Comments on the Draft Environmental Impact Statement for Deregulation of Roundup Ready Alfafa
Center for Food Safety

Docket No. APHIS-2007-0044
Regulatory Analysis and Development
PPD, APHIS
Station 3A-03.8
4700 River Road Unit 118
Riverdale, MD 20737-1238

Comments submitted to the USDA APHIS regarding:

Glyphosate-Tolerant Alfalfa Events J101 and J163: Request for Nonregulated Status, Draft Environmental Impact Statement – November 2009

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Roundup Ready alfalfa is one of several crops that have been genetically engineered to withstand direct application of glyphosate-based herbicides to kill nearby weeds. One cannot apply glyphosate in this way to most conventional crops without killing or badly injuring the plant. Thus, glyphosate use is generally limited to "pre-emergence" applications in conventional field crops, meaning before the seed has "emerged" or sprouted. The tolerance trait has made it possible to apply glyphosate "post-emergence" (directly to the growing plant), thus facilitating vastly increased, season-long use of glyphosate on major field crops. Because of this unique tolerance trait and the profound changes in weed control practices it made possible, Roundup Ready (RR) alfalfa (like other RR crops) can only be understood as one element of a binary weed control system that comprises the RR alfalfa plant and associated use of glyphosate.[1] Following Monsanto, we henceforth refer to this weed control technology as the "Roundup Ready crop [e.g. alfalfa] system."

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[1] This concept is borrowed from Monsanto, which described its latest Roundup Ready soybean in these terms: "The utilization of Roundup agricultural herbicides plus Roundup Ready soybean, collectively referred to as the Roundup Ready soybean system…" From: "Petition for the Determination of Nonregulated Status for Roundup Ready2Yield™ Soybean MON 89788," submitted to USDA by Monsanto on June 27, 2006 (revised November 3, 2006), APHIS Docket No. APHIS-2006-0195, p. 4).

Alfalfa farmers generally do not use herbicides on alfalfa, or only to a very limited extent. According to USDA's National Agricultural Statistics Service (NASS), universally acknowledged as the gold standard for pesticide usage information, just 7% of alfalfa hay acreage was treated with herbicides of any sort in 1998, while overall herbicide use on alfalfa was 1.468 million lbs.[2] Thus, just 1 of 14 acres of alfalfa hay was treated with weed-killing chemicals, while 13 of 14 acres were grown without them. EPA reports that 465 million lbs. of herbicides were applied agriculturally in 1998, so alfalfa's share of total herbicide use was just 0.32% (1.468/465). Given the fact that alfalfa ranks 4th in U.S. crop acreage (23.6 million acres in 1998), this is a remarkably small amount of herbicide. Please refer to Appendix 1 for discussion of the quality of these data sources on pesticide use versus those APHIS relies on in the EIS.

This paucity of herbicide use makes alfalfa unique among major field crops in mainstream American agriculture. Unlike alfalfa, the great majority of acreage of other major crops is heavily treated with chemical herbicides. Ever year, over 90%, and usually over 95%, of corn, soybeans and cotton receive herbicides; these three crops received the bulk of the 465 million lbs. of herbicides that were applied in 1998.

Alfalfa is grown practically without herbicides because it is a perennial plant that grows vigorously in dense stands that crowd out weeds. As a perennial plant, it is grown for 3-5 years or sometimes up to 10 years without the yearly plowing or chemical burndown that is typical of annual crops like corn and soybeans. In an annual cropping system, weeds start off each year in a "cropless" field, with full access to the light, moisture and nutrients they need to thrive. Weeds that sprout early, with a head start on the crop plant, are thus much more problematic, while later-sprouting weeds are often shaded out and "outcompeted" by the crop plants. In contrast, a perennial like alfalfa survives the winter, and its thick stands give weeds little or no opportunity to compete for the life of the stand. For alfalfa, harvest is not a year-end prelude to death and dessication, as it is for annual crops, but rather a periodic mowing, which when conducted properly reinvigorates the stand. This is not to say that alfalfa is never infested with weeds, just that they are relatively insignificant in comparison weed competition in other (annual) crops. Unfortunately, APHIS gives the false impression throughout the EIS that alfalfa is an herbicide-intensive crop like corn or soybeans. This false impression sets up an equally false "need" for a pesticide-based weed control technology like Roundup

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[2] USDA NASS (1999). "Agricultural Chemical Usage: 1998 Field Crops Summary," USDA's National Agricultural Statistics Service, May 1999, pp. 9-10. On page 9, see U.S. figure under the Percent column for percent of national alfalfa acreage treated with herbicides. On p. 10, see the entry ("*" = less than one percent) for glyphosate. 1998 is the last year in which NASS surveyed alfalfa farmers for their pesticide usage practices. APHIS did not consult these NASS data, universally regarded as the highest quality data on national pesticide use, in the EIS. For more on NASS data as the gold standard for pesticide usage information, see Appendix 1.

Ready alfalfa. This false presumption of extensive herbicide use on conventional alfalfa also sets up thoroughly unrealistic and overblown estimates of the extent to which the RR alfalfa system will "displace" herbicides used on conventional alfalfa.

In the supporting materials, CFS has included a number of studies which demonstrate that:

1) When weeds do infest alfalfa, it is primarily in the first year of stand establishment, and in particular the first harvest of the first year. By the end of the first year, weed biomass drops off considerably as the vigorously growing alfalfa outcompetes weeds. Weed growth is also diminished as successive mowing operations (typically, 4 times a year) weaken weeds, further diminishing their ability to compete or reproduce. Typically, weeds become even more insignificant in subsequent years, even in stands of alfalfa hay that receive no herbicides.

2) A traditional practice known as companion cropping is sometimes used to suppress weeds in the early stages of alfalfa growth. Companion crops such as oats are seeded concurrently with alfalfa, and grow more quickly. The companion crop also provides protection against soil erosion and protects the young alfalfa plant from wind damage, and is then harvested for either silage or grain, providing a valuable source of feed or extra income to the grower. Several studies have shown that companion cropping provides excellent weed control, equal or at times even superior to that provided by herbicides.

3) Most weeds are not a problem even when they are ubiquitous, as in the first several harvests of the first year of stand establishment. Studies of the nutrient composition of common alfalfa weeds have shown many of them to be nutritionally equivalent (i.e. protein and mineral content), or nearly so, to alfalfa, and so perfectly good fodder for dairy cattle and other livestock.

However much the experts APHIS consults favor greater use of weed-killers, it is important to remember that very few farmers find any use for them on alfalfa. If they did, then much more than 7% of alfalfa hay acreage would be treated with herbicides.

Unfortunately, the introduction and adoption of a pesticide-based weed control system like Roundup Ready alfalfa will substantially increase herbicide use on alfalfa. That is, it is likely that many of the farmers who now use little or no herbicide will switch to GT alfalfa. This assessment is based chiefly on two considerations. First, GT crop systems are very seductive, in that glyphosate initially offers effective weed control in an unregulated GT crop system. But after a few years, the GT system's built-in overreliance on glyphosate leads to rapid evolution of glyphosate-resistant weeds and "weed shifts" to species with natural tolerance to glyphosate. These glyphosate-resistant and glyphosate-tolerant weeds proliferate, making glyphosate progressively less effective, leading first to increased doses and more frequent applications of glyphosate, then to supplementation of glyphosate with multiple other herbicides. Thus, after a brief honeymoon period of effective weed control, the GT crop system rapidly leads to greater use of more toxic weed-killers, with concomitant adverse impacts on human health, the environment and farmer income. This dynamic has been thoroughly demonstrated with unregulated use of other GT crop systems, and has already led to such severe glyphosate-resistant weed infestations on millions of acres that leading weed scientists warn that glyphosate-resistant weeds pose a threat to world food production. Glyphosate-resistant weeds as the inexorable result of GT crop systems are discussed further in Appendix 2.

The second consideration relates to the highly concentrated nature of the seed market. Experience in corn, soybeans and cotton demonstrates that farmers have ever fewer choices of high-quality conventional seed, as the biotechnology-pesticide companies buy up independent seed firms, preferentially offer higher-priced GM seed, and rapidly eliminate more affordable conventional varieties from their seed catalogs, and exert pressure on their licensees to do the same. This dynamic is exacerbated by the decline in public sector (land-grant university) breeding programs, which were once a major source of affordable seed to American farmers. As a result, farmers are often unable to find high-quality conventional seeds, and are constrained to purchase GM seeds with traits, such as the Roundup Ready trait, that they do not want. Once a farmer has purchased Roundup Ready seeds, the significant premium (double the price of conventional seed in the case of alfalfa) incentivizes use of the trait through application of Roundup.

While it is beyond the scope of these comments to elaborate much further, we will point out that recent years have witnessed the beginnings of a backlash against Roundup Ready soybeans. Many growers are turning away from the Roundup Ready system due to the sharp hikes in the price of RR seeds, the high cost of Roundup and additional herbicides needed to combat glyphosate-resistant (GR) weeds, and/or the ability to legally save and replant conventional soybean seed (which is illegal with patented RR seed).

The important point here is that ***there is a severe shortage of conventional soybean seeds. Demand is far outstripping supply in at least five states.[3] Many farmers who would like to buy conventional soybean seeds are not able to find them.*** In the case of Roundup Ready seed, this is a clear consequence of Monsanto's "biotech trait penetration" strategy, according to which lower profit-margin conventional seeds are phased-out in favor of more profitable GM seeds, in particular those with the RR trait. This strategy only becomes possible to implement in a concentrated seed marketplace, where the increasing market power

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[3] See file entitled: Conventional seeds hard to find in demand-COLLECTION in supporting materials.

of a few dominant seed providers takes precedence over farmer demand in determining which seeds are offered to American farmers. A sign of the seriousness of this problem is the ongoing Dept. of Justice investigation of seed industry concentration, which is focused particularly on the Monsanto Company, for anticompetitive practices. Declining choice of conventional and other more affordable seed varieties is one area of investigation.[4]

In the EIS, APHIS did not assess the potential for deregulation of RR alfalfa to lead to a decline in the availability of conventional alfalfa seed varieties. The few sentences in the EIS on "seed market concentration" are completely general in nature and contain no such analysis of the alfalfa seed market. In fact, APHIS mis-cites a study by USDA's Economic Research Service to the effect that seed industry concentration "has been accompanied by a decrease in the intensity of ***public*** research in crop variety development."[5] In fact, what USDA's researchers actually said was as follows:

"…consolidation in the private seed industry over the past decade may have dampened the intensity of ***private*** research undertaken on crop biotechnology relative to what would have occurred without consolidation, at least for corn, cotton and soybeans." They add: "Also, ***fewer companies developing crops and marketing seeds may translate into fewer varieties offered***" (Fernandez-Cornejo & Schimmelpfennig 2004, emphasis added).

Thus, APHIS not only fails to analyze the alfalfa seed market for potential impacts of deregulation on limiting conventional seed choices, but APHIS also distorts a USDA study pointing to this very possibility.

One obvious consequence of introducing the RR alfalfa system would be a substantial increase in the use of glyphosate, over already extremely high and growing levels. Glyphosate is (by far) the most heavily used chemical pesticide in the history of agriculture, due primarily to the widespread adoption of other RR crop systems. EPA's latest estimate for overall agricultural use of glyphosate in the U.S. is 135 million lbs. acid equivalents,[6] which translates to 182 million lbs. of the most commonly used isopropylamine salt of glyphosate, as found in many of Monsanto's glyphosate products, including Honcho brand herbicide (Figure 1).

The adverse consequences of unrestrained use of glyphosate with RR crop systems argues for great caution before any more RR crop systems, including RR alfalfa, are deregulated. These adverse consequences include a rapidly growing epidemic of glyphosate-resistant weeds; increased disease susceptibility and reduced

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[4] See file entitled: CFS-CTA Monsanto-DPL Merger Report Public Release Final in supporting materials, together with other related documents.

[5] EIS at 177-78, emphasis added.

[6] EPA (2009). "Glyphosate Summary Document Registration Review: Initial Docket," Environmental Protection Agency, June 2009, p. 12. See also EPA (2008), both in supporting materials.

nutritional content of major crops, stemming mainly from adverse impacts of glyphosate on soil microbiota; increased rates of cancer and possibly other diseases in farmers and farmworkers who use Roundup; and a possible role in the worldwide decline of amphibian populations. These important issues are discussed in detail in several documents included in the supporting materials. A documented overview can be found in the file entitled Glyphosate Registration Review – FINAL 9-21-09, which CFS submitted to the EPA in September of last year for the initial phases of its registration review of glyphosate, and which is included in the supporting materials submitted to this docket. We would add that the EPA last reviewed glyphosate in 1993, and that there has been an enormous increase in its use since that time, as well as a substantial amount of new research on the various adverse impacts of glyphosate and glyphosate-based herbicide formulations on the environment and the interests of agriculture. CFS believes it would be only prudent of APHIS to refrain from taking any action, such as deregulation of RR alfalfa, that promises to substantially increase the use of this herbicide, before EPA has the opportunity to review glyphosate's registration and impose any needed restrictions on its use.

While APHIS has generally failed to provide an adequate quantitative analysis of the likely impacts of the RR alfalfa system on herbicide use in general, or glyphosate in particular, there is one attempt at estimating glyphosate use. Assuming 90% adoption of the RR alfalfa system (that is, on 90% of the 2007 alfalfa acreage of 21.67 million acres), and assuming application of the highest allowable annual rate of glyphosate on GT crops of 7.32 lbs./acre/year, APHIS provides a high-end estimate of the "potential amount of glyphosate due to adoption of GT alfalfa" of 142,761,960 lbs. per year.[7]

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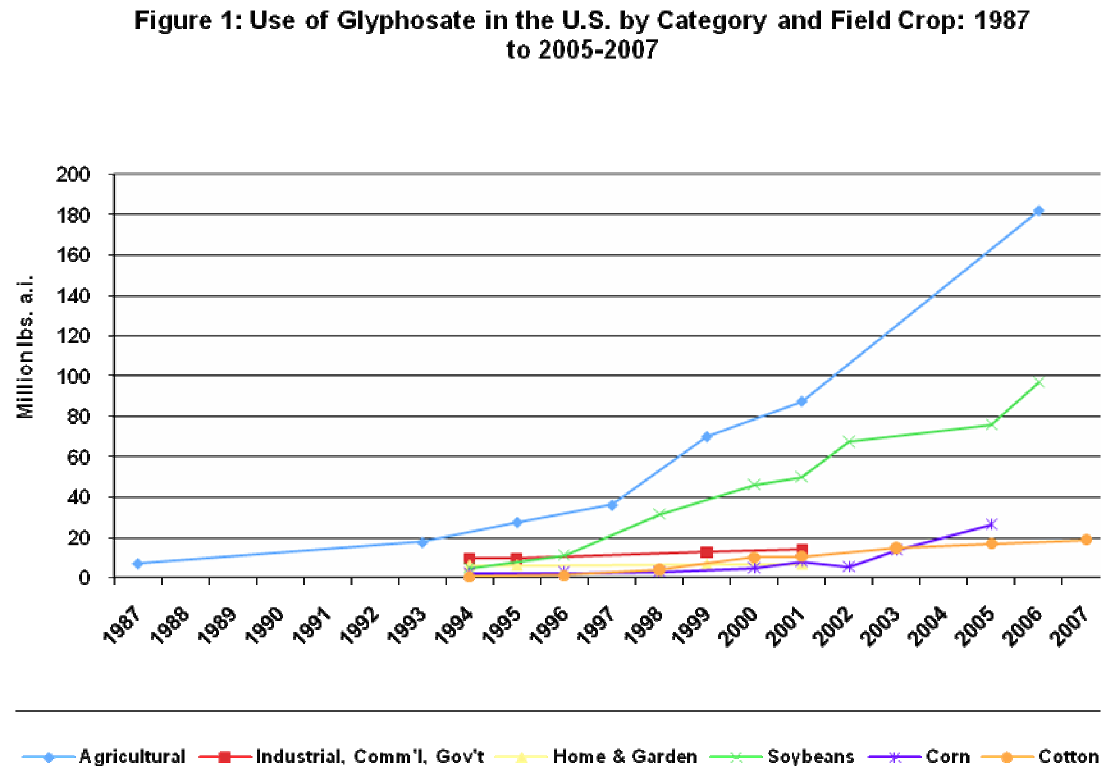
[7] EIS at N-17 to N-18.



Figures for agricultural; industrial, comm'l, gov't; and home & garden uses of glyphosate from EPA. For the years 1987 to 1995: "Pesticides Industry Sales and Usage: 1994 and 1995 Market Estimates," EPA, August 1997, Tables 8 & 9. For the years 1997, 1999 & 2001, see: "Pesticides Industry Sales and Usage: 2000 and 2001 Market Estimates," EPA, May 2004, Tables 3.6 to 3.8. Both available at: http://www.epa.gov/oppbead1/pestsales/. Each data point is the midpoint of the range (e.g. 27.5 for 25-30 million) given in the documents cited above. EPA figure for 2006 derived from EPA (2009). "Glyphosate Summary Document Registration Review: Initial Docket," June 2009, p. 12. See: http://www.regulations.gov/search/Regs/home.html#documentDetail?D=EPA-HQ-OPP-2009-0361-0003, which states that 135 million lbs. glyphosate acid equivalents are applied annually to agricultural crops in the U.S., based on data from Screening Level Estimates of Agricultural Uses of the Case Glyphosate, 11/26/08. Acid equivalents converted to the most common salt of glyphosate (isopropylamine) using 0.74 conversion factor to arrive at the equivalent figure for the isopropylamine salt of glyphosate (182 million lbs.) to facilitate comparison to prior years. EPA leaves unclear in which year this estimated 135 a.e./182 a.i. million lbs. of glyphosate were applied. Comparison of EPA's figures for soybeans, corn and cotton in the Screening Level Estimates with the latest available from USDA NASS for soybeans (2006), corn (2005) and cotton (2007) suggests that EPA relied primarily on these USDA NASS data. We choose 2006 as the midpoint of this three year (2005-2007) range, and because soybeans, surveyed in 2006, receive the most glyphosate. See text for explanation as to why this figure likely underestimates actual glyphosate use, which CFS estimates at 210-220 million lbs. a.i. (iso.). Glyphosate use figures for soybeans, corn and cotton derived from USDA NASS Agricultural Chemical Usage reports for respective years, adjusted to reflect usage on 100% of crop acreage. See: http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1560.

Reference to Figure 1 (based on EPA's latest estimate of total glyphosate use in American agriculture) reveals that this amount of glyphosate applied to Roundup

Ready alfalfa would exceed the amount of glyphosate applied to all agricultural crops combined (using EPA's acid equivalents estimate of 135 million lbs., and assuming APHIS's estimate is also in acid equivalent units). Frankly, we find this estimate excessive. Our own assessment (see Appendix 2) is based on a somewhat lower RR alfalfa adoption rate, and usage at less than the maximal allowable rates. According to this estimate, glyphosate use on Roundup Ready alfalfa would be more on the order of 30 – 70 million lbs, though with the important caveat that it will increase as time goes by, with the inexorable emergence of glyphosate-resistant weeds.

What is remarkable about APHIS's estimate above is that APHIS does nothing with it. It is a meaningless number-crunching exercize without consequence for its later analysis.

One clear consequence of the vastly increased glyphosate use to be expected with introduction of the RR alfalfa system is acceleration of the emergence and spread of glyphosate-resistant weeds, which is covered in some depth in Benbrook (2009), included in the supporting materials.

Since that report was released just months ago (November 2009), there has been a flood of new reports of GR weeds (see Appendix 3). CFS has kept close tabs on glyphosate-resistant weed reports on the best available source, which is the Weed Science Society of America's reporting system at www.weedscience.com. As Appendix 3 makes clear, the confirmed reports of both the number of GR biotypes and the acreage infested by them have increased dramatically of late. From November 2007 to the present, the maximum acreage infested has increased from just over 2 million acres to 11.4 million acres.

In Appendix 4, we describe a biotype of a new GR weed species that has particular relevance to alfalfa, sugar beet and wheat cropping systems, glyphosate-resistant kochia.

We have discussed kochia at some length because it is an especially problematic weed in alfalfa and sugar beets, and because there is a high likelihood that GR kochia will emerge rapidly in RR alfalfa and RR sugar beets. Continued, unregulated use of RR crop systems ensures that the future will see the evolution of many other GR weeds.

Chuck Foresman, manager of weed resistance strategies for Syngenta Crop Protection, Inc., estimates a 40% growth rate in acreage infested with glyphosate-resistant weeds in the coming years, with 38 million row crop acres infested with GR weeds by 2013, or one in every four acres.[8]

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[8] Syngenta (2009). "Leading the fight against glyphosate resistance," Syngenta Crop Protection, Inc.

Below, we give just a few of the many examples of costs – in terms of the environment, human health and financial – attributable to RR crop systems and their consequences. These are costs that APHIS has either completely ignored, or made no attempt to quantify, in the EIS.

1) **Arsenic-based herbicides make comeback to control GR weed caused by RR crop systems:**
In 2006, the EPA decided not to reregister (i.e. prohibit all further uses of) arsenic-based herbicides. The EPA came to this decision because of concern that these organic arsenicals could contaminate drinking water supplies; wind up in meat and milk products derived from livestock fed cotton byproducts laced with arsenical herbicide residues; and impair the health of farmers and farm-workers who apply these chemicals. The EPA subsequently changed course and decided to reregister (permit continued use of) organic arsenical herbicides on cotton. The major reason for this about-face was the desperate need of cotton growers for effective herbicides to control an extremely damaging glyphosate-resistant (GR) weed known as Palmer amaranth.[9] GR Palmer amaranth first arose in 2005, and has since infested millions of acres of cotton- and soybean-growing land in the South and Midwest. The extremely rapid emergence of this GR weed since 2005 is ***directly attributable*** to the RR cotton and RR soybean systems, with their heavy and (at least initially) near exclusive reliance on glyphosate. While other uses of these arsenic-based herbicides will be phased out over the coming years, the exemption for continued use on cotton appears to have no time limit.[10] No one predicted the emergence of this damaging weed, just as no one predicted GR kochia would emerge. This example illustrates the potential for harm to human health and the environment from use of a class of toxic, arsenic-based herbicides specifically for control of a noxious GR weed whose emergence is attributable to unregulated RR crop systems.

2) **Cocktail of seven herbicides recommended to control GR Palmer amaranth**
Arsenic-based herbicides are not sufficient to control GR Palmer amaranth, however. In fact, leading weed scientists in Georgia, where GR Palmer amaranth is worst, have recommended an herbicide regime comprising 7 different chemicals as needed to control this noxious weed, as follows:

    a) Pre-emergence: fomesafen, pyrithiobac, and pendimethalin
    b) Post-emergence: glyphosate and metolachlor
    c) Lay-by directed application: MSMA (monosodium methaneaersonic acid) and

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[9] EPA Arsenic (2009a). "Amendment to Organic Arsenicals RED," Letter from EPA's Richard P. Keigwin, Director, Special Review and Reregistration Division, to Registrant, April 22, 2009;
[10] EPA Arsenic (2009b). "Organic Aresenicals; Product Cancellation Order and Amendments to Terminate Use," EPA Notice, Fed. Reg. Vol. 74, No. 188, Sept. 30, 2009, pp. 50187-50194. Last page has exemptions for cotton.

diuron.[11]

MSMA is one of the arsenic-based herbicides to which EPA has given a new lease on life to battle the noxious GR Palmer amaranth.

3) **"Likely carcinogenic" corn herbicide poised for use in soybeans and cotton to combat GR weeds caused by RR crop systems**
Monsanto recently registered a new formulation of the corn herbicide, acetochlor, for use in soybeans and cotton, explicitly to combat glyphosate-resistant weeds (e.g. GR Palmer amaranth and GR tall waterhemp) in those crops.[12] Although acetochlor was the second most heavily used herbicide on corn in 2005 (over 32 million lbs. applied nationally), USDA NASS data show that essentially no acetochlor was used in cotton or soybeans in that year.[13] EPA has classified acetochlor as "likely to be carcinogenic to humans" based on increased incidence of lung tumors and histiocytic sacrcoma in mice, and increased incidence of nasal epithelial tumors and thyroid follicular cell adenomas in rats.[14] Chronic exposure to acetochlor has produced testicular atrophy, renal injury and neurologic movement abnormalities in laboratory animals.[15] EPA believes exposure to acetochlor in drinking water and other sources is below levels of concern. Yet additional, and perhaps substantial additional use of acetochlor to combat GR weeds in two major crops (soybeans and cotton) where it had not been used before will likely increase human exposure to the chemical. Here too, GR weeds are the occasion for increased use of a carcinogenic herbicide that otherwise would not be deployed.

4) **Use of 2,4-D – component of Vietnam War defoliant Agent Orange – increases substantially in soybeans to combat GR weeds**
When weeds evolve resistance to glyphosate, 2,4-D is one of the most commonly

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[11] Webster, T.M. & L.M. Sosnoskie (2010). "Loss of glyphosate efficacy: a changing weed spectrum in Georgia cotton," Weed Science 58: 73-79.
[12] Monsanto (2010). "Monsanto Company receives approval for new acetochlor herbicide formulation," Monsanto, Feb. 2, 2010. http://www.greenbook.net/viewStory.aspx?StoryID=1085, last visited 2/28/10.
[13] USDA NASS (2006). "Agricultural Chemical Usage: 2005 Field Crops Summary," USDA NASS, May 2006, pp. 2, 19. Pesticide usage surveyed on 93% of corn acres (p. 2), to which 29.802 million lbs. were applied (p. 19). National use = 29.802/0.93 = 32.045 million lbs.
[14] EPA (2006). "Report of the Food Quality Protection Act (FQPA) Tolerance Reassessment Progress and Risk Management Decision (TRED) for Acetochlor," US EPA, March 2006, p. 4. http://www.epa.gov/oppsrrd1/reregistration/REDs/acetochlor_tred.pdf.
[15] CDC (undated). "Acetochlor: Chemical Information," National Report on Human Exposure to Environmental Chemicals, Centers for Disease Control, http://www.cdc.gov/exposurereport/data_tables/Acetochlor_ChemicalInformation.html.

recommended supplements. As early as 2001, Ohio State University agricultural advisers recommended using a combination of 2,4-D, metribuzin and paraquat as pre-emergence chemicals to prevent the evolution of glyphosate-resistant marestail (horseweed) in Roundup Ready soybeans in Ohio.[16] In 2005, 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 2,4-D, Clarity (dicamba), Gramoxone Max (paraquat) or Ignite (glufosinate).[17] In 2006, it was reported that farmers would rely increasingly on older herbicides such as 2,4-D, dicamba and paraquat to control glyphosate-resistant giant ragweed and other GR weeds.[18]

USDA NASS figures confirm that farmers are in fact using substantially more 2,4-D to combat GR weeds. From just 2002 to 2006, use of the chemical on soybeans increased from 1.39 to 3.67 million lbs., a more than 160% increase. 2,4-dichlorophenoxyacetic acid (2,4-D) is one of the oldest herbicides, and formed part of the Vietnam War defoliant Agent Orange. Ingestion or inhalation of 2,4-D has adverse effects on the nervous system – loss of coordination, limb stiffness, stupor, coma. A growing body of evidence points to 2,4-D as a carcinogen. Studies in the U.S., Italy, Canada, Denmark and Sweden link 2,4-D exposure to non-Hodgkin's lymphoma, a cancer of the immune system. Studies of farmworkers who handled 2,4-D in northern states reveal higher than normal rates of birth defects in their children. 2,4-D is also a mutagen and an endocrine disruptor, and is sometimes found contaminated with the highly toxic compound dioxin, which is highly carcinogenic, weakens the immune system, decreases fertility, and causes birth defects. 2,4-D is banned in Norway.[19]

5) Supplemental herbicide recommended for use with glyphosate for "improved weed control" in Roundup Ready sugar beets

Just as APHIS wrongly assumes that glyphosate will displace all other herbicides in the RR alfalfa system, so one often encounters the same "Roundup only" claim with respect to the RR sugar beet system. Yet even though RR sugar beets have

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[16] Loux, M. and J. Stachler (2001). "Is There a Marestail Problem in Your Future?" Crop Observation and Recommendation Network, Ohio State University Extension, April 2001. http://corn.osu.edu/archive/2001/apr/01-07.html#linkg.

[17] "Glyphosate-resistant Palmer Pigweed Found in West Tennessee," Farm Progress, Staff Report, September 23, 2005. http://nebraskafarmer.com/story.aspx/glyphosateresistant/palmer/pigweed/found/in/west/tennessee/8/394

[18] Roberson, R. (2006). "Pigweed not only threat to glyphosate resistance," Southeast Farm Press, Oct. 19, 2006. http://southeastfarmpress.com/news/101906-herbicide-resistance/.

[19] Based on: Beyond Pesticides (2004). "2,4-D: chemicalWATCH Factsheet," Beyond Pesticides, 2004. http://www.beyondpesticides.org/pesticides/factsheets/24D_Jul04.pdf.

only been grown commercially for two years (introduced in 2008), already one major pesticide manufacturer is recommending supplemental use of an herbicide, known as "Upbeet" (triflusulfuron methyl), "for improved weed control in Roundup Ready sugar beets" – and in particular, to "provide improved control of wild buckwheat, common lambsquarter, common mallow, redroot pigweed, and velvetleaf."[20] Two of these weeds are naturally glyphosate-tolerant, meaning they become more prevalent members of the local weed community due to "weed shifts" in RR crop fields continually subjected to glyphosate applications over time.[21]

6) **GR weeds driving increased use of premix herbicides and tank mixtures with multiple herbicides, to be used with multiple herbicide-resistant crops**

Glyphosate-resistant weeds are such a serious problem that much of the research of agricultural biotechnology companies is geared toward development of crops with "enhanced" resistance to glyphosate; to non-glyphosate herbicides such as 2,4-D and dicamba (chlorophenoxy herbicides that are probable human carcinogens); and to multiple herbicides. These developments are described in Benbrook (2009) in the supporting materials. One example of a crop resistant to multiple herbicides is DuPont-Pioneer's Optimum GAT corn and soybeans, which resist applications of both glyphosate and certain classes of the large herbicide family known as ALS inhibitors. These new dual-HT crops are being sold together with premix herbicide products containing two and usually three herbicidal active ingredients, and marketed as a partial solution to weeds that have evolved resistance to glyphosate or to ALS inhibitors. For instance, Instigate herbicide contains rimulfuron and chlorimuron-ethyl, ALS inhibiting herbicides to handle glyphosate-resistant weeds, and the HPPD herbicide mestrione to control ALS inhibitor-resistant weeds. Of course, an increasing number of weed populations have developed dual-resistance to both glyphosate and ALS inhibitors, meaning that even this 3-in-one product will not be sufficient, and making it necessary for Dupont to offer the following recommendation:

"**Tank-Mix Partners**

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[20] DuPont (2007). "DUPONT UPBEET HERBICIDE: UpBeet plus glyphosate for improved weed control in Roundup Ready Sugar Beets," 2(ee) Recommendation under FIFRA, 2007, expires 12/31/11.

[21] APHIS misunderstands a fundamental tenet of weed science in the EIS, the difference between species tolerance and evolved resistance. APHIS also wrongly excludes velvetleaf from the list of glyphosate-tolerant weeds that are problematic in alfalfa (see EIS at G-25, velvetleaf listing; and Hower et al (1999), op. cit., Table 29, p. 60, where velvetleaf is the 4th most problematic summer annual weed of spring-seeded alfalfa; and Tables 30 & 31 (pp. 63, 66), where velvetleaf is also listed as a weed in fall-seeded alfalfa and established alfalfa stands.

Instigate™ demonstrated additional control of emerged weeds when tank mixed with herbicides such as 2,4-D, atrazine, glyphosate and glufosinate.
Instigate™ demonstrated additional residual weed control when tank mixed with herbicides such as atrazine, metolachlor and acetochlor."[22]

Thus, farmers could easily use a total of 4-7 different herbicidal active ingredients (3 in one product, plus one to four tank-mix partners) in an effort to kill increasingly herbicide-resistant weeds. This is one of several pre-mix herbicide products sold specifically for use together with dual-herbicide-resistant Optimum GAT corn and/or soybeans. In each case, DuPont gives similar "Tank-Mix Partners" recommendations.

Roundup Ready alfalfa system will increase use of toxic herbicides for removal of RR alfalfa stands

As even APHIS is forced to concede, introduction of Roundup Ready alfalfa will eliminate glyphosate as an option for alfalfa stand removal, and therefore increase the use of more toxic herbicides for this purpose.[23] Though APHIS makes this concession, it fails to give even a rough estimate of the increase in use of more toxic herbicides for stand removal. Below, we supply such a rough estimate.

As noted above, EPA estimates that 200,000 lbs. a.e. glyphosate are applied to alfalfa each year, on less than 2.5% of national alfalfa acreage. If one assumes 2% of 22.25 million acres receive glyphosate, that equals 0.45 million acres, or 450,000 acres. Since so little glyphosate or any other herbicide is needed for weed control in alfalfa, and as APHIS and its sources agree, glyphosate is "often used" for alfalfa stand removal, the majority of the glyphosate-treated alfalfa acreage is likely used for stand removal purposes. If one assumes 400,000 acres treated with glyphosate are for stand removal purposes, then replacement herbicides would be needed for this much acreage. Sources cited by APHIS (Mayerle 2002, Manitoba 2002) and one other (U of Wy 2006) give several possible herbicide regimes for stand removal without glyphosate:

Herbicide(s) (chemical name(s))	Rate (combined)	Source
Curtail (clopyralid + 2,4-D)	0.8 liter/acre	Mayerle (2002)

[22] DuPont Instigate Herbicide (2008). Instigate is one of several "premix" herbicides being marketed for use with dual herbicide-tolerant, Optimum GAT corn and soybeans. Each comes with similar "Tank-Mix Partner" recommendations. EPA recently approved the registration petition for Instigate herbicide.
[23] EIS at 121 (emphasis added): "In conventional alfalfa fields, ***glyphosate is often used*** to remove alfalfa after 3 to 8 years when it has become vulnerable to weeds and thinning. For stand removal, adoption of GT [alfalfa] would likely result in a shift from glyphosate to other herbicides due to the inability of glyphosate to remove stands of GT alfalfa."

Curtail (clopyralid + 2,4-D)	1 liter/acre	Manitoba (2002)
Curtail (clopyralid + 2,4-D)	40 oz/acre	U of Wy (2006)
Banvel + 2,4-D (dicamba + 2,4-D)	0.9 liter/acre	Manitoba (2002)
Tordon + 2,4-D (picloram + 2,4-D)	8 oz/acre	U of Wy (2006)
2,4-D ester alone	1-2 qts/acre	Endres (1999)
Banvel (dicamba) alone	0.5 liter/acre	Manitoba (2002)

Below, we estimate how much additional other herbicides would be used if each regime were to completely replace glyphosate. This would approximate a scenario in which all alfalfa is RR alfalfa, and so should be regarded as upper-bound estimates. Obviously, growers will make different choices, so the overall increase will be an aggregrate of some portion of each of these totals (and others not listed).

If glyphosate were to be completely replaced by Curtail for alfalfa stand removal, this would result in roughly 1 liter per acre or an additional 400,000 liters of Curtail (a mixture of clopyralid and 2,4-D); replacement with dicamba + 2,4-D at 0.9 liter/acre = an additional 360,000 liters of dicamba + 2,4-D; an additional 100,000 quarts of picloram + 2,4-D; an additional 400,000 to 800,000 quarts of 2,4-D alone; or an additional 200,000 liters of dicamba. The latter two regimes are not as likely, as neither chemical alone gives very good weed control on its own. Mayerle (2002) explains that another chemical “kick” (treatment) is often required later on to achieve adequate control of alfalfa prior to next season’s rotation crop, so these calculations likely underestimate the true impact of “losing” glyphosate for stand removal purposes.

One serious problem with increased use of several of these herbicides for stand removal is long-lasting residual effects that, in the case of picloram, can last for more than a year. Even very low levels of picloram residues on hay or straw can be hazardous.

Roundup Ready alfalfa system will increase use of toxic chemicals for eradication of volunteer RR alfalfa

Alfalfa stands grow dense and thick, with extremely deep roots. Removal is no easy task. This explains why many growers who use tillage have to make multiple passes, and why thorough removal of an old alfalfa stand is often accomplished with a combination of tillage and chemicals.[24] Even so, volunteer plants springing up in the following season’s crop are to be expected, and may prove to be significant problems for many growers. Volunteer RR alfalfa has the potential to be a widespread problem, for instance in vegetable fields previously planted to alfalfa,[25]

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[24] U of Wy (2006). “Roundup Ready Alfalfa,” University of Wyoming Cooperative Extension Service, B-1173, February 2006, Table 3.
[25] Tickes, B. (2002). “Evaluation of Stinger (clopyralid) for weed control in broccoli,” 2002 Vegetable Report, College of Agriculture and Life Sciences, University of Arizona.

just as volunteer RR corn is becoming a significant weed problem in RR soybean fields planted in subsequent years. As with alfalfa stand removal, if the volunteer alfalfa is Roundup Ready, then glyphosate is eliminated as an option for controlling it. As a result, there will be an increase in the use of the non-glyphosate herbicides listed above for stand removal, and/or others appropriate to the follow-on crop, to control volunteer RR alfalfa. APHIS gives a few examples of herbicide regimes that have shown promise in controlling volunteer RR alfalfa in a following season corn crop – but once again, as with alfalfa stand removal, fails to give any quantitative estimate of the increase in herbicide usage this would require:

> "Additional data demonstrated that early postemergence applications of herbicides (applied during the stage between the emergence of a seedling, and the maturity of the plant) used to control weeds in corn (Harness XTRA (acetochlor + atrazine), Degree (acetochlor), and Degree XTRA (acetochlor + atrazine) applied in tank mixtures with broadleaf herbicides Banvel (dicamba), 2,4-D, Marksman (atrazine + dicamba) and Hornet (clopyralid + flumetsulam) effectively controlled GT alfalfa in a GT corn crop."[26]

Thus, it appears that tank mixtures of up to 6 different herbicides will be applied to control RR alfalfa volunteers. Dicamba is a chlorophenoxy herbicide of the same class as 2,4-D, discussed above, and the State of California recently required both compounds be labeled as "probable human carcinogens." Acetochlor was described above.

Atrazine is a potent endocrine-disrupting compound that has been found to cause gonadal malformations in frogs at concentrations as low as 0.1 part per billion, and act as an endocrine disruptor in fish and reptiles as well.[27] A recent study demonstrated complete feminization and chemical castration of male African clawed toads from long-term exposure to just 2.5 parts per billion (ppb) atrazine, which is an environmentally-relevant concentration.[28] Atrazine is a leading suspected culprit in the worldwide decline of amphibians,[29] as are Roundup formulations with POEA (polyethoxylated tallowamine) surfactants (see supporting

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[26] EIS at 20.

[27] Hayes, T.B. et al (2006). "Characterization of Atrazine-Induced Gonadal Malformations in African Clawed Frogs (Xenopus laevis) and Comparisons with Effects of an Androgen Antagonist (Cyproterone Acetate) and Exogenous Estrogen (17β-Estradiol): Support for the Demasculinization/Feminization Hypothesis," Environmental Health Perspectives 114 (Suppl. 1): 134-141.

[28] Hayes, T.B. et al (2010). "Atrazine induces complete feminization and chemical castration in male African clawed frogs (*Xenopus laevis*), Proceedings of the National Academy of Sciences (Early Edition), www.pnas.org/cgi/doi/10.1073/pnas.0909519107.

[29] Biello, D. (2008). "World without Frogs: Combined Threats May Croak Amphibians," Scientific American News, October 30, 2008.

materials on atrazine as well as the studies by Dr. Rick Relyea on Roundup's toxicity to many species of frogs at quite low levels.

Atrazine is one of the most heavily used used corn herbicides, with lesser use in soybeans. In 2005, atrazine use in the U.S. totaled nearly 63 million lbs. on corn and soybeans: 62.29 million lbs. on corn and 0.61 million lbs. on soybeans.[30] Atrazine is one of the most common pesticide contaminants of ground and surface waters in the U.S. Atrazine has been demonstrated to induce breast and prostrate cancers in laboratory animals,[31] and workers exposed to atrazine in manufacturing plants have substantially increased rates of prostate cancer, reinforcing the carcinogenic potential of this compound.[32] Because of these health threats, the European Union banned atrazine in 2004. The U.S. EPA yielded to pressure from Syngenta and others, allowing atrazine use to continue despite its many harmful effects.[33]

APHIS does not supply any estimate of the increase in the use of atrazine, acetochlor, monosodium methanearsonic acid, the chlorophenoxy herbicides 2,4-D and dicamba, clopyralid, picloram, or any other non-glyphosate herbicide that will be required for:

1) Removal of old stands of RR alfalfa
2) Eradication of Roundup Ready alfalfa volunteers in follow-on crops
3) Control of glyphosate-resistant weeds fostered by the RR alfalfa system, both independently of and in conjunction with existing RR crop systems, including RR soybeans, RR corn, RR cotton, RR canola, or RR sugar beets.

In contrast, companion cropping provides an economical and effective means to control weeds without the use of toxic chemicals, as described briefly above. First, as a perennial plant it covers the ground uninterruptedly for the life of the stand,

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30 USDA NASS (2006), op. cit. For corn, 57.390 million lbs. (p. 19) reported on 93% of corn acreage (p. 2), for 57.390/0.93 = 62.29 million lbs. nationwide. For soybeans, 0.542 million lbs. (p. 97) on 89% of soybean acreage (p. 2) = 0.61 million lbs. nationwide.

31 Fan, W. et al (2007). "Atrazine-Induced Aromatase Expression Is SF-1 Dependent: Implications for Endocrine Disruption in Wildlife and Reproductive Cancers in Humans," Environmental Health Perspectives 115: 720-727.

32 Cox, C. (2002). "Group uncovers study linking atrazine with prostrate cancer," Journal of Pesticide Reform 22(2): Summer 2002.

33 LoE (2006). "EU on Atrazine," Living on Earth, PBS, transcript of interview with Tyrone Hays, April 21, 2006. http://www.loe.org/shows/segments.htm?programID=06-P13-00016&segmentID=1; Blumenstyk, G. (2003). "The Price of Research: A Berkeley scientist says a corporate sponsor tried to bury his unwelcome findings and then buy his silence," The Chronicle of Higher Education, October 31, 2003. http://chronicle.com/article/The-Price-of-Research/21691.

leaving little or no open ground for weeds to get started. By contrast, annual crops that are harvested in the fall leave vast expanses of bare ground open where weeds can flourish the following spring; spring plowing brings buried weed seeds to the surface, exacerbating weed problems.[34] In addition, alfalfa grows quite vigorously, in dense stands, outcompeting weeds for light, moisture and nutrients. Regular mowing ensures that any weeds present are continually cut before they can propagate.

Observers have long noted alfalfa's ability to outcompete damaging weeds, such as Canadian thistle.[35] In a study of field bindweed, Stahler remarks on alfalfa's "inherent ability" to successfully compete with this injurious weed for sunlight and soil moisture.[36] Alfalfa is also recommended for use in crop rotations because of its ability to suppress damaging annual weeds like wild oats, green foxtail and wild mustard in subsequently grown cereal crops.[37]

Healthy alfalfa is only vulnerable to weeds in the early stages of growth – the first 30-60 days – because many weeds initially grow faster than alfalfa seedlings. The bulk of these weeds are taken together with the first mowing of alfalfa, which explains why weed biomass can comprise over 50% of the first harvest of untreated alfalfa. However, alfalfa's vigorous growth leads rapidly to diminution of the weed community in its ranks, often by the end of the first year.

Even weedy alfalfa is usually perfectly acceptable as forage. In a study of the palatability and nutrient composition of 12 major alfalfa weeds included in the supporting materials, 6 were shown to be both palatable to livestock (sheep) and as nutritious as alfalfa.
In Appendix 5, CFS critiques APHIS's assessment of the herbicide use impacts of past GT crops.

In conclusion, we urge APHIS to take no action on Monsanto's petition for deregulated status for Roundup Ready alfalfa.

Bill Freese, Science Policy Analyst
Center for Food Safety

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[34] Sullivan, P. (2003). "Principles of Sustainable Weed Management for Croplands," Agronomy Systems Series, Appropriate Technology Transfer for Rural Areas, Sept. 2003. http://attra.ncat.org/attra-pub/PDF/weed.pdf.
[35] Entz, M.H., P.D. Ominski, A. Schoofs, and N. Kenkel (1999). "Perennial and Annual Forage Crops for Weed Control," University of Manitoba. http://www.umanitoba.ca/afs/Plant_Science/extension/ztill99.html.
[36] Stahler, L.M. (1948). "Shade and Soil Moisture as Factors in Competition Between Selected Crops and Field Bindweed, *Convolvulus arvensis," Journal of the American Society of Agronomy* 40: 490-502.
[37] Entz et al (1999), op. cit.

Appendix 1:
Data Sources for Pesticide Usage Information in Alfalfa Farming

For some reason, APHIS consistently ignores pesticide usage data collected by its sister agency, USDA's National Agricultural Statistics Service (NASS). This is quite surprising and unacceptable, given the fact that NASS is universally acknowledged to provide the most accurate and reliable pesticide information available in the U.S. As we will see, APHIS couples its neglect of NASS data with unfortunate reliance on data one to two decades old, on dubious "simulation studies" conducted by organizations funded by the biotechnology industry, and by use of a variety of illegitimate methods of its own.

CFS relies on NASS data for several reasons. First, NASS utilizes transparent, rigorous procedures and statistically valid sampling methods to deliver highly accurate pesticide data. Second, NASS has regularly collected pesticide usage data on the major crops for which glyphosate-tolerant (GT) versions are predominant (soybeans, corn and cotton) over the entire period of GT crop adoption, offering a consistent set of data that facilitates accurate, year-to-year comparisons. Finally, NASS data and methodologies are freely and publicly available, which allows for open review and criticism of any analysis utilizing them.

NASS's Advisory Committee on Agricultural Statistics, comprised of experts from academia and industry, had this to say in 2006:

> "NASS employs rigorous methods to ensure that statistically representative samples are achieved…." thus ensuring "a high level of data reliability and accuracy, which are the greatest advantage of NASS data."[38]

NASS data are also extensively used by the U.S. Environmental Protection Agency, state pesticide officials, pesticide firms and independent analysts.

The same NASS Advisory Committee quoted above found fault with alternative, private sector pesticide data, finding it non-transparent and potentially based on faulty sampling techniques (e.g. overly small sample sizes). With reference to Doane, the major private-sector provider of pesticide usage information, the Advisory Committee found that:

> "The proprietary agreements entered into by Doane subscribers extend well

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[38] USDA NASS (2006). "Meeting of the Advisory Committee on Agriculture Statistics (ACAS): Summary and Recommendations," February 14-15, 2006, USDA NASS, Appendix III, at: http://www.nass.usda.gov/About_NASS/Advisory_Committee_on_Agriculture_Statistics/advisory-es021406.pdf.

> beyond prohibitions on data disclosure, to embargo revelation of the sampling and analytical procedures used to generate their data. Thus, it may be that a large number of the area wide estimates included in the Doane system are based on individual or statistically unrepresentative observations."[39]

In other words, NASS is regarded by experts in the field as the authoritative source for pesticide usage information in American agriculture, while private sector companies may at times supply faulty pesticide data because of illegitimate (and secretive) techniques whose validity cannot be confirmed.

Our other major source of pesticide usage data – the US Environmental Protection Agency – is also ignored by APHIS. EPA recently began its "registration review" of glyphosate – the first since 1993, and in this context has developed the latest estimates for agricultural use of glyphosate by crop, including alfalfa. EPA's figures are contained in the EPA document "Screening Level Estimates of Agricultural Uses of the Case Glyphosate," November 26, 2008. The USDA and the EPA data referred to in these comments are included in the supporting materials.

APHIS offers no serious quantitative assessment of the likely impact of introducing GT alfalfa on pesticide use. "No calculations or speculation on GT alfalfa's specific impact on herbicide usage have been published…."[40] This is a startling deficiency, given the fact that GT alfalfa is engineered explicitly to alter herbicide usage practices; and that pesticide use is generally acknowledged to have adverse impacts on human health, the environment and farmer welfare; and that there is a real need to promote integrated pest (including weed) management to reduce the use of pesticides and the negative impacts to which they give rise. Instead, APHIS continually repeats the mantra that Roundup Ready alfalfa will or may reduce the use of non-glyphosate herbicides, but gives no quantitative analysis to back up these assertions.

One source that APHIS does cite repeatedly deserves examination. This is a white paper – not peer-reviewed, not published in any journal – called "The Importance of Pesticides and Other Pest Management Practices in U.S. Alfalfa Production," published for USDA's The National Agricultural Pesticide Impact Assessment Program (NAPIAP) in 1999.[41] While this white paper has certain useful information, it has several disadvantages that make it less reliable than USDA NASS data. First, the NAPIAP is based on data from 1988 to 1992, while USDA NASS surveyed pesticide use on alfalfa in 1998, so the latter data are more recent. Second, the

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[39] USDA NASS (2006), op. cit., Appendix III.

[40] EIS at 170. repeated almost verbatim at N-17.

[41] Hower, A.A., J.K. Harper and R. Gordon Harvey (1999). "The Importance of Pesticides and Other Pest Management Practices in U.S. Alfalfa Production," prepared for The National Agricultural Pesticide Impact Assessment Program, USDA, NAPIAP Document No. 2-CA-99.

NAPIAP white paper is not based on real pesticide usage data collected from alfalfa farmers themselves. Rather, it is based on responses to questionnaires mailed to unnamed "state specialists," who were asked to supply opinions about pesticide use and other weed control methods, problematic weeds and weed control costs in alfalfa farming for an "average year" in the period from 1988 to 1992 (the questionnaires were mailed out in December 1993).[42] Not only are state specialists less reliable sources of information about pesticide usage practices than the farmers who actually purchase and apply those pesticides, the fact that these specialists were asked to supply opinions on these matters for "an average year" over a period stretching back six years must have made real demands on their memory; and calls into question the accuracy and reliability of the extremely nuanced data supplied in the course of the paper's 65 tables. Finally, we are a bit suspicious of the objectivity of a study that insists, in its very title, on the "importance" of pesticides in a crop in which farmers demonstrably find so little use for them.

USDA NASS Agricultural Chemical Usage reports are not based on opinions of specialists, who in our experience are often biased to favor more input-intensive practices, but rather on detailed surveys of individual farmers chosen so as to form a statistically representative picture of the pesticide usage practices of farmers in their state or region. The surveys are conducted by trained enumerators, and the results are carefully assessed as to their reliability. In 1998, USDA NASS collected 755 usable reports of pesticide usage from alfalfa hay farmers in 48 states across the country (p. 6), with appropriate weighting of numbers surveyed from each region according to its relative importance in alfalfa production: Western region (274); North Central region (317); Northeast (62); and South (102). The survey procedure and reliability assessment are explained on pages 125-26. The major result was that just 7% of alfalfa hay acres were treated with herbicides:

"**Alfalfa Hay:** Growers applied herbicides to 7 percent of their acres across the United States." (p. 3)

In contrast, according to the opinions of the unnamed state specialists consulted by questionnaire by Hower et al (1999): "an average of only 16.6% of the alfalfa hay acreage was treated with herbicides…"[43] – over twice as much as the 7% determined by NASS. APHIS mistakenly cites Hower et al (1999) as stating that 22% of alfalfa hay acreage was treated with herbicides[44] – thus arriving at a figure more than three times as high as the NASS figure. This is by no means an insignificant error (or misrepresentation) on APHIS's part. It makes herbicide use appear to be more than three times more prevalent than it actually is, which as we

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[42] Ibid at 7.

[43] Hower et al, op. cit., p. 59.

[44] EIS at 67-68. APHIS wrongly cites Hower et al as stating that "16.6% of total fields; 22 percent of acreage" of hay fields were treated with herbicides. Hower et al (1999) say nothing about "total field," but rather refer explicitly to 16.6% of hay acreage as being treated with herbicides, as quoted above.

will see fits a pattern of pervasive bias throughout the EIS. APHIS's intent is to make alfalfa seem to be a much more herbicide-intensive crop than it really is, in order to make it seem that the huge increase in glyphosate use with RR alfalfa would be offset by significant decreases in the use of other herbicides. As we shall see, this is not the case.

APHIS also refers to Wilke (1998)[45] as the source of the latest available estimate for the percentage of alfalfa hay acres treated with herbicides – 17% -- which is incorrect. Wilke (1998) quotes one of the co-authors of the Howe et al (1999) study we referred to above, R. Gordon Harvey, who is referring to the 16.6% figure found in that study for the "average year" between 1988 ad 1992. As we noted above, USDA NASS's 1998 figure of 7% of hay acreage treated with herbicides is 6-10 years more recent, as well as being more accurate and reliable.

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[45] EIS at 61 and N-18.

Appendix 2
On How GT Crop Systems Trigger Evolution of Noxious, Glyphosate-Resistant Weeds

(We mistakenly cited two appendices as Appendix 2; this is the first one referred to, on page 4 of the body of these comment)

RR Crop Systems Trigger Evolution of Noxious Resistant Weeds
RR crop systems exert tremendous selection pressure for the emergence of glyphosate-resistant weed populations, in much the same way that overused antibiotics foster the evolution of antibiotic-resistant bacteria. This selection pressure consists of three key factors: 1) Massive extent of glyphosate use; 2) Frequent application of glyphosate over time; and 3) Overreliance on glyphosate. Each of these factors favors the survival and propagation of extremely rare individual weeds that have genetic mutations lending them resistance to glyphosate. Over time, as their susceptible brethren are killed off, such rare individual weeds become more numerous, and eventually dominate the weed population. This mechanism of resistant weed development does not involve gene transfer, but rather artificial selection pressure exerted by use of glyphosate.

The massive ***extent*** of glyphosate use on ever more acreage means an increasing number of individual weeds are exposed to the chemical. The more weeds exposed to glyphosate in any given area, the greater the likelihood that there exists among them a mutant individual with the rare genetic disposition to withstand glyphosate. Such rare mutants will then survive to propagate and gradually, over time, displace susceptible weeds to form a glyphosate-resistant weed population. This important scale factor explains why small-scale field trials are unlikely to accurately predict the potential for resistant weeds to evolve in an herbicide-tolerant crop system. The smaller the field trial, the fewer the weeds and the less likely a rare resistant mutant exists among them. In the Roundup Ready alfalfa petition for deregulation, Monsanto relied heavily on such small-scale field trials for its conclusion that continuous glyphosate use accompanying the continuous planting of Roundup Ready crops does not foster glyphosate-resistant weeds.[46] This theoretical prediction has long since been disproven by field experience with RR crops, as discussed further below.

High ***frequency*** of glyphosate application means frequent suppression of susceptible weeds, offering (at frequent intervals) a competition-free environment for any resistant individuals to thrive. Finally, ***overreliance*** on glyphosate means little opportunity for glyphosate-resistant individuals to be killed off by alternative weed control methods, thus increasing the likelihood they will survive to propagate and dominate the local weed population.

[46] Monsanto, Roundup Ready Alfalfa Petition, p. 359.

1. Massive extent of glyphosate use

Glyphosate was introduced by Monsanto in 1974, and for the next 10-15 years it remained a modestly used herbicide with a restricted range of uses, primarily in orchards. By 1987, six to eight million lbs. of glyphosate were used agriculturally in the U.S., placing it just 17th among agricultural pesticides (in terms of quantity applied). Two major agricultural developments over the past quarter-century have dramatically increased the extent of glyphosate's use (see Figure 1 in the body of these comments).

a. Glyphosate for burndown use

First, increasing adoption of conservation tillage/no-till cultivation practices in major field crops, especially in soybeans, drove a substantial increase in acreage treated with glyphosate for burndown use in the late 1980s and first half of the 1990s.[47] In no-till cultivation, crops are killed chemically (burnt down) at the end of the season, and the following year's seeds are drilled through crop stubble, rather than the traditional plowing under of crop residues. Glyphosate quickly became the herbicide of choice for such applications, facilitating its initial adoption in high-acreage field crop cultivation. This is the main factor driving the four- to six-fold increase in agricultural use of glyphosate from 1987 (6 to 8 million lbs.) to 1997 (34 to 38 million lbs.) (Figure 1).

b. Glyphosate use with glyphosate-tolerant crops

The second major factor driving increased glyphosate use has been the widespread adoption of transgenic, glyphosate-tolerant soybeans, cotton, and corn by farmers beginning in 1996, 1997 and 1998, respectively. While glyphosate had previously been restricted mainly to orchard use and burndown applications in field crops, glyphosate tolerance facilitated "over-the-top" or in-field application of this broad-spectrum herbicide that had previously been infeasible.

Glyphosate-tolerant (GT) varieties of soybeans and cotton were rapidly adopted, while GT corn lagged. Figure 2 shows that Roundup Ready (RR) crops, planted on just 1.2 million acres in 1996 (all RR soybeans), covered a massive 78.7 million acres just six years later in 2002,[48] or roughly ¾ of the overall acreage planted to both soybeans and cotton, and 10% of corn acreage. By 2008, the increasing adoption of RR versions of corn (up to 60% of overall crop acreage) and continuing increases in RR soybeans and cotton to the 90+% level, had pushed the total U.S.

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[47] That is, farmers who ***first*** adopt no-till or conservation tillage are then somewhat more predisposed to buy Roundup Ready seeds, which fit well into a reduced tillage system; however, the purchase of Roundup Ready seeds does not drive adoption of no-till/reduced tillage. This is frequently confused in the media and even the scientific press.

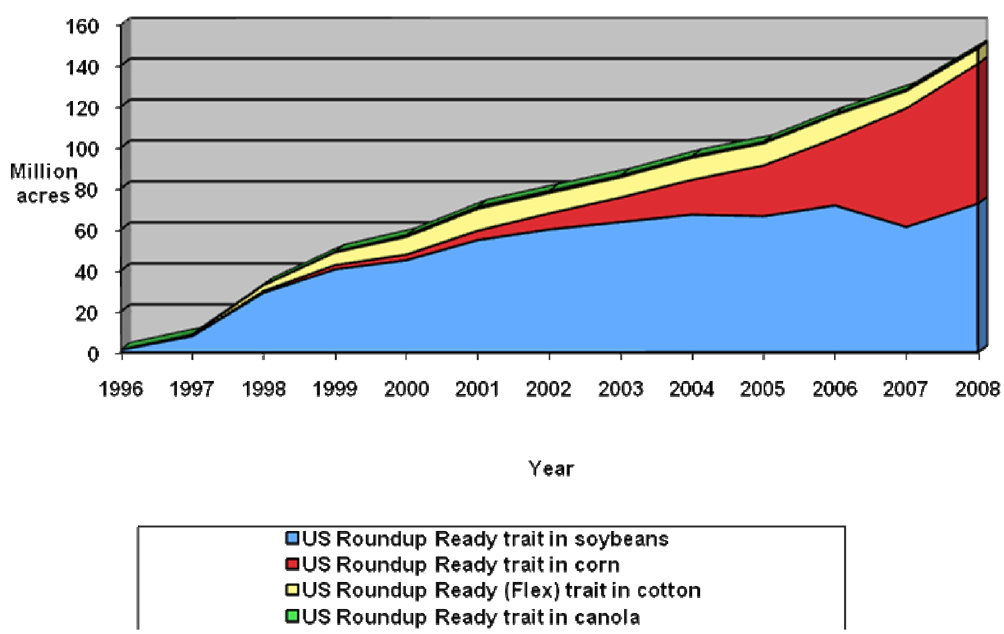
[48] Based on Monsanto's figures. The breakdown is RR soybeans (60 million acres), RR cotton (10 million), RR corn (7.8 million) and RR canola (0.9 million). Since canola is a relatively minor crop for which consistent data are lacking re: glyphosate use, we exclude it from the subsequent discussion.

Roundup Ready crop acres to near 150 million. For perspective, 150 million acres is equal to the areas of Iowa, Illinois, Missouri and Arkansas combined.

The use of glyphosate expanded along with Roundup Ready crop acreage. In the years before the RR version of soybeans (1995), cotton (1996) and corn (1997) were introduced, glyphosate was applied to just 20%, 13% and 4% of overall crop acreage, respectively. By 2006 and 2007, 97% of soybean acreage and 92% of cotton acreage, respectively, were treated with glyphosate. As noted above, RR corn adoption has been slower; but by 2005, the latest year for which we have NASS data, over 1/3 of corn acres (34%) were sprayed with glyphosate, and the total is likely 60-70% today, tracking RR crop adoption.

It is safe to say that American farmers have never before relied so completely on a single herbicide.

Figure 2: U.S. Acreage Planted to Crops with Roundup Ready Trait: 1996 to 2008



Source: Monsanto Biotechnology Trait Acreage: Fiscal Years 1996 to 2008, October 8, 2008. http://www.monsanto.com/pdf/investors/2008/q4_biotech_acres.pdf.

2. High Frequency and Intensity of Glyphosate Application

However, the huge ***expansion*** in glyphosate use is only part of the story. There has also been a marked increase in ***intensity***, as is evident from USDA NASS data.

Intensity is equivalent to pounds of herbicide applied per acre per year. This factor, known as the rate per crop year, has two components: the average amount of glyphosate applied to one acre in one application, multiplied by the average number of applications per year.

Crop	1996 (All Crops)			2005 (Corn), 2006 (Soy), 2007 (Cotton)		
	App's/year	Rate/app.	Rate/year	App's/year	Rate/app.	Rate/year
Corn	1.0	0.68	0.71	1.3	0.727	0.963
Soybeans	1.1	0.63	0.69	1.7	0.802	1.330
Cotton	1.0	0.63	0.66	2.4	0.787	1.900

Notes: Rate/year for corn and cotton is a bit more than the product of app's/year and rate/app. This is simply a rounding error. All figures from USDA NASS Agricultural Chemical Usage reports for the respective years, which are included in the supporting materials.

As shown in the table above, the average glyphosate intensity, as measured by the rate/year, nearly doubled for soybeans (0.69 to 1.330 lbs./acre/year) and nearly tripled for cotton (0.66 to 1.900 lbs./acre/year) over the indicated periods. To give a rough sense of the magnitude of these average increases, consider how they alter total glyphosate applied to typical national plantings of 70 million acres of soybeans and 10 million acres of cotton. For soybeans, the 0.64 lbs/acre/year increase (1.33 minus 0.69) raises total glyphosate use on soybeans by 45 million lbs. For cotton, the 1.24 lbs./acre/year increase (1.900 minus 0.66) raises total glyphosate use on cotton by 12-13 million lbs. These spikes in glyphosate usage derive only from the increased ***intensity***, and neglect the vastly increased ***extent***, of the herbicide's use, which latter is determined primarily by increases in soybean, cotton and corn acreage planted to Roundup Ready varieties, as discussed above.

A closer look at these figures shows that the average single application rate for both cotton and soybeans has increased modestly, by about 25%, while the average number of applications has climbed much more sharply (1.1 to 1.7, or 55%, for soybeans; 1.0 to 2.4, or 140%, for cotton). Thus, the increased average frequency of glyphosate application is largely responsible for the increased intensity of its use. Additional applications of glyphosate are a typical response to the increased prevalence of glyphosate-tolerant or glyphosate-resistant weeds.

This increasingly frequent "within-in season" use of glyphosate is matched by more frequent use at longer time scales. Farmers often utilize a corn/soybean rotation, growing one crop one year, and the other the next. A few years ago, RR soybean growers were likely to rotate to conventional (or non-RR) corn. Today, with high adoption rates of Roundup Ready corn, they are much more likely to grow a Roundup Ready crop every year. Growing RR crops every year means frequent use of glyphosate year after year, without a break. Micheal Owen, agronomist at Iowa State University, expressed concern five years ago that with over 90% of soybeans in Iowa planted to Roundup Ready varieties, the rapid adoption of Roundup Ready corn would lead to "an increasing number of crop acres where glyphosate will follow glyphosate" in the popular corn-soybean rotation,[49] vastly increasing selection pressure for glyphosate-resistant weeds (see below).

3. Overreliance

RR crop growers often rely exclusively on glyphosate for weed control. For example, a fairly recent survey of 400 soybean farmers found that ***56% in northern states and 42% in southern states used glyphosate as their sole herbicide***.[50] These are remarkably high levels of reliance on a single herbicide, contrasting sharply with the common use of several herbicides on conventional crops. The overreliance on glyphosate with RR crops is explained chiefly by two factors. First, the tolerance trait enables ("invites") repeated application of the chemical throughout the growing season, while conventional crops, which for the most part have no special tolerance to any herbicide, create no such incentive to use a particular herbicide. Secondly, glyphosate has been an extremely effective herbicide that controls a broad range of weeds, which until recently has made supplementary use of other weed control methods – weed-suppressing cover crops, crop rotations, or other weed-killers – largely unnecessary.

It is the combination of these three factors – increasing extent of use, which tracks Roundup Ready crop acreage; increasing intensity of use, determined chiefly by more frequent applications; and overreliance on glyphosate as the sole means to control weeds – that is responsible for the both steep rise in glyphosate use depicted in Figure 1, and the ongoing epidemic of glyphosate-resistant weeds.

In the decade from 1987 to 1997 (largely prior to the advent of RR crops), agricultural glyphosate use rose by an average of 2.9 million lbs. a.i. (iso.) per year. This was driven primarily by increasing burndown use of glyphosate, as noted above.

In the four years from 1997 to 2001, the average annual growth rate had more than quadrupled, to 12.9 million lbs. per year (i.e. 36 to 87.5 million lbs.).[51] The major factors driving this increase were widespread adoption of Roundup Ready soybeans and cotton.

The years since 2001 have seen not only continued growth, but ***a substantial acceleration in glyphosate's growth rate.*** Based on EPA's figures, agricultural use

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[49] Owen, M.D.K. (2005). "Update 2005 on Herbicide Resistant Weeds and Weed Population Shifts," 2005 Integrated Crop Management Conference, Iowa State University.
[50] Service, R.F. (2007). "A growing threat down on the farm," *Science*, May 25, 2007, pp. 1114-1117.
[51] Note that EPA figures for glyphosate use are given in ranges: e.g. 34 to 38 million lbs. (1997) and 85 to 90 million lbs. (2001). We have used the midpoint of these ranges for simplicity's sake.

of glyphosate rose from 87.5 million lbs. in 2001 to 182 million lbs. by 2006,[52] an average annual growth rate of 18.9 million lbs. over this period. The major factors driving this accelerated rate are glyphosate usage associated with increasing adoption of Roundup Ready corn, and the rapid emergence of weeds tolerant or resistant to glyphosate, to which we now turn.

Glyphosate-Resistant Weeds

Glyphosate was first introduced in 1974, and for the next 22 years there were no confirmed reports of glyphosate-resistant (GR) weeds. A few isolated populations of resistant weeds – mainly rigid and Italian ryegrass and goosegrass – emerged in the late 1990s, attributable to intensive glyphosate use in orchards (e.g., Malaysia, Chile, and California) or in wheat production (Australia).

The first GR weed population confirmed in the U.S, reported in 1998, was rigid ryegrass, which infested several thousand acres in California almond orchards. Beginning in the year 2000 in Delaware, GR horseweed rapidly emerged in RR soybeans and cotton in the East and South. Twelve prominent weed scientists reported on the rapid spread of this GR weed in 2004:

> "It is well known that glyphosate-resistant horseweed (also known as marestail) populations have been selected in Roundup Ready soybean and cotton cropping systems. Resistance was first reported in Delaware in 2000, a mere 5 years after the introduction of Roundup Ready soybean. Since that initial report, glyphosate-resistant horseweed is now reported in 12 states and is estimated to affect 1.5 million acres in Tennessee alone."[53]

CFS has closely followed the emergence of glyphosate-resistance weeds since November 2007, making use of the www.weedscience.com website of the Weed Science Society of America-Herbicide Resistance Action Committee website (WSSC-HRAC). Appendix 3 gives more information on the accelerating emergence of glyphosate-resistant weeds. In just a single decade, a snapshot in evolutionary time, GR weeds have expanded dramatically. Originally confined to the South and East (aside from the single biotype in California), they now infest at least 22 states. From a single biotype of one species (rigid species), 53 populations of 10 different species at tens of thousands of sites have evolved glyphosate resistance. And from just a few thousand acres infested in almond orchards in California, confirmed GR weeds now infest an estimated 11.4 million acres (upperbound estimate). Of those 53 populations, only two are listed as not expanding, while 41 are increasing in scope (for the 10 others, there was no report).

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[52] For conversion of 135 million lbs. glyphosate a.e. to 182 million lbs a.i. (isopropylamine salt), see caption to Figure 1. As explained further below, we believe this 182 million lbs. a.i. figure is a substantial underestimate attributable to a large underestimate of glyphosate use on corn.

[53] http://www.plant.uoguelph.ca/resistant-weeds/resources/preserving.html.

Since at least 2004, weed scientists have done their utmost to utmost to persuade commodity groups, the biotechnology-agrichemical-seed companies, the government, and farmers to make "stewardship" of glyphosate a priority. In that year, and again in 2007, preeminent weed scientists convened a "National Glyphosate Stewardship Forum" to that end.[54] A perusal of the proceedings of these meetings reveals a good deal of frustration. To these scientists, it is clear that the current use patterns of glyphosate in GT crop systems are not sustainable, and are rapidly undermining the efficacy of this "once in a century herbicide," as it has been called, through the rapid emergence of glyphosate-resistant weeds. Despite their efforts, there has been no concerted effort by industry or government to address the serious and growing threat posed by herbicide-resistant weeds.

The standard response to resistance is to switch "modes of action" – that is, use another herbicide that works in a different way to circumvent the plant's defenses. And while this will often work, the number of multiple-herbicide-resistant biotypes is on the rise, which threatens to undermine this strategy at least in some cases, and generate weeds that are still more difficult, expensive and hazardous to control in others. A growing number of glyphosate-resistant weeds are showing resistance to a second popular class of herbicides, ALS inhibitors. In Missouri, an initially small population of triple-resistant common waterhemp (resistant to glyphosate, ALS inhibitors and a 3rd class known as PPO inhibitors) was quite recently documented as having expanded from a thousand acres up to as much as one million acres.[55] In neighboring Illinois, a waterhemp population found in 23 southern counties has resistance to an astounding four classes of herbicide – glyphosate, ALS inhibitors, PPO inhibitors, and triazines (e.g. atrazine).[56] Two populations with dual resistance to glyphosate and paraquat have also emerged recently: hairy fleabane in California and horseweed in Mississippi.[57] These multiple herbicide-resistant populations are very troubling, because they suggest that non-specific modes of resistance may be involved, such as translocation (shunting an absorbed herbicide to tissues where it isn't lethal).

North Carolina weed scientist Alan York has called glyphosate-resistant weeds

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54 Owen, M. & C. Boerboom (2004). National Glyphosate Stewardship Forum, Nov. 17, 2004, St. Louis; http://www.weeds.iastate.edu/weednews/2006/NGSF%20final%20report.pdf; Boerboom, C. & Owen, M. (2007). "National Glyphosate Stewardship Forum: A Call to Action," March 20-21, 2007, St. Louis. http://www.agronext.iastate.edu/showitem.php?id=61.

55 http://www.weedscience.org/Case/Case.asp?ResistID=5269. Complete list of 53 reports of GR weeds as of March 3rd included in supporting materials.

56 Roberson, R. (2010). "Herbicide resistance finding troublesome," Southeast Farm Press, Jan. 19, 2010. http://southeastfarmpress.com/cotton/herbicide-resistance-0119/

57 http://www.weedscience.org/Summary/UspeciesMOA.asp?lstMOAID=12&FmHRACGroup=Go

"potentially the worst threat [to cotton] since the boll weevil," the devastating pest that virtually ended cotton-growing in the U.S. until an intensive spraying program eradicated it in some states in the late 1970s and early 1980s.[58] York concedes that: "Resistance is not unique with glyphosate," but goes on to state that: ***"What makes glyphosate resistance so important is our level of dependence on glyphosate***" (emphasis added).[59] In a similar vein, leading weed scientist Stephen Powles of the Western Australian Herbicide Resistance Initiative states: ***"Glyphosate is as important to world agriculture as penicillin is to human health."***[60]

These statements are measures of how thoroughly dependent North (and South) American farmers of our major field crops have become on this single chemical for weed control. The situation with glyphosate is in one sense a classic example of the pesticide treadmill, the process by which unrestrained use of the pesticide d'jour leads inexorably to resistance in pests (whether insect or weed), until a new chemical is introduced, to be rendered ineffective in its turn. It was repeated experience with this phenomenon in the 1960s and 1970s that led to calls for integrated pest (including weed) management, an approach that sought to lessen dependence on chemicals in favor of fundamental changes in farming methods. For instance, a practice as simple as rotating among three or four different crops, so that crop-specific pests don't have the opportunity to become established and proliferate; and cover crops like rye and hairy vetch, which replenish the soil and suppress weeds as well; could dramatically lessen reliance on pesticides. True integrated pest and weed practices employ pesticides only as a last resort, while industrial agriculture pretends that no other pest control technique exists.

Ironically, one of the big promises of biotechnology was that it would move us beyond the age of chemistry into a green world of agriculture founded on biology. It is quite obvious by now that this has not been the case. On the contrary, herbicide-tolerant crops like GT crop systems have significantly strengthened the already strong dependence of American agriculture on short-term chemical "fixes" to our pest problems. This reality was obscured for many, in the case of glyphosate-tolerant crops, by the presumed safety of glyphosate, and its seeming immunity (for two decades) to the plague of resistance that had undermined or at least seriously reduced the efficacy of prior pesticides. The myth of resistance immunity, fostered especially by Monsanto scientists, has certainly been shattered. And CFS does not share the reverence that many seem to feel for glyphosate. There is a growing body of evidence that this chemical, absorbed by the plant and exuded from its roots, fosters the growth of disease-causing fungi, and kills off beneficial soil microorganisms that are essential for the plant's uptake of essential minerals like manganese, which in turn are necessary for plant health and disease resistance. There are

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[58] Minor, E. (2006). "Herbicide-resistant weed worries farmers," *Associated Press*, 12/18/06. http://www.enn.com/top_stories/article/5679 (last visited Sept. 9, 2007).

[59] Yancy, C. (2005). "Weed scientists develop plan to combat glyphosate resistance," Southeast Farm Press, June 3, 2005.

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

also a number of good studies implicating glyphosate formulations in increased incidence of cancers (non-Hodgkin's lymphoma, multiple myeloma) in farmers. There is little doubt by now that popular Roundup formulations containing certain surfactants (POEA) are extremely toxic to amphibian populations, and may be implicated (along with other factors, chemical, biological and climate-related) in the worldwide decline of amphibian populations. None of this evidence has received the attention it deserves, though we urge APHIS to give it serious consideration.

Even if one doesn't accept the need for fundamental changes in our agricultural system, however, and even if one can't imagine a farming model that is a just a bit less chemical intensive, one can still agree, it seems to us, to the proposition that we should not make the production of every major food and feed crop so thoroughly dependent on a single chemical. Though we can well imagine that it brought smiles of condescension in certain quarters, we can't help but recall the following passage:

> *"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."*

We would hope, at least, that there might be somewhat less inclination to smile at the following, from a recent Commentary for the Proceedings of the National Academy of Sciences:

> *"The massive adoption of transgenic glyphosate-resistant crops has meant excessive reliance on glyphosate for weed control across vast areas. …. Globally, no weed control tools are as good as glyphosate, and its potential widespread loss because of resistance is a looming threat to global cropping and food production. …. It is not an exaggeration to state that the potential loss of glyphosate to significant areas of world cropping is a threat to global food production."*[61]

Dr. Stephen B. Powles, Australian Herbicide Resistance Initiative, University of Western Australia

Dr. Powles is a leading weed scientist, and also a farmer, who is given to calling glyphosate a "precious herbicide." If that is so, do we really want to spend it on a crop in so little need of a weed-killer as alfalfa?

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61 "Gene amplification delivers glyphosate-resistant weed evolution," PNAS, January 19, 2010, 955-56.

Appendix 2

Estimation of Glyphosate Use with Varying Rates of Adoption of Roundup Ready Alfalfa and Varying Rates of Application

The EPA estimates that 200,000 lbs. a.e. glyphosate are applied to alfalfa nationwide.[62] Two recent studies on glyphosate use and weed control with RR alfalfa funded in part by Monsanto are used below to estimate the likely increase in glyphosate use with introduction and varying degrees of adoption of RR alfalfa. These studies are included in the supporting material; McCordick et al (2008) is cited in the EIS.

McCordick et al (2008) conducted field studies in Michigan in 2004 and 2005 to compare the effects of different establishment and weed control methods on glyphosate-tolerant alfalfa production. Four glyphosate treatments of 0.8 kg a.e./hectare (= 0.71 lbs./acre) were applied over the course of the season, once roughly 5 weeks after seeding, then 7-10 days after each of three harvests. The total glyphosate applied for the season was thus 3.2 kg a.e./ha (= 2.86 lbs./acre).[63] In the second study, Wilson and Burgener (2009) tested RR alfalfa for three years from 2005 to 2007 in Nebraska, using a number of different glyphosate application regimes involving one or two applications of 0.75, 1.12 or 1.50 lbs. a.e./acre glyphosate at different alfalfa growth stages. Seasonal application rates of glyphosate thus ranged from (1 x 0.75) to (2 x 1.50) = 0.75 to 3.0 lbs. a.e./acre/year. In both studies, glyphosate was compared to other weed control regimes (discussed further below). Finally, the theoretical, legally permissible, upper limit of glyphosate use on RR alfalfa (based on the current maximum label rate) is also modeled.

Table 1 below estimates nationwide use of glyphosate use with several of the RR alfalfa system glyphosate regimens noted above, under each of three different adoption scenarios: 20%, 50% or 80% of total alfalfa acreage = Roundup Ready alfalfa. The figure we use for total alfalfa acreage (22.25 million acres) was derived by averaging the acreage of alfalfa harvested over the past decade (2000 to 2009), as reported by USDA NASS.

Glyphosate use varies quite widely under the different scenarios. At the low end, a single application per year of roughly half the maximum, single application label rate would mean 3.3, 8.3 or 13.3 million lbs. of glyphosate applied to RR alfalfa at 20%, 50% or 80% adoption rates, respectively. Relative to current annual

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[62] EPA (2008), op. cit. a.e. = acid equivalents, which represents the weight of glyphosate acid itself, excluding the weight of the salt that commercial formulations of glyphosate normally come with.

[63] 1 kg = 2.2046 lbs.; 1 hectare = 2.4711 acres. Multiplication of the kg/ha figures by 0.8922 gives lbs./acre.

nationwide use of glyphosate on alfalfa of 200,000 lbs. a.e. (= 0.2 million lbs), these scenarios yield 16-fold, 41-fold or 66-fold increases in glyphosate use, respectively.

Table 1

Glyphosate Application Regimen (No. Applications x Rate/Application = Lbs./Acre/Year)				Million Pounds Glyphosate Applied to RR Alfalfa at Different Adoption Rates (22.25 million acres = Total)		
Source	No Appl's	Rate	Lbs. a.e./acre/year	20%	50%	80%
a	1	0.75	0.75	3.3	8.3	13.3
a	1	1.12	1.12	5.0	12.4	19.9
a	2	1.12	2.23	9.9	24.8	39.7
a	2	1.50	3.00	13.3	33.4	53.4
b	4	0.71	2.86	12.7	31.8	50.8
c	1	1.55	1.55	6.9	17.2	27.6
d	n.a.	1.55	5.96	26.5	66.3	106.1

a) Wilson & Burgener (2009). "Evaluation of Glyphosate-Tolerant and Conventional Alfalfa Weed Control Systems during the First Year of Establishment," Weed Technology 23: 257-63.

b) McCordick et al (2008). "Establishment Systems for Glyphosate-Resistant Alfalfa," Weed Technology 22: 22-29.

c) Maximum rate for conventional alflafa. From: Roundup UltraMAX II label (2004): For conventional alfalfa, usage limited to one application of 1.55 lbs./acre for the season (if alfalfa is to be grazed or cut for feeding to livestock), p. 11. http://www.greenbook.net/Docs/Label/L72631.pdf

d) Maximum single and seasonal rates for RR alfalfa. EIS at N-22.

At the high end, the maximal seasonal rate applied by Wilson and Burgener (2009) of 3.0 lbs. a.e./acre/year (2 application of 1.5 lbs./acre) would mean 13.3 million, 33.4 million or 53.4 million lbs. glyphosate a.e. applied at 20%, 50% or 80% RR alfalfa adoption, respectively. In this scenario, glyphosate use would increase by 66 times over current levels with just 20% of alfalfa acreage converted to the Roundup Ready alfalfa system. Glyphosate use would increase 167-fold or 267-fold over current levels in the 50% or 80% adoption scenarios.

Finally, given the current maximum label rates for use of glyphosate on RR alfalfa, it would be legally permissible to apply 26.5, 66.3 or 106.1 million lbs. a.e. of glyphosate to RR alfalfa, if adopted at the 20%, 50% or 80% level, respectively – yielding 130 to 530 times as much glyphosate as is currently applied to alfalfa. It is unlikely that this much glyphosate would ever be applied to Roundup Ready alfalfa, however; we report these figures merely to delineate the theoretical, legally permissible limits to glyphosate use in the Roundup Ready alfalfa system.[64]

In general, the amount of glyphosate applied with use of the RR alfalfa system will increase over time, with evolution of glyphosate-resistant weeds and weed shifts to more glyphosate-tolerant species.

To what extent would the 16- to several hundred-fold increase in glyphosate use with the RR alfalfa system displace use of other "more toxic," "more environmentally harmful," herbicides, as APHIS claims *ad nauseum,* ***without any serious quantitative analysis,*** throughout the EIS? The NASS and EPA alfalfa pesticide usage data that APHIS somehow neglected to consult provide the answer. Overall herbicide use on alfalfa in 1998 was 1.468 million lbs.;[65] if one subtracts the 0.2 million lbs. of glyphosate, that leaves roughly 1.3 million lbs. of non-glyphosate herbicides applied to alfalfa. Even the low-end scenario of glyphosate use with RR alfalfa was 3.3 million lbs., with more likely scenarios roughly ten times higher (see below). The idea of replacing just over a million lbs. of non-glyphosate herbicides with 10 to 20 to 30 million or more lbs. of glyphosate-based formulations makes sense only to those who understand nothing about this pesticide's toxicity, its numerous harmful effects on the interests of agriculture, human health and the environment.

The scenarios above give a very wide range of possible glyphosate use with the RR alfalfa system. How much glyphosate would actually be used? No definitive answer is possible, yet it was clearly incumbent on APHIS to carefully analyze this matter rather than merely throwing out a casual upper-bound estimate.

An important factor that must be considered is that one substantial application of glyphosate is "built-in" to the RR alfalfa system – that is, necessary even in the event that a farmer doesn't have weed problems and otherwise wouldn't apply Roundup. According to the Monsanto label for several Roundup products:

> "….up to 10% of the [RR alfalfa] seedlings may not contain a Roundup Ready gene and will not survive the first application of this product. To eliminate the undesirable effects of stand gaps created by this loss of plants, a single application of at least 22 fluid ounces per acre of this product should be applied at or before the 4-trifoliate growth stage."[66]

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[64] With conventional alfalfa, the maximal single application rate of 1.55 lbs. a.e./acre is also the seasonal maximum, since only one application per year is permitted (at least for alfalfa that will be grazed or fed as forage). See Monsanto UltraMAX II label (2004), p. 11.
[65] USDA NASS (1999), op. cit., p. 9. See figure in row "U.S." and column "1,000 Lbs" under "Herbicide."
[66] Roundup WeatherMAX label (2007), Section 12.1, Roundup Ready Alfalfa, p. 14. Virtually identical wording is found in the Honcho label (2007), Section 12.1, Roundup Ready alfalfa, p. 14.

The recommended application rate for this purpose is 22 to 44 fluid ounces of Roundup WeatherMax, or 1 to 2 quarts of Honcho, both equivalent to a dose of 0.75 to 1.5 lbs. glyphosate a.e./acre. Thus, a farmer who wishes to avoid stand gaps in his/her RR alfalfa (which provide opportunities for weeds to invade the alfalfa stand, defeating the weed control purpose of the RR system) must make a quite early application of Roundup whether weeds are present or not. Reference to the scenarios in Table 1 shows that this "built-in" application by itself ensures that the RR alfalfa system will require from 3.3 to 13.3 million lbs. (if 0.75 lbs./acre are used) or from 6.6 to 26.6 million lbs. (if 1.5 lbs./acre) are used, depending on the RR alfalfa adoption rate.

For some growers, this application of glyphosate that is required to remedy defects in the RR alfalfa technology will do double duty for adequate, season-long weed control, at least in the short term. However, most growers will make at least one and in some cases several additional applications of glyphosate. This is because, generally speaking, somewhat later applications when the alfalfa seedlings are bigger provide more effective weed control than early treatments. Of the treatments tested by Wilson & Burgener (2009), the one that provided the best weed control was two applications of glyphosate (2 x 1.5 lbs. a.e./acre), one each at the four- and 16-trifoliate alfalfa growth stages. The second best treatment involved two treatments (2 x 1.12 lbs. a.e./acre) at the two- and eight-trifoliate stages.[67] Improved weed control with a second, later application is attributable to "catching" more weeds that have had the time to sprout since the earlier treatment.[68] The common use of a second application of glyphosate by RR alfalfa growers would correspond to the scenarios in Table 1 that project from 10 to over 50 million lbs. of glyphosate, depending on the adoption rate. Once again, this substantial amount of glyphosate could displace no more than just over 1 million lbs. of non-glyphosate herbicides.

Up to this point, the analysis has been based on two key assumptions: 1) That glyphosate at the recommended rates provides effective weed control; and 2) That the RR alfalfa system does not require supplementation with non-glyphosate herbicides. In the short term, these assumptions are probably justified. However, they quickly lose credibility when one considers medium to longer-term prospects.

In the medium to longer-term time frame, as little as 3-10 years, RR alfalfa growers will find that they need to apply two to three times as much glyphosate per acre per year as they did initially, and resort to other herbicides as well, in response to

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[67] Wilson & Burgener (2009), Table 2. Note that the corresponding treatments in the paper, in kg/ha, are 2 x 1.25 and 2 x 1.68. We have converted units to lbs./acre, as in Table 1 of these comments.

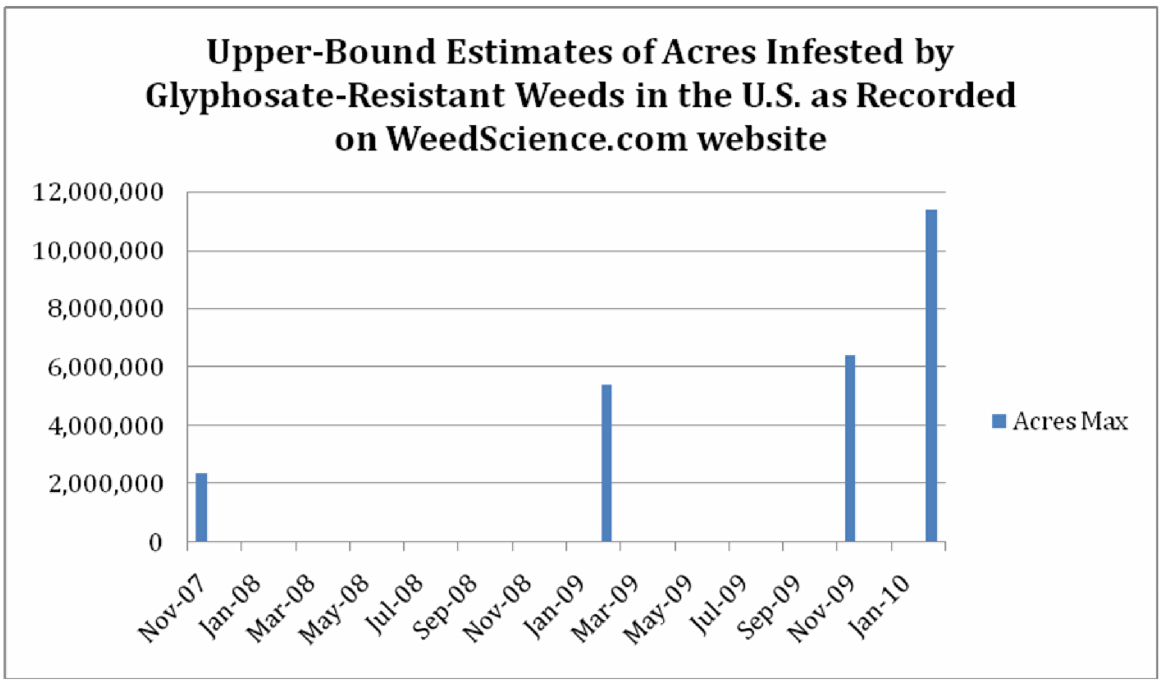
[68] Many growers of other RR crops attempt to make do with one late or very late application of glyphosate, to both "catch" more weeds and economize. This popular practice greatly enhances the risk of glyphosate-resistant weed evolution.

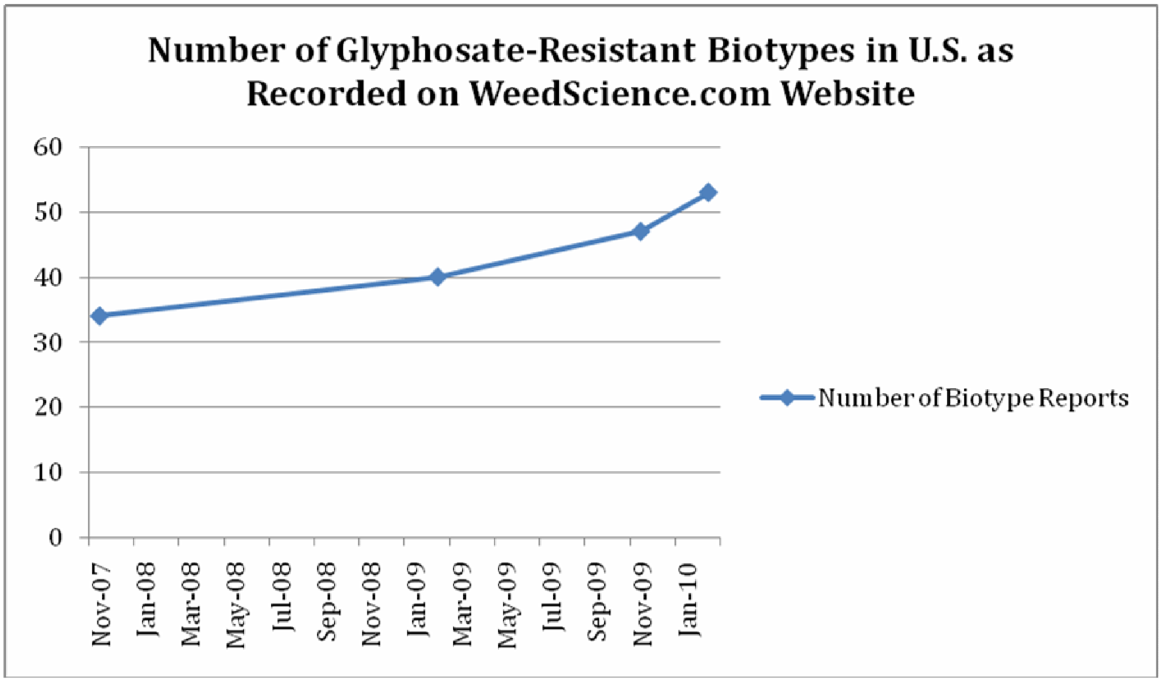
growing glyphosate-resistance in weed populations. This has been the experience of RR soybean and RR cotton growers.[69], as discussed further in _________, and it is remarkable that APHIS completely ignores this experience, and assumes, completely without argument, that only glyphosate will be used for weed control in established stands of RR alfalfa.[70]

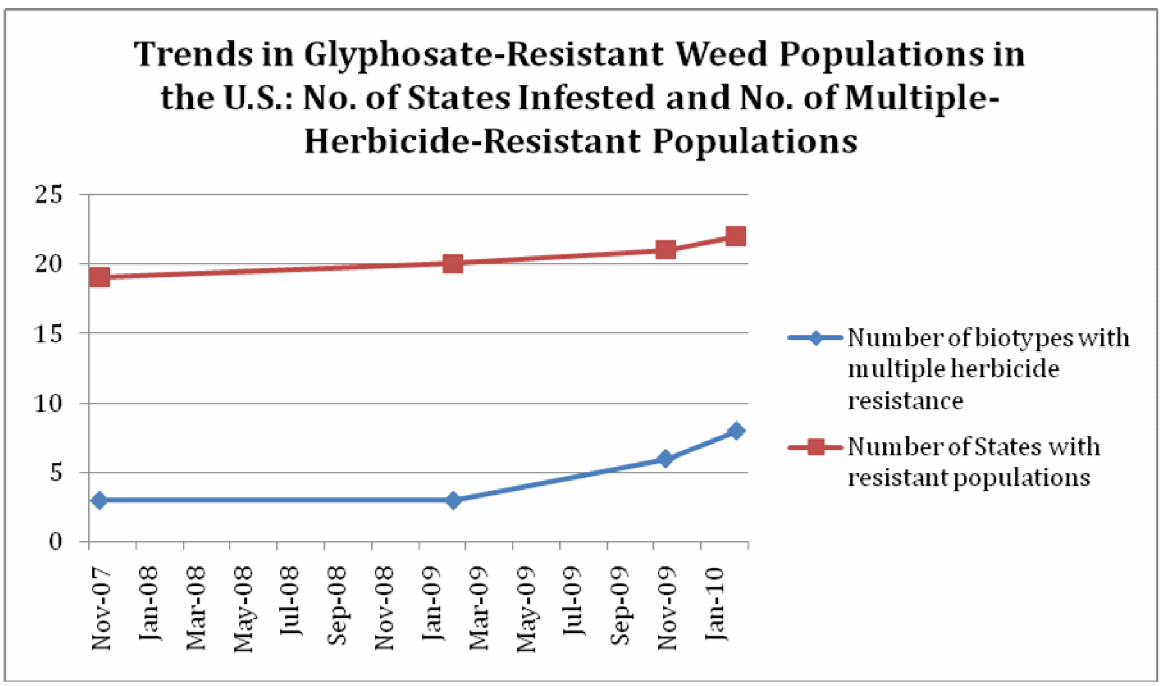
[69] Benbrook, C. (2009). "Impacts of Genetically Engineered Crops on Pesticide Use: The First Thirteen Years," The Organic Center, Nov. 2009.
[70] APHIS does concede the need for non-glyphosate herbicides for "stand removal," which we address elsewhere. However, CFS found no mention, much less analysis, of the use of non-glyphosate herbicides in established RR alfalfa stands.

Appendix 3
Trends in the Emergence of Glyphosate-Resistant Weeds

As alluded to in the text, CFS has collated all reports of glyphosate-resistant weeds (i.e. herbicide class "glycine") listed in the database of the Weed Science Society of America-Herbicide Resistance Action Committee (WSSA-HRAC) on four occasions beginning in November of 2007 (11/21/07, 2/2/09, 11/19/09 and 2/25/10). WSSA is a society of academic weed scientists; HRAC is a group of agrichemical companies that fund this passive reporting system. Confirmed reports of resistant weeds are listed at www.weedscience.com. Each report typically lists the weed species, state, number of sites and number of acres infested, reported in ranges. The first graph below reports the aggregate upper-bound estimate of acres infested with glyphosate-resistant (GR) weeds. The second graph portrays the number of biotypes, or distinct populations of GR weeds, while the third charts the number of states affected and the number of populations that are resistant to both glyphosate and one or two other types of herbicides.




Number of Glyphosate-Resistant Biotypes in U.S. as Recorded on WeedScience.com Website
60
50
40
30
20
10
0
Nov-07
Jan-08
Mar-08
May-08
Jul-08
Sep-08
Nov-08
Jan-09
Mar-09
May-09
Jul-09
Sep-09
Nov-09
Jan-10
Number of Biotype Reports


Trends in Glyphosate-Resistant Weed Populations in the U.S.: No. of States Infested and No. of Multiple-Herbicide-Resistant Populations
25
20
15
10
5
0
Nov-07
Jan-08
Mar-08
May-08
Jul-08
Sep-08
Nov-08
Jan-09
Mar-09
May-09
Jul-09
Sep-09
Nov-09
Jan-10
Number of biotypes with multiple herbicide resistance
Number of States with resistant populations

The following list of glyphosate resistant weeds can be found on Syngenta's Resistance Fighter website at http://resistancefighter.com/about/locations.aspx. The website offers farmers information on where glyphosate weed resistance has been found. Although many of the resistant populations on the map are not listed on the Weed Science Society of America (WSSA) website, they have been reported to Syngenta's Resistance Fighter website in a Solution Builder Report. Some populations are of species known to be glyphosate-tolerant (e.g. morningglory, velvetleaf), and so may represent weed shifts rather than true resistance. However, since weed shifts to more tolerant species can also be problematic for growers, these reports may offer a fuller picture of glyphosate's progressive loss of efficacy. Site last visited March 2, 2010.

GR weed biotype	State	County	Crop
Barnyardgrass	Alabama	Arkansas	Round up Flex Cotton
Barnyardgrass	Alabama	Autauga	Corn - Conventional
Barnyardgrass	Alabama	Baldwin	Corn - Conventional
Barnyardgrass	Alabama	Barbour	Corn - Conventional
Barnyardgrass	Alabama	Bullock	Corn - Conventional
Barnyardgrass	Alabama	Butler	Liberty Link Cotton
Barnyardgrass	Alabama	Chambers	Corn - Conventional
Barnyardgrass	Alabama	Clarke	Corn - Conventional
Barnyardgrass	Alabama	Conecuh	Corn - Conventional
Barnyardgrass	Arkansas	Coosa	Corn - Conventional
Barnyardgrass	Arkansas	Desha	Corn - Conventional
Barnyardgrass	Arkansas	Franklin	Round up Ready Cotton
Barnyardgrass	Georgia	Carroll	Corn - Conventional
Barnyardgrass	Mississippi	Hancock	Round up Flex Cotton
Barnyardgrass	Mississippi	Leflore	Round up Flex Cotton
Barnyardgrass	North Carolina	Avery	Round up Flex Cotton
Barnyardgrass	Tennessee	Anderson	Round up Ready Cotton
Barnyardgrass	Texas	Castro	Round up Flex Cotton
Barnyardgrass	Texas	Floyd	Round up Ready Cotton
Broadleaf Signalgrass	Alabama	Bibb	Liberty Link Cotton
Broadleaf Signalgrass	Alabama	Choctaw	Corn - Conventional
Broadleaf Signalgrass	Alabama	Covington	Corn - Conventional
Broadleaf Signalgrass	Nebraska	Blaine	Corn - Glyphosate Tolerant
Cocklebur	Georgia	Atkinson	Corn - Conventional
Cocklebur	Tennessee	Blount	Round up Flex Cotton
Common Ragweed	Arkansas		

Common Ragweed	Kansas		
Common Ragweed	Missouri		
Common Ragweed	Ohio		
Giant Ragweed	Arkansas		
Giant Ragweed	Kansas		
Giant Ragweed	Kentucky	Campbell	Corn - Glyphosate Tolerant
Giant Ragweed	Indiana		
Giant Ragweed	Iowa	Appanoose	Corn - Conventional
Giant Ragweed	Minnesota		
Giant Ragweed	Missouri		
Giant Ragweed	Ohio		
Giant Ragweed	Tennessee		
GT Volunteer Corn	North Carolina	Alexander	Round up Flex Cotton
GT Volunteer Corn	North Carolina	Beaufort	Round up Flex Cotton
Hairy Fleabane	California		
Horseweed	Arkansas	Bradley	Flex Cotton
Horseweed	Arkansas	Chicot	Liberty Link Cotton
Horseweed	Arkansas	Clark	Round up Ready Cotton
Horseweed	Arkansas	Faulkner	Liberty Link Cotton
Horseweed	Arkansas	Montgomery	Liberty Link Cotton
Horseweed	California		
Horseweed	Delaware		
Horseweed	Illinois		
Horseweed	Indiana		
Horseweed	Kansas		
Horseweed	Kentucky		
Horseweed	Maryland		
Horseweed	Michigan		
Horseweed	Mississippi		
Horseweed	Missouri	Dunklin	Corn - Glyphosate Tolerant
Horseweed	Missouri	Clark	Round up Flex Cotton
Horseweed	New Jersey		
Horseweed	North Carolina		
Horseweed	Ohio		
Horseweed	Pennsylvania		
Horseweed	Tennessee		
Italian Ryegrass	Arkansas		
Italian Ryegrass	Mississippi		

Italian Ryegrass	Oregon		
Johnsongrass	Arkansas	Carroll	Round up Ready Cotton
Johnsongrass	Arkansas	Columbia	Round up Ready Cotton
Johnsongrass	Arkansas	Crittenden	Round up Flex Cotton
Johnsongrass	Florida	Franklin	Round up Flex Cotton
Johnsongrass	North Carolina	Ashe	Round up Flex Cotton
Johnsongrass	North Carolina	Chatham	Round up Ready Cotton
Johnsongrass	South Carolina	Berkeley	Round up Flex Cotton
Johnsongrass	Tennessee	Dyer	Round up Ready Cotton
Johnsongrass	Texas	Bowie	Round up Ready Cotton
Johnsongrass	Texas	Brazoria	Round up Ready Cotton
Johsongrass	Texas	Deaf Smith	Round up Ready Cotton
Johsongrass	Virginia	Augusta	Round up Flex Cotton
Kochia	Texas	Angelina	Round up Flex Cotton
Morningglory	Alabama	Crenshaw	Liberty Link Cotton
Morningglory	Arkansas	Conway	Round up Ready Cotton
Morningglory	Georgia	Bacon	Liberty Link Cotton
Morningglory	Iowa	Clayton	Corn - Glyphosate Tolerant
Morningglory	Missouri	Chariton	Round up Ready Cotton
Morningglory	North Carolina	Alleghany	Round up Flex Cotton
Morningglory	North Carolina	Cherokee	Round up Flex Cotton
Morningglory	South Carolina	Abbeville	Round up Flex Cotton
Morningglory	South Carolina	Aiken	Round up Flex Cotton
Morningglory	Texas	Bailey	Liberty Link Cotton
Morningglory	Texas	Brazos	Liberty Link Cotton
Palmer Pigweed	Alabama		
Palmer Pigweed	Arkansas	Ashley	Round up Flex Cotton
Palmer Pigweed	Arkansas	Baxter	Round up Ready Cotton
Palmer Pigweed	Georgia		
Palmer Pigweed	Mississippi		
Palmer Pigweed	Missouri		
Palmer Pigweed	New Mexico		
Palmer Pigweed	North Carolina	Pitt	Round up Flex Cotton
Palmer Pigweed	Tennessee		

Palmer Pigweed	Texas	Caldwell	Corn - Glyphosate Tolerant
Palmer Pigweed	Texas	Franklin	Corn - Glyphosate Tolerant
Rigid Ryegrass	California		
Russian Thistle	Louisiana	Ascension	Round up Ready Cotton
Sicklepod	Louisiana	De Soto	Round up Ready Cotton
SilverLeaf Nightshade	Florida	Madison	Round up Ready Cotton
Smartweed spp.	Alabama	Cullman	Round up Flex Cotton
Texas Panicum	Alabama	Chilton	Corn - Conventional
Texas Panicum	Florida	Bay	Round up Ready Cotton
Texas Panicum	Florida	Calhoun	Round up Ready Cotton
Texas Panicum	Texas	Brewster	Round up Ready Cotton
Texas Panicum	Texas	Yoakum	Round up Ready Cotton
Velvetleaf	Alabama	Blount	Round up Ready Cotton
Velvetleaf	Illinois	Cumberland	Corn - Glyphosate Tolerant
Velvetleaf	Mississippi	Clay	Round up Ready Cotton
Velvetleaf	Missouri	Atchinson	Round up Ready Cotton
Velvetleaf	Tennessee	Decatur	Round up Ready Cotton
Waterhemp	Arkansas	Dallas	Corn - Glyphosate Tolerant
Waterhemp	Kansas		
Waterhemp	Illinois		
Waterhemp	Iowa		
Waterhemp	Minnesota	Beltrami	Corn - Glyphosate Tolerant
Waterhemp	Mississippi	Bolivar	Liberty Link Cotton
Waterhemp	Missouri		
Waterhemp	Texas	Wharton	Corn - Glyphosate Tolerant
Woolly Cupgrass	Georgia	Candler	Corn - Glyphosate Tolerant
Woolly Cupgrass	Illinois	Douglas	Corn - Glyphosate Tolerant
Woolly Cupgrass	Minnesota	Cottonwood	Soybeans - Conventional
Woolly Cupgrass	Minnesota	Dakota	Corn - Conventional
Woolly Cupgrass	Wisconsin	Eau Claire	Soybeans - Conventional
Yellow nutsedge	Georgia	Baker	Liberty Link Cotton

Appendix 4
Glyphosate-Resistant Kochia

Additional herbicides will rapidly become necessary to combat glyphosate-resistant weeds like kochia. Kansas State University recently confirmed glyphosate resistance in five populations of this damaging weed in corn and soybean fields of far western Kansas, with other populations suspected of resistance.[71] This latest addition to the ranks of glyphosate-resistant weeds in the U.S. – the 10th species and 53rd "biotype" – is very disturbing for several reasons.

Kochia is an invasive, drought-resistant weed that has swept across the country since its introduction from Eurasia in the early 20th century. It is present in almost every state, but is a particularly problematic weed in small grain crops like wheat, as well as alfalfa and sugar beets, in the Northern Plains, Intermountain and Western states. No other GR weed population has yet emerged in these areas or crops. Kochia has been designated a class B noxious weed in Washington and Oregon states, and is banned as "potentially invasive" in Connecticut.

Kochia (without glyphosate resistance) is regarded as the 5th worst summer annual weed in established alfalfa stands, and the 6th and 7th worst in spring- and fall-seeded alfalfa stands, respectively.[72] Kochia is also "extremely troublesome" in sugar beets.[73] GR populations of this weed could emerge in alfalfa and/or sugar beets in one or both of two ways.

Pre-existing GR kochia populations, such as those in western Kansas, could rapidly spread long distances to infest neighboring areas and states. This is because mature, seed-bearing kochia plants dry out, and are snapped off at the soil surface by wind action to disperse their seeds over very long distances as "tumbleweeds" during windstorms.[74] Since each mature kochia plant can produce tens of

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[71] Kansas State (2010). "Glyphosate-Resistant Kochia Confirmed in Kansas," Kansas State University press release, Feb. 26, 2010. http://www.ksre.ksu.edu/news/story/Kochia_confirmed022610.aspx, last visited 2/28/10.
[72] Hower, A.A., J.K. Harper and R. Gordon Harvey (1999). "The Importance of Pesticides and Other Pest Management Practices in U.S. Alfalfa Production," prepared for The National Agricultural Pesticide Impact Assessment Program, USDA, NAPIAP Document No. 2-CA-99, Tables 29-31.
[73] Weatherspoon, D.M. & E.E. Schweizer (1969). "Competition between kochia and sugarbeet," Weed Science 17(4): 464-467.
[74] Menalled, F.D. & R.G. Smith (2007). "Competitiveness of herbicide-resistant and herbicide-susceptible kochia (*Kochia scoparia* [L.] Schrad.) under contrasting management practices," Weed Biology and Management 7: 115-119.

thousands of seeds (by one account, up to 50,000 seeds),[75] GR kochia could spread rapidly and widely from western Kansas and other epicenters where they have evolved.[76]

GR kochia that in this way infests RR alfalfa, RR sugar beets or other RR crops would thus force these growers to utilize other more toxic herbicides rather just glyphosate, thus undermining the facile assumption upon which so much of APHIS's flawed EIS is based. GR kochia could also infest conventional cropland, such as wheat and alfalfa, and eliminate glyphosate, or greatly reduce its efficacy, for growers of these conventional crops. Glyphosate is much relied upon by growers of wheat, our third most widely grown crop., so its loss due to GR weeds would constrain wheat farmers to turn to more toxic herbicides. This, in turn, would increase the potential for more harmful pesticide residues in wheat-based foods.

New GR kochia populations could arise through independent evolution of GR biotypes. In this scenario, high selection pressure from frequent application of glyphosate is the key factor. Introduction of the RR alfalfa system would increase the already substantial selection pressure for GR weed evolution that is presently being exerted by existing RR crop systems, and which has already generated the western Kansas GR kochia populations.

Thus, RR alfalfa and RR sugar beet systems could play two distinct roles. In one scenario, they are the "victim" of GR weeds generated by other RR crop systems that develop independently of, but spread to infest, them. In a second scenario, they contribute substantially to the already high selection pressure exerted by current RR crop systems – selection pressure that has generated 53 GR weed populations infesting up to 11.4 million acres in the U.S. These newly evolved GR kochia populations would then become epicenters for infestation of other crops, whether RR or not, and areas.

Kochia is listed as a class B noxious or designated weed in Washington and Oregon,

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[75] Whatcom Weeds (undated). Kochia. http://www.co.whatcom.wa.us/publicworks/pdf/weeds/kochia2.pdf, last visited 2/28/10.

[76] Interestingly, the recent report by Kansas State University and Monsanto of GR kochia referred to above is dated 2007 (see item 11 at http://www.weedscience.org/Summary/UspeciesMOA.asp?lstMOAID=12). The researchers apparently first discovered the putative GR kochia populations in 2007, but have not been able to confirm resistance (which requires growth over several generations to confirm heritability, a key criterion of true herbicide resistance) until late February 2010. This lag time (unusually long in this case) makes it more likely that other populations of GR kochia have already evolved, in Kansas or elsewhere, but have simply not been discovered or reported yet.

and is banned as potentially invasive in Connecticut.[77] Whatcom County and King County, both in Washington State, urge residents to report any kochia they see, and King County weed experts state that kochia is economically damaging to alfalfa, among other crops.

Even before this glyphosate-resistant population, weed experts had rated kochia as one of the world's worst herbicide-resistant weeds,[78] because 33 populations had been reported with resistance to one or two of three different herbicide families on a total of more than 1 million acres.[79] Many of these populations infest wheat in Montana and the Northern Plains states, and are already difficult to control. Glyphosate use in wheat is substantial, and has grown over the past few decades, though at 9.8 million lbs. (2006) it pales in comparison to the amount of glyphosate applied to Roundup Ready soybeans and corn (Monsanto has developed RR wheat, but it has not been introduced yet due to widespread opposition from wheat traders, growers and consumers). GR kochia, and even more so kochia with resistance to glyphosate and one, two, or three other herbicide classes, would impose substantial weed control burdens and costs on wheat growers – wheat growers who played essentially no role in the genesis of GR kochia, which is attributable to RR soybean and corn systems. Appendix 3 shows an increasing number of GR weed biotypes that are also resistant to other herbicides.

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[77] http://plants.usda.gov/java/profile?symbol=BASC5#synonym, last visited 2/28/10.

[78] WSSA-HRAC (undated). "Most Important Herbicide-Resistant Species," Weed Science Society of America-Herbicide Resistance Action Committee, http://www.weedscience.org/WorstWeeds.GIF. WSSA is an organization of academic weed scientists, HRAC is a pesticide industry group. WSSA-HRAC maintain the www.weedscience.com website with information on herbicide-resistant weeds.

[79] http://www.weedscience.org/Case/Case.asp?ResistID=5470, last visited 2/28/10.

Appendix 5
Critique of APHIS's Assessment of the Herbicide Use Impacts of Other GT Crop Systems

APHIS finds "scientific disagreement" and "controversy"[80] regarding the important question of whether glyphosate-tolerant, Roundup Ready crop systems have increased or reduced overall herbicide use. Yet there is there no reason at all for doubt on this question. It is absolutely clear that glyphosate-tolerant crops have fostered substantial increases in overall and per acre herbicide use, as we document below.

APHIS's confusion on this matter has several sources, chiefly:

1) Unwitting reliance on decade-old data that no longer reflect current conditions in the rapidly changing dynamic of GT crop adoption, resistant weed evolution and herbicide use;
2) Misguided rejection of high-quality pesticide usage data from its sister agency, USDA's National Agricultural Statistics Service (NASS);[81] and
3) Uncritical reliance on bogus "simulation studies" by organizations representing the biotechnology-pesticide industry.

CFS relies on NASS data for several reasons. First, NASS utilizes transparent, rigorous procedures and statistically valid sampling methods to deliver highly accurate pesticide data. Second, NASS has regularly collected pesticide usage data on the major crops for which GT versions are predominant (soybeans, corn and cotton) over the entire period of GT crop adoption, offering a consistent set of data that facilitates accurate, year-to-year comparisons. Finally, NASS data and methodologies are freely and publicly available, which allows for open review and criticism of any analysis utilizing them.

NASS's Advisory Committee on Agricultural Statistics, comprised of experts from academia and industry, had this to say:

> "NASS employs rigorous methods to ensure that statistically representative samples are achieved…." thus ensuring "a high level of data reliability and accuracy, which are the greatest advantage of NASS data."[82]

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[80] EIS at 166, N-2, N-11.
[81] EIS at N-2.
[82] USDA NASS (2006). "Meeting of the Advisory Committee on Agriculture Statistics (ACAS): Summary and Recommendations," February 14-15, 2006, USDA NASS, Appendix III, at: http://www.nass.usda.gov/About_NASS/Advisory_Committee_on_Agriculture_Statistics/advisory-es021406.pdf.

NASS data are also extensively used by the U.S. Environmental Protection Agency, state pesticide officials, pesticide firms and independent analysts.

The same Advisory Committee quoted above found fault with alternative, private sector pesticide data, finding it non-transparent and potentially based on faulty sampling techniques (e.g. overly small sample sizes). With reference to Doane, the major private-sector provider of pesticide usage information, the Advisory Committee found that:

> "The proprietary agreements entered into by Doane subscribers extend well beyond prohibitions on data disclosure, to embargo revelation of the sampling and analytical procedures used to generate their data. Thus, it may be that a large number of the area wide estimates included in the Doane system are based on individual or statistically unrepresentative observations."[83]

In other words, NASS is regarded by experts in the field as the authoritative source for pesticide usage information in American agriculture, while private sector companies may at times supply faulty pesticide data because of illegitimate (and secretive) sampling techniques. For these and other reasons, APHIS's criticisms of NASS data[84] are unfounded, and its confidence in private sector data misplaced, as explained further in Appendix 1.

Despite APHIS's dissatisfaction with NASS's pesticide reporting program, it reproduces a graph (Figure N-7, at N-17) based on NASS pesticide use data that first appeared in a USDA Economic Research Service publication (Fernandez-Cornejo 2006, Figure 3.3.3; APHIS neglected to record the source, which Fernandez-Cornejo cites as "USDA, NASS surveys").[85] In Figure 3 below, we have used all available NASS data from 2003 to 2007 to update Figure N-7. One can confirm by inspection that all herbicide usage data points from 1995 to 2002 are the same in the two graphs (we exclude corn insecticide use). In Appendix 2, we describe the simple steps required to calculate the figures in Figure 3 from NASS data.

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83 USDA NASS (2006), op. cit., Appendix III.

84 EIS at N-2.

85 It may well be that APHIS carelessly overlooked the fact that Fernandez-Cornejo (2006) used NASS survey data for this figure. Otherwise, it is difficult to explain how APHIS could criticize NASS data as unreliable (p. N-2) and yet here utilize the same data to support its preferred conclusion that HT crops reduce herbicide use. A second possible explanation is that APHIS has a pervasive bias leading it to uncritically accept any study or secondary article or undocumented claim to the effect that HT crops reduce herbicide use, and condemn studies that reach the contrary conclusion, irrespective of the quality of data employed to reach these respective conclusions. Appendix __ explores the abundant evidence to support this latter explanation.

Although NASS does not break out herbicide use separately on GT versus conventional crops, any study purporting to do so must be consistent with NASS data. That is, if a study's conclusions are impossible or extremely difficult to explain in light of NASS data, such a study must be rejected, absent some very convincing explanation for the disparity. The study should also not be merely a number-crunching exercise, completely removed from on-the-ground farming reality. Instead, it should provide explanations for its results in terms of farmers' weed control challenges and their responses to these challenges, and how this dynamic changes over the time period covered by the study. Such explanations should be fact-based and quantitative whenever possible. This explanatory burden weighs more heavily on those whose conclusions do not comport with NASS data.

The figure below portrays the change in average herbicide use per acre per year[86] in the U.S. from 1994 to 2005 (corn), 2006 (soybeans) and 2007 (cotton), based on all available NASS data. These are the three major crops with high adoption rates of glyphosate-tolerant versions, and the last years for which NASS data are available for each of them. GT versions were introduced by Monsanto in 1996 (soybeans), 1997 (cotton), and 1998 (corn). Figures 4, 5 and 6 portray the same average herbicide usage data separately for soybeans, cotton and corn, respectively. In addition, these figures plot adoption of HT varieties as a percentage of total crop acreage, in order to explore possible correlations between the two parameters.

Overall herbicide use on soybeans and cotton follow the same trend, and in fact are remarkably similar – slowly declining herbicide use in the first 5-6 years of GT crop adoption; a nadir in the year 2001 when HT varieties had reached roughly three-fourths of total crop acreage; and then, sharp, 50% spikes in herbicide intensity in the following 5-6 years. Herbicide use on corn generally fell in the first 5 years of HT corn adoption, bottoming out in 2002; and then increased slightly in 2003, remaining constant in 2005. HT corn was adopted more slowly than GT soybeans and HT cotton, with just 11% and 26% adoption in 2002 and 2005, respectively.

Of the many studies cited by APHIS on herbicide use and HT crops, Benbrook (2004) is the only one that both: 1) Comports with the NASS data presented above; and 2) Offers real-world farming explanations for the trends these data reveal. Dr. Benbrook has recently published another study on GE crops and pesticide use (Benbrook 2009) that employs the same methods as his earlier study, but extends the analysis through crop year 2008.

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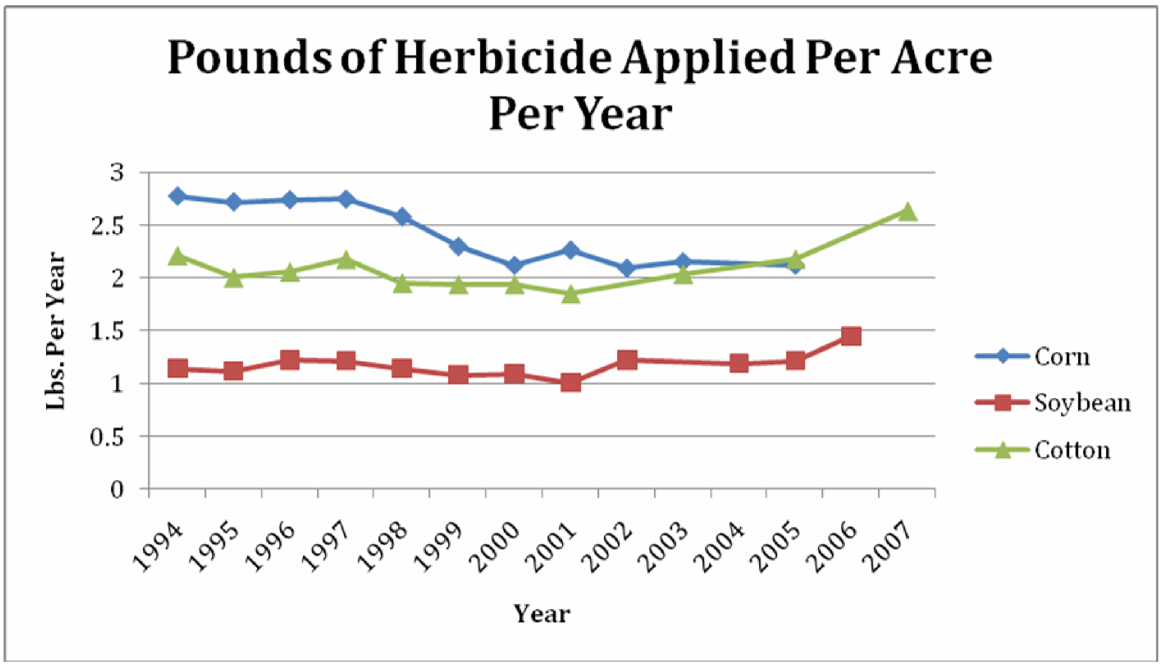
[86] Herbicide use per acre is preferred as a metric over total pounds of herbicide applied for the following reason. Total pounds applied to a crop in a given year depends in part on the number of acres planted, which can fluctuate, sometimes substantially, from year to year. The pounds per acre metric eliminates the effect of this arbitrary fluctuation and so provides an "acres-adjusted" measure of herbicide use to facilitate year-to-year comparisons of herbicide intensity.

Benbrook (2004 & 2009) explains the reduction in herbicide use in the early years of GT crop adoption in the same terms as industry does. GT crops permitted field crop farmers to make much greater use of glyphosate, an extremely effective herbicide. In particular, RR crops' tolerance to glyphosate enabled farmers to apply the chemical "post-emergence" – that is, directly to the growing crop in order to kill nearby weeds – whereas prior to RR crops (i.e. and now with conventional crops), glyphosate use was/is limited to before planting or prior to seedling emergence to avoid crop damage. GT crops thus enabled farmers to better time their glyphosate applications to more efficiently kill weeds. This efficiency factor helped farmers kill more weeds with less herbicide than was possible with conventional crops in the first 3 years of GT crop adoption, resulting in slightly less herbicide use on GT crops relative to the conventional crop acres they displaced from 1996 to 1998.



The situation stayed relatively constant for the next two years, although the slight decline in herbicide use from 1996-98 from HT crops shifted over to a slight increase in 1999 to 2000. Two factors changed this situation. First, the dramatic upsurge in glyphosate use with Roundup Ready crops, as well as often ***exclusive reliance*** on glyphosate as the sole means of weed control, led inexorably to the rapid emergence of weed populations tolerant of or resistant to this chemical. This is the same principle by which bacteria evolve resistance to overused antibiotics. Resistant weeds, in turn, require higher doses or more applications of glyphosate to kill. In recent years, glyphosate use continues to rise, while aggregate non-glyphosate herbicide use remains constant. In some cases, increased rates of glyphosate are accompanied by higher doses of non-glyphosate herbicides as well (e.g. 2,4-D on soybeans).

The second factor involves the introduction of new, low-dose soybean herbicides for use on conventional soybeans. As RR crop adoption increased dramatically, use of glyphosate (a moderate- to high-dose herbicide) rose in tandem, and displaced the low-dose herbicides that would otherwise have been applied had those RR crop acres remained conventional. Together, these two factors are responsible for the herbicide-promoting impacts of HT crops over the past decade.

Beginning in earnest by 2001, GT crops have been responsible for a growing herbicide surplus relative to the hypothetical situation where they had never been introduced. Over the 13 year period from 1996 to 2008, GT crops are responsible for an additional 383 million lbs. of herbicides applied. Significantly, 46% of this additional herbicide burden accrued in just the past two years – 2007 and 2008 – which reflects farmers' use of substantially greater amounts of herbicide to counter the accelerated emergence of particularly damaging glyphosate-resistant weed populations, such as GR Palmer amaranth that has exploded to infest millions of acres of cotton-growing land in the South, and the spread of GR marestail from southern and eastern states deeper into the Midwest.

Additional real-world evidence supporting increased herbicide use with GT crops includes: 1) The sheer prevalence of glyphosate-resistant weed reports and analysis and beefed up herbicide recommendations to counter these weeds in the nation's farm press publications; 2) Increased exhortations from university extension agents to farmers to utilize full/increased glyphosate application rates, and supplement glyphosate with other herbicides to control or forestall GR weeds; 3) Monsanto's recently introduced program to subsidize RR farmers' purchase of non-glyphosate herbicides, with the aim of controlling or forestalling GR weeds; 4) The rapid development of new herbicide-tolerant crops by numerous biotech companies that are: a) Resistant to non-glyphosate herbicides; b) Resistant to multiple herbicides, usually glyphosate in combination with one or more non-glyphosate herbicides; and/or c) Engineered for tolerance to higher doses of glyphosate. All of these developments are explicitly or implicitly geared to enabling farmers to better control or forestall GR weeds – at least in the short term – through further increases in the use of multiple toxic herbicides. The resistant weed section below provides a fuller description of these and other developments.

The other studies or secondary articles cited by APHIS for the proposition that GT crops reduce herbicide use have one or more of several flaws: 1) They rely on NASS data from the late 1990s period, which have no relevance to the dramatically altered situation today; 2) They present no original research or findings of their own, but rather superficially cite the results of ***other*** studies that often in their turn uncritically cite the results of still ***other*** studies, creating an echo chamber effect; or 3) They are "simulation studies" that arrive at the conclusion that HT crops reduce pesticide use. These latter require some discussion.

Unlike NASS chemical usage reports, these simulation studies are not based on surveys of farmers' herbicide usage practices – much less surveys of thousands of farmers selected to comprise statistically representative populations of their states' farmers. Instead, the researchers requested university weed control experts in various states to supply them with typical herbicide regimes that farmers in their states might use: a) For the Roundup Ready crop; and b) To achieve RR crop-equivalent weed control with the corresponding conventional crop. These two "typical" herbicide regimes are then expanded to simulate the overall herbicide use of all Roundup Ready vs. all conventional growers, using USDA NASS data on the percent acres RR vs. percent conventional in the respective state. In other words, it is assumed that every RR soybean grower in a particular states uses exactly the same herbicide regime (e.g. 1 application of glyphosate at 0.95 lbs./acre for the year), while every conventional soybean grower uses a second herbicide regime that the expert deems is needed to achieve weed control equivalent to that of the Roundup Ready grower. To put it another way, NASS's pesticide use figures are built solidly on thousands of data points, derived from interviews with hundreds of growers in each state. In contrast, Sankula et al (2006) have constructed an extremely shaky "simulation" of herbicide use based essentially on just two data points for each state: one for weed control in the RR crop, and the second for the conventional crop. If one or both of the two herbicide regimes cited by the expert is even modestly "off-base" with respect to average state-wide farmer practice, the modest errors will ramify tremendously in the expansion. With NASS surveys, however, the multitude of data points ensures that the inevitable inaccuracies in individual farmer reports (underestimates or overestimates of this or that herbicide) are ironed out in the wash.

There is nothing inherently wrong with simulation studies (also called models or modeling studies) of this sort, as long as their limitations are kept firmly in mind. ***The biggest limitation is that the results of simulation studies do not represent statistically valid representations of the real world parameters they model, and they should not be presented as if they did.*** Unfortunately, this fundamental stricture is not observed by Sankula et al (2006) or Johnson et al (2008), each of whom present their results as if they represented actual farmer herbicide use data.

Second, to the extent that models or simulations of this sort do become reliable indicators of real world phenomena, it is only through an iterative process of checking simulation results against actual data. If the simulation results deviate from the data, it is a clear sign that the model assumptions are flawed and need to be revised. In this case, the simulation results in Sankula et al (2006) and Johnson et al (2008) – namely, that HT crops reduce herbicide use by such and such an amount – are simply irreconcileable with NASS data showing sharply increasing herbicide usage rates with increasing adoption of GT crops (soybeans & cotton) since the year 2001. The authors of both studies could have performed an easy "check" of their simulation results against NASS data. Add up the total herbicide use of RR crop growers and non-RR crop farmers as predicted by their simulations (= 100% of crop acreage), and compare it with the NASS figure, which represents total herbicide use by all growers of the given crop. In Appendix __, we have carried out this check and several others on Sankula et al (2006)'s simulation values for herbicide use on RR vs. conventional soybeans in 2005. As discussed there, the large discrepancies with NASS data are indicative of seriously flawed model assumptions. In short, the models of Sankula et al (2006) and Johnson et al (2008) are pure fabrications because they conflict dramatically with real herbicide usage data. Thus, these simulations simulate nothing but the authors' flawed assumptions, and have no grounding in fact or farming practice.

One of those flawed assumptions is that conventional crop growers seek out and utilize herbicide regimes that will give them weed control equivalent to that of the Roundup Ready system. Conventional growers are more likely to be satisfied with adequate weed control that eliminates economic yield loss[87] from weed competition, but does not reach the cosmetic standards of a Roundup Ready system.[88] After all, if the conventional grower wanted RR crop-similar weed control, he would presumably switch to the RR crop. Extension agents have long advised growers to spare both their pocketbooks and the environment by limiting pesticide use to that needed to prevent economic damage, and refraining from application of the greater amount needed to achieve a cosmetically perfect, weed-free field. The RR crop system has been criticized for encouraging this unnecessary, herbicide-promoting cosmetic weed control standard. Irrespective of this, however, it is clearly inappropriate for these authors to solicit the expert for a conventional crop herbicide regimen that will meet some arbitrary standard (here, weed control similar to an RR crop system) foreign to the farmer, rather than simply ask for typical herbicide regimen(s) that conventional growers in fact use. By this neat trick, Sankula et al (2006) and Johnson et al (2008) solicited conventional crop herbicide regimes that employed more weedkiller than the average conventional grower would likely use, which in turn helped them to reach the false conclusion of reduced pesticide use with RR crops.

Finally, these simulation studies are purely number-crunching exercises that make no attempt to explain their findings in terms of farmers' experience. Most strikingly, neither of these two studies make a single mention of: 1) Glyphosate-resistant weed evolution and its clear and growing stimulation of greater herbicide use; 2) The rapid development of multiple-herbicide and enhanced glyphosate-tolerant crops as a response to this problem; 3) The grave warnings from eminent weed scientists about the serious nature of the threat posed by resistant weeds.

Given these facts, one cannot help but wonder if the funding source of the group which turns out these simulation studies – the major biotechnology companies – has distorted their methodologies or conclusions. Clearly, the biotechnology industry has a great stake in presenting their products as environmentally friendly, and the

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[87] Shorthand for "yield loss that reaches economically significant levels in terms of reducing farmer income."

[88] In those areas of the country where glyphosate-resistant weeds have either not emerged or only begun to appear (e.g. most Western and Northern Plains states), glyphosate can still deliver good weed control.

alleged reduction in pesticide use with GM crops has been the central myth supporting this image. A hard analysis of the facts – using real data – shows the fraudulent nature of such "simulation studies."

APHIS's main treatment of herbicide usage related to glyphosate-tolerant crops is found in Appendix N: page N-2 and Section 1.3, pages N-11 to N-18. Disjointed fragments appear in the cumulative impacts section as well (pp. 169 ff). The chief flaws in APHIS's treatment are its reliance on outdated studies with decade-old pesticide usage data that reporting on pesticide usage a decade or more ago; confusion of tendentious secondary literature for actual studies; reliance on unreviewed, bogus "simulation studies" that misrepresent pesticide use on GE and conventional crops; and an obvious and pervasive bias that leads APHIS to accept uncritically any study or secondary article that purports to show reduced herbicide use with HT crops.

APHIS describes a 2004 study by Dr. Charles Benbrook that found an aggregate increase in herbicide use of 138 million pounds due to the cultivation of GE herbicide-tolerant soybeans, corn and cotton over the nine years from 1996 to 2004. In other words, 138 million lbs. more herbicide were used than would have been the case had these HT crops not been introduced. Benbrook found that HT crops slightly reduced herbicide use from 1996 to 1998; but then stimulated a much greater increase in herbicide use from 1999 to 2004 (as portrayed in Figure N-1, p. N-12). Benbrook discusses two factors as being chiefly responsible for these findings. First, the rapid emergence of glyphosate-resistant weeds beginning in the year 2000, attributable to excessive reliance on glyphosate for weed control in Roundup Ready crop systems, led to increased herbicide application frequency and rates as more and more farmers were forced to respond to increasingly resistant weeds. Second, the introduction and greater use of low-dose soybean herbicides applied primarily to conventional soybean acres also widened the herbicide usage gap between conventional vs. Roundup Ready soybeans (i.e. glyphosate is a relatively high dose herbicide).

APHIS then cites a number of studies it claims contradict Benbrook's results and find lower herbicide use on HT crops, thus generating "controversy" (N-11) and "scientific disagreement" (p. 166). APHIS uses this controversy and disagreement as an excuse to avoid an assessment of the herbicide usage impacts of currently grown RR crops, and to avoid conducting a prospective assessment of the herbicide usage impacts of Roundup Ready alfalfa. Thus, it is very important to determine whether this supposed controversy has any merit, and what the true impact of RR crops has been.

In several cases, the conflict is only apparent. For instance, APHIS cites Heimlich et al (2000) as one of those studies that conflict with Benbrook [cited twice for different and conflicting statements]. Yet, examination of Heimlich et al (2000) reveals that the study's conclusions of reduced pesticide use with GE crops (including HT crops) applies only to crop years 1997 and 1998. These are among the same years that Benbrook (2004) also found that GE crops reduced herbicide use. It is fairly clear that APHIS officers or consultants made this simple error because they simply never read Heimlich et al (2000).

The conflict with Benbrook (2004) is only apparent with a second report cited by APHIS as well – Fernandez-Cornejo (2006). This report, by an USDA Economic Research Service analyst, has no original research on GE crops and pesticide use. Instead, the author reiterates the conclusions of a decade-old study that compared pesticide use on GE vs. conventional crops from 1996 to 1998 – 8 to 10 years before the publication date.[89] Once again, Benbrook also found that GE crops reduced pesticide use in that time frame. However, such findings are completely useless in 2010. The rapidly evolving dynamic between increasing RR crop adoption and rising herbicide use and widespread emergence of resistant weeds has produced a an agronomic landscape that has altered dramatically for most American field crop growers since 1996.

Fernandez-Cornejo (2006) also states that "pesticide use on corn and soybeans has declined since the introduction of GE corn and soybeans in 1996" referring to a Fig. 3.3.3 (p. 72). APHIS reproduces this Figure 3.3.3 as Figure N-7 (p. N-17) in the EIS. The graph plots average herbicide usage from 1995 to 2001 (for cotton) or 2002 (for corn and soybeans), based on NASS data.[90] For some unexplained reason, in this 2006 report, Fernandez-Cornejo failed to plot available NASS data for herbicide use on cotton and corn (2003, 2005) and soybeans (2004, 2005). The insistence on referring to outdated data and the curious reluctance to discuss recent data is puzzling, and positively misleading in an area that is changing so rapidly.

A third study cited by APHIS for the proposition that HT crops reduce herbicide use is Gianessi and Reigner (2006). This study, entitled "Pesticide Use in U.S. Crop Production 2002: With Comparisons to 1992 and 1997 – Fungicides and Herbicides," was written by employees or contractors of the pesticide lobby group, CropLife Foundation. Once again, APHIS gets it wrong. This study has nothing to do with GE crops, and Gianessi and Reigner say nothing about whether HT crops reduce or increase herbicide use. Instead, this publication is a collection of tables with figures that purport to give a broad-brush numerical overview of fungicide and herbicide use in the U.S. in 1992, 1997 and 2002, with the data broken down by crop, herbicide, state, etc. While a variety of sources are listed, Gianessi and Reigner fail to present any methodology. Interestingly, Gianessi and Reigner falsely claim that a widely used herbicde – metolachlor – was phased out in 2001, when USDA NASS data clearly show that it continued to be used in the millions of pounds each

[89] "The overall reduction in pesticide use associated with the increased adoption of GE crops (Bt cotton; and HT corn, cotton, and soybeans, ***using 1997/1998 data***) also resulted in a significant reduction in potential exposure to pesticides. The decline in pesticide applications was estimated to be 19.1 million acre-treatments (Fernandez-Cornejo and McBride, 2002, pp. 26-28)." (p. 72) (emphasis added). Reference to Fernandez-Cornejo and McBride (2002) (p. 27) reveals that while most of the data are indeed for 1997/1998, the HT corn data is based on crop years 1996/1997.

[90] APHIS neglects to include the information source in the EIS, but the original Figure 3.3.3 cites USDA NASS pesticide survey data. (We will come back to this point.)

year, for some years afterwards. This is demonstrated in the supporting materials as well as NASS data.

APHIS refers to a fourth study as follows: "Trewavas and Leaver (2001) conducted an analysis which revealed that 3.27 million kg of other herbicides have been replaced with 2.45 million kg. of glyphosate in soybean fields in the US." Over which years? How was this "analysis" conducted? Did GE soybeans have anything to do with this alleged change in herbicide use? We checked this article to seek answers, and found the following: 1) The findings quoted above are taken directly from Heimlich et al (2000) (discussed above), and so provides no new information to corroborate APHIS's "less pesticide with GE crops" story line; 2) As noted above the results apply to crop years 1996 to 1998, and so do not conflict with Benbrook (2004); and 3) APHIS for some reason alters the lb. units used in Trewavas and Leaver (2001) to kilograms, perhaps to give the false impression that the reported results are indeed new rather than duplicative of Heimlich et al (2000).

In at least seven cases, it is clear that APHIS has not even taken the trouble to read the articles/studies it cites. Instead, APHIS has "lifted" citations for these seven works from a review article where the conclusion of each is briefly and uncritically described. Such third-hand reporting is a flagrant breach of scientific protocol. The legal equivalent would be for a witness to present second-hand hearsay (he said she said) as if it were his/her personal experience. It is no more permissible in science than in law. It is irresponsible to report the bare conclusions of a study one has not read, because one does so on faith, without having made a critical assessment of the validity of the study's methodology, the assumptions upon which it is based, or possible errors. The fact that error is a huge and ineradicable part of scientific endeavor is implicit in the discipline of peer-review. When one uncritically cribs conclusions and citations at third hand, as APHIS has done here, it represents a betrayal of this core scientific principle.