-tolerance that are utilized by commercially by Monsanto in Roundup Ready crops. It is unclear if DuPont-Pioneer plans to license the use of these patented mechanisms from Monsanto, or alternately utilize them when the pertinent patents lapse.

> hydroxyphenylpyruvatedioxygenase, a sulfonamide-tolerant acetolactate synthase, a sulfonamide-tolerant acetohydroxy acid synthase, a phosphinothricin acetyltransferase and a mutated protoporphyrinogen oxidase and applying to the crop and the weeds in the field a sufficient amount of glyphosate and an additional herbicide, such as, a hydroxyphenylpyruvatedioxygenase inhibitor, sulfonamide, imidazolinone, bialaphos, phosphinothricin, azafenidin, butafenacil, sulfosate, glufosinate, and a protox inhibitor to control the weeds without significantly affecting the crop." (Ibid, par. 0033)

Commercial availability of a corn variety like Pioneer 98140 with enhanced tolerance to glyphosate could have aggravating effects on GR weed development. Growers with problematic glyphosate-resistant weed populations who might otherwise choose to employ non-glyphosate methods of weed control (either different types of herbicides, mechanical tillage or other some other cultural weed control practice) might instead choose Pioneer HT corn in the hopes that its increased glyphosate resistance would allow him to up the dose of glyphosate he applies to better kill glyphosate-resistant weed populations. This short-term "solution" would likely lead to a vicious circle of ever higher doses of glyphosate and other more toxic herbicides, followed by evolution of higher levels of weed resistance. Such a development might in turn encourage DuPont-Pioneer to exploit its patent claims to develop plants with still higher levels of glyphosate tolerance, or spur Monsanto or some other competitor to do the same. We note that Monsanto has already developed a "second-generation" Roundup Ready Flex cotton variety that permits heavier applications of glyphosate over a larger segment of the cotton plant's life than its original Roundup Ready cotton.

APHIS justifies its do-nothing approach to glyphosate-resistant weeds by reference to a single limited study on a lesser GR weed, the tall morning glory.[60] The authors collected 32 morning glory plants from a Georgia field that had been sprayed consistently with Roundup for approximately 8 years, and then bred the plants for several generations. The progeny were sprayed with glyphosate, and differences in glyphosate tolerance noted. The results indicated that "the most tolerant line produced 35% fewer seeds in the absence of Round-Up than the most susceptible line," which the authors interpreted as a reduction in fitness that would tend to minimize tolerance to glyphosate in the population due to natural selection in the absence of glyphosate.[61] APHIS's conclusion from this single study on a minor GR weed is as follows: "These results suggest that in the absence of herbicide selection (e.g. spraying with Roundup), herbicide tolerance would be lost in subsequent generations due to higher metabolic costs to resistant weeds. Therefore, it is possible that weeds may lose their resistance trait if herbicide use is discontinued."

In contrast, the authors of the study APHIS cites constructed a crude model that took account of both the fitness costs of the glyhosate resistance trait, as well as the rapidly growing area planted to soybeans, cotton and corn that were sprayed with glyphosate from 1991 to 2002, based on US Dept. of Agriculture data. Their conclusion was that the high cost of tolerance provided a successful evolutionary constraint on propagation of the

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[60] EA at 10.

[61] Baucum & Mauricio (2004). "Fitness costs and benefits of novel herbicide tolerance in a noxious weed," PNAS 101(36): 13386-13390.

resistant morning glory from 1991 to 2001; in 2002, however, the rapidly increasing acreage sprayed with glyphosate tipped the balance toward selection for the evolution of glyphosate-tolerant morning glory, in spite of the fitness cost of the resistance trait. The authors go on to state: "These calculations do suggest that serious and immediate consideration should be given to developing regional strategies for managing the evolution of [glyphosate]-tolerance to *I. purpurea* [tall morning glory]." This is a perfect example of APHIS's unscientific, industry-biased, and rubber-stamp approach to its regulatory responsibilities.

APHIS completely failed to analyze the potential for increased glyphosate use with Pioneer 98140 corn, and the associated increased selection pressure it would bring to bear for more rapid development of glyphosate-resistant weeds. This matter deserves careful evaluation in the context of a comprehensive EIS.

Weeds resistant to ALS inhibitors

The first ALS inhibitor, chlorsulfuron, was introduced in 1982, followed five years later by the first reports of chlorsulfuron-resistant weeds: prickly lettuce and kochia.[62] Weed resistance to ALS inhibitors developed extremely rapidly from the mid 1980s to mid 1990s. Some important weeds of corn have evolved numerous populations resistant to ALS inhibitors. For instance, over 16 million acres each of corn[63] and soybeans[64] were treated with herbicides to control common waterhemp in 2004. WSSC-HRAC report up to 104,000 sites covering 5 million acres in eight states infested with ALS-inhibitor-resistant common waterhemp.[65] This weed is considered the number one weed problem for Illinois corn and soybean growers, in part because of its ability to grow 2-3 meters tall, emerge over an extended period of time late into the growing season, and substantially decrease corn yields even at relatively low levels of infestation.[66] So much waterhemp in Illinois is resistant to ALS inhibitors that these herbicides are no longer recommended for use to control common waterhemp there.[67] Kochia, a weed more problematic in wheat but that is also found in corn, has developed documented resistance to ALS inhibitors in fields covering up to 3.4 million acres in 18 states. Other weeds of corn and soybeans (often rotated with corn) with substantial populations resistant to ALS inhibitors include common cocklebur, common ragweed, giant ragweed, Palmer amaranth, lambsquarters, and horseweed, among others.

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[62] Tranel & Wright (2002). "Resistance of weeds to ALS-inhibiting herbicides: what have we learned?" *Weed Science* 50: 700-712.
[63] Petition at 115.
[64] DuPont-Pioneer (2006). "Petition for the Determination of Nonregulated Status for Herbicide Tolerant 356043 Soybean," submitted to USDA's APHIS Sept. 27, 2006, p. 102. The figures for corn and soybeans include multiple sprayings.
[65] WSSA-HRAC (2009), op. cit. Unless otherwise noted, acreage figures for fields infested with resistant weeds are from this website.
[66] Steckel & Sprague (2004). "Common waterhemp (*Amaranthus rudis*) interference in corn," *Weed Science* 52: 359-64.
[67] Tranel & Wright (2002), p. 701.

As noted above, non-GE crops with resistance to ALS inhibitors have been developed and grown since the 1990s. A few these include Clearfield corn and canola, with resistance to the imidazolinone class of ALS inhibitors, introduced in 1993 and 1997, respectively. STS soybeans, a non-GE crop resistant to sulfonylureas, were introduced in 1994.[68] Figure 4 shows that the bulk of reports on ALS inhibitor-resistant weeds came in the latter half of the 1980s and first half of the 1990s. It is possible that increased ALS inhibitor use associated with adoption of Clearfield corn and STS soybeans contributed to the already expanding populations of resistant weeds. WSSC-HRAC data show that the reports of ALS-inhibitor-resistant weeds in the late 1980s were primarily in wheat in western and northern states. It was only in the 1990s that ALS inhibitor-resistant weeds began turning up in Midwestern soybean and corn fields, most notably 2 million acre infestations with resistant common waterhemp in Illinois and Missouri as well as one million acres in Kansas. This explosion of weed resistance in corn and especially soybean fields probably explains the more than 10-fold reduction in ALS inhibitor use on soybeans from 1994 to 2006, as growers switched to other modes of action to control ALS inhibitor-resistant weeds.[69]

The potential impact of Pioneer 98140 corn on development of multiple herbicide resistant weeds

APHIS provides no discussion of glyphosate-resistant weeds, and does little more than mention the populations of weeds that have resistance to both glyphosate and ALS inhibitors.[70] A good starting point would be to identify those weed species for which biotypes exist that are resistant to both ALS inhibitors and glyphosate. In the U.S., eight of the nine species of weeds with glyphosate-resistant biotypes also have biotypes with resistant to ALS-inhibitors. One very troubling aspect of ALS-resistance is that resistance imposes little or no "fitness costs" on the resistant populations.[71] This means that resistant populations will thrive and reproduce as well or nearly as well as susceptible populations, and thus persist to pass their resistance trait to susceptible individuals through cross-pollination or to future generations via seed even if use of the herbicide is stopped. In fact, there are even reports of ALS-resistant populations with enhanced fitness, making it still more likely that they will survive to propagate resistance.[72] Another characteristic of ALS-inhibitor-resistant weeds is their propensity for cross-resistance to other classes of herbicides, notably ACCase inhibitors.[73] Cross-resistant weeds are obviously problematic because they reduce the number of chemical

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[68] USDA APHIS (2007). "Introduction of Genetically Engineered Organisms: Draft Programmatic Environmental Impact Statement," July 2007. US Dept. of Agriculture, p. 120.
[69] "Agricultural Chemical Usage: Field Crops Summary," USDA National Agricultural Statistics Service, for the respective years. Accessible from: http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1560.
[70] EA at 26.
[71] Powles & Preston (2006), "Evolved glyphosate resistance in plants: biochemical and genetic basis of resistance," *Weed Technology* 20: 282-289.
[72] Tranel & Wright (2006), p. 706.
[73] Preston, C. (2004). "Herbicide resistance in weeds endowed by enhanced detoxification: complications for management," *Weed Science* 52: 448-453.

weed control options, and can impose additional costs on growers for mechanical tillage or additional chemicals.

The likely long-term persistence of most ALS-inhibitor resistant weed populations, coupled with their vast extent, makes the development of more dual-herbicide-tolerant weed populations both likely and worrisome. WSSC-HRAC currently list three biotypes of dual glyhosate/ALS inhibitor-resistent weeds: a population of resistant horseweed in Ohio that infest up to 500 acres; a population of dual-resistant common waterhemp in Illinois; and a population of triple-resistant common waterhemp infesting up to 10,000 acres in Missouri (also resistant to PPO inhibitors). The resistance to the PPO inhibitors developed, predictably, from use of PPO inhibitors to kill resistant waterhemp that had become resistant to ALS-inhibitors.[74] These reports are all worrisome. Recall that both Missouri and especially Illinois have million acre infestations of ALS-inhibitor-resistant common waterhemp. The problem could become much worse. One Midwestern weed expert has heard anecdotal reports from farmers of inconsistent control of common waterhemp with glyphosate. He confirmed substantial inherent variability in the susceptibility to glyphosate (18-fold) in an Iowa population of common waterhemp, was able to select for populations with decreased sensitivity to glyphosate, and concluded that: "the potential for the evolution of glyphosate resistance is significant." He further noted that the potential for glyphosate resistance "is relevant as most *A tuberculatus* [waterhemp] populations in the Midwest are suspected to be resistant to ALS-inhibiting herbicides and further selection pressure by glyphosate may select for multiple-resistant populations."[75]

Giant ragweed is another good candidate for development of multiple herbicide resistance. Since just 2004, 6 reports of glyphosate-resistant giant ragweed have been reported in Ohio, Arkansas, Indiana, Minnesota, Kansas and Tennessee. Purdue University extension agents first confirmed a single population of glyphosate-resistant giant ragweed in Indiana in December of 2006;[76] just a year and half later, they announced GR giant ragweed in 14 counties in Indiana, and noted that some are also dual-resistant to ALS inhibitors as well.[77] Ohio State University researchers have reported giant ragweed with relatively high levels of resistance to both PPO and ALS inhibitor herbicides in three counties, and populations with lower levels of dual resistance in four other counties. They warn that although these weeds can be managed with glyphosate, "continuous use of this practice is likely to result in resistance to glyphosate as well."[78]

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[74] Owen & Zelaya (2005), op. cit.
[75] Zelaya & Owen (2005). "Differential response of *Amaranthus tuberculatus* (Moq ex DC) JD Sauer to glyphosate," *Pest Manag Sci* 61: 936-950.
[76] Johnson, B and Loux, M. (2006). "Glyphosate-resistant giant ragweed confirmed in Indiana, Ohio," Purdue University press release, 12/21/06.
[77] Johnson, B and G Nice (2008). "Lots of weedy soybean fields," Purdue Extension Weed Science, July 2008.
[78] Loux, M and J Stachler (2008). "Giant ragweed with resistance to PPO and ALS inhibiting herbicides," Crop Observation and Recommendation Network Newsletter 2008-11, 4/29 to 5/6/08.

Most identified herbicide resistance mechanisms are so-called target site mutations. Herbicides often attack and disable a particular enzyme that performs crucial functions in the plant's cellular metabolism. A mutation-induced alteration in the enzyme can render it less susceptible to the herbicide, conferring resistance. ALS inhibitor resistance appears to be mostly due to one of a number of target-site mutations to the relevant enzyme. Target-site resistance has been identified in just three of the world's 15 glyphosate-resistant weed species, however.[79] Apparently more common in GR weeds is a mechanism whereby glyphosate absorbed by the weed is subject to "reduced translocation" such that it is sequestered more in leaf tissue and not allowed to travel throughout the plant.[80] Some believe that such non-target resistance mechanisms might be mainly responsible for glyphosate resistance, and are thought to "pose a greater threat to agriculture because of the often unexpected multi-herbicide resistance and multi-gene involvement in the mechanisms."[81]

Much remains to be learned about the mechanisms of herbicide resistance in weeds, particularly with respect to glyphosate. APHIS would do well to remember that a number of reputable weed scientists predicted little or no potential for weeds to develop resistance to this highly potent and seemingly almost miraculous herbicide,[82] only to be proven decisively wrong by events. It has become abundantly clear that the sort of voluntary stewardship measures that APHIS recommends are inadequate to address the growing threat of that glyphosate- and multiple-resistant weeds pose to American agriculture. Weed scientists are increasingly calling for stronger stewardship measures to preserve the utility of glyphosate, which is at risk.[83] Increasing agricultural chemical use conflicts with official commitments of USDA and EPA to implement integrated pest management practices, include integrated weed management, with the object of reducing chemical pesticide use. APHIS is urged to use its authority to address these serious issues, starting with an EIS on Pioneer 98140.

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[79] Powles and Preston (2006). "Evolved glyphosate resistance in plants: biochemical and genetic basis of resistance," *Weed Technology* 20: 282-89.

[80] Preston and Wakelin (2008). "Resistance to glyphosate from altered herbicide location patterns," *Pest Manag Sci* 64: 372-376.

[81] Yuan, JS et al (2006). "Non-target-site herbicide resistance: a family business," *Trends in Plant Science* 12(1): 6-13.

[82] Waters, S. (1991). "Glyphosate tolerant crops for the future: development, risks, and benefits," Proceedings of the Brighton Crop Protection Conference: Weeds 165-170; Jasieniuk M, Constraints on the evolution of glyphosate resistance in weeds. *Resistant Pest Manag Newslett* **7**:31–32 (1995); Bradshaw LD, Padgette SR, Kimball SL and Wells BH, Perspectives on glyphosate resistance. *Weed Technol* **11**:189–198 (1997); Watkinson et al (2000). "Glyphosate-resistant crops: history, status and future," Pest Manag. Sci. 61: 219-224.

[83] Owen, MDK (2008). "Weed species shifts in glyphosate-resistant crops," *Pest Manag Sci* 64: 377-387.

II. Glyphosate-Tolerant Crop Systems Have Led to Increased Herbicide Use. The Issue of Increased Herbicide Use in HT Corn and Event 98140 Requires Comprehensive Analysis in an EIS.

Increased Use of Glyphosate

Glyphosate-tolerant crop systems, defined as the use of glyphosate together with a glyphosate-tolerant crop, have dramatically increased glyphosate use by all measures – number of acres treated, amount applied, as well as frequency and rate of application.

The number of acres treated with glyphosate is reflected in RR crop adoption figures, since glyphosate is invariably applied to RR crops. As noted above, RR crops were planted on over 148.9 million acres in 2008, up substantially from 114 million acres in 2006.

Overall glyphosate use on soybeans, corn and cotton in the U.S. has jumped 15-fold from just 1994 to 2005, tracking both the dramatic rise in RR crop acreage and the upsurge in glyphosate-resistant weeds, which require higher doses to kill. The amount of glyphosate applied to cotton climbed 753% from 1992 to 2002.[84] The introduction in 2006 of Roundup Ready Flex cotton, which tolerates a higher application rate than original RR cotton, and also permits glyphosate application throughout the cotton plant's growing season,[85] promises to lead to continued increases in glyphosate use on cotton. In 2006, 96.7 million lbs. of glyphosate were applied to soybeans alone, a huge 28% increase from the previous year. Glyphosate use on corn has also increased rapidly, rising more than five-fold from 5.1 million lbs in 2002 to 26.1 million lbs. in 2005, the latest year for which USDA statistics are available (see Appendix 1).

Both the number and rate of glyphosate applications have also increased. From just 2002 to 2006, annual glyphosate applications to soybeans increased by a substantial 24%, from 1.07 to 1.33 lbs/acre.[86] Glyphosate use on corn has risen even more rapidly, from 0.71 lbs/acre in 2002 to 0.96 lbs/acre in 2005, a 32% rise in just three years.[87]

Increased Use of Other Herbicides

Since a major feature of HT crop systems is reliance on the single herbicide to which the HT crop is tolerant, one would expect declining use of other weed control methods,

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[84] Steckel, L., S. Culpepper and K. Smith (2006). "The Impact of Glyphosate-Resistant Horseweed and Pigweed on Cotton Weed Management and Costs," Power Point presentation at Cotton Incorporated's "Crop Management Seminar," Memphis, 2006. http://www.cottoninc.com/CropManagementSeminar2006/SeminarProceedings/images/Steckle%20Larry.pdf

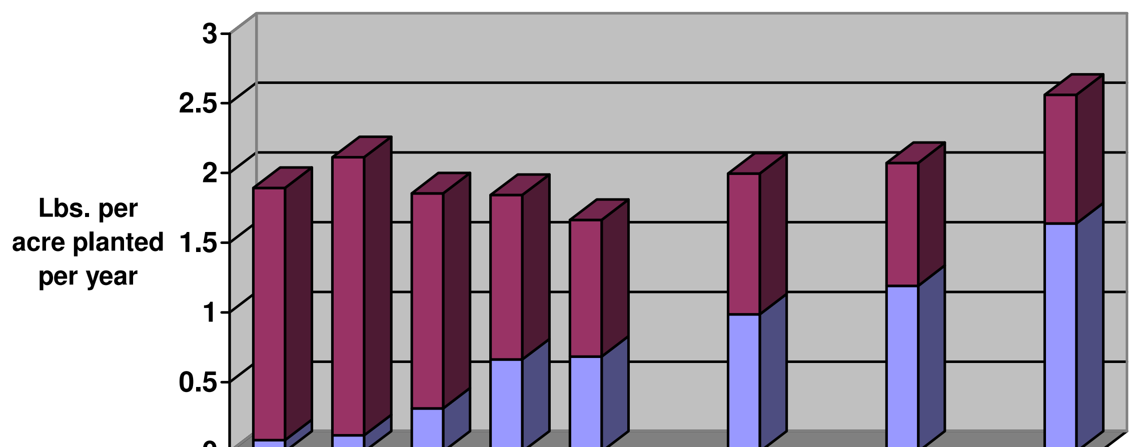
[85] Bennett, D. (2005). "A look at Roundup Ready Flex cotton," *Delta Farm Press*, 2/24/05, http://deltafarmpress.com/news/050224-roundup-flex/.

[86] From an average 1.4 applications of 0.74 lbs. glyphosate per acre in 2002 to an average 1.7 applications of 0.80 lbs./acre in 2006. See USDA NASS reports cited in last footnote.

[87] From an average 1.1 applications of 0.64 pounds per acre in 2002 to 1.3 applications of 0.73 lbs./acre in 2005. See USDA NASS reports cited above.

including other herbicides. This has in fact occurred in the past, but in recent years we have seen a trend towards steady or even rising use of non-glyphosate herbicides even as glyphosate use increases. Cotton provides a good example. Figure 5 presents data on herbicide use per acre of upland cotton planted from 1996 to 2007, the latest year for which USDA NASS "Agricultural Chemical Usage" data are available, broken down between glyphosate and the total of non-glyphosate herbicides. The trend is clear. From 2001 to 2007, when adoption of HT cotton rose from 74% to 92%, use of non-glyphosate herbicides remains essentially unchanged at roughly 0.9 lbs/acre, while over the same period glyphosate use increases 2.4-fold. Clearly, increasing adoption of the glyphosate-tolerant cotton system dramatically increased glyphosate use while providing no displacement of other more toxic herbicides. It is possible that the 2007 spike in glyphosate use is attributable to increased adoption of the glyphosate-promoting Roundup Ready Flex cotton mentioned above. We note that Pioneer 98140 corn is similar to Roundup Ready Flex in that it offers a higher level of glyphosate resistance, and so might well have the same glyphosate-boosting effect.

Figure 5: Herbicide Use on Upland Cotton: Glyphosate vs. Other Herbicides



	1996	1997	1998	2000	2001	2002	2003	2004	2005	2006	2007
Cotton (non-glyphosate)	1.81	1.994	1.543	1.18	0.982		1.011		0.882		0.923
Cotton (glyphosate)	0.083	0.118	0.311	0.662	0.682		0.985		1.189		1.637

Cotton (glyphosate) Cotton (non-glyphosate)

Recommendations by extension experts and weed scientists to use additional herbicides to help control glyphosate-resistant weeds offers further support for the contention that glyphosate-tolerant crop systems are no longer displacing use of more toxic herbicides, and may in some cases be increasing them.

As early as 2002, Ohio State Extension experts recommended using 2,4-D plus metribuzin plus paraquat as pre-emergence chemicals to control glyphosate-resistant marestail in RR soy.[88] In the same year, Syngenta recommended growers use a number of chemicals, including AAtrex®, Bicep®, DoublePlay®, Dual® MAGNUM, Gramoxone® Max, Princep®, atrazine and metribuzin, with their Roundup Ready soy, cotton and corn crops.[89]

In August 2005, reports of resistant horseweed in California prompted Monsanto to recommend that farmers should "use other chemicals" along with Roundup on their Roundup Ready crops. In addition to adding other herbicides, University of California researchers suggested tillage to control weeds.[90] In September 2005, reports of glyphosate-resistant Palmer amaranth in Georgia cotton fields prompted Monsanto to recommend that farmers use several additional herbicides with Roundup, including Prowl (pendimethalin), metolachlor, diuron and others. The company also suggested that farmers planting any RR crops use pre-emergence residual herbicides in addition to Roundup.[91] In the same year, weed scientists in Tennessee noted that Palmer amaranth in the state survived applications of up to 44 ounces per acre of Roundup, and so recommended that farmers use additional herbicides such as Clarity, 2,4-D, Gramoxone Max or Ignite.[92]

October 2005, reports of glyphosate-resistant weeds in Roundup Ready corn and soybeans prompted Monsanto to recommend using cultivation and additional herbicides, including Harness Extra, Degree Extra, Intrro, Prowl, Valor, and 2,4-D. Weed scientists also suggested using Lasso, Dual, Diuron, Gramoxone, Ignite, Suprend, Direx or MSMA, and noted that weed problems were so severe that herbicides such as Direx, Cotoran and Caporal were in short supply at retailers.[93]

In June 2006, reports of widespread populations of lambsquarters that were not controlled even with application of up to 48 oz per acre of Roundup prompted Iowa State University experts to recommend farmers use additional applications of Roundup and/or other chemicals, including Harmony GT, Ultra Blazer, and/or Phoenix herbicides.[94] Also in

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[88] Mark Loux, and Jeff Stachler, "Is There a Marestail Problem in Your Future?" O.S.U. Extension Specialist, Weed Science, 2002.

[89] Syngenta Announces Guidelines To Prevent Weed Resistance To Glyphosate Herbicides, press release, Greensboro, N.C., February 25, 2002, online at http://www.syngentacropprotection-us.com/media/article.asp?article_id=199

[90] Juliana Barbassa, "Attack of the 12-foot horse weed: Herbicide-resistant strains plague California farmers." Associated Press, August 10, 2005, online at http://lists.ifas.ufl.edu/cgi-bin/wa.exe?A2=ind0508&L=sanet-mg&P=6738

[91] "Investigation Confirms Case Of Glyphosate-Resistant Palmer Pigweed In Georgia." Monsanto press release, September 13, 2005

[92] "Glyphosate-resistant Palmer Pigweed Found in West Tennessee." Farm Progress, staff report, September 23, 2005.

[93] Andrew Burchett, "Glyphosate Resistant Weeds," Farm Journal, October 4, 2005.

[94] Michael Owen, "Large common lambsquarters is a problem for glyphosate." Iowa State University Extension Agronomy, June 15, 2006, online at http://www.weeds.iastate.edu/mgmt/2006/Largecommonlambsquarters.htm

2006, it was reported that farmers would rely increasingly on older herbicides such as paraquat and 2,4-D to control glyphosate-resistant weeds.[95]

In 2007, resistant weeds prompted Monsanto to recommend that farmers use tillage and apply a pre-emergence herbicide in combination with Roundup. Monsanto also noted that it would pay for an additional application of Roundup if growers still experienced weed problems after using a pre-emergence herbicide.[96] By 2007, the American Soybean Association was advocating that farmers return to multiple-herbicide weed control systems on their Roundup Ready soybeans.[97]

Finally, over-reliance on Roundup Ready crops and glyphosate has dampened research into new herbicides, meaning none are on the horizon.[98]

USDA statistics on herbicide use demonstrate that farmers are in fact using both more glyphosate (see above) as well as increased amounts of other herbicides. For instance, 2,4-D is the second most-heavily used herbicide on soybeans (after glyphosate). From 2002 to 2006, while glyphosate use on soybeans increased by a substantial 29 million lbs (43% rise), 2,4-D use on soybeans increased by nearly 2.7-fold, from 1.39 to 3.69 million lbs. Clearly, glyphosate is not displacing 2,4-D, but both herbicides are being used at higher rates (Appendix 2).

Atrazine is the most heavily applied herbicide on corn, followed by acetochlor and S-metolachlor/metolachlor. At the same time that glyphosate use on corn climbed over five-fold from 2002 to 2006, atrazine use rose by 12%, and aggregate use of the top 4 corn herbicides rose by 4.9% (Appendix 1). Clearly, glyphosate is not displacing use of the top three corn herbicides, but rather all four herbicides are being applied in substantially increased quantities.

We note that APHIS's contention in the EA (p. 18) that the "no action" alternative would lead to increased spraying of atrazine and dicamba instead of glyphosate directly contradicts its repeated assertion that Pioneer 98140 corn is merely a "replacement product" for existing HT corn, which is nearly all glyphosate-tolerant. APHIS is requested to correct this faulty reasoning and remove any reference to increased use of atrazine and dicamba in the event that Pioneer 98140, or to explain the reasoning behind this assertion and how it comports with the "replacement product" paradigm.

These pesticide use figures are derived from the gold standard in pesticide reporting, the USDA National Agricultural Statistics Service Agricultural Chemical Usage Reports.

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[95] Roberson (2006), *see supra,* note 31.
[96] Henderson & Wenzel (2007). "War of the Weeds," Agweb.com, Feb. 16, 2007. http://www.agweb.com/Get_Article.aspx?sigcat=farmjournal&pageid=134469.
[97] Tom Sellen, "Herbicide-Resistant Weeds Force Change In Agriculture." Dow Jones, February 7, 2007, online at http://www.cattlenetwork.com/content.asp?contentid=104080
[98] Mueller, T.C., P.D. Mitchell, B.G. Young and A.S. Culpepper (2005). "Proactive versus reactive management of glyphosate-resistant or –tolerant weeds," *Weed Technology* 19:924-933; Yancy, C.H. (2005). "Weed scientists develop plan to combat glyphosate resistance," *Southeast Farm Press*, June 1, 2005. http://southeastfarmpress.com/mag/farming_weed_scientists_develop/.

While APHIS does make use of "acres treated" data from these reports in the draft EA (Table 4, p. 8), it conspicuously fails to refer to this objective source of information to identify trends in actual amounts of pesticide used in American agriculture with respect to GE crops. Although USDA NASS does not break down pesticide usage data for GE and non-GE crops, APHIS could nevertheless use these data (as we have above) to identify trends, as well as to check the validity of studies it does cite for pesticide use claims related to GE crops. A case in point is APHIS's inexcusable citation of Gianessi (2005) for the patently false claim that glyphosate tolerant crops have reduced pesticide use.[99] An examination of this study reveals that its methods are based on an unpublished white paper published by the National Center for Food and Agricultural Policy, an organization funded by the biotech industry chiefly to churn out "simulation studies" based on false assumptions to manufacture false "benefits" with respect to GE crops, such as reduced pesticide use.[100] If USDA had bothered to check Mr. Gianessi's false claims of pesticide use reductions with glyphosate-tolerant crops against USDA data on pesticide use on soybeans for 2005 and 2006, it would have discovered that Gianessi's conclusions re: reduced pesticide use with glyphosate-tolerant crops bore no relation to reality. An examination of Gianessi (2005) reveals that the author did not check his simulation model results against objective USDA NASS data on pesticide use. The author also purports to calculate pesticide use with GE and non-GE soybeans for the year 2001; even if his methods were valid, one must ask why APHIS would refer to such outdated research, especially given the substantial changes in pesticide use associated with GE crops in the intervening 7-8 years.

Similar criticisms apply to APHIS's citation of Brookes and Barfoot (2006),[101] given that these authors too are unscrupulous contractors for the biotech industy who put out misleading studies on biotech crops. APHIS is urged to consult objective and independent sources – including data and studies generated by its sister agencies in the Dept. of Agriculture – in order to arrive at truthful conclusions about the impacts of GE crops.

One independent study that APHIS should have consulted (we have brought this study to APHIS's attention in numerous prior comments on APHIS BRS decisionmaking, to no avail) is an exhaustive analysis of the impacts of GE crops on pesticide use – based on USDA NASS data – by Dr. Charles Benbrook, former head of the Board on Agriculture of the National Academy of Sciences. Dr. Benbrook's meticulously documented study has estimated that the widespread adoption of Roundup Ready crops increased ***overall herbicide use*** by 138 million lbs. from 1996-2004.[102] Interestingly, Roundup Ready crops slightly reduced herbicide use from 1996-1999, before increased reliance on glyphosate as the near-exclusive weed control method spurred a dramatic rise in

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[99] EA at 24.

[100] For an expose of NCFAP, see: "Genetic Engineering Industry Front Group Exposed," Center for Food Safety, February 2005, at: http://www.centerforfoodsafety.org/pubs/NCFAP%20debunked%20-%20Final%20Feb%202005.pdf.

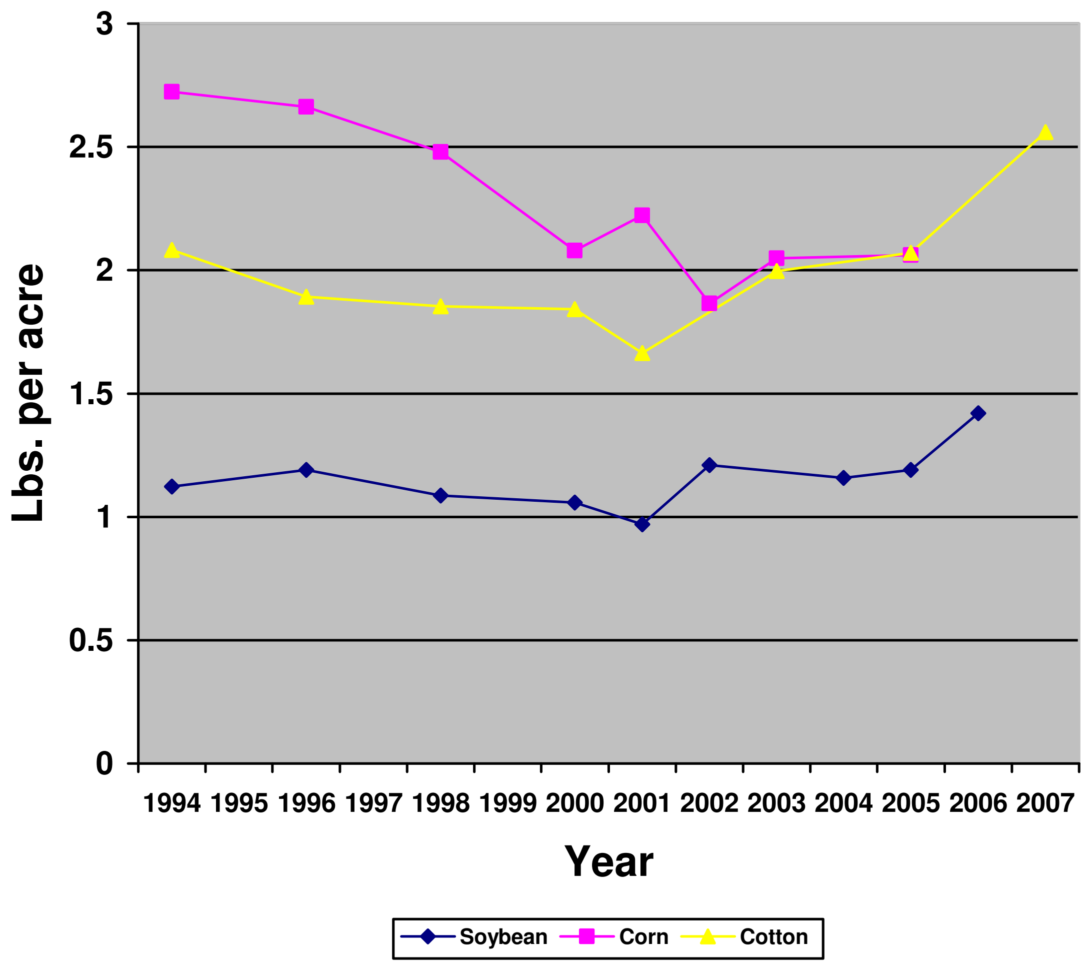
[101] EA at 26.

[102] Benbrook, C. (2004). "Genetically Engineered Crops and Pesticide Use in the United States: The First Nine Years," AgBioTech InfoNet, Technical Paper No. 7, Oct. 2004. http://www.biotech-info.net/technicalpaper7.html.

glyphosate-resistant weed populations, which in turn has driven accelerating use of both glyphosate and other herbicides since the year 2000.

Finally, we refer APHIS to Figure 6, which is also based on USDA NASS data, for the substantial increase in herbicide use intensity on soybeans and especially cotton in recent years, which supports Dr. Benbrook's thesis of increased pesticide use associated with GE HT crops since the year 2000, and is exceedingly difficult to reconcile with the results reported in Gianessi (2005) or Brookes and Barfoot (2006). We expect that if NASS had collected data for corn in 2007, as it was scheduled to do, we would see a similar upward trend in herbicide use on corn.

Figure 6: Intensity of Herbicide Use on Major Field Crops in the U.S.: 1994 - 2006



APHIS has not previously looked at these continuing impacts of increased individual and cumulative herbicide use an EIS for any previous GE HT corn. After failing to comply with NEPA previously and being sued by CFS for its failure, APHIS was ordered by a federal court to analyze, among other potentially significant impacts, increases in weed resistance and in herbicide use and their impacts on the environment, farmers and the public in the context of HT alfalfa.[103] As the Court in Geertson noted, in rejecting APHIS' argument that it was solely EPA's responsibility to assess the impacts of herbicides used in GE crop systems, "Since the Court has concluded that APHIS must consider the cumulative impact of increased glyphosate use with respect to the development of glyphosate-resistant weeds, APHIS will have to examine the increased use of glyphosate … The Court notes, however, that it is unclear from the record whether any federal agency is considering the cumulative impact of the introduction of so many glyphosate resistant crops; one would expect that *some federal agency* is considering whether there is some risk to engineering all of America's crops to include the gene that confers resistance to glyphosate."[104] As explained in detail above, there are most definitely significant potential risks, individually and cumulatively. Perhaps for earlier GE HT corn deregulations, before *Geertson*, APHIS did not understand its NEPA responsibilities to include analysis of these impacts and thus did not make such assessments. That time is past. And the "some agency" that should be doing this EIS analysis is APHIS. A proper cumulative impacts analysis must include past, present and foreseeable future impacts precisely such as those presented by already deregulated GE corn. Accordingly, APHIS needs to undertake this EIS analysis for GE HT corn crops, including Event 98140, before considering deregulation. The fact that there are some GE HT corn varieties already in unregulated cultivation only increases the need and urgency of this analysis with respect to this GE corn.

III. The EA's Analysis of the Environmental Impacts Regarding Tillage and Climate Change is Inadequate and Requires an EIS.

The Analysis of Tillage is Inadequate

One major benefit to the environment APHIS ascribes to deregulation of Pioneer HT corn is an increase in the adoption of conservation tillage: "Under the 'preferred' alternative, growers will have access to Pioneer HT corn as an herbicide tolerant corn option that will require less tillage than that required for non-herbicide tolerant corn."[105] Similarly: "Under the 'no action' alternative, Pioneer HT corn would not be available to growers, and it is likely that there would be more use of tillage as a means of weed management."[106]

This comparison between Pioneer HT corn and non-herbicide tolerant corn is surprising in light of repeated assertions made by APHIS throughout the EA that Pioneer HT corn is being put forward as a "replacement" for or alternative to existing HT corn varieties,

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[103] *Geertson Seed Farms v. Johanns*, 2007 WL 518624 (N.D. Cal. Feb. 13, 2007) *aff'd*, 541 F.3d 938 (9th Cir. 2008).
[104] *Id.* at 11.
[105] EA at 23.
[106] EA at 20.

especially glyphosate-tolerant corn.[107] For instance, APHIS states that adoption of Pioneer HT corn will leave corn cultivation practices unchanged: "Cultivation of Pioneer HT corn is not expected to differ from typical corn cultivation. Although the extent to which Pioneer HT corn will be grown is unknown, this product is expected to replace the existing glyphosate tolerant corn varieties available on the market, and used in areas where glyphosate tolerant corn is already present."[108]

APHIS thus asserts that growing HT corn instead of conventional varieties will increase conservation tillage, but also that Pioneer HT corn will merely replace other HT varieties. How then would Pioneer HT corn provide additional stimulus for conservation tillage? This is not explained.

Nor does APHIS provide any compelling evidence that growing HT corn of any sort has led to or will result in greater adoption of no-till or other conservation tillage methods. For example, APHIS notes that "the use of conservation tillage has been increasing since the 1990s (Table 6). The ability of growers to utilize herbicides to control weeds without crop damage has greatly contributed to this shift."[109] However, Table 6 reports aggregate acreage data for various tillage systems for a range of major crops in the US, not merely to corn, much less HT corn in particular, so it offers no support for APHIS's thesis. Additionally, the aggregate data in Table 6 are for 1989 to 2000. The dominant variety of genetically engineered HT corn, Monsanto's glyphosate-tolerant Roundup Ready, was not introduced until 1998. By APHIS's own reckoning, genetically engineered HT corn represented only 6% of all corn in that year.[110] APHIS does not report acreage planted to non-GE HT corn (Clearfield) over this time period, except for the year 2000, when Clearfield HT corn was reportedly planted on just 7% of all corn.[111] Thus, Table 6 provides no support for APHIS's thesis that HT corn promotes use of no-till or other conservation tillage methods.

In fact, the source APHIS cites for Table 6 does provide other data that break down tillage practices used for corn over the same time period, 1989-2000.[112] It is curious that APHIS ignored these data on corn tillage practices, which are much more relevant to its thesis than the data presented in Table 6, which appear to apply to all (major) crops (i.e. corn, soybeans, small grains and cotton). We present these data for corn tillage systems in graphical form below in the figure below. Use of conservation tillage increased modestly from 32.3% of total corn acres in 1990 to 43.4% in 1993, remained stagnant for a number of years, then declined to the 37-39% range by the end of the decade. Thus, to the small extent that HT corn varieties (GE or non-GE) were planted over this time frame, they do not appear to have promoted adoption of conservation tillage practices.

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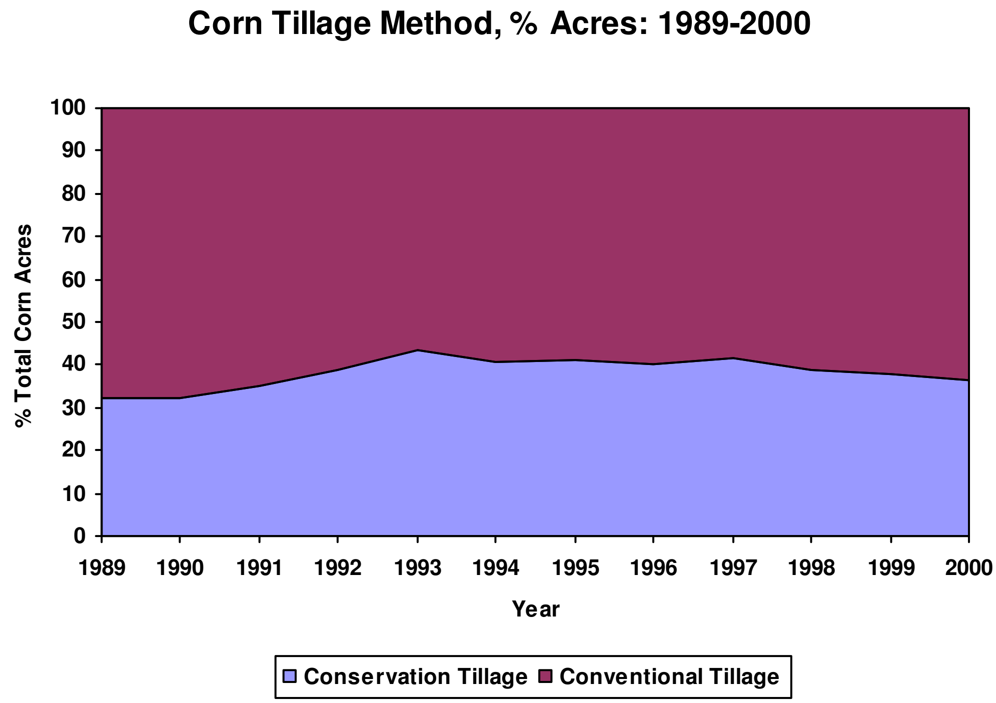
[107] EA at 14, 20, 23, 29, 31, 32.
[108] EA at 31.
[109] EA at 16-17, Table 6.
[110] EA at 16, Table 5. The true figure is 7%. We discuss APHIS's huge errors in Table 5 elsewhere in these comments.
[111] EA at 28.
[112] USDA-ERS (2002), "Agricultural Resources and Environmental Indicators: Soil Management and Conservation," US Dept. of Agriculture, Economic Research Service, Chapter 4.2, Table 4.2.9: "Tillage systems used on major crops, contiguous 48 states: 1989-2000."



Based on data from: USDA-ERS (2002), "Agricultural Resources and Environmental Indicators: Soil Management and Conservation," US Dept. of Agriculture, Economic Research Service, Chapter 4.2, Table 4.2.9: "Tillage systems used on major crops, contiguous 48 states: 1989-2000." Note that conservation tillage = tillage methods that leave 30% or more of crop residue remaining in the field (no-till, ridge-till, mulch til); conventional tillage = tillage methods that leave less than 30% of crop residue in field (intensive <15% and reduced till (15-30%)). This breakdown conforms to APHIS's definition of "conservation tillage" in Table 3, p. 7 of the draft EA.

APHIS also states: "…the availability of herbicide tolerant crops has promoted the use of conservation tillage because herbicides can be sprayed to control weeds as needed without affecting crop yield (Cerdeira and Duke 2006)."[113]

However, examination of Cerdeira and Duke (2006) reveals that it has nothing at all to say about tillage practices with herbicide-tolerant corn. Instead, the authors refer to a survey of farmer tillage practices with soybeans in 1996 and 2001 conducted by a commodity groups, the American Soybean Association (ASA). This survey found a positive correlation between glyphosate-tolerant soybeans and no-till/reduced tillage practices.[114] Interestingly, the authors preface their presentation of the ASA survey results as follows: "Considering the relatively high level of potential environmental improvement that can be gained by reducing tillage, ***there is a remarkable paucity of refereed publications on the influence of GRCs [glyphosate-resistant crops] on tillage practices and associated environmental effects."***[115] We note that the American Soybean Association is a strong proponent of GM crops, and received $2.1 million in funding

[113] EA at 22.
[114] Cerdeira & Duke (2006). "The current status and environmental impacts of glyphosate-resistant crops: a review," Journal of Environmental Quality 35: 1633-58, see pp. 1638-39.
[115] Id at 1638, emphasis added.

from Monsanto, Pioneer Hi-Bred International and other biotech/seed/chemical companies in fiscal year 2000.[116] It should not need to be said that an unrefeered (i.e. non-peer reviewed) survey by an organization with a clear financial interest in promoting the products of a funder cannot be regarded as a reliable source of information.

Rather than rely on such a dubious survey, APHIS should have consulted USDA researchers, who examined this very question of tillage practices with glyphosate-tolerant soybeans.[117] First of all, USDA data show that the dramatic increase in conservation tillage for soybeans (from 25 to 60% of U.S. soy acres) occurred from 1990-1996.[118] Monsanto's HT soybeans were first introduced in 1996, and so could not have had anything to do with this dramatic shift to conservation tillage, except perhaps in 1996, when roughly 10% of soybean acres were planted to glyphosate tolerant varieties. In the following three years, from 1997 to 1999, as glyphosate-tolerant sobyean adoption increased from 17% to 56%, the acreage under conservation tillage actually decreased a bit, further undermining the supposed "conservation-tillage-promoting" effect of HT soybeans.[119]

Data on soybean varieties and tillage systems was analyzed for 1997. Although USDA determined that "[a] larger portion of the acreage planted with herbicide-tolerant soybeans was under conservation tillage than was acreage growing conventional soybeans" in 1997,[120] did the adoption of HT soybeans cause this difference? Determining causality requires more sophisticated statistical methods, because "[d]espite the relationship between conservation tillage and adoption of herbicide-tolerant crops, cause and effect is uncertain. Availability of the herbicide-tolerant technology may boost conservation tillage, while use of conservation tillage may predispose farmers to adopt herbicide-tolerant seeds." In order to understand causality, an econometric model was used to look at both decisions together.

At least for soybeans in 1997, growing an HT variety did not predispose farmers to adopt no-till methods. "The most interesting result in the simultaneous model was the interactive effects of the no-till and herbicide- tolerant seed variables. Farmers using no-till were found to have a higher probability of adopting herbicide-tolerant seed, but using herbicide-tolerant seed did not significantly affect no-till adoption. The result seems to suggest that farmers already using no-till found herbicide-tolerant seeds to be an effective weed control mechanism that could be easily incorporated into their weed management systems. Alternatively, the commercialization of herbicide-tolerant soybeans did not seem to encourage the adoption of no-till, at least at the time of the survey in 1997."[121]

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[116] Schubert, R. "Some claim that corporate cash compromises role of farm groups," CropChoice News, 2/13/02: http://www.cropchoice.com/leadstry260b.html?recid=587.

[117] Fernandez-Cornejo, J. and W.D. McBride (2002). "Adoption of Bioengineered Crops," U.S. Dept. of Agriculture, Economic Research Service, Agricultural Economic Report No. 810, May 2002. http://www.ers.usda.gov/publications/aer810/aer810.pdf.

[118] Id at p. 29, see Figure 11.

[119] Id at iv. Fig. 11.

[120] Id at 29.

[121] Id at 59.

In sum, APHIS has failed to demonstrate that Pioneer HT corn (or any HT corn or even HT soybean variety) promotes adoption of conservation tillage practices. Hence, the many environmental benefits that APHIS attributes to adoption of Pioneer HT corn are completely unsubstantiated. In the following section, we discuss evidence suggesting that conservation tillage – even if it were to be promoted by Pioneer HT corn – does not have the many benefits claimed for it by APHIS.

Tillage's Purported Benefits are not Adequately Analyzed

Assume as APHIS does that conservation tillage does increase as a result of allowing Pioneer HT corn to be grown. Are the benefits and risks to the environment of no-till corn analyzed critically in the EA?

In "*Agriculture and Climate Change*,"[122] APHIS asserts that conservation tillage has numerous beneficial environmental effects:

"The use of conservation tillage and residue cover has been shown to increase soil organic carbon content."[123] This is fleshed out a bit more in the "*Affected Environment*":[124]

> Research shows that crop soils are prone to degradation due to the disturbance and exposure of the top surface layer by certain agronomic practices. Two environmental impacts of soil degradation (discussed further under section IV) are the decline in water quality and the contribution to the greenhouse effect.[125] It has been shown that a decline in soil quality and soil resilience enhances the greenhouse effect through emission of radiatively-active gases (CO2, N2O) and depletion of the soil carbon pool.[126] In turn, a decrease in carbon aggregation and sequestration in the soil leads to increase [*sic*] runoff and soil erosion.[127]

None of these purported benefits of an increase in no-till corn acreage can be generally substantiated. Climate change research is a rapidly advancing field, and more recent work by Lal[128] and a careful review of the literature by USDA researchers Baker et al.[129] cast doubt on the claim that no-till results in more carbon sequestration than tillage in most conditions. Other gases that contribute to global warming (greenhouse gases – GHGs) – such as nitrous oxide (N2O), methane (CH4), and ammonia (NH3) – are

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[122] EA, p. 26
[123] EA, p. 26, ¶ 3
[124] Id. At section on p. 13
[125] Lal, R. and J. P. Bruce. 1999. The Potential of World Cropland Soils to Sequester C and Mitigate the Greenhouse Effect. Environmental Science & Policy 2:177-185.
[126] Lal, R. 2003. Soil Erosion and the Global Carbon Budget. Environment International 29(4):437-450.
[127] EA, p. 13
[128] Lal, H.B.-C.R (2008). "No-tillage and soil-profile carbon sequestration: an on-farm assissment," *Soil Sci. Soc. Am. J.* 72: 693-701.
[129] Baker et al (2007). "Tillage and soil carbon sequestration – What do we really know?", *Agriculture, Ecosystems and Environment* 118: 1-5.

reported to be higher generally higher in no-till fields, as well. In addition, recent work by ecologists and soil scientists has shown that no-till in some environments can exacerbate runoff of fertilizers and pesticides from fields, with attendant ill effects.

First, scientists from the USDA's Agricultural Research Service and Department of Soil, Water & Climate at the University of Minnesota reviewed the literature on the effects of tillage on carbon sequestration in agricultural soils in an article published in AGRICULTURE ECOSYSTEMS & ENVIRONMENT entitled "*Tillage and soil carbon sequestration—What do we really know?*"[130] They took a close look at numerous past studies on tillage and soil carbon, and concluded that in order to accurately determine how much carbon is sequestered, it is necessary to sample the soil to a depth that the roots grow. This is because much of the carbon fixed in photosynthesis is translocated to the roots and some is exuded into the soil where it stimulates the growth of various microorganisms. The deeper roots and microorganisms may also store carbon for a longer period of time than the more shallow roots.

The vast majority of tillage-soil carbon sequestration studies have sampled no deeper than the top 30 cm (roughly 1 foot) of soil. When studies of carbon sequestration are limited to the top 30 cm of soil, more carbon is stored in no-till than tilled fields, on average. However, when the sampling includes more of the root zone (below 30 cm; corn roots can go down more than 200 cm),[131] tilled fields have as much stored carbon as their no-till counterparts. In some cases, tillage results in more carbon storage. Thus, the claim that conservation tillage results in more carbon sequestration than conventional tillage seems to be a result of sampling bias.

Even Dr. Lal at the Carbon Management and Sequestration Center FAES/OARDC, Ohio State University, cited by APHIS for advocating no-till farming to sequester carbon, has recently published a study questioning whether it does so.[132] This study covered a large geographic area, looking at farmers' fields rather than small research plots, and sampling throughout the root zone. Not only did the plowed plots store as much carbon as the no-till plots when sampled below 10 cm, three of the plowed areas sequestered more carbon.

He comes to a similar conclusion about using no-till to sequester carbon as Baker and colleagues:

> This regional study shows that NT [no-till] farming impacts on SOC [soil organic carbon] and N [nitrogen] are highly variable and soil specific. In MLRAs [Major Land Resource Areas] where NT soils have greater SOC than tilled soils, the gains in SOC are limited solely to the surface soil layers (<10 cm). The net effect of NT on SOC sequestration for the whole soil profile (0-60 cm) is not significantly different from that of plow tillage…

[130] Id., Baker, 2007.
[131] Id, Baker, 2007.
[132] Id, Lal, 2008.

> Based on the data on soil profile C distribution from previous reports and this regional study, the view that NT farming would increase SOC over PT [plow tillage] is questionable...[133]

Why would plowing result in the same or more carbon sequestration as no tillage? At least part of the answer has to do with the way corn plants grow in plowed vs. unplowed fields. Particularly at the beginning of the season, roots grow better when the soil is warm, and plowed soil warms more quickly than stubble-covered un-tilled soil. Also, the looser structure of plowed soil is easier for roots to grow through, and the roots grow deeper. The higher moisture content near the surface of no-till soils encourages more shallow root growth than in plowed fields. This results in more root tissue distributed lower in the ground in plowed vs. no-till fields. "Qin et al.[134] conducted a comparison of root length density of maize in plowed and no-till soils, and reported that generally root length densities were greater in no-till for the upper 5 – 10 cm, but greater in the plowed soil at the deeper depths."[135]

A significant amount of the carbon fixed in photosynthesis is sent to roots, and there is evidence that this under-ground carbon is sequestered better than the carbon in leaves and stems that remain on the surface. "Using stable isotope fractionation , Wilts et al.[136] estimated that the ratio of SOC [soil organic carbon] derived from below-ground plant C to that derived from above-ground stover [leaves, stems, prop roots and cob material on the soil surface] was nearly 2:1 in long-term corn plots, further emphasizing the importance of root systems in C sequestration."[137]

In addition to having deeper roots, in a tilled field the aboveground parts of the corn plant get buried during plowing, which may make these tissues less available for decomposition, thus delaying return of their fixed carbon to the atmosphere:

> …[B]uried residues in PT [plow tillage] soils are more closely associated with the soil matrix than surface residues in NT [no-tillage] soils.[138] The buried-residue-derived particulate organic matter could react with clay particles and organo-mineral complexes and favor formation of stable SOC. The SOC may then be physically entrapped and chemically adsorbed as recalcitrant compounds with lower turnover rates than surface SOC.[139][140]

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[133] Id, Lal at p. 701.

[134] Quin et al. (2004). "Impact of tillage on root systems of winter wheat," *Agron. J.* 96: 1523-1530. (as cited in Baker et al., 2007)

[135] Id, Baker at pg 3.

[136] Wilts et al (2004). "Long-term corn residue effects," *Soil Sci. Soc. Am. J.* 69: 1342-1351. (as cited in Baker et al., 2007)

[137] Id, Baker at p. 2

[138] Angers et al (1997). "Impact of tillage practices on organic carbon and nitrogen storage in cool, humid soils of eastern Canada," *Soil Tillage Res.* 41: 191-201. (as cited in Lal, 2008)

[139] Tisdale, J.M. and J.M Oades (1982). "Organic matter and water stable aggregates in soils," *J. Soil Sci.* 33: 141-163. (as cited in Lal, 2008)

[140] Id, Lal, 2008 at p. 698

The history of rotations may have affected the amount of residues that were buried by plowing in some of the plots studied by Lal.[141] As mentioned, some of his plowed vs. no-till comparisons showed more carbon sequestered in the plowed plot. Lal suggests that the use of cover crops in some of the tilled fields could account for the increase in stored carbon when the cover crops were plowed under each year.

Conventional tillage with cover crops is not the only option for lessening the effects of agriculture on climate change. Over the long term, organic agriculture results in better soil than no-till, storing more carbon and nitrogen.[142] USDA-ARS researchers conducted a 9-year study at the USDA experimental farm in Beltsville, MD to compare soil fertility and yields of corn, soybeans and wheat grown in either a standard no-till system, a living-mulch no-till system or a plow-based organic system. They found that even though the organic fields were tilled they contained more carbon and nitrogen at all depths (down to 30 cm) than the no-till plots. This was attributed to incorporation into the soil of both manure (organic fertilizer) and cover crops. Yields of corn and soybeans, but not wheat, were lower in the organic plots, though, because weeds were not adequately controlled by the particular organic methods they used. Further experiments showed that use of certain crop rotations in the organic system could control weeds and restore the lost yields, and that the stored nutrients in the organic soils were able to boost corn yields for subsequent crops relative to the soils that had been managed using no-till methods.[143]

Another factor that must be considered is the activity of soil microbes, which can release more or less carbon based on the tillage system and on the fertilizers and pesticides applied.[144] Glyphosate is of particular concern, because although glyphosate that contacts the soil during an application generally remains close to surface, glyphosate absorbed by weeds or HT crops is translocated into their roots and is exuded into the rhizosphere throughout the root zone where it can influence the metabolism of bacteria and fungi deep in the soil.[145]

<u>Thus, the use of glyphosate in the Pioneer HT corn system and its effects of carbon sequestration should be examined in the context of no-till agriculture.</u>

In summary, recent research conducted by both USDA researchers and an author cited by APHIS casts great doubt on APHIS's contention that no-till agriculture sequesters more soil carbon and thus ameliorates climate change. The USDA researchers even noted that promotion of no-till agriculture could ultimately imperil adoption of practices that really do mitigate global warming:

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[141] Id, Lal, 2008.
[142] Teasdale, J.R., C.B. Coffman, and R.W. Mangum. 2007. Potential long-term benefits of no-tillage and organic cropping systems for grain production and soil improvement. Agron. J. 99:1297-1305.
[143] Comis, D. (2007) "No shortcuts in checking soil health," Agricultural Research/July 2007. http://www.ars.usda.gov/is/AR/archive/jul07/soil0707.htm?pf=1
[144] Edwards, C.A. (1989). "Impact of herbicides on soil ecosystems." *Critical Reviews in Plant Sciences* 8: 222-257.
[145] Laitinen, P., S. Rämö and K. Siimes (2007). "Glyphosate translocation from plants to soil – does this constitute a significant proportion of residues in soil?" *Plant Soil* 300: 51-60.

> … it is premature to predict the C sequestration potential of agricultural systems on the basis of projected changes in tillage practices, or to stimulate such changes with policies or market instruments designed to sequester C. The risk to the scientific community is a loss of credibility that may make it more difficult to foster adoption of other land use and management practices that demonstrably mitigate rising atmospheric concentrations of greenhouse gases.[146]

Impacts of Other Greenhouse Gases

What about the other greenhouse gases (GHGs)? Although nitrous oxide (N2O) is listed as a GHG in the EA,[147] APHIS fails to discuss how tillage might affect its levels. When considering the global warming potential of agricultural systems, it is especially important to consider N2O, since it is 310 times as potent as carbon dioxide and has an atmospheric lifetime of nearly 120 years.[148] Globally, agriculture accounts for about 75% of all N2O emissions.[149] A growing body of research shows that no-till agriculture emits more N2O than plowing.

Reasons for the increase in N2O involve the ways in which fertilizers and pesticides behave after they are applied to no-till vs. plowed fields:

> 1) Nitrogen fertilizers applied to the surface of no-till fields exhibit greater volatilization of ammonia, itself a GHG, but which is also converted to N2O.
> 2) No-till agriculture increases the water-filled pore space in soils, correlated with microbial activity that favors N2O production.
> 3) There are more denitrifying bacteria at the surface of no-till soils, promoting N2O emissions.

Increased Ammonia Volatilization on No-Till Soils

Fertilizers in no-till fields are generally more vulnerable to volatilization. Fertilizers are often applied to the surface in no-till fields[150], which can result in up to 50% of urea being volatized as ammonia (NH3).[151] Some studies have demonstrated that cumulative NH3 volatilization was three times greater in no-till than in plowed fields, attributed to

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[146] Id, Baker, 2007 at p. 4-5
[147] EA, p. 13.
[148] Inter-governmental Panel on Climate Change (IPCC), 1996. Climate Change 1995. In: Impact, Adaptation and Mitigation of Climate Change: Scientific-Technical Analyses, Cambridge University Press.
[149] Ruser, R., Flessa, H., Russow, R., Schmidt, G., Buegger, F., Munch, J.C. 2006. Emission of N2O, N2 and CO2 from soil fertilized with nitrate: effect of compaction, soil moisture and rewetting. *Soil Biology and Biochemistry*. 38: 263-274.
[150] Rochette, P., Angers A.A., Chantigny M.H., MacDonald J.D., Bissonnette N., Bertrand N. 2008. Ammonia volatilization following surface application of urea to tilled and no-till soils : A laboratory comparison. *Soil Tillage Res*. In Press.
[151] Sommer S.G., Schjoerring, J.K., Denmead, O.T., 2004. Ammonia emission from mineral fertilizers and fertilized crops. *Adv. Agron.* 82: 557-622.

the reduced ability of nitrogen to infiltrate soils in the presence of crop residues on the surface of untilled soils.[152] One recent study conducted in Canada compared NH3 emissions after fertilizer applications to no-till and plowed fields. They showed that cumulative NH3 emissions were significantly greater in the no-till system. At one site, mean cumulative emissions up to 22 hours after application were more than 250 times greater in the no-till system than in the plowed plots.[153] The authors noted, "Higher urease activity and rapid increase in volatilization after urea application at the surface of NT [no-till] soils suggested that part of the higher NH3 losses in NT was the result of a more rapid hydrolysis of urea. This higher enzymatic activity is inherent to the practice of NT since it is associated with the presence of crop residues at the soil surface."[154] Other studies have demonstrated similar results[155][156], attributing the increased ammonia volatilization in no-till to increased urease activity in the surface soil and a relatively smooth surface, which prevents urea prills from penetrating the soil.[157] In essence, increased ammonia volatilization can be expected in most no-till soils because of their smooth soil surfaces with unincorporated residues.

Ammonia volatilization has extensive ramifications for global warming. Ammonia can be oxidized and transformed into N2O, constituting about 5% of the global N2O emissions.[158] Once emitted, ammonia can also be rapidly converted to the aerosol ammonium (NH_4^+) which "contributes to ecosystem fertilization, acidification, and eutrophication. After NH_3 enters the atmosphere, each nitrogen atom can participate in a sequence of effects, known as the nitrogen cascade, in which a molecule of NH_3 can, in sequence, impact atmospheric visibility, soil acidity, forest productivity, terrestrial ecosystem biodiversity, stream acidity and coastal productivity."[159][160] These processes increase methane emissions[161] and decrease carbon sequestration through photosynthesis,[162] thereby exacerbating climate change.

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152 Al-Kanani, T., MacKenzie, A.F. 1992. Effect of tillage practices and hay straw on ammonia volatilization from nitrogen fertilizer solution. *Can. J. Soil Sci*. 72:145-157.

153 Id, Rochette, 2008, pg. 4

154 Id, Rochette, 2008, Pg 5.

155 Mkhabela M.S., Madani A., Gordon R., Burton D., Cudmore D., Elmi A., Hart W. 2008. Gaseous and leaching nitrogen losses from no-tillage and conventional tillage systems following surface application of cattle manure. *Soil Tillage Res*. 98:187-199.

156 Bacon P.E., and Freney J.R. 1989. Nitrogen loss from different tillage systems and the effect on cereal grain yield. *Fertilizer Research*. 20:59-66.

157 Ibid. Pg. 64.

158 Ferm, M. 1998. Atmospheric ammonia and ammonium transport in Europe and critical loads: a review. *Nutr. Cycl. Agroecosyst.* 51: 5-17.

159 Amon, B. et al. Methane, nitrous oxide and ammonia emissions during storage and after application of dairy cattle slurry and influence of slurry treatment, *Agriculture, Ecosystems and Environment* 112 (2006) 153-162.

160 Ad Hoc Committee on Air Emissions from Animal Feeding Operations. Air Emissions from Animal Feeding Operations: Current Knowledge, Future Need. *National Academies* 2003. p. 52 online at http://site.ebrary.com/lib/columbia/Doc?id+10032352&ppg=74

161 Giani, Luise; Ahrensfeld, Elke. (2002). Pedobiochemical indicators for eutrophication and the development of "black spots" in tidal flat soils on the North Sea coast. *Journal of Plant Nutrition and Soil Science*, 165: 537-543.

162 Lal, R.; Stewart, B.A. (1990). Soil Degradation. New York: Springer-Verlag. *In* Pimentel, David; Pimentel, Marcia. (2008). Food, Energy, and Society: Third Edition. CRC Press: Boca Raton, FL.

The Effect of Water Filled Pore Space on Denitrification and N2O Emissions

Globally, around 65% of all N2O emissions are the result of microbial processes in soil, both aerobic nitrification and anaerobic denitrification.[163] No-till soils have demonstrated elevated levels of water-filled pore space (WFPS), determined by water content and total porosity.[164] WFPS appears to be closely related to soil microbial activity. One study demonstrated that WFPS in no-till systems to be 62% compared to 44% for plowed soils.[165] In general, N2O emissions increase with increasing soil moisture.[166] Studies have found a positive correlation between WFPS in soils and N2O emissions.

Mkhabela and colleagues observed that "denitrification and N2O emissions are impacted by WFPS, with greater emissions observed at higher WFPS."[167] Ball and colleagues found that no-till systems emitted significantly greater N2O emissions, particularly after rainfall events, and noted that the increased emissions corresponded to lower *in situ* gas diffusivities and higher water contents in no-till soils.[168] One study found that no-till soils produced emissions at a rate 9.4 times greater than tilled soils.[169] Other studies have also shown no-till to have higher denitrification rates and N2O losses[170][171] and in one study no-till soils had higher populations of denitrifiers.[172]

The Whole Picture of GHGs in No-Till Soils

The argument made by APHIS regarding climate change benefits of Pioneer HT corn is simplistic and fatally flawed. Agricultural greenhouse gas emissions are complex and one must examine not just CO2 but also N2O, NH3 and CH4, which APHIS failed to do.

When all emissions are considered in no-till agriculture, the picture is clear. As discussed above, carbon sequestration gains for no-till practices are most likely a sampling artifact from measuring carbon in the top 30 cm or less of the soil profile. When deeper soils are sampled, representing more of the root zone, carbon sequestration is either no different

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[163] Smith, K.A., and Conen, F. 2004. Impacts of land management on fluxes of trace greenhouse gases. *Soil Use and Management*. 20: 255-263. Pg. 258.

[164] Mosier, A.R., Halvorson, A.D., Reule, C.A., Xuejun, J.L. 2006. Net global warming potential and greenhouse gas intensity in irrigated cropping systems in northeastern Colorado. J. Environ. Qual. 35:1584-1598. Pg. 1586.

[165] Linn, D.M., Doran, J.W. 1984. effect of water-filled pore space on carbon dioxide and nitrous oxide production in tilled and nontilled soils. *Soil Sci Soc Am J*. 48:1267-1272.

[166] Ball, B.C., Scott, A., Parker, J.P. 1999. Field N2O, CO2, and CH4 fluxes in relation to tillage, compaction and soil quality in Scotland. *Soil Tillage Res*. 53:29-39. Pg. 32.

[167] Id, Mkhabela, at Pg. 195.

[168] Id, Ball, 1999, Pg. 33.

[169] Id, Linn, 1984.

[170] Id, Smith et al.

[171] Rice, C.W. , Smith, M.S. 1982. Denitrification in no-till and plowed soils. *Soil Sci. Soc. Am. J.* 46:1168-1173.

[172] Aulakh, M.S., Rennie, D.A., Paul, E.A. 1984. Gaseous N losses from soils under zero-till as compared to conventional-till management systems. *J. Environ. Qual*. 13:130-136.

between tillage methods, or is actually better in plowed fields. However, even if no-till systems were to sequester more carbon in some conditions, the benefits of such carbon storage are swamped by increased emissions of potent, nitrogen-based GHGs.

For example, Li et al. found that N2O emissions as CO2 equivalents offset up to 310% of the purported soil carbon sequestration, creating an increase in net greenhouse gas emissions.[173] Other studies have come to similar conclusions. One study found that N2O emissions on poorly aerated soils were 2kg N2O-N ha^{-1} higher with no-till than conventional tillage: "Considering that the global warming potential of 1kg of emitted N2O-N ha^{-1} is equivalent to a loss in soil C of approximately 125 kg C ha^{-1}, we conclude that no-till may increase net greenhouse gas emissions from many poorly-drained agricultural soils located in regions with a humid climate."[174] Finally, research published just this year found that no-till maize-after-grass systems that were fully fertilized emitted significantly more GHGs than were sequestered. The no-till system resulted in as much as 2600 kg of CO_2e [CO2 equivalents] ha^{-1} increase in greenhouse gas emissions.

From these studies, then, it is clear that APHIS has not considered the relevant research when assessing the benefits and risks of an increase in conservation tillage related to climate change. An EIS is required.

Purported Benefits of Conservation Tillage to Wildlife and Water Quality Unfounded

Besides claiming that the increase in conservation tillage will sequester more carbon, APHIS cites other purported benefits to the environment of reduced plowing (Preferred Alternative, Agronomic Practices, Tillage, Non-target effects), such as "on-site benefits [for wildlife], which are often in the form of increased food and cover; and off-site benefits, particularly to aquatic ecosystems, which may be cumulative over longer time spans as a result of, for example, a reduction in soil erosion (reducing herbicide runoff)."[175] APHIS also asserts that organisms such as earthworms will increase in number because their burrows will not be destroyed by the plow, and there will be more surface organic matter to conserve moisture and provide food for them.

Again, these ecological impacts of a putative increase in no-till corn plantings need to be explored in much greater depth in an EIS, looking at the risks as well as benefits.

Increased Runoff in No-Till Systems May Degrade Water Quality

No-till and other conservation-tillage systems discourage the disturbance of the soil, which can lead to over-compaction.[176][177] In the absence of soil disturbance, some studies

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[173] Li, C., Frolking S., Butterbach-Bahl, K. 2005. Carbon sequestration in arable soils is likely to increase nitrous oxide emissions, offsetting reductions in climate radiative forcing. *Climatic Change*. 72:321-338.
[174] Id, Rochette, 2008, Pg 5.
[175] EA, p. 23, ¶ 2
[176] Fabrizzi, K.P., Garcia, F.O., Costa J.L., Picone, L.I., 2005. Soil water dynamics, physical properties and corn and wheat responses to minimum and no-tillage Systems in the southern Pampas of Argentina. *Soil Tillage Res*. 81:57-69.

have shown that fertilizers broadcast on the soil surface are lost from the field, thus lowering nutrient-use efficiency.[178] Pesticides also can end up at higher concentrations in runoff from fields in conservation tillage, but for a more complex reason. Crop residues are left on the surface in these systems, and surface residues intercept sprayed pesticides. A 30% residue cover would result in about 30% of a broadcast-sprayed pesticide being found on the crop residue rather than the soil after application. Washoff studies for commonly used herbicides applied to corn residue have shown little interaction between the herbicide and corn residue, resulting in up to 50% of the intercepted herbicide washing off in the first centimeter of rain.[179][180] "If this washoff water becomes a part of surface runoff, herbicide concentrations can be quite high."[181] Research conducted on corn herbicides confirmed these conclusions. While no-till systems had the lowest volume of runoff, the concentrations of atrazine and cyanazine in runoff water were always greater (statistically significant in most cases) in no-till systems than for the other tillage regimes.[182]

Another surprising contributor to fertilizer and pesticide runoff from no-till fields is the common earthworm. Earthworms can cause a rapid increase in the amount of manure and chemical runoff from no-till fields into drainage ditches and thus into the watershed. This was reported first in Finland[183], and then in Ohio.[184] "No-till fields in poorly drained areas of the United States, such as northwestern Ohio—and fertilized with liquid manure—are especially conducive to worms. Nightcrawlers (*Lumbricus terrestris*) especially like the combination of no-till, drainage pipes, and manure." They preferentially dig their burrows over the drainage pipes, and their deep, wide burrows "…can become a shortcut for conducting pesticides or manure or surplus fertilizers to groundwater or streams."[185]

Earthworms have been shown to influence the rate of degradation of herbicides and other pesticides. While some research suggests that the presence of earthworms can enhance the rate of pesticide degradation, other studies show that they slow the rate of degradation and increase the likelihood that a toxic chemical will end up in the watershed. USDA-ARS researchers have demonstrated the latter effect for atrazine, the most heavily applied

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177 Tebrugge, F., During, R.A., 1999. Reducing tillage intensity: a review of results from a long-term study in Germany. *Soil Tillage Res*. 53:15-28.

178 Malhi, S.S., Nyborg, M., Solberg, E.D., 1996. Influence of source, method of placement and simulated rainfall on the recovery of N-lballed fertilizers under zero-tillage. *Can. J. Soil Sci*. 76: 93-100.

179 Baker, J.L., Shiers, L.E. 1989. Effects of herbicide formulation and application method on washoff from corn residue. *Trans. ASAE*. 32: 830-833.

180 Martin, D.C., Baker, J.L., Erbach, D.C., Johnson, H.P., 1978. Washoff of herbicides applied to corn residue. Tr*ans. ASAE*. 21: 1164-1168.

181 Mickelson, S.K., Boyd, P., Baker, J.L., Ahmed, S.I. 2001. Tillage and herbicide incorporation effects on residue cover, runoff, erosion, and herbicide loss. *Soil Till. Res.* 60: 55-66. Pg. 57.

182 Ibid.

183 Shipitalo et al (2004). "Interaction of earthworm burrows and cracks in a clayey, subsurface-drained, soil," *Applied Soil Ecology* 26: 209-217.

184 Id, Comis, 2005.

185 Id, Comis, 2005 at p. 10

herbicide in corn production.[186] In an interpretive summary of their study[187] the authors state: "In this laboratory study, radio-labeled atrazine was used to investigate how two species of earthworms affect the fate of atrazine in soil. The results indicated that earthworms stimulated microbial activity and increased the rate of organic matter decomposition, thus should also increase atrazine breakdown. Nevertheless, atrazine breakdown was reduced by earthworms because of intimate mixing with soil during passage through the earthworms. This promoted binding of atrazine to the soil, which reduced its rate of decomposition by soil microorganisms. Longer persistence of atrazine may increase its potential to leach or be transferred offsite by surface runoff. This phenomenon may have to be taken into account when farmers are selecting crop and weed management practices." Although APHIS expects atrazine use to decrease with adoption of Pioneer HT corn,[188] an expectation that we dispute elsewhere in these comments, similar changes in delivery of ALS-inhibitor herbicides and glyphosate to waterways are possible, and should be addressed.

APHIS has failed to evaluate the potential for increased runoff of fertilizers and pesticides from the no-till agriculture purportedly encouraged by adoption of Pioneer 98140 to degrade water quality. These issues must be addressed in a comprehensive EIS.

No-Till Production Systems May Foster Spread of Damaging Exotic Earthworm

APHIS cites increased earthworm populations under no-till production systems purportedly facilitated by Pioneer 98140 corn as a wildife benefit that would accrue if it were to be adopted. However, APHIS fails to analyze the potential for increased populations of damaging, exotic earthworm species. Abundant in many no-till fields is the European exotic burrowing earthworm *Lumbricus terrestris* L., the common nightcrawler. These animals have a big impact on the ecology of fields and forests, affecting soil structure, nutrient cycling and amount of leaf litter on the soil surface, thus influencing many other species.[189] The impacts are not all beneficial, as discussed in the previous section analyzing the increased pesticide and fertilizer runoff into waterways that is facilitated by nightcrawler burrows. Farm chemicals not only affect nutrient relationships in waterways, they also are outright toxic to various organisms, and these toxic effects should be examined.

Nightcrawlers and other exotic earthworms are now recognized as invasive species that are wreaking havoc in native forests as they expand their range.[190] If the de-regulation of Pioneer HT corn does increase the acreage in no-till agriculture, thus increasing the

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[186] Binet et al (2006). "Lumbricid macrofauna alter atrazine mineralization and sorption in a silt loam soil," *Soil Biology and Biochemistry* 38: 1255-1263. (USDA summary: http://www.ars.usda.gov/research/publications/publications.htm?SEQ_NO_115=183735&pf=1)
[187] Available at: http://www.ars.usda.gov/research/publications/publications.htm?SEQ_NO_115=183735&pf=1
[188] EA, p. 18
[189] Hale, C.M. (2008). "Evidence for human-mediated dispersal of exotic earthworms: support for exploring strategies to limit further spread," *Molecular Ecology* 17: 1165-1169.
[190] Hale et al (2006). "Changes in hardwood forest understory plant communities in response to European earthworm invasions," *Ecology* 87: 1637-1649.

populations of *L. terrestris*, an analysis of whether these increased numbers would be likely to contribute to the invasion of nightcrawlers into vulnerable habitats would be required in an environmental assessment.[191] APHIS should at least analyze the current range of *L. terrestris*, the areas of concern for its spread, the proximity of corn cultivation to these areas, and an assessment of the likelihood that adoption of Pioneer HT corn would result in an increased risk of invasion.[192]

There are other potential downsides to increased nightcrawler populations in agricultural fields. An ecologist at Ohio State University has shown that these same worms preferentially collect and bury the seeds of giant ragweed,[193] making them less likely to be predated by rodents,[194] and also perhaps increasing the numbers of these relatively large weed seeds in the soil seedbank, and ultimately in the cornfield.

Giant ragweed is one of the most difficult weeds to control in corn, and has biotypes that are resistant to ALS-inhibitor herbicides, glyphosate, and resistance to both herbicide types.[195] If nightcrawlers are more abundant in no-till fields and are caching giant ragweed seeds, it is quite plausible that herbicide-resistant weed seeds are being maintained in the seedbank. These seeds could increase the likelihood that management of Pioneer HT corn with both glyphosate and ALS-inhibitor herbicides would more rapidly select for dual-herbicide resistance in giant ragweed in those fields, making the weed even more difficult to control.

Any change in tillage will also entail a shift in the kinds of plant diseases that are prevalent in the field, and thus which chemicals are used for controlling those diseases. For example, the use of fungicides could change, with consequences for the environment.[196] There are many studies of the effects of no-till on disease prevalence in corn, but ramifications have not been addressed in the EA and should be analyzed in an EIS.

Clearly, determining the environmental risks and benefits of an increase in conservation tillage based on adoption of Pioneer HT corn involves analyzing an array of possibilities, which APHIS did not do.

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[191] EO 13112 "Invasive Species", p. 33 of the EA

[192] Id, Hale, 2008.

[193] Regnier et al (2008). "Impact of an exotic earthworm on seed dispersal of an indigenous US weed," *Journal of Applied Ecology* 45: 1621-1629.

[194] Liu et al (2007). "Net influence of earthworms (Lumbricus terrestris) on giant ragwee (Ambrosia trifida) seedling recruitment," *2007 North Central Weed Science Society Proceedings* 62: 108.

[195] Boerboom, C. (2008) "Glyphosate resistance update, April 2008," University of Wisconsin, Integrated Pest and Crop Management, Wisconsin Crop Manager: http://ipcm.wisc.edu/WCMNews/tabid/53/EntryId/477/Glyphosate-Resistance-Update-April-2008.aspx

[196] Jeschke, M. and T. Doerge (2008). "Management of foliar diseases in corn with fungicides," *Pioneer Agronomy Sciences, Crop Insights* 18 (2): 1-4.

IV. The EA Fails to Adequately Analyze the Harm of Biological Contamination, and its Concomitant Harms to Organic and Conventional Farmers, Exporters, and the Public. An EIS is Required.

Geertson Seed Farms v. Johanns

In the recent federal court decision *Geertson Seed Farms v. Johanns,* the United States District Court held, and the United States Court of Appeals for the Ninth Circuit affirmed, that where biological contamination of a non-GE crop by is made possible by the deregulation of its GE counterpart, APHIS must prepare an EIS to disclose and analyze the contamination as well as the interrelated adverse economic effects.[197] These effects include impacts to conventional and organic farmers, exports and consumers' right to choose. As in *Geertson*, the EA here fails to sufficiently evaluate the impacts from contamination, and there is ample evidence from the deregulation of Event 98140 corn that such adverse impacts are not only possible, but highly likely.

Biological Contamination from Gene flow

The potential for biological contamination, through pollen flow and uncontrolled seed movement of Event 98140, triggers the requirement that APHIS prepare an EIS for this deregulation. The term "biological contamination" refers to the unintended comingling of GE crops with non-GE crops. "Biological contamination can occur through pollination of non-genetically engineered plants by genetically engineered plants or by the mixing of genetically engineered seed with natural or non-genetically engineered seed."[198]

As the *Geertson* Court found, once a GE crop is deregulated "the government will not be able to impose isolation distances on the growers of [the GE crop]; in other words, it cannot ensure that farmers using genetically engineered seed will be more than two miles away from seed farmers who do not wish to grow [the GE crop]."[199] Given that APHIS opted not to consider any alternatives that include isolations distances or any other such measures to prevent contamination (EA at 14), the same is true here, and there is ample evidence here that without imposing any such requirements, contamination is not only possible but highly likely.

APHIS admits as much in the EA: "APHIS does note that gene flow can take place between a field planted with Pioneer HT corn and a neighboring corn crop;" (EA at 20) "Due to inevitable drift of pollen between two crops, there is a general agreement in agriculture that a 100% purity standard is not practical in field production systems." (EA at 21). APHIS attempts to minimize this admission by relying on the concept of co-existence, "growers involved in the production of production of corn seed … should attempt to follow the co-existence principles in order to maintain the purity of their crop and minimize gene flow from neighboring fields to herbicide tolerant varieties." (*Id.*).

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[197] 2007 WL 518624 (N.D. Cal. Feb. 13, 2007) *aff'd*, 541 F.3d 938 (9th Cir. 2008).
[198] Id. at 5.
[199] Id.

However this is mere rhetoric. As APHIS explains, co-existence is based on "good communication," "shared responsibilities," and "respect for each others' practices and requirements." (*Id*.). APHIS's analysis discloses that there no actual measures that are required, or in fact practiced, to fulfill the idea of co-existence. Furthermore, while APHIS admits that 100% purity is not possible, it fails to analyze or quantify in any way what level of contamination constitutes an acceptable threshold of biological contamination that might be considered significant.

In its Plant Pest Risk Assessment (Appendix A to the EA), APHIS admits that it intentionally avoided doing any quantitative or in depth analysis of contamination of non-GE corn crops from this new HT corn. (EA at 48 ("This assessment covers only wild and weedy relatives of corn and the possibility that increased weediness could result from gene flow and introgression from Pioneer HT corn in such relatives. Although general information on pollen is given, this evaluation does not directly look at gene flow between a GE corn crop and a conventional and/or organic corn crop.")). After acknowledging that "gene flow can take place between field planted with Pioneer HT corn and a neighboring corn crop" (EA at 20), APHIS then refers back to this very analysis that it disavowed as analyzing such contamination to conclude "Although the biology of the crop [See Appendix A] … limits the amount of gene flow that may occur between two corn plants, certain measures can be taken to minimize such flow (e.g. isolation distances)." (EA at 20-21). This is APHIS entire analysis regarding contamination of non-GE conventional and/or organic corn. Such conclusory language mirrors that which *Geertson Seed* specifically held inadequate to meet NEPA's requirements, 2007 WL 518624 at *6-7, and at the very least, APHIS's admission that contamination at some level *will* happen creates a substantial question that contamination *may* be a significant impact here.[200] Thus, APHIS must prepare an EIS.

APHIS Fails to Articulate or Analyze Any Concrete Measures to Prevent Contamination

To argue away the potential impacts associated with gene flow, APHIS makes the cursory statement that "certain measures can be taken to minimize such flow (e.g. isolation distance)." (EA at 21).[201] APHIS later notes that biological contamination harm to conventional and organic farmers is not likely in part due to the fact that "isolation distances can be maintained to prevent cross-pollination." (EA at 27). Yet APHIS does not require or even analyze the efficacy of any isolation measures in the EA. Other than listing "isolation distance" as an example, APHIS offers *nothing* to demonstrate that such hypothetical measures are effective at preventing contamination,

[200] An EIS must be prepared if substantial questions are raised as to whether a project may cause significant environmental degradation Blue Mountains Biodiversity Project v. Blackwood, 161 F.3d 1208, 1216 (9th Cir. 1998). "The plaintiff need not show that significant effects will in fact occur, but if the plaintiff raises substantial questions whether a project may have a significant effect, an EIS must be prepared." Klamath Siskiyou Wildlands Center v. Boody, 468 F.3d 549, 562 (9th Cir. 2006) (emphasis in original) (citations omitted). As the Ninth Circuit has recognized, "[t]his is a low standard." Id.

[201] "Gene flow … has been managed using various types of buffer zones or isolation practices, such as differences in planting dates which results in differences in flowering or making sure fields are at an appropriate distance from other compatible crops such as using isolation distances." (EA at 22).

that farmers in fact implement such measures, or that APHIS requires any such measures as a condition of deregulation.

Yet vague reference to the mere concept that some hypothetical measures may prevent contamination is insufficient to absolve APHIS of its NEPA duties. It is a form of mitigation, relied on by Pioneer and APHIS to mitigate potential gene flow and the impacts that flow from biological contamination. CEQ has warned that "as a general rule … agencies should use a broad approach in defining significance and should not rely on the possibility of mitigation [of adverse environmental consequences] as an excuse to avoid the EIS requirement."[202] APHIS should heed this guidance and prepare an EIS analyzing, among other things, concrete stewardship measures such as quantitative isolations distances that actually prevent biological contamination.

That APHIS merely relies on the vague notion of stewards measures is clearly insufficient. CEQ has indicated that "Mitigation measures may be relied upon to make a finding of no significant impact only if they are imposed by statute or regulation, or submitted by an applicant or agency as part of the original proposal."[203] Here, no stewardship measures is required, never mind concretely explained. (EA at 21). Nor has APHIS considered reasonable alternatives to the proposed action or propose any monitoring. The sufficiency of mitigation measures has been stated as whether they constitute "an adequate buffer against the negative impacts that may result from the authorized activity."[204] While APHIS admits that contamination will happen, APHIS has not undertaken any of its own analysis regarding whether any stewardship measures might prevent such contamination.[205]

Contamination By Pioneer HT Corn Is Highly Likely

Although APHIS refers to a few studies concerning pollen flow (EA at 48), it must be emphasized that there are a huge number of corn pollen flow studies, and that the results of various studies with respect to the distance corn pollen can travel vary dramatically depending upon the conditions under which they are conducted. For instance, though corn pollen only remains viable for only 1 to 2 hours, under milder temperatures and

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[202] Council on Environmental Quality, "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations," Question 40, 46 Fed. Reg. 18026, 18037 (1981).

[203] Council on Environmental Quality, "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations," Question 40, 46 Fed. Reg. 18026, 18037 (1981).

[204] National Parks & Conservation Ass'n v. Babbitt, 241 F.3d 722 (9th Cir. 2001).

[205] APHIS also improperly relies on un-analyzed volunteer stewardship measures regarding the development of weed resistance. *See, e.g.*, "Pioneer has shown strong support for IWM programs in the past and is likely that they will continue to do so in the future." (EA at 26). "Growers who apply recommended principles of IWM will best be able to delay the onset of resistant weeds." (EA at 28). "APHIS suggests that growers follow IWM practices … in order to minimize the environmental impacts of agriculture and prevent cumulative impacts." (EA at 31). In *Geertson* APHIS similarly relied on "good stewardship" with regard to the development of weed resistance, without APHIS's own investigation and analysis of if that stewardship was effective or not, a reliance the court held arbitrary and capricious without APHIS own analysis, which it agreed to do in the alfalfa EIS. *Geertson*, 2007 WL 5186624, at *10.

higher humidity it can remain viable longer, up to several days, increasing the potential for cross-fertilization of neighboring corn fields. Individual corn plants produce four to five million pollen grains, each of which is responsible for the fertilization of a single kernel. "Therefore, even if only a small percentage of the total pollen shed by a field of corn drifts into a neighboring field, there is considerable potential for contamination through cross pollination."[206]

According to Emerson Nafziger, Professor of Agronomy at the University of Illinois: "*…it is possible for corn pollen to move on the wind for more than a mile*. Even under low wind conditions, some corn plants on the edge of a field are normally pollinated by pollen from outside the field. ... producers of white corn often see the light yellow kernels that result from pollination by yellow corn pollen, and they report that low frequencies of such kernels often occur throughout a field."[207] The importance of wind speed during pollen shed is difficult to overemphasize.

Purdue University agronomist R.L. Nielsen reports that "with only a 15 mph wind, pollen grains can travel as far as ½ mile within those couple of minutes [of pollen viability]."[208] Discussing the difficulties of preventing contamination of organic by GE corn, Iowa State Univeristy plant physiologist Mark Westgate stated that: "Six hundred feet of isolation doesn't mean a thing if the wind is blowing your way at 20 miles an hour."[209]

A report commissioned by the European Environment Agency that reviewed numerous corn pollen flow studies found that: "Maize pollen has been shown, by the action of wind, to cross with other cultivars of maize at up to 800 m [2625 ft.] away. It is estimated that small quantities of pollen are likely to travel much further under suitable atmospheric conditions."[210]

The Ohio State University Extension Service reports that "research has indicated that cross-pollination between corn fields could be limited to 1% or less on a whole field basis by a separation distance of 660 ft., and limited to 0.5% or less on a whole field basis by a separation distance of 984 ft. *However, cross-pollination could not be limited to 0.1% consistently even with isolation distances of 1640 ft.*"[211]

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[206] Thomison, P. "Managing 'Pollen Drift' to Minimize Contamination of Non-GMO Corn, AGF-153," Ohio State University Extension Fact Sheet, undated. http://ohioline.osu.edu/agf-fact/0153.html.

[207] "How are 'GMO-free soybeans and corn labeled?" by Emerson Nafziger, Professor of Agronomy, Extension Service, University of Illinois-Urbana-Champaign, undated. http://faq.aces.uiuc.edu/faq.pdl?project_id=28&faq_id=590. Last accessed 1/20/09.

[208] Nielsen, R.L. (2001, rev. 2007). "Tassel Emergence & Pollen Shed," Purdue University Extension Service. http://www.agry.purdue.edu/ext/corn/news/timeless/Tassels.html.

[209] As quoted in: Perkins, J. "Genetically modified mystery," Des Moines Register, August 10, 2003.

[210] Eastham, K. and Sweet, J. (2002). Genetically modified organisms (GMOs): the significance of gene flow through pollen transfer. *Environmental Issue Report 28*. Copenhagen: European Environment Agency.

[211] Thomison, P. "Managing 'Pollen Drift' to Minimize Contamination of Non-GMO Corn, AGF-153," Ohio State University Extension Fact Sheet, undated, emphasis added. http://ohioline.osu.edu/agf-fact/0153.html.

Clearly, there is no pat answer to the question of how far corn pollen can flow to fertilize neighboring corn fields, which can vary dramatically depending on conditions. What is clear is that even if Pioneer were to stipulate an isolation distance of 660 feet (for which we have no evidence, as discussed above), Event 98140 would inevitably contaminate neighboring corn fields at levels that would vary dramatically depending on the particular conditions.

The setting of isolation distances in any particular case depends upon the degree of purity that one wishes to achieve, and the adverse impacts of not achieving this goal. APHIS's discussion of the potential for Event 98140 to contaminate surrounding corn is vitiated by its failure to discuss these important matters. Further, there is no discussion of the efficacy of the no action alternative in preventing or mitigating contamination of organic or conventional corn by Event 98140, and any interrelated economic impacts, versus the preferred alternative, which would allow cultivation of Event 98140 without any APHIS oversight and without any mandatory isolation distance between plantings of Event 98140 and organic or conventional varieties grown nearby.

Other Modes of Contamination

Although APHIS only refers to contamination by pollen flow, there are many possible modes of contamination that APHIS should analyze and failed to do so here, including seed spillage, residues of contaminating seeds in farm equipment, volunteer growth, cross-pollination not just by wind, but by insect or animal, and post-harvest mixing in the grain-handling system. These issues are not addressed at all in the EA.

In the Union of Concerned Scientist ("UCS") report, "Gone to Seed," UCS found that about 50% or more of the certified non-GE corn, canola, and soybean seed has been contaminated with transgenes.[212] The level of contamination was typically 0.05%-1.0%, far greater than the minimum levels that can be detected. "Gone to Seed" demonstrated that the frequency and levels of contamination of soybean seed was found to be about as high as for corn. Soybeans are largely self-pollinating (do not pollinate other soybean flowers very often), while corn is highly out-crossing. Therefore, the contamination of soybean seed is likely to be largely from causes other than cross-pollination. Such causes could include seed mixing or human error, and suggests that these sources may be at least as important as cross-pollination.

Another report, "A Growing Concern: Protecting the Food Supply in an Era of Pharmaceutical and Industrial Crops," UCS enlisted the assistance of several academic experts in agricultural sciences to determine whether GE pharmaceutical-producing crops could be kept out of food. This report demonstrates how difficult this is, even for pharmaceutical crops that would be grown on small acreage and under stringent confinement, to avoid contaminating food. The authors of this report examined confinement methods, such as field separation, cleaning of farm equipment, segregation of seed, and others, and found that it would still be difficult to ensure the absence of

[212] M. Mellon and J. Rissler, Gone to Seed: Transgenic Contaminants in the Traditional Seed Supply, Union of Concerned Scientists, 2004.

contamination.[213] The experts felt that contamination might be prevented by taking heroic means, such as geographical isolation from food crops. Union of Concerned Scientists concluded that even though it may be theoretically possible to prevent contamination, it would not be economically feasible.

Another route of contamination that is unpredictable, but likely over time, is human error. Two academic ecologists address this in a peer-reviewed paper, and conclude that contamination by GE crops due to human error or other means has occurred numerous times, and is likely to continue to occur. This paper documents many instances where GE crops are known to have contaminated non-GE crops or food.[214] Thus, biological contamination through human error and human behavior, such as composting and exchanging seeds, must be addressed in an EIS.

Past Contamination Episodes

Past contamination episodes from GE crops provide cautionary tales for why contamination is an impact that must be considered here. For example, the Star Link corn contamination showed how much damage a GE-crop can do to the agricultural economy. StarLink is a variety of corn genetically engineered to produce the Cry9C insecticidal toxin to kill certain corn pests.[215] Due to the concerns of leading allergists advising the EPA that this toxin might cause food allergies, the EPA approved StarLink in 1998 only for animal feed and industrial uses such as ethanol production, but not for human consumption. The EPA had a binding agreement with the developer of StarLink, Aventis CropScience. According to this agreement, all Aventis-affiliated seed dealers would sell StarLink corn seed to farmers only if the farmers would agree to the following conditions: 1) Plant a buffer strip 660 feet wide around StarLink corn plots to mitigate cross-fertilization of neighboring corn fields; and 2) Segregate StarLink corn and buffer strip corn for distribution only to non-food channels.[216] Aventis CropScience assured the EPA that with these measures it could keep StarLink out of the human food supply.

StarLink corn was grown for only three years, from 1998 to 2000, on at most 341,000 acres, or 0.43% of total U.S. corn acreage (year 2000).[217] Despite the limited acreage planted to StarLink, and the conditions attaching to its cultivation, testing initiated by public interest groups and subsequently conducted by the U.S. Food and Drug Administration (FDA) found that over 300 corn products in grocery stores around the

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[213] David Andow, et al., A Growing Concern: Protecting the Food Supply in an Era of Pharmaceutical and Industrial Crops Union of Concerned Scientists, December 2004.

[214] M. Marvier and R. Van Acker, "Can crop transgenes be kept on a leash?" Front. Ecol. Environ., 2005, vol.3, p.95-100.

[215] For the following discussion of StarLink, see Freese, B. (2001). "The StarLink Affair," Friends of the Earth, July 2001. www.foe.org/safefood/starlink.pdf.

[216] EPA Cry9C Fact Sheet (2000). "Biopesticide Fact Sheet: *Bacillus thuringiensis* subspecies *tolworthi* Cry9C Protein and the Genetic Material Necessary for Its Production in Corn (006466)," Issued November 2000.

[217] SAP StarLink (2001). "Assessment of Additional Scientific Information Concerning StarLink Corn," FIFRA Scientific Advisory Panel to the EPA, SAP Report No. 2001-09, from meeting on July 17/18, 2001.

country were contaminated with StarLink. The USDA found StarLink contaminating 9-22% of grain samples.[218]

The extent of the contamination is startling when one considers that StarLink never represented more than 0.43% of U.S. corn acreage. While post-harvest mixing was responsible for much of the contamination, there is also abundant evidence that popcorn, sweet corn, white corn and seed corn stocks were also contaminated with StarLink.[219] These latter findings strongly suggest that StarLink pollen blown by the wind fertilized conventional corn, despite the 660-foot border strip requirement. In fact, the a USDA-sponsored testing program for seed companies that had never been licensed to grow StarLink found that nearly one-fourth of these seed firms (71 of 288) had some corn lines that tested positive for StarLink. USDA had to buy back nearly 450,000 units of StarLink-contaminated seed corn at a cost of several million dollars to prevent further spread of StarLink in future years. Tainted seed dated anywhere from production year 1997 to 2001.[220]

Recent contamination events in other crops illustrate how difficult it is to prevent contamination at detectable and economically important levels. Of particular interest is the recent contamination of rice by the unapproved GE LL601 "Liberty Link" rice. This type of GE rice was grown only in limited-acreage field tests, rather than on a commercial scale, and under the regulatory auspices of APHIS, which includes confinement recommendations. It had not been grown at all for several years, but contamination of the US rice supply was detected several years later at low levels that have nonetheless caused economic harm to the US rice industry. At least one identified source of contamination by LL601 occurred at Louisiana State University (LSU), where one of the scientists in charge has claimed that they exceeded APHIS confinement recommendation considerably, but still experienced contamination.[221]

By one estimate, rice farmers lost $150 million due to rejection of LL601-contaminated rice shipments by countries in Europe and elsewhere, and the consequent sharp drops in rice prices.[222] Affected rice farmers were forced to sue Bayer CropScience, the developer of LL601, in an effort to recover their losses. In response to a petition from Bayer CropScience, APHIS subsequently deregulated LL601, but did nothing to redress the economic harms to rice farmers. Rather than accept responsibility for the episode, Bayer CropScience blamed farmers and an "Act of God" for the contamination episode.[223] At

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[218] Shadid, A. "Genetically engineered corn appears in one-tenth of grain tests," Boston Globe, May 3, 2001. Shadid, A. "Testing shows unapproved, altered corn more prevalent than thought," Boston Globe, May 17, 2001.
[219] USDA News Release (2001). "USDA purchases Cry9C affected corn seed from seed companies," June 15, 2001. Formerly accessible at: www.usda.gov/news/releases/2001/06/0101.htm; Hovey, A (2001). "StarLink protein found in other crops," Lincoln Star Journal, March 29, 2001.

[220] Freese, B. (2001). "The StarLink Affair," Friends of the Earth, July 2001, p. 12.
[221] G. Vogel, "Tracing the transatlantic spread of GM rice," Science, 2006, vol. 313, p. 1714.
[222] Weiss, R. (2006). "Gene-altered profit-killer," Washington Post, Sept. 21, 2006 (Attachment 13).
[223] Weiss, R. (2006). "Firm Blames Farmers, 'Act of God' for Rice Contamination," Washington Post, Nov. 22, 2006 (Attachment 14).

least one identified source of contamination by LL601 occurred at Louisiana State University (LSU), where LL601 had been grown in small-scale field trials. One of the scientists in charge of the field-testing stated that LSU had grown LL601 under conditions that met and exceeded APHIS confinement recommendations considerably, but still experienced contamination.[224] Just months later, still another unapproved GE rice variety developed by Bayer CropScience, LL604, was found contaminating a popular variety of conventional rice sold to farmers as seed rice (Clearfield 131). APHIS responded by issuing several emergency action notifications to distributors of Clearfield 131 to halt sales of the contaminated seed rice.[225] As a result, rice farmers in the South experienced a severe shortage of seed rice for the 2007 season.[226] APHIS conducted an investigation into the contamination episodes, but was unable to determine precisely how they occurred.[227]

Furthermore, there is substantial variation in the results from different experiments when measuring biological contamination through pollen transfer. This has been seen for virtually every crop studied. Many factors affect gene flow frequencies, including weather conditions (precipitation, wind, temperature, humidity), which will affect bee behavior, pollination levels, and the duration of pollen viability. The relative size of the pollen recipient and pollen production fields also has a very big impact on the distances and frequencies of gene flow. As one example, a field trial of creeping bentgrass containing 286 plants revealed contamination at up to about 1400 feet, while one of 400 acres had cross-pollination at 13 miles.[228] Small canola field trials (a bee pollinated crop) often have significant cross pollination at several hundred to several thousand feet, while a study in Australia at the commercial scale observed contamination at up to about 3 kilometers.[229]

Despite evidence of potential widespread contamination, APHIS failed to address in its EA the potential for biological contamination once Event 98140 is deregulated in this case. In this case as in *Geertson*, "APHIS's reasons for concluding that the potential for the transmission of the genetically engineered gene is not significant are not 'convincing' and do not demonstrate the 'hard look' that NEPA requires."[230] Thus, APHIS must prepare an EIS to disclose and analyze the potential for biological contamination prior to deregulating the GE variety at issue here.

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[224] Vogel, G. (2006). "Tracing the transatlantic spread of GM rice," Science, 2006, vol. 313, p. 1714 (Attachment 15).
[225] USDA APHIS (2007). "Statement by Dr. Ron DeHaven regarding APHIS hold on Clearfield CL131 long-grain rice seed," March 5, 2007 (Attachment 16).
http://www.aphis.usda.gov/newsroom/content/2007/03/content/printable/gericeseed_statement.doc.
[226] Bennett, D. (2007). "Arkansas' emergency session on CL 131 rice," Delta Farm Press, March 1, 2007 (Attachment #17).
[227] USDA (2007). "Report of LibertyLink Rice Incidents," October 2007 (Attachment 18).
[228] (JK. Wipff and C. Fricker, "Gene flow from transgenic creeping bentgrass (Agrostis stolonifera L.) in the Willamette Valley, Oregon," International Turfgrass Society Research Journal, 2001, vol. 9, p. 224;LS Watrud et al., "Evidence for landscape-level, pollen-mediated gene flow from genetically modified creeping bentgrass with CP4 EPSPS as a marker," 2004, PNAS.
[229] MA Rieger et al., "Pollen-mediated movement of herbicide resistance between commercial canola fields," Science, 2002, vol. 296, p. 2386-2388.
[230] 2007 WL 518624 at 6.

Socio-Economic Impacts

APHIS completely failed to address potential adverse socio-economic effects from the deregulation of Event 98140. Given substantial evidence that contamination will occur if Event 98140 is deregulated, potentially significant adverse socio-economic impacts trigger the need for APHIS to prepare an EIS.

NEPA requires that economic effects are relevant and must be examined "when they are interrelated with natural or physical environmental effects."[231] As the court explained in *Geertson Seed Farms*: "The economic effects on the organic and conventional farmers of the government's deregulation decision are interrelated with, and, indeed, a direct result of, the effect on the physical environment; namely, the alteration of a plant species' DNA through the transmission of the genetically engineered gene to organic and conventional alfalfa."[232] The court continued, "APHIS was required to consider those effects in assessing whether the impact of its proposed action is 'significant.'"[233]

APHIS is similarly required to consider such economic effects in this case as well, yet APHIS completely failed to do. This is critical given that no country has approved Event 98140 for importation.[234] Market rejection of corn contamination by Event 98140, like what occurred in the recent LL601 case, and the resulting adverse economic effects of such rejection must be considered in an EIS.

APHIS Inadequately Assessed Impacts to Organic Farming

APHIS failed to adequately assess the potential impact on organic farming from contamination with Event 98140. As has become APHIS practice, it dismissed any impacts to organic farming by summarily stating that under the National Organic Standards program, "unintentional presence of the products of excluded methods [namely GE corn here] will not affect the status of an organic product or operation when the operation has not used excluded methods." (EA at 27). This argument, that the National Organic Standards program is merely a process based standard, completely misses the point that "organic" is much more than merely a label, it is a class off food that consumers demand, and they demand that their organic food does not contain GE material.

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[231] *Ashley Creek Phosphate Co. v. Norton*, 420 F.3d 934, 944 (9th Cir. 2005) (quoting 40 C.F.R. §1508.14).
[232] 2007 WL 518624 at 8.
[233] Id.
[234] Agbios, GM Database, http://www.agbios.com/dbase.php?action=ShowProd&data=Event+98140 (last updated January 17, 2009).

In response to a proposed rule concerning national organic standards, USDA was deluged with an outpouring of opposition to allowing genetic engineering in production of organic foods:

> 275,603 commenters on the first proposal nearly universally opposed the use of this technology in organic production systems. Based on this overwhelming public opposition, this proposal prohibits its use in the production of all organic foods even though there is no current scientific evidence that use of excluded methods presents unacceptable risks to the environment or human health. While these methods have been approved for use in general agricultural production and may offer certain benefits for the environment and human health, consumers have made clear their strong opposition to their use in organically grown food. Since the use of excluded methods in the production of organic foods runs counter to consumer expectations, foods produced with these methods will not be permitted to carry the organic label.[235]

Furthermore, USDA has acknowledged that organic is more than simply a labeling process, but a standard that satisfies consumer expectation that organic food will not contain genetic engineering. During the implementation of the Organic Food Production Act, the USDA indicated that the presence of GE contaminants would render a product unmarketable as organic. The Department explained, "[C]onsumers have made clear their opposition to the use of [GE] techniques in organic food production. **This rule is a marketing standard**, not a safety standard. **Since use of genetic engineering in the production of organic food runs counter to consumer expectations, [GE foods] will not be permitted to carry the organic label**."[236] This dismissing potential impacts based on the process argument, misses completely the fact that consumers may reject food that contains any GE content whatsoever.

When confronted with the same logic used by APHI here, the *Geertson* Court found that "[E]ven APHIS is uncertain whether farmers can still label their products organic under the federal government's organic standards. Second, many farmers and consumers have higher standards than what the federal government currently permits; to these farmers and consumers organic means not genetically engineered, even if the farmer did not intend for his crop to be so engineered. . . . Third, and most importantly, APHIS's comment simply ignores that these farmers do not want to grow . . . genetically engineered alfalfa, regardless of how such alfalfa can be marketed."[237] Here, as in *Geertson*, "APHIS reasoning that farmers will not 'necessarily' be prohibited from labeling their products as organic is wholly inadequate."[238]

APHIS itself admits in the EA that corn produced using organic methods is increasing at approximately 30% a year. (EA at 27). This reflects the fact that organic food production is the fastest growing agricultural sector. Yet, based on evidence whatsoever, APHIS concludes that "[i]t is not likely that growers, including organic and conventional

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[235] 65 Fed. Reg. 13512, 13513-13514 (March 13, 2000) (emphasis added).
[236] 65 Fed. Reg. 13534-35 (Mar. 13, 2000) (emphasis added).
[237] Id.
[238] Id.

growers, who choose not to plant transgenic corn varities or sell transgenic corn, will be significantly impacted by the commercial use of this product." This unsubstantiated conclusion is simply arbitrary, capricious, and unsupported by any evidence. Thus, APHIS must disclose and analyze the impact of deregulating Event 98140 on both organic and conventional non-GE corn in an EIS prior to adopting a deregulation decision.

Impacts on the Public's Right to Choose

NEPA aims to 'maintain, wherever possible, an environment which supports diversity and a variety of individual choice."[239] Accordingly, "[a] federal action that eliminates a farmer's choice to grow non-genetically engineered crops, or a consumer's choice to eat non-genetically engineered food, is an undesirable consequence."[240] "An action which potentially eliminates or at least greatly reduces the availability of a particular plant…has a significant effect on the environment."[241] NEPA and its implementing regulations provide that where a social or economic effect is tied to a physical impact, those effects must be discussed.[242] Elimination of grower and consumer choice are "interrelated with, and indeed, a direct result of, the effect on the physical environment, namely, the alteration of a plant specie's [sic] DNA though the transmission of the genetically engineered gene to organic and conventional [crops]."[243] APHIS violated NEPA when it did not consider the impact that deregulating Event 98140 will have on the public's right to choose non-GMO corn.

As noted at the outset of these comments, the Center for Food Safety (CFS) is a non-profit public interest advocacy organization. We have over 75,000 members in our True-Food Network, a grass-roots network that provides resources for individuals interested in learning more about critical food safety issues and in participating in the government's food policy-making processes. The Public's right to know,[244] choose and refuse certain agricultural practices and food products is central to the interests of CFS and its members.

APHIS dismisses potential contamination based on the existence of market forces supporting maintaining crop standards and that growers choose their crops based on "price premiums" for certain varieties. (EA at 21). More is at stake than just economic harm however. The introduction of GMOs into the food supply remains extremely

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[239] *Geertson Seed Farms v. Johanns*, 2007 WL 518624, *8 (N.D.Cal. 2007).
[240] *Id*.
[241] *Id*.
[242] 40 C.F.R. § 1508.14.
[243] *Id*.
[244] U.S. law has codified the Public right to know into provisions of existing environmental laws, for example in 1986 with the passage of the Emergency Planning and Community Right to Know Act (EPCRA) of 1986 (U.S.C. 1100-11050), an amendment of the Superfund (CERCLA) law of 1980 (SARA title II). Right to know provisions, as they pertain to environmental legislation, are intended to afford the public open access to information generated by the government at federal, state and local levels, and by private parties required to report to the government, regarding the production, use, release, and disposal of hazardous material in the environment. Genetically modified organisms (GMOs) fall into this category.

controversial. GMOs represent an unknown environmental and public health risk to communities because they have not been proven safe. For this reason, the public has the right to know if not only GMOs such as HT Corn Event 98140 are grown in their community but also if they are in the food they purchase at the grocery store. Public access to such information, which currently does not exist, allows the public to make informed choices about the food they eat and feed to their families. Recent opinion polls indicate that 60 percent of Americans would avoid genetically modified foods if they were appropriately labeled, and up to 90 percent of Americans support such labeling.[245] The public and county officials alike are banning genetically modified foods.[246] Residents of five California counties and Hawai'i County, HI, have banned or restricted the planting of GMOs. Efforts in other states across the country are ongoing to stop the planting of GMOs.

The public is concerned about GE foods for many potential adverse health and environmental impacts, as are raised in detail in these comments regarding Event 98140. The public is not being provided adequate information to facilitate informed choices about Event 98140. The public is sensitive to the potential negative effects Event 98140 could have on their health and the health of their families and their concerns are grounded in these unknowns. Such concern is also illustrated by the over 13k public comments filed concurrently opposing the deregulation.

In an effort to avoid genetically modified foods, the public often turns to certified organic products, the definition of which expressly excludes genetically modified foods.[247] In fact, the public mobilized in great numbers to ensure that organic food is free of genetically modified organisms. Over 275,000 people sent comments to USDA on the first proposed rule concerning the National Organic Standards.[248] These commenters "nearly universally opposed" allowing genetic engineering in the production of organic foods.[249] Due to the "overwhelmingly public opposition" to genetic engineering in organically grown food, the organic rule now prohibits genetic engineering.[250] APHIS erroneously claims that GE contamination does not harm the organic standard or eliminate the public's right to choose, a claim we address in these comments at length above and that has been uniformly rejected by a federal court. *See Impacts on Organic Section supra.* Through contamination, individuals who think they are avoiding GMOs may in fact be eating them. The millions of people who choose organic to avoid genetically modified foods are being stripped of their right to choose with the introduction of event 98140 corn. As more and more genetically modified organisms

[245] This information is based on two opinion polls, both from Rutgers Food Policy Institute. The 2003 poll found that 94 percent of Americans want labeling; the 2004 poll found that 89 percent want labeling. W.K. Hallman, W.C. Hebden, C.L. Cuite, H.L. Aquino, and J.T. Land, "Americans and GM Food: Knowledge, Opinion and Interest in 2004," Food Policy Institute Report RR (2004): 1104-7.

[246] Anderson, G., *Lake County Votes to Ban GMO Crops*, available at, http://www1.pressdemocrat.com/article/20081022/NEWS/810220349/1350.

[247] EA at 27.

[248] 65 Fed. Reg. 13512, 13513-13514 (March 13, 2000).

[249] 65 Fed. Reg. 13512, 13513-13514 (March 13, 2000).

[250] 65 Fed. Reg. 13512, 13513-13514 (March 13, 2000).

enter the food supply through unconditional deregulation, it becomes increasingly difficult for the public to avoid food containing GMOs.

This cursory review of the impacts deregulating Event 98140 may have on the public's right to choose is a direct violation of NEPA. APHIS must prepare an EIS that addresses foreseeable potential significant impacts to the public's right to choose non-GE corn.

V. APHIS Failed to Adequately Assess Impacts on Endangered and Threatened Species and Comply with NEPA and the ESA. An EIS and Consultation under ESA §7 is Required.

APHIS did not comply with the Endangered Species Act (ESA), failing to adequately consider effects on threatened or endangered species. The ESA requires APHIS to consult with FWS and/or NMFS to determine "whether any species which is listed or proposed to be listed [as an endangered species or a threatened species] may be present in the area of such proposed action."[251] Then if APHIS learns from FWS and/or NMFS that threatened or endangered species may be present, a biological assessment must be prepared to identify any endangered species or threatened species which are likely to be affected by such action.[252] The initial request for information from FWS and/or NMFS is a predicate to further agency action and cannot be ignored.[253]

Accordingly, prior to a completion of the deregulation, APHIS must demonstrate that at the very least, it has consulted with the United States Fish and Wildlife Service ("FWS") and/or the National Marine Fisheries Service ("NMFS") and taken the first step in considering the impacts of an APHIS deregulation of Event 98140 on threatened or endangered species. As has become APHIS' pattern, it once again failed to take even the first step by doing any consultation with any other agency regarding endangered species.[254] APHIS has already once been previously found to have violated the ESA when it skipped this initial, mandatory step of obtaining information about listed species and critical habitats from FWS and/or NMFS.[255] The court emphasized that regardless of whether there is any evidence that species or habitat may be harmed in any way, "an agency violates the ESA when it fails to follow the procedures mandated by Congress, and an agency will not escape scrutiny based on the fortunate outcome that no listed plant, animal, or habitat was harmed."[256]

APHIS claims that the impacts of Event 98140 are "those associated with typical agriculture." (EA at 31). Yet at the outset APHIS acknowledges that it has not before deregulated a GE corn like Event 98140, that is engineered for dual herbicide tolerance. (EA at 4). APHIS also notes that it "expect[s]" that "the effect of agricultural practices (tillage and herbicide use)" "would also have an impact on [protected] species, and those

[251] 16 U.S.C. § 1536(c)(1); 50 C.F.R. § 402.12(c) (requiring federal agencies to request information regarding listed species and critical habitat from the Department of the Interior).
[252] Id.
[253] *Thomas v. Peterson*, 753 F.2d 754, 764 (9th Cir. 1985).
[254] *Center for Food Safety v. Johanns*, 451 F.Supp.2d 1165, 1182 (D. Hawaii 2006).
[255] *Center for Food Safety v. Johanns*, 451 F.Supp.2d 1165, 1182 (D. Hawaii 2006).
[256] Id.

proposed for listing, just as they did for non-[protected] species." (EA at 31). Yet APHIS did not assess or consult regarding what those impacts would be. It is arbitrary and capricious to dismiss potential impacts simply because they are caused in other contexts. APHIS notes that growers should "consider" these impacts on protected species "found in and around their corn field." (EA at 31). Yet APHIS does not explain what species might be harmed by these activities or assess what measures could be taken to ameliorate that harm.

APHIS notes that the soil in corn fields is a "complex environment rich in microorganisms and arthropods." (EA at 12). Many of the organisms are "considered beneficial" and "perform valuable functions" (EA at 12), yet APHIS did not analyze if and how such complexities and beneficial soil organisms might be impacted by the deregulation. This includes potential impacts from invasive earthworms on such species and their habitat.[257] For example, the endangered American burying beetle *Nicrophorus americanus* found in corn-growing states like Michigan, Nebraska, Ohio, and South Dakota (as well as Oklahoma, Rhode Island, Arkansas, and Massachusetts) has been part of the discussion before. In 2007, Syngenta Seeds Inc. petitioned APHIS for determination of nonregulated status of a corn variety (MIR604) genetically engineered to be insect resistant. In the Environmental Assessment issued regarding that petition, APHIS noted that the American burying beetle "may occur in old fields or cropland hedge rows."[258] According to basic ecological principles of interspecific competition, when a limited amount of shared resources (food, water, habitat) are available, species will compete against each other for those resources. The rapid growth and extensive burrowing depth of the European earthworm[259] could disrupt the dietary behavior of the beetle, as it buries carcasses underground for the larvae to feed upon. It is reasonable to assume that, under increased population pressure and limited resources, European earthworms might displace or disrupt the natural behavior of the American burying beetle. Therefore, it is important to address the interspecific interactions and potential competition between the European earthworm and the endangered American burying beetle.

APHIS failed to conduct any independent evaluation of the environmental impacts of herbicide usage associated with the commercialization of Event 98140

Assessment of the potential impacts of Event 98140 introduction on threatened and endangered species and their habitat must include analysis of the impacts of increased herbicide usage that will accompany it. This is because HT crops are invariably cultivated with use of glyphosate-based herbicides, the chemical they are specifically engineered to

[257] Hale et al (2006). "Changes in hardwood forest understory plant communities in response to European earthworm invasions," *Ecology* 87: 1637-1649.
[258] USDA-APHIS Final Environmental Assessment: In response to petition application (04-362-01p), received from Syngenta Seeds, Inc., for determination of nonregulated status of a corn variety (MIR604) genetically engineered to be insect resistant. U.S. Department of Agriculture, Animal and Plant Health Inspection Service: Biotechnology Regulatory Services. p. 14 Available at: http://www.aphis.usda.gov/brs/aphisdocs2/04_36201p_com.pdf

[259] Up to 2m. Id, Hale, 2006 at p. 4)

tolerate. The assessment should also consider cumulative impacts from glyphosate use associated with Event 98140 together with that from existing uses. The assessment should consider not only glyphosate, but commercial glyphosate formulations (e.g. those containing polyethoxylated tallowamine), which have been shown to have greater toxicity than glyphosate alone to amphibians and other organisms.

APHIS notes that the deregulation "may result" in an increase in the use of ALS-inhibiting herbicides and that several ALS-inhibitors have "comparable environmental impacts" to glyphosate. (EA at 31-32).[260] APHIS is conclusory in its assessment of whether or not deregulation will increase herbicide usage and impacts, noting because there has been use in the past, "There is no indication that their use on a higher percentage of acres would be associated with significant impacts." (EA at 32). Yet this just the type of incremental increase of impacts that NEPA requires be assessed.[261]

Regarding impacts of the herbicides used on Event 98140 in the crop system, APHIS in the main relies on EPA's regulation and registration of these herbicides, (EA at 32), going to some length explaining EPA's duties, such as stating that "[FIFRA] registration review by EPA for these herbicides ensures these products do not present unreasonable risks to humans, wildlife, fish and plants. …before allowing a pesticide product to be sold on market, EPA ensures that the pesticide will not pose any unreasonable risks to wildlife and the environment." (EA at 32) (noting that, *inter alia*, "EPA ensures"; "EPA conducts"; "EPA does this"; "considered by EPA").

However EPA's prior registration of these herbicides does not alleviate APHIS of its duty to comply with the ESA and NEPA.[262] The FIFRA registration process is very different that review pursuant to NEPA and the ESA. Section 7 of the ESA requires every Federal agency to conserve species listed as endangered or threatened.[263] It also mandates that "in consultation with and with the assistance of the Secretary," each agency shall "insure that any action authorized, funded or carried out by such agency . . . is not likely to jeopardize the continued existence of any endangered species or threatened species . . ."[264]

The risks of glyphosate herbicides to endangered plant and some animal species are documented in numerous studies. In 1996, The U.S. Fish and Wildlife service identified 74 endangered plant species believed to be at risk as a result of glyphosate use. Endangered species known to be harmed or put at further risk by glyphosate specifically include the California red-legged frog[265] , the Houston toad[266], Monarch butterflies and

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[260] APHIS does not even assess which ALS-inhibiting herbicides will be used in the deregulation, only noting that it is "uncertain" and that growers will have "several options." (EA at 32). APHIS must specifically assess the impacts of these different "options."
[261] *Grand Canyon Trust v. F.A.A.*, 290 F.3d 399, 345 (D.C. Cir. 2002).
[262] *Wash. Toxics Coal. v. U.S. EPA*, 413 F. 3d 1024 (9th Cir. 2005); *Or. Envtl. Council v. Kunzman*, 714 F.2d 901 (9th Cir. 1983).
[263] 16 U.S.C. § 1536(a)(1).
[264] 16 U.S.C. § 1536(a)(2).
[265] http://www.epa.gov/espp/litstatus/effects/redleg-frog/glyphosate/transmittal-ltr.pdf
[266] http://www.epa.gov/oppsrrd1/REDs/factsheets/0178fact.pdf

the plant they rely solely upon, Milkweed,[267] and the Valley Elderberry Longhorn beetle.[268] Glyphosate has been found harmful to a predatory beetle (Bembidion) and slightly harmful to a parasitic wasp (Trichogramma), a predatory mite (Typholodromus pyn), a ladybird (Semiadalia) and a lacewing (Chrysoperla carnea)[269], and Lepidoptera butterflies and moths,[270] the African amphibian species X laevis.[271] Studies have shown glyphosate to be toxic to fish, particularly rainbow trout, sockeye salmon and coho salmon.[272]. Glyphosate has also been shown to reduce midge populations, vital to aquatic processes.[273]

Endangered insects that live in major areas of corn production and are directly harmed by pesticides include the Salt Creek Tiger beetle[274], the Illinois cave amphipod[275] and the Iowa Pleistocene snail. [276]

Even Monsanto acknowledges glyphosate's potential harm to endangered species. The company has a web-based tool called "*Pre-Serve: Glyphosate Mitigation Instructions*", which shows areas in the United States where threatened or endangered plant species may exist near agriculture. This web site advises growers on appropriate pattern and application rates of glyphosate to minimize risks to rare or endangered plant species.[277]

A 1986 EPA Guidance for the Reregistration of Pesticide Products Containing Glyphosate (EPA Case No. 0178), identifies three listed species that, according to EPA's consultation with the USFWS Office of Endangered Species, may be jeopardized by use of the compound (jeopardy being the highest level of effect under the Sec. 7 regulations). In particular, for use of glyphosate in a "crop cluster" in that document, the then-listed species jeopardized were *Solano grass,* the *Valley elderberry longhorn beetle,* and the *Houston toad*. (Each of those species is still listed.) EPA also stated that many endangered plants may be at risk from glyphosate. The EPA's 1993 Re-registration Eligibility Decision (RED) for Glyphosate, the most current registration for the compound, confirmed and expanded on this 1986 jeopardy opinion, stating:

> *The Agency does have concerns regarding exposure of endangered plant species to glyphosate. In the June 1986 Registration Standard, the Agency discussed consultations with the US Fish and Wildlife Service (FWS) on*

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267 Nottingham, Stephen. "Genescapes." 2002
268 http://www.blm.gov/pgdata/etc/medialib/blm/ca/pdf/folsom/ea.Par.91728.File.dat/Amador_spurge.pdf
269 Nottingham, Stephen referencing Hassan et all 1988.
270 Nottingham, Stephen. "Genescapes." 2002
271 http://www.earthjustice.org/library/references/AIDASprayingCritique122106.pdf
272 Nottingham, Stephen. "Genescapes." 2002. Referencing the studies Folmar et al. 1979 Holtby and Baillie, 1987; Liong et. All 1988, Mitchell et al. 1987; Servizi et al. 1987, Wan et al 1989.
273 (Buhl and Faerber, 1989).
274 Cornell University Insect Conservation Biology Program Website: Salt Creek Tiger Beetle. Available at: http://courses.cit.cornell.edu/icb344/abstracts/salt-creek-tiger-beetle.htm
275 U.S. Fish and Wildlife Service Endangered Species Program: Illinois Cave Amphipod. Available at: http://www.fws.gov/midwest/endangered/crustacn/ilca_fct.html
276 U.S. Fish and Wildlife Service Endangered Species Program: Iowa Plesitocene snail Fact Sheet. Availabe at: http://www.fws.gov/Midwest/endangered/Snails/iops_fct.html
277 http://www.pre-serve.org/Pre-Serve-B02/, http://www.monsanto.com/responsibility/pre-serve.asp

> *hazards to crops, rangeland, silvicultural sites, and the Houston toad which may result from the use of glyphosate. Because a jeopardy opinion resulted from these consultations, the agency imposed endangered species labeling requirements in the Registration Standard to mitigate the risk to endangered species. Since that time, additional plant species have been added to the list of endangered species.*[278]

APHIS failed to consider the 1986 Guidance and the 1993 RED with respect to the threatened and endangered plants and animals they identified as potentially jeopardized by glyphosate use in conjunction with Event 98140, or to update the analysis to the current, greater number of potentially affected listed species.

In addition, APHIS relies on EPA's analysis of glyphosate's use in this new context without its own analysis even though EPA has made no determinations on the impacts on threatened and endangered species from glyphosate use in conjunction since 1993. In 1993, EPA named the *Houston toad* as jeopardized by glyphosate use in association with its use on crops, but the RED failed to even list the other two species that had been found to be in similar jeopardy as of 1986, the *Solano grass* and the Valley *elderberry longhorn beetle*. It also failed to even preliminarily list the many other potentially-affected species that were listed between 1986 and 1993, even though it acknowledged that many would be affected.[279] For example, in addition to the above species, the following protected plant and animal species are known to be found in close proximity to both corn production and glyphosate use in the State of California[280]:

ALEUTIAN CANADA GOOSE
ARROYO SOUTHWESTERN TOAD
BLUNT NOSED LEOPARD LIZARD
BURKE'S GOLDFIELDS
CALIFORNIA GNATCATCHER
CALIFORNIA JEWELFLOWER
COACHELLA VALLEY FRINGE TOED LIZARD
COLUSA GRASS
CONEJO DUDLEYA
CONTRA COSTA GOLDFIELDS
CONSERVANCY FAIRY SHRIMP
DESERT PUPFISH
FLAT TAILED HORNED LIZARD
FRESNO KANGAROO RAT

[278] Online at www.epa.gov/oppsrrd1/REDs/old_reds/glyphosate.pdf , at p. 70.
[279] EPA's September, 1993, Re-registration Eligibility Decision ("RED") for glyphosate (No. 738-R-93-014).
[280] Kishaba, S. and Marovich, R. "Species by Commodity and Commodities by Species: An Index to Pesticide Use Sites (Commodities) That Occur in Proximity to Federally Listed, Proposed and Candidate Species in California". California EPA: Department of Pesticide Regulation, 1997. Available at: http://www.cdpr.ca.gov/docs/endspec/espdfs/comxsp.pdf
Kishaba, S. and Marovich, R. "Species by Pesticide (Volume I) An Index to Pesticides That Are Used in Proximity to Federally Listed, Proposed and Candidate Species in California by Species". California EPA: Department of Pesticide Regulation, 1997. Available at: http://www.cdpr.ca.gov/docs/endspec/espdfs/spxpest.pdf

GIANT GARTER SNAKE
GREENE'S TUCTORIA
HOOVER'S ERIASTRUM
HOOVER'S SPURGE
LEAST BELLS VIREO
METCALF CANYON JEWELFLOWER
MONTEREY SPINEFLOWER
PALMATE-BRACTED BIRD'S-BEAK
PEIRSON'S MILK-VETCH
SALT MARSH HARVEST MOUSE
SAN DIEGO THORN MINT
SAN FRANCISCO GARTER SNAKE
SAN JOAQUIN ADOBE SUNBURST
SAN JOAQUIN KIT FOX
SAN JOAQUIN VALLEY ORCUTT GRASS
SAND MESA MANZANITA
SONOMA SUNSHINE
STEPHENS KANGAROO RAT
STRIPED ADOBE LILY
SUCCULENT OWL'S-CLOVER
SACRAMENTO SPLITTAIL
THREAD-LEAVED BRODIAEA
TIDEWATER GOBY
TIPTON KANGAROO RAT
VALLEY ELDERBERRY LONGHORN BEETLE
VERNAL POOL FAIRY SHRIMP
VERNAL POOL TADPOLE SHRIMP
WESTERN SNOWY PLOVER
YUMA CLAPPER RAIL

The aforementioned *Valley Elderberry Longhorn Beetle* is listed, as is numerous protected plant species.

APHIS must adequately assess the impacts of these herbicides on protected species and their habitat. There is no evidence in the EA that APHIS took the first steps of consultation with FWS and/or NMFS to determine whether the deregulation of Event 98140 may harm listed species or habitat. Prior to deregulation, APHIS must at the very least consult with FWS and/or NMFS prior to approving this deregulation.

VI. The EA Alternatives Analysis is Deficient and Improperly Limited. APHIS Mischaracterizes its Authority as Overly Narrow Instead of Properly Analyzing Reasonable Alternatives to the Proposed Action. An EIS is Required.

The EA's Alternatives Section is legally deficient and without further analysis, including more alternatives, will render APHIS's determination arbitrary and capricious. (EA at 14). "NEPA requires that alternatives ... be given full and meaningful consideration, whether the agency prepares an EA or an EIS, the agency must "provide sufficient evidence and analysis for determining whether to prepare an environmental impact statement or a finding of no significant impact."[281] The consideration of alternatives requirement furthers NEPA's goal by guaranteeing that agency decisionmakers "[have] before [them] and take [ ] into proper account all possible approaches to a particular project (including total abandonment of the project) which would alter the environmental impact and the cost-benefit balance."[282] NEPA's requirement that alternatives be studied, developed, and described both guides the substance of environmental decisionmaking and provides evidence that the mandated decisionmaking process has actually taken place.[283] Informed and meaningful consideration of alternatives is thus an integral part of the statutory scheme.[284]

The draft EA only analyzes two alternatives: a no-action alternative and complete deregulation of Event 98140. (EA at 14). In order to comply with NEPA, APHIS must "[r]igorously explore and objectively evaluate all reasonable alternatives."[285] APHIS's determination it must only analyze two alternatives, no-action and complete deregulation, that there are no other "reasonable alternatives," is arbitrary and capricious.[286]

Partial Deregulation Alternatives Arbitrarily and Capriciously Limited and Rejected

The regulations expressly state that APHIS may deny deregulation petitions, grant them in whole or in part.[287] However APHIS claims that no partial deregulation needed to be analyzed in this case, that no analysis of any third alternative need be included. In the very few sentences the EA devotes to this, APHIS says that one partial deregulation "third alternative" was considered and dismissed: geographic restrictions. (EA at 14).

This alternative was rejected first because Pioneer HT corn does "not pose a greater plant pest risk in a specific geographic location." (EA at 14). Second, it was dismissed because it would "hinder the purpose and need of the action to allow for the safe development of use of GE organisms given that Pioneer HT corn has been determined by APHIS not to be a plant pest in any region of the United States." (EA at 14).

APHIS's application in the EA of its partial deregulation authority is limited to only one alternative, seemingly handpicked in order to dismiss it out of hand. Why not an alternative with isolation distances? Why one that is not progeny-limiting? In other sections APHIS discusses the use of precisely such measures to reduce gene flow: "Gene flow … has been managed using various types of buffer zones or isolation practices, such as differences in planting dates which results in differences in flowering or making sure fields are at an appropriate distance from other compatible crops such as using isolation

[281] 40 C.F.R. § 1508.9; Center for Biological Diversity v. National Highway Traffic Safety Admin. 538 F.3d 1172, 1217 -1218 (9th Cir. 2008)
[282] Calvert Cliffs' Coordinating Committee, Inc. v. United States Atomic Energy Commission, 449 F.2d 1109, 1114 (D.C. Cir.1971).
[283] Id.
[284] *See* Bob Marshall Alliance v. Hodel, 852 F.2d 1223, 1228 (9th Cir. 1988).
[285] 40 C.F.R. § 1502.14(a).
[286] *See, e.g.*, *Curry v. U.S. Forest Service*, 988 F. Supp. 541, 553-554 (W.D. Pa. 1997) (failure of the Forest Service to consider more than two alternatives in connection to forest project was arbitrary and capricious).
[287] 7 C.F.R. § 340.6(d)(3)(i).

distances." (EA at 22). Regarding gene flow, APHIS acknowledges that "certain measures can be taken to minimize such flow (e.g. isolation distances). (EA at 21). APHIS later notes that biological contamination harm to conventional and organic farmers is not likely in part due to the fact that "isolation distances can be maintained to prevent cross-pollination." (EA at 27). Such a "reasonable" alternatives should have been included in the EA and "rigorously analyzed" in order to comply with NEPA.[288]

More fundamentally, APHIS's determination in the EA of the scope of its "in part" deregulation authority is arbitrary and capricious.[289] In the draft EA APHIS limits when it can approve a petition "in part" to only geographic restrictions. (EA at 14). *Nothing in the Plant Protection Act or its implementing regulations so constricts APHIS's authority to only that type of applications of a partial deregulation*. Agencies cannot define the project so narrowly that it foreclosed a reasonable consideration of alternatives;"[290] they "cannot define its purpose and need so as to winnow down the alternatives until only the desired one survives."[291] "NEPA's legislative history reflects Congress's concern that agencies might *attempt to avoid any compliance with NEPA by narrowly construing other statutory directives* to create a conflict with NEPA. Section 102(2) of NEPA therefore requires government agencies to comply 'to the fullest extent possible.'[292] Partial deregulation is logically interpreted to encompass a range of alternatives stretching from a regulated article or prohibiting release to complete deregulation. There is no rational basis (or explanation given) for APHIS conclusion in the EA that its authority is limited to only geographic restrictions. For example, at least one court has held, in a ruling that APHIS did not appeal, that APHIS can and should consider in an EIS measures that would inform a judgment of a partial deregulation such as isolation distances.[293] APHIS is in the process of completing the EIS presumably analyzing, among other things, the efficacy of any such isolation distance measures.

Improper Reliance on Earlier Plant Pest Assessment

In the Alternatives section APHIS re-states its earlier conclusion that it found Event 98140 unlikely to pose a plant pest risk and thus that "APHIS does not have authority to regulate Pioneer HT corn if APHIS determines it does not pose a plant pest risk." (EA at 14). APHIS states that the "no-action" alternative is "not preferred" because "APHIS has already determined that "Pioneer HT corn does not pose a plant pest risk." Further the one third alternative dismissed in two sentences – geographic restrictions – is dismissed because it would "hinder" the deregulation because APHIS already determined HT corn "not to be a plant pest in any region of the United States." (EA at 14). Later APHIS concludes it "must reject" the no-action alternative because it lacks regulatory authority because of the plant pest assessment. (EA at 15). This gets to the crux of APHIS's

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[288] 40 C.F.R. § 1502.14(a).
[289] 7 C.F.R. § 340.6(d)(3)(i).
[290] *Davis*, 302 F.3d at 1119; *Klamath-Siskiyou Wildlands Center v. U.S. Forest Service*, 373 F. Supp. 2d 1069 (E.D. Cal. 2004)
[291] *Klamath-Siskiyou Wildlands Center v. U.S. Forest Service*, 373 F. Supp. 2d 1069 (E.D. Cal. 2004).
[292] *Center for Biological Diversity v. National Highway Traffic Safety Admin*, 538 F.3d 1172, 1213 - 1214 (9th Cir. 2008).
[293] Geertson Seed, 2007 WL 518624 at *6.

misconception of NEPA and mischaracterization of its authority under the Plant Protection Act. Essentially, APHIS refuses to assess any further alternatives, or even meaningful consider the no-action alternative, not because other alternatives like isolation distances or progeny-limitations would not work or because such measures might not be needed, *but just because APHIS claims that it is unable to impose any such restrictions* based on its authority, because it already previously decided, in a separate document, that Event 98140 is not a plant pest.

APHIS essentially argues that the scope of its NEPA obligations is very narrow, limited to whether or not Event 98140 is a plant pest under the PPA. Further, since APHIS has already made its decision that Event 98140 is NOT a plant pest in an earlier document that pre-dates the final EA, included Appendix A to the draft EA, it need not look at any impacts that might be associated with plant pest risk, because in its judgment Event 98140 is not a plant pest. This doesn't leave very much at all that APHIS must then address in the EA.

The agency's reasoning is conclusory and circular: the EA need not a hard look at risks related to whether or not Event 98140 may adversely impact the environment or other crops as a plant pest because Event 98140 is not a plant pest. APHIS has the analysis process precisely backwards: the EA *should inform the agency's decision-making process*, not the other way around (i.e., have the agency's forgone conclusion limit and prejudge the NEPA analysis). The policy behind NEPA is "to ensure that an agency has at its disposal all relevant information about environmental impacts *before* the agency embarks on the project."[294] Under the agency's reasoning the actual deregulation decision and EA accompanying it is just a formality: the only thing that matters is the seven-page plant pest assessment. If the agency doesn't have to look at any alternatives because it has already previously determined Event 98140 is not a plant pest (and that is the extent of its authority and required analysis), then why any analysis at all? It would seem the agency views the NEPA process as nothing more than a formality dance to complete in order to deregulate, rather than a searching process that should inform the agency regarding its decisions.

Improper Scope of APHIS's NEPA Obligations

The one alternative other than complete deregulation and a no-action alternative was dismissed out of hand because it would "hinder the purpose and need of the action," which was stated as "to allow for the safe development of use of GE organisms" (EA at 14). Actually, the PPA's purpose is summarized in its first finding: "detection, control, eradication, suppression, prevention, or retardation of the spread of plant pests or noxious weeds is necessary for the protection of the agriculture, environment, and economy of the United States."[295] Further, the EA cabins its view of potential alternatives and of impacts generally to its plant pest assessment finding. (EA at 14). Because APHIS determined Event 98140 "not to be a plant pest in any region of the United States," it concluded that

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[294] *Salmon River Concerned Citizens v. Robertson*, 32 F.3d 1346, 1356 (9th Cir.1994).
[295] 7 U.S.C. § 7701(1).

it need not look at any alternatives save complete deregulation and that its review of impacts pursuant to NEPA was limited to direct plant pest risks.

APHIS's cannot evade any meaningful NEPA review, including dismissing without assessing partial deregulation alternatives or declining to even analyze the no-action alternative, by simply pointing to its earlier plant pest assessment because APHIS's statutory authority is much broader than just "plant pest." NEPA review can be limited by statutory authority, not by individual regulation. And APHIS's claim that its authority is limited to plant pests only is erroneous. The PPA gives APHIS broad power to prohibit or regulate not only plant pests, but "noxious weeds":

> The Secretary may prohibit or restrict the importation, entry, exportation, or movement in interstate commerce of any plant, plant product, biological control organism, noxious weed, article, or means of conveyance, if the Secretary determines that the prohibition or restriction is necessary to prevent the introduction into the United States or the dissemination of a plant pest or noxious weed within the United States.[296]

The statutory definition of "noxious weed" is very broad:

> The term "noxious weed" means any plant or plant product that can directly or indirectly injure or cause damage to crops (including nursery stock or plant products), livestock, poultry, or other interests of agriculture, irrigation, navigation, the natural resources of the United States, the public health, or the environment.[297]

Thus APHIS has much more authority over Event 98140 than the EA acknowledges. It clearly has the statutory authority to "prevent" and "restrict" any plant if necessary to prevent the dissemination of a plant pest *or noxious weed*. What is a noxious weed is defined to include many of the harms noted in these comments from biological contamination to other crops from Event 98140: public health risks, damage to crops, the environment, and the interests of agriculture, for example. The NEPA assessment APHIS must do, including what alternatives are "reasonable," therefore is not cabined to merely the question of plant pest; but rather includes these broader types of impacts it is defined to include. As such, other alternatives that would explore these impacts and risks must be considered and cannot be disregarded simply because of APHIS's plant pest finding, without any further analysis.[298]

[296] 7 U.S.C. § 7712(a) (emphasis added).
[297] 7 U.S.C. § 7702(10) (emphasis added).
[298] APHIS claims it has no authority to mandate isolation distances and so it does not have to analyze an alternative with isolation distances, but the 2008 Farm Bill, Section 10204(b)(7), requires the Secretary to take actions that enhance "the use of the latest scientific techniques for isolation and confinement distances." Farm Bill Section 10204(c)(1)(C) requires the Secretary to consider establishing "standards for isolation and containment distances."

APHIS has also acknowledged that its statutory authority is broader than it claims in this EA in its new proposed regulations. In the new proposed regulations APHIS points out:

> The PPA grants the Secretary authority to regulate … noxious weeds.
>
> …In order to best evaluate the risks associated with these GE organisms and regulate them when necessary, APHIS needs to exercise its authorities regarding noxious weeds and biological control organisms, in addition to its authority regarding plant pests.
>
> …
> We propose to better align the regulations with the PPA authorities in order to ensure that the environmental release, importation, or interstate movement of GE organisms does not pose a risk of introducing or disseminating plant pests or noxious weeds. … [T]echnological advances have led to the possibility of developing GE organisms that do not fit within the plant pest definition, but may cause environmental or other types of physical harm or damage covered by the definition of noxious weed in the PPA. Therefore, we consider that it is appropriate to align the regulations with both the plant pest and noxious weed authorities of the PPA.[299]

Finally, under the current regulations, no existing regulation prohibits APHIS from regulating GE crops that do not pose a plant pest risk, nor does any regulation demand that APHIS deregulate organisms that are not plant pests. APHIS's statutory authority aside, as noted above it has discretion whether to grant a petition under its plant pest regulatory authority, and may exercise that discretion to grant a petition "in whole," "in part," or not at all.[300] And partial deregulation could include isolation distances, geographic restrictions, or agronomic practices, for example. The EA gives no rational basis or analyze of why the alternatives here were ignored other than the claim of lack of authority, which as shown above is in error.

The EA is arbitrary and capricious in its disregard for reasonable alternatives, failure to assess any alternatives except the "no action" alternative and the complete deregulation, and failure to meaningfully assess the no-action alternative. An EIS is required.

VII. APHIS Failed to Adequately Analyze Cumulative Impacts. An EIS is Required.

The potential cumulative impacts associated with Event 98140 Corn must be disclosed and analyzed in an EIS. NEPA requires an agency to consider the possible cumulative impacts of deregulating a regulated article.[301]

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[299] 73 Fed. Reg. 60008, 60011 (Oct. 9, 2008) (emphasis added).
[300] 7 C.F.R. § 340.6(3)(i).
[301] Geertson Seed Farm v. Johanns, 2007 WL 518624, *10 (N.D. Cal. 2007).

"A cumulative impact is defined as 'the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency ... or person undertakes such other actions. Individually minor, but collectively significant actions, taking place over time, can generate cumulative impacts.[302]

Cumulative impacts must be fully considered in an EA. "Given that so many more EAs are prepared than EISs, *adequate consideration of cumulative effects requires that EAs address them fully*."[303] NEPA requires agencies to consider the cumulative impacts of their proposed actions.[304] Specifically, an EA must provide a quantified assessment of project's environmental impacts when combined with other projects.[305] The EA cannot simply discuss the direct effect of the project and conclude that there are no cumulative impacts.[306] Instead, cumulative effects must be evaluated along with the direct and indirect effects of a project and its alternatives. A meaningful cumulative impacts analysis, according to the D.C. Circuit, must identify:

> (1) the area in which the effects of the proposed project will be felt; (2) the impacts that are expected in that area from the proposed project; (3) other actions-past, present, and proposed, and reasonably foreseeable-that have had or are expected to have impacts in the same area; (4) the impacts or expected impacts from these other actions; and (5) the overall impact that can be expected if the individual impacts are allowed to accumulate.[307]

Also lacking is a discussion of the "overall impacts that can be felt if incremental impacts are allowed to accumulate."[308] APHIS fails to consider how adding an additional GE corn variety to the many existing GE corn varieties increases the likelihood of contamination. Throughout the EA, APHIS consistently concludes that no cumulative effects have been identified without providing an "objective quantification of the impacts."[309] Climate change impacts are one type of cumulative impact that here requires further analysis. *See Section on Climate Change Analysis supra.* Another is the issue of stacking.

Stacking

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[302] Id.
[303] Kern v. United States Bureau of Land Mgmt., 284 F.3d 1062, 1076 (9th Cir. 2002) ("We have held that an EA may be deficient if it fails to include a cumulative impact analysis or to tier to an EIS that has conducted such an analysis.")
[304] 40 C.F.R. § 1508.27(b)(7); Utahns for Better Transp. v. United States Dep't of Transp., 305 F.3d 1152, 1172 (10th Cir. 2002); [304] Kern v. United States Bureau of Land Mgmt., 284 F.3d at 1076; Vill. Of Grand View v. Skinner, 947 F.2d 651, 659 (2nd Cir. 1991).
[305] Great Basin Mine Watch v. Hankins, 456 F.3d 955, 972 (9th Cir. 2006) (quoting Klamath-Siskiyou Wildlands Center v. Bureau of Land Management, 387 F.3d 989, 994 (9th Cir. 2004).
[306] Id.
[307] Grand Canyon Trust v. F.A.A., 290 F.3d 399, 345 (D.C. Cir. 2002).
[308] Grand Canyon Trust, 290 F.3d at 345.
[309] Great Basin Mine Watch, 456 F.3d at 972.

Deregulation decisions have generally absolved APHIS of any post-deregulation authority over GE crops, including all progeny of that event, including crosses with other deregulated GE crops. But this need not be the case. APHIS has legal authority to deregulate a crop "in whole" or "in part."[310] Thus, APHIS can impose conditions on deregulation, such as excluding "stacking" of deregulated crop with other deregulated crops.

APHIS acknowledges that "in the future there is the potential of stacking Pioneer HT corn with, for example, an insect resistant variety." (EA at 29). APHIS no longer has regulatory authority over the varieties of GE-corn previously granted non-regulated status, including GE corn varieties that may be bred with other conventional varieties or other GE varieties as determined by the applicant or developer. Because APHIS has no continuing legal authority over deregulated crops, APHIS will also have no authority to late consider the environmental impacts associated with such breeding. Therefore it must do so in a cumulative impacts analysis here.

This lack of a thorough cumulative impacts analysis regarding the potential combinations of Pioneer's Event 98140 varieties is a direct violation of NEPA. The Ninth Circuit explains, "[s]ometimes the total impact from a set of actions may be greater than the sum of the parts."[311] Thus, APHIS must evaluate the cumulative effects of deregulating Event 98140 in consideration of potential breeding Event 98140 with crops deregulated in the past, crops currently proposed for deregulation [such as Syngenta's Event 3272, for example] and other varieties that may be approved in the reasonably foreseeable future. The potential for stacking with these varieties, and the possible impacts associated with such stacked crops, must be evaluated before deregulation, because after deregulation they will go un-tested. There are currently no commercially available GE corns that are both glyphosate and ALS herbicide tolerant.

Stacking of GE crops may create significant environmental impacts that have not before been analyzed anywhere, such as "super-glyphosate tolerance." DuPont-Pioneer scientists reported that maize plants transformed with one version of its GAT enzyme were tolerant to six times the dose of glyphosate normally applied to Roundup Ready corn (Castle et al 2004, p. 1154, see also Figure 4, p. 1153). Event 98140 corn may exhibit a similar level of enhanced glyphosate tolerance. Additionally, DuPont-Pioneer has announced its intention to develop super-glyphosate-tolerant crops that combine its GAT mechanism of glyphosate tolerance with one or both of the two glyphosate-tolerance traits developed by Monsanto. In its 2005 patent, "Novel Glyphosate-N-Acetyltransferase (GAT) Genes," DuPont-Pioneer claims: "A transgenic plant or transgenic plant having an enhanced tolerance to glyphosate, wherein the plant or plant explant expresses a polypeptide with glyphosate-N-acetyltransferase activity… and at least one polypeptide imparting glyphosate tolerance by an additional mechanism." (GAT Patent 2005, claim 111, p. 89).

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[310] 7 C.F.R. § 340.6(d)(3)(i).

[311] CBD, 538 F.3d at 1215.

DuPont-Pioneer is clearly interested in super-glyphosate-tolerant crops even without tolerance to ALS inhibitors or other herbicides, and regards them as a legitimate means of controlling glyphosate-resistant weeds.[312]

The stacking of up to three mechanisms of glyphosate-tolerance in a single plant will allow more frequent applications of higher doses of glyphosate, perhaps over the entire growing season of the crop. Such super-tolerance will enable vastly increased use of glyphosate (over already exorbitant and growing levels) in an attempt to keep up with the rapidly growing level of glyphosate-resistance found in various weed species. The end result is a vicious circle of rising glyphosate use to control resistant weeds, followed by increased weed resistance, which in turns drives still more chemical use.

DuPont-Pioneer also claims a plant with GAT glyphosate-tolerance and tolerance to one additional herbicide, as well as plants that incorporate super-glyphosate tolerance plus tolerance to one of a whole battery of additional herbicides.[313]

APHIS concedes that weeds with confirmed resistance to both ALS inhibitors and glyphosate have already developed. (EA at 9, 19). Detailed analysis of the www.weedscience.org website cited by APHIS reveals that weeds with confirmed cross-resistance to two or three major classes of herbicides now infest up to 1459 sites covering 245,755 acres in the U.S. alone. Since just 2003, weeds with cross-resistance to ALS inhibitors and glyphosate have been confirmed in Ohio, Missouri and Illinois. Deregulation of Event 98140 corn will foster increased use of glyphosate, and probably increased use of ALS inhibitors as well in those areas where weeds resistant to these herbicides are not yet legion. Thus, deregulation of Event 98140 corn will likely foster more rapid development of cross-resistant weeds.

APHIS completely failed to analyze the significant potential for increased glyphosate use and exacerbation of glyphosate-resistant weeds from deregulation of Event 98140 corn or super-glyphosate-resistant progeny derived from it. Instead, APHIS incorrectly assumes

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[312] "The invention provides methods for controlling weeds in a field and preventing the emergence of glyphosate-resistant weeds in a field containing a crop which involve planting the field with crop seeds or plants that are glyphosate-tolerant as a result of being transformed with a gene encoding a glyphosate-N-acetyltransferase [GAT] and a gene encoding a polypeptide imparting glyphosate tolerance by another mechanism, such as a glyphosate-tolerant 5-enolpyruvylshikimate-3-phosphate synthase and/or a glyphosate-tolerant glyphosate oxido-reductase and applying to the crop and the weeds in the field a sufficient amount of glyphosate to control the weeds without significantly affecting the crop." (GAT Patent 2005, par. 0032).

[313] "In a further embodiment the invention provides for …[super-glyphosate tolerance as described above] … and a gene encoding a polypeptide imparting tolerance to an additional herbicide, such as a mutated hydroxyphenylpyruvatedioxygenase, a sulfonamide-tolerant acetolactate synthase, a sulfonamide-tolerant acetohydroxy acid synthase, a phosphinothricin acetyltransferase and a mutated protoporphyrinogen oxidase and applying to the crop and the weeds in the field a sufficient amount of glyphosate and an additional herbicide, such as, a hydroxyphenylpyruvatedioxygenase inhibitor, sulfonamide, imidazolinone, bialaphos, phosphinothricin, azafenidin, butafenacil, sulfosate, glufosinate, and a protox inhibitor to control the weeds without significantly affecting the crop." (DuPont-Pioneer Patent, par. 0033)

that displacement of existing GE corn by Event 98140 would have no impact on agronomic practices. Deregulation decisions normally cover not only the deregulated event, but all progeny of that event, including crosses with other deregulated GE crops. The EA here assumes that progeny will also be deregulated. (EA at 2.) This need not be the only option. APHIS has the option of imposing conditions on deregulation, including restricting the scope of deregulation to exclude "stacking" of the deregulated crop with certain other deregulated crops. At the very least APHIS should analyze such an alternative, as well as the cumulative impacts associated with the stacking where permitted, in an EIS.

VIII. The EA is Deficient Because it Fails to Adequately Analyze Potential Significant Human Health Impacts. An EIS is required.

Public Health

Public health issues may be significant environmental impacts requiring the preparation of an EIS. The CEQ regulations explain what factors may be significant effects on the human environment and one such factor is "[t]he degree to which the proposed action affects public health or safety."[314] The presence of one or more of the factors in 40 C.F.R. § 1508.27 may be sufficient to require the preparation of an EIS.[315] Moreover in the APHIS draft programmatic EIS, issued July 7, 2007, APHIS listed impacts on human health as a category of impacts of its NEPA assessment.[316] Accordingly, APHIS's EA must address any potential human health or safety risks and determine whether those human health and safety impacts may be significant. If those impacts are to be found not to be significant, there must be a convincing statement of reasons.[317]

Here there is no meaningful analysis by the agency (p. 22) of potential human health impacts or a convincing statement of reasons" why such impacts may not be significant. APHIS has not complied with NEPA and an EIS is required. The EA has one lone paragraph supporting its conclusion that the corn will have no impacts on human or animal health.

APHIS bases its conclusion first on Pioneer's completion of the FDA's consultation process (i.e., that FDA had "no questions"). With regard to FDA's "analysis" from its voluntary consultation process, APHIS cannot solely rely on another agency's evaluation of environmental effects under a separate statute to adequately fulfill its own NEPA obligations.[318] As explained above, the health impacts discussed below are cognizable impacts pursuant to NEPA that require an EIS if they may significantly impact the "human environment." These impacts are interrelated to the environment because they would stem from the biological contamination of other non-Event 98140 corn (through

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[314] 40 C.F.R. § 1508.27(b)(2).
[315] National Parks & Conservation Ass'n v. Babbitt, 241 F.3d 722, 731 (9th Cir. 2001); Public Service Co. of Colorado v. Andrus, 825 F.Supp. 1483, 1495 (D. Idaho 1993).
[316] DEIS at 67-90.
[317] National Parks & Conservation Ass'n v. Babbitt, 241 F.3d 722, 731 (9th Cir. 2001).
[318] Save Our Ecosystems v. Clark, 747 F.2d 1240, 1248 (9th Cir. 1983); Oregon Envtl. Council v. Kunzman, 714 F.2d 901, 905 (9th Cir. 1983).

cross-pollination and other means) and cause unknown and unwilling human exposures. Accordingly, APHIS has its own duty to comply with NEPA, including assessment of potential significant impacts to public health and safety.

There is a further reason APHIS must not merely defer in toto to FDA: FDA's voluntary consultation process is extraordinarily weak. It is based on a statement of policy, not a binding regulation.[319] GE crop developers may choose to consult with FDA, but this process is vitiated by its voluntary nature and a lack of any established testing standards; in particular, GE crop developers seldom if ever conduct animal feeding trials with GE crops for the purpose of detecting potential toxicity. FDA did not prepare any NEPA documentation (no EA nor EIS) on its policy nor provide notice and comment.[320] The manufacturer merely sends FDA a summary of its findings. FDA makes no findings' rather FDA merely had no questions with Pioneer's submission.

Other potential adverse health impacts

It is well accepted that genetic engineering has a greater likelihood of producing unintended effects than traditional breeding, some of them hazardous or detrimental.[321] Unintended effects are rarely well-understood, but can result from extensive mutations to the organism's genes caused by the genetic engineering process,[322] or unexpected metabolic alterations. Such disruptions are sometimes evident in the form of non-viable or debilitated organisms. Others may have subtler effects that go undetected in the development process. Potential adverse effects include the unintended amplification of naturally occurring toxins that are normally present at low, unobjectionable, levels; the unintended creation of novel toxins; or reduced levels of nutrients.

For example, yeast genetically modified for altered glycolytic pathways exhibited a 30-fold increase in production of methylglyoxal,[323] a highly toxic and mutagenic compound that also causes enhanced protein glycation and oxidative stress, conditions associated with diabetes, neurodegenerative disease and a variety of autoimmune disorders.[324] The authors of the yeast study concluded that "careful thought should be given to the potential metabolic products and their safety when a genetically modified yeast is applied to food-related fermentation processes.[325]

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[319] *Alliance for Bio-Integrity v. Shalala*, 116 F.Supp.2d 166 (D.D.C.2000).
[320] *Id.* at 170.
[321] NAS (2004). *Safety of Genetically Engineered Foods: Approaches to Assessing Unintended Health Effects, Committee on Identifying and Assessing Unintended Effects of Genetically Engineered Foods on Human Health*, Institute of Medicine & National Research Council, National Academy of Sciences.
[322] Wilson, AK, Latham, JR and RA Steinbrecher (2006). "Transformation-induced mutations in transgenic plants: Analysis and biosafety implications," *Biotechnology and Genetic Engineering Reviews*, Vol 23, Dec. 2006, 209-234.
[323] Inose, T. & Murata, K. Enhanced accumulation of toxic compound in yeast cells having high glycolytic activity: A case study on the safety of genetically engineered yeast. *Intl J Food Sci Tech* **30**, 141-146 (1995).
[324] Kurien, B.T., Hensley, K., Bachmann, M. & Scofield, R.H. Oxidatively modified autoantigens in autoimmune diseases. *Free radical biology & medicine* **41**, 549-556 (2006).
[325] Inose et al (1995), op. cit.

A second example involves production of the dietary supplement tryptophan in bacteria. In the late 1980s, thousands of consumers of tryptophan contracted a rare and debilitating disease, eosinophilia myalgia syndrome, that was most likely due to the unintended creation of highly toxic metabolites when the manufacturer switched from conventional to genetically modified bacteria to produce the tryptophan.[326] The world's most widely planted GM crop, Roundup Ready soybeans, have been reported to have lower phytoestrogen levels,[327] and higher levels of lignin,[328] the latter effect implicated in stem-splitting at high temperatures. Other unintended effects reported in GM plants are necrotic lesions in wheat, adverse tuber tissue perturbations in GM potatoes, and unexpected carotenoid derivatives in GM rice.[329]

Current assessment procedures examine a very limited array of key nutrients and selected anti-nutrients and toxicants for potential changes in levels of expression relative to non-engineered plants. With this "targeted approach:"

"…unexpected changes are merely identified by chance. The targeted approach has severe limitations with respect to unknown anti-nutrients and natural toxins…"[330]

The inadequacies of this approach have led to calls for a "non-targeted" assessment utilizing profiling methods.

Profiling methods currently available or under development include DNA expression analysis, proteomics, two-dimensional gel electrophoresis, and chemical fingerprinting. These techniques – used singly or in combination – permit simultaneous, small-scale, quantitative analysis of a large array of plant components, including messenger RNA, proteins and metabolites. The virtue of this "non-targeted" approach is that it casts a wide net, implicitly acknowledging what genetic engineers often prefer to ignore: that genetic engineering often causes completely unintended effects, making the crude "targeted" analysis of a few cellular components ineffective as a means for detecting them. Kuiper et al (2001) urge rapid refinement and application of these profiling techniques to ensure the most complete assessment possible of unintended effects caused by any application of genetic engineering. In part because profiling techniques have not been perfected, long-term animal feeding studies with the whole GM plant are also

[326] Kilbourne, EM et al (1996). "Tryptophan produced by Showa Denko and epidemic eosinophilia-myalgia syndrome," *J. Rheumatol Suppl.*, 46: 81-88; Schubert, D.R. (2002). "A different perspective on GM foods," Nature Biotechnology 20: 969.
[327] Lappe, MA et al (1998). "Alterations in clinically important phytoestrogens in genetically modified, herbicide-tolerant soybeans," *Journal of Medicinal Food,* 1: 241-45.
[328] Gertz, J.M., Vencill, W.K. and Hill, N.S. (1999). Tolerance of transgenic soybean (Glycine max) to heat stress. In: Proceedings of the 1999 Brighton Crop Protection Conference: Weeds, Vol. 3. Farnham, UK: British Crop Protection Council, pp. 835-840.
[329] Kuiper, HA, Kleter, GA, Noteborn, HPJM & Kok, EJ (2001). Assessment of the food safety issues related to genetically modified foods," *The Plant Journal* 27(6): 503-528, Table 6.
[330] Kuiper et al (2001), op. cit., p. 516.

needed to ensure that any subtle, long-term effects (such as reproductive disorders, cancers, or endocrine disruption) do not go undetected.[331]

It should be noted that neither US nor EU regulatory authorities demand either comprehensive profiling assessments or long-term animal feeding studies with the whole GM plant. For one recommended GM crop safety testing scheme, see Freese and Schubert (2004).

The Need for additional testing of Event 98140 for unintended effects

U.S. regulators have yet to acknowledge the need for long-term animal feeding studies, despite the fact that several such studies suggest that certain GM crops may be harmful.[332] However, the need to test for unintended alterations in the levels of nutrients and naturally occurring, harmful plant compounds is better accepted. No tests were conducted for several toxins that have recently been characterized in ground corncobs, fresh corn, and as well as corn tortillas in a series of seven papers published by a Baylor University team from 2002 to 2008.[333]

The presence of these toxins was first discovered by accident, when researchers observed severe disruption in the sexual behavior of laboratory rats raised on ground corncob bedding material. The endocrine-disrupting substances were eventually isolated, and were found to be tetrahydrofuran-diol (THF-diol) and leukotoxin-diol (LTX-diol) derivatives of linoleic acid, the most common fatty acid in corn. The lowest observed

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[331] Freese, W. & Schubert, D. (2004), "Safety Testing and Regulation of Genetically Engineered Foods," *Biotechnology and Genetic Engineering Reviews,* Vol. 21, November 2004, pp. 299-324.; http://www.foe.org/camps/comm/safefood/gefood/testingregbackgrounder.pdf.

[332] Velmirov, A, Binter, C and J. Zentek (2008). "Biological effects of transgenic maize NK603 x MON810 fed in long term reproduction studies in mice," Federal Ministry for Health, Families and Youth, Government of Austria, October 2008; Seralini, GE, Dellier, D, de Vendomois, JS (2007). "New analysis of a rat feeding study with a genetically modified maize reveals signs of hepatorenal toxicity," Arch. Environ. Contam. Toxicol. 52(4): 596-602.

[333] Shoulars K, Rodriguez MA, Thompson T, Turk J, Crowley J, Markaverich BM (2008). "Regulation of the nitric oxide pathway genes by tetrahydrofurandiols: microarray analysis of MCF-7 human breast cancer cells," *Cancer Lett.* 264(2): 265-73; Markaverich BM, Crowley J, Rodriquez M, Shoulars K, Thompson T (2007). "Tetrahydrofurandiol stimulation of phospholipase A2, lipoxygenase, and cyclooxygenase gene expression and MCF-7 human breast cancer cell proliferation," *Environmental Health Perspectives* 115(12): 1727-31; Markaverich BM, Alejandro M, Thompson T, Mani S, Reyna A, Portillo W, Sharp J, Turk J, Crowley JR (2007). "Tetrahydrofurandiols (THF-diols), leukotoxindiols (LTX-diols), and endocrine disruption in rats," *Environmental Health Perspectives* 115(5): 702-8; Markaverich BM, Crowley JR, Alejandro MA, Shoulars K, Casajuna N, Mani S, Reyna A, Sharp J (2005). "Leukotoxin diols from ground corncob bedding disrupt estrous cyclicity in rats
and stimulate MCF-7 breast cancer cell proliferation," *Environmental Health Perspectives* 113(12): 1698-704; Mani SK, Reyna AM, Alejandro MA, Crowley J, Markaverich BM (2005). "Disruption of male sexual behavior in rats by tetrahydrofurandiols (THF-diols)," *Steroids* 70(11): 750-754; Markaverich BM, Alejandro MA, Markaverich D, Zitzow L, Casajuna N, Camarao N, Hill J, Bhirdo K, Faith R, Turk J, Crowley JR (2002). "Identification of an endocrine disrupting agent from corn with mitogenic activity," *Biochem Biophys Res Commun* 291(3): 692-700;
Markaverich et al (2002). "A Novel Endocrine-Disrupting Agent in Corn with Mitogenic Activity in Human Breast and Prostatic Cancer Cells," *Environmental Health Perspectives*, 110(2), Feb. 2002, pp. 169-177.

adverse effects levels of THF-diols and LTX-diols for blocking estrous cyclicity in female rats were found to be 0.5-1.0 ppm and 0.2-0.5 ppm, respectively, while 1-2 ppm of THF-diols block male sexual behavior. These potent compounds are therefore active at levels 200-fold lower than classical phytoestrogen endocrine disruptors. In addition to their impacts on rat sexual behavior, these compounds also foster proliferation of human breast and prostrate cancer cells *in vitro*, and so may adversely affect human health.

These potential significant impacts to public health require analysis in an EIS.

Submitted on February 6, 2009

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Appendix 1: Adoption of Herbicide-Tolerant GM Crops vs. Quantity of Glyphosate Applied in the U.S.

Year	**Soybeans**		**Corn**		**Cotton**		**Soybeans, corn, cotton**	**Notes**
	Glyphosate applied[1]	% = HT[2]	Glyphosate applied[1]	% = HT[2]	Glyphosate applied[1]	% = HT	Glyphosate applied	
1994	4,896,000	0%	2,248,000	0%	789,189	0%	**7,933,189**	The first HT crop, Roundup Ready soybeans, were introduced in 1995.
2002	67,413,000	75%	5,088,000	11%	n.a.	74%[3]	n.a.	
2003	n.a.	81%	13,696,000	15%	14,817,000		n.a.	
2005	75,743,000	87%	26,304,000	26%	17,024,000		**119,071,000**	More than 15-fold increase in glyphosate use on soybeans, corn and cotton from 1994 to 2005.
2006	96,725,000	89%	n.a.	36%	n.a.	86%[4]	n.a.	More than 19-fold increase in glyphosate use on soybeans, the most widely planted Roundup Ready crop, from 1994 to 2006.
2007	n.a.	91%	n.a.	52%	18,572,000	92%[5]	n.a.	

[1] Pounds of active ingredient. Source for all crops: "Agricultural Chemical Usage: Field Crops Summary," USDA National Agricultural Statistics Service, for the respective years. Accessible from: http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1560. The figures represent sum of all versions of glyphosate, including sulfosate. USDA pesticide usage figures cover only a certain percentage of the nationwide acreage planted to the given crop, a percentage which varies from year to year. In order to obtain the best estimate of nationwide use, we have corrected by dividing total reported glyphosate use by the percentage of the nationwide crop acreage for which pesticide usage data was reported. n.a. = not available, note that USDA does not report pesticide usage for all crops in all years.

[2] Percentage of overall crop acreage planted to herbicide-tolerant varieties. From USDA's Economic Research Service (ERS), see: http://www.ers.usda.gov/Data/BiotechCrops/alltables.xls. Figures are the sum of percentages listed for "herbicide-tolerant only" and "stacked gene varieties." As defined by ERS, stacked gene varieties always contain an HT trait. All HT soybeans are Roundup Ready. In 2006, 96% of HT cotton was Roundup Ready, 4% was tolerant to glufosinate (LibertyLink). Most HT corn is Roundup Ready; a small but unknown percentage is tolerant to glufosinate (LibertyLink).

[3] May, O.L., F.M. Bourland and R.L. Nichols (2003). "Challenges in Testing Transgenic and Nontransgenic Cotton Cultivars," *Crop Science* 43: 1594-1601. http://crop.scijournals.org/cgi/reprint/43/5/1594.pdf. Figure calculated by adding all HT varieties in Table 1. Based on USDA AMS data, see next footnote.

[4] From USDA's Agricultural Marketing Service (AMS), which has more reliable statistics on cotton than USDA's ERS. See: "Cotton Varieties Planted: 2006 Crop," USDA AMS. Figure calculated by adding percentages of all HT varieties (those with designations R, RR = Roundup Ready or RF = Roundup Ready Flex and LL for LibertyLink). Note that most HT cotton is Roundup Ready (Flex); LL cotton varieties comprised only 3-4% of US cotton in 2006.
[5] From "Cotton Varieties Planted: 2007 Crop," USDA AMS, at: http://www.ams.usda.gov/mnreports/cnavar.pdf.

Appendix 2: Usage of Leading Herbicides Other Than Glyphosate on Corn and Soy in the U.S.: 2002 to 2006

Crop	**Soy**	**Corn**				**Notes**
Active ingredient	2,4-D[1] (lbs.)	Atrazine[2] (lbs.)	Acetachlor (lbs.)	Metalachlor/ S-metalachlor (lbs.)	Top 4 corn herbicides (lbs.)	
2002	1,389,000	55,018,000	34,702,000	25,875,000	115,595,000	
2003	n.a.	60,480,000	39,203,000	27,535,000	127,218,000	
2005	1,729,000	61,710,000	32,045,000	27,511,000	121,266,000	From 2002 to 2005, atrazine use on corn increased by 12%. Use of the top four corn herbicides increased 4.9%. The 5-fold increase in glyphosate use on corn over the same time span (see Table 1) has clearly not displaced any of the leading corn herbicides.
2006	3,673,000	n.a.	n.a.	n.a.	n.a.	Use of 2,4-D on soy rose by more than 2.6-fold from 2002 to 2006. Over the same period, glyphosate use on soy rose 43% (see Table 1). Glyphosate is clearly not displacing use of 2,4-D.

Figures = pounds of active ingredient. Source: "Agricultural Chemical Usage: Field Crops Summary," USDA National Agricultural Statistics Service for the respective years. Accessible from: http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1560. USDA pesticide usage figures cover only a certain percentage of the nationwide acreage planted to the given crop, a percentage which varies from year to year. In order to obtain the best estimate of nationwide use, we have corrected by dividing total reported use of the respective herbicide by the percentage of the nationwide crop acreage for which pesticide usage data was reported. n.a. = not available, note that USDA does not report pesticide usage for all crops in all years.

1 2,4-D, the second-most heavily used herbicide on soybeans (after glyphosate), is a phenoxy herbicide that formed part of the Vietnam War defoliant Agent Orange. 2,4-D has been associated with a number of adverse health impacts on agricultural workers who apply it: increased risk of cancer, particularly non-Hodgkin's lymphoma, and increased rate of birth defects in children of men who apply the herbicide. 2,4-D is also a suspected endocrine disruptor. For more, see http://www.beyondpesticides.org/pesticides/factsheets/2,4-D.pdf. For restrictions on residential use of 2,4-D in various countries, see: http://en.wikipedia.org/wiki/2,4-D. Figures cited are the sum of all forms of 2,4-D.

2 Atrazine, the most heavily used herbicide on corn, has been linked to endocrine disruption, neuropathy and cancer (particularly breast and prostate cancer). Atrazine is regularly detected in drinking water supplies in the Midwest, and has been associated with low sperm counts in men. Exposure to extremely low levels of atrazine can cause sex change and/or deformities in frogs, fish and other organisms. Based on this evidence, and the widespread presence of atrazine in drinking water supplies, the European Union announced a ban on atrazine in 2006. The U.S. EPA re-registered atrazine in 2003 despite objections from scientists and environmental groups. See http://www.beyondpesticides.org/pesticides/factsheets/Atrazine.pdf and http://www.loe.org/shows/segments.htm?programID=06-P13-00016&segmentID=1.