Center for Food Safety
660 Pennsylvania Ave., SE, Suite 302
Washington, DC 20003

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

Comments on Draft Environmental Impact Statement for Genetically Engineered Glyphosate Tolerant Event H7-1 Sugar Beets

CFS appreciates the opportunity to submit these science comments addressing APHIS's Environmental Impact Statement (EIS) on Monsanto's request for full deregulation of Roundup Ready sugar beets (RRSB). CFS is also separately submitting legal comments and a second set of science comments.

One year ago, CFS submitted three sets of comments on the petition for partial deregulation of RRSB, one legal and two science. The science comments addressing weed issues have been re-submitted to this docket separately under the filename CFS Science Comments 2010, and are incorporated herein by reference. Supporting material corresponding mainly to cited studies is also being submitted, and filenames for such material will generally be the same as the references used in comments (e.g. Kniss et al 2010). Supporting material includes materials supporting both CFS Science Comments 2010 and other materials referenced in these comments, which address primarily the (cumulative) effects of RRSB deregulation with respect to glyphosate-resistant and multiple herbicide-resistant weeds. Some materials cited by APHIS that CFS also refers to may not be separately submitted.

Herbicide-resistant (HR) weeds have long been a serious and underappreciated obstacle to development of a truly sustainable agricultural system. HR weeds are both the result of an unsustainable fixation on exclusively chemical means of weed control, and also the occasion for still greater dependence on herbicides. Over the past 15 years, widespread adoption of herbicide-resistant crop systems, which today consist overwhelmingly of Monsanto's Roundup Ready systems, have substantially accelerated the toxic spiral of increasing weed resistance and herbicide use. The best indication of this is the ongoing epidemic of glyphosate-resistant (GR) weeds triggered by Roundup Ready (RR) crop systems, and the plethora of new and often multiple HR crop systems being developed as short-sighted "fixes" to this epidemic – notably including major field crops resistant to 2,4-D, dicamba, imidazolinones, and other toxic herbicides, often in combination. See CFS

Science Comments 2010 (1-3) and Benbrook 13Years2009 – 11-15-01 for further background and analysis.

Table 1: Glyphosate-Resistant Weeds in the U.S.

(November 2007 to December 2011)

	No. of Reports	Sites (min)	Sites (max)	Acres (min)	Acres (max)
November 21, 2007	34	1,020	3,251	2,038,175	2,367,115
February 2, 2009	39	2,228	14,260	2,339,168	5,377,065
November 19, 2009	47	3,242	24,286	2,440,323	6,387,365
February 25, 2010	53	4,368	34,827	2,641,090	11,389,515
May 18, 2010	55	4,371	34,868	2,641,202	11,390,065
November 30, 2010	59	14,425	134,970	3,543,310	12,410,575
December 27, 2010	64	15,493	137,122	3,565,165	12,621,985
December 12, 2011	79	117,288	249,686	5,580,231	16,771,500

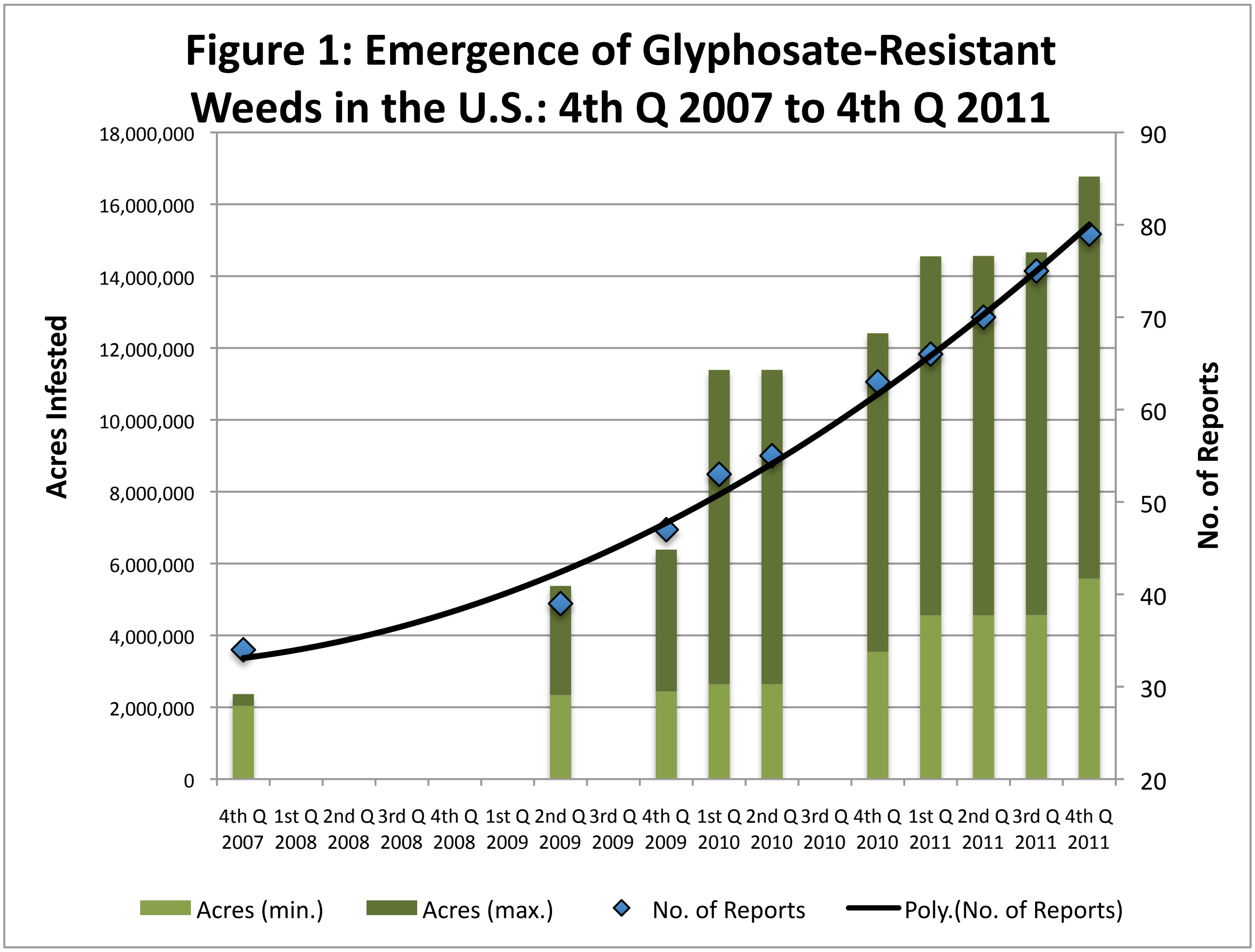
See legend to Figure 1 and CFS Science Comments 2010 for explanation of data.

Roundup Ready crop systems and glyphosate-resistant weeds

Roundup Ready sugar beets (RRSB) represent a binary weed control system consisting of a sugar beet genetically engineered to withstand direct application of glyphosate and multiple applications of this herbicide. RR crop systems are responsible for a growing epidemic of GR weeds. CFS Science Comments 2010 (pages 3-10) provide an analysis of the epidemic, and a detailed explanation of the data CFS relies on for its analysis of GR and other HR weeds, the International Survey of Herbicide-Resistant Weeds (ISHRW). Here, those comments are supplemented and updated.

Table 1 shows that GR weeds have increased dramatically in geographic extent over just the past four years, with an average of 3.1 million acres added each year over that period.[1] The average annual gain over each of the past four years exceeds the overall acreage that became infested in the entire eight years from the time the first RR crop-associated GR weed emerged in 2000 (horseweed in Delaware) through 2007. As portrayed graphically in Figure 1 with finer-grained data, GR weed emergence has been increasing exponentially over the past four years.

[1] Based on maximum infested acreage, which for several reasons explained in CFS Science Comments 2010 is a more accurate reflection of reality than minimum acreage. Table 1 data aggregated from reports listed at CFS Science Comments – Appendix 1 in supporting materials.



Legend: This chart plots data on glyphosate-resistant weeds in the U.S. compiled from the International Survey of Herbicide-Resistant Weeds (ISHRW) as of December 12, 2011. The ISHRW lists reports of confirmed herbicide-resistant weeds submitted by weed scientists.[2] Each report normally contains the year of discovery, the number of sites and acreage infested by the resistant weed population, the crop or non-crop setting where the weed was found, whether or not the population is expanding, and date the report was last updated. Note that months to several years can elapse before a putative resistant weed population is confirmed as resistant and listed on the website. ISHRW reports sites and acreage infested in ranges due to the difficulty of making precise point estimates. CFS aggregated ISHRW data for all glyphosate-resistant weed reports on ten dates – 11/21/07, 2/2/09, 11/19/09, 2/25/10, 5/18/10, 11/30/10, 1/6/11, 7/5/11, 9/28/11 and 12/12/11 – corresponding to the ten bars in the graph above. The bars were assigned to the appropriate quarterly period on the x-axis. The minimum and maximum acreage values represent the aggregate lower- and upper-bound acreage infested by all glyphosate-resistant weeds listed by ISHRW on the given date. The number of reports is plotted on the secondary y-axis. ISHRW organizer Dr. Ian Heap made a point estimate of 10.4 million acres infested with GR weeds in May of 2010,[3] when the maximum acreage infested was 11.4 million acres. This suggests that the upper-bound estimates more closely approximate real world conditions. However, these ISHRW data likely underestimate the true extent of GR weed populations, perhaps substantially, for several reasons. First, no acreage estimates are given for 9 of the 79 reports. Second, since 61 of the 79 GR weed populations are expanding in range, and there is no mechanism for regular updating of reports, some populations are likely larger than indicated. Finally, the ISHRW reporting system is voluntary, and "the voluntary basis of the contributions likely results in underestimation of the extent of resistance to herbicides, including glyphosate (see NRC 2010, p. 2-12). See ISHRW Report Example for sample report, or explore links at http://www.weedscience.org/Summary/UspeciesMOA.asp?lstMOAID=12&FmHRACGroup=Go.

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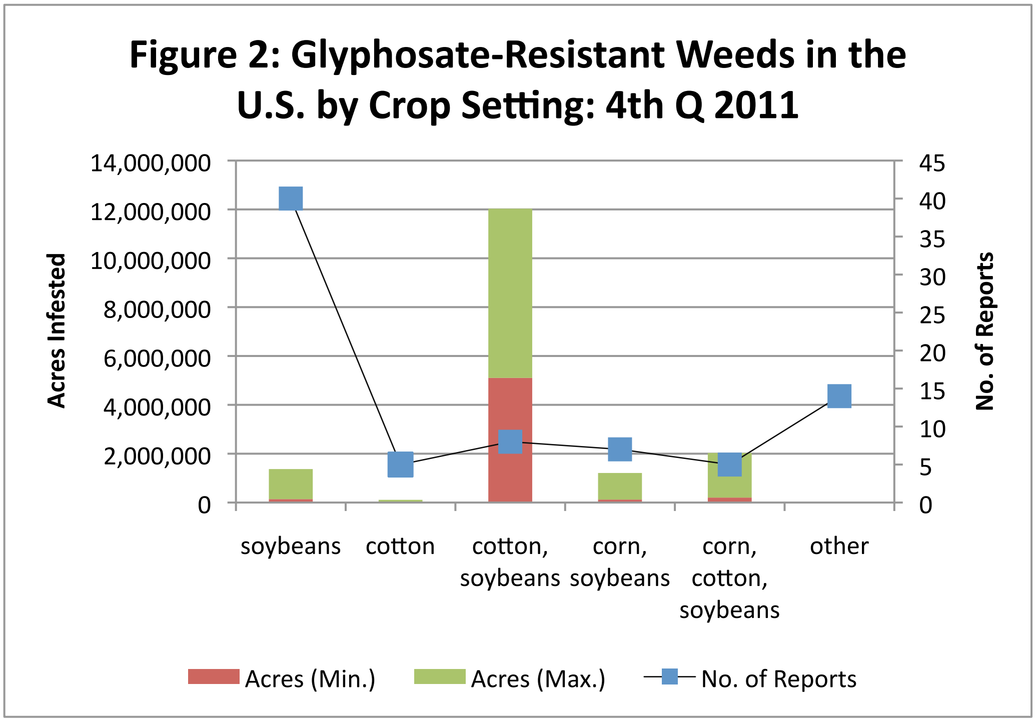
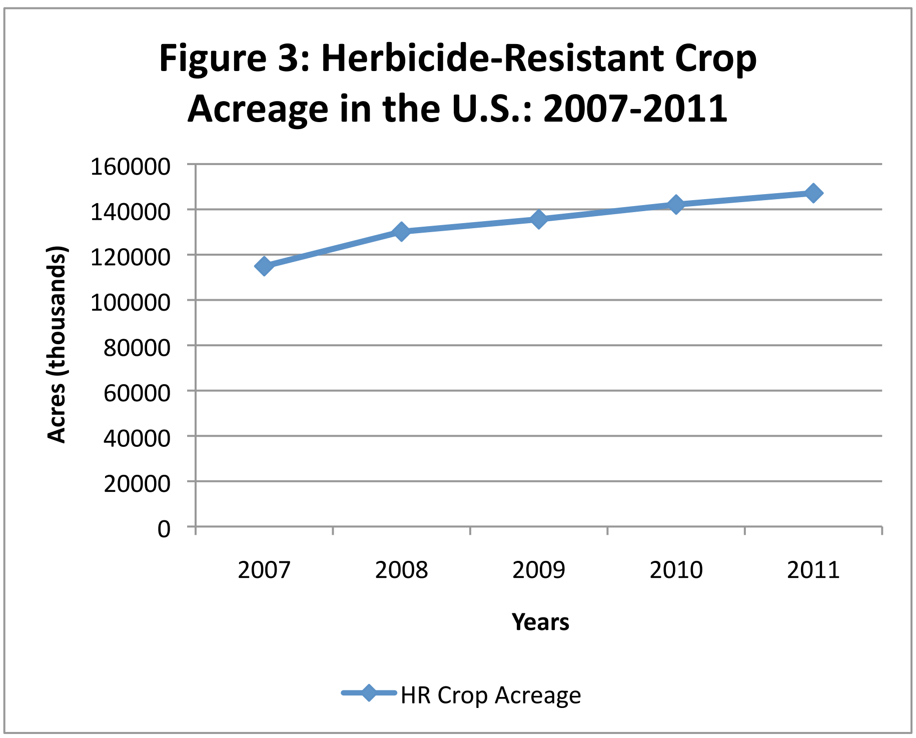
[2] Each report may be accessed by (and corresponds to) a link at: http://www.weedscience.org/Summary/UspeciesMOA.asp?lstMOAID=12&FmHRACGroup=Go.

[3] WSSA (2010). "WSSA supports NRC Findings on Weed Control," Weed Science Society of America, 5/27/10. Dr. Heap is cited for the statement that 6% of total area planted to corn, soybean and cotton in the U.S. [which is 173 million acres] is infested with GR weeds. http://www.wssa.net/WSSA/Information/WSSA%20position%20paper%20on%20herbicide%20resistance%205-27-2010.pdf.



See legend to Figure 1 and CFS Science Comments 2010 for explanation of data. One of the five reports under "corn, cotton, soybeans" actually involves GR weeds that emerged in corn, soybeans and sugar beets.



USDA NASS Quik Stats for overall corn, soybean and cotton acreage; USDA-ERS Excel spreadsheet on "Adoption of Genetically Engineered Crops in the U.S." for percentage of acres of each crop planted to herbicide-resistant varieties. http://www.ers.usda.gov/Data/BiotechCrops/. Canola, sugar beets and alfalfa excluded. Nearly all HR crops are Roundup Ready. For HR percentage, add figures for "herbicide-tolerant only" and "stacked gene varieties."

It is well-known and completely undisputed in the weed science community that glyphosate-resistant crop systems are responsible for the vast majority of glyphosate-resistant weeds, as discussed in CFS Science Comments 2010. APHIS's attempt to obfuscate this point by speaking of the number of "weed species" that have evolved resistance to glyphosate in non-RR crop settings[4] is wrong on several counts. First, an entire "weed species" does not evolve resistance to an herbicide; rather, geographically distinct populations of a weed species evolve resistance, while most remain susceptible. Second, as explained in CFS Science Comments 2010, it is the ***acreage infested*** by a GR weed population that mainly determines its agronomic and environmental impact, not number of "weed species" with resistant populations. The number of weed species with GR populations or biotypes is not a good indicator of impact because this parameter says nothing about the size of the population (i.e. acreage of land infested), which in turn correlates with the amount of additional herbicide or tillage or hand weeding utilized to control the resistant weed population.

ISHRW data show clearly that even though 14 of 79 reports of confirmed GR weeds in the U.S. arose in orchards, roadways, nurseries, and other non-RR crop settings, the total reported area infested by those GR weed populations is just 20,465 acres (maximum), or only 0.1% of the 16.8 million total GR weed infested acres (see Figure 2, "Other" column).[5] Over 99% of the reported GR weed-infested acreage emerged in soybeans, cotton, corn and/or sugar beets, all crops that are predominantly Roundup Ready (Figure 2). See also CFS Science Comments – Appendix 1 in the supporting materials for a listing of the 79 reports of GR weeds upon which Table 1 and Figures 1 and 2 are based.

Figure 2 also refutes another misconception in the DEIS. APHIS states erroneously that glyphosate-resistant weeds are most common when glyphosate is used on the same crop planted year after year without crop rotation, for instance continuous Roundup Ready soybeans or corn.[6] APHIS further states that only "two species of weeds" have been selected for in situations involving rotation of RR corn and RR soybeans, and no GR weeds have arisen in a three-crop rotation.[7] These statements are grossly misleading.[8] Figure 2 shows that while roughly half (40 of 79) of GR weed reports have only "soybeans" listed as the crop setting, and five more list only "cotton," the aggregate GR weed-infested acreage of those 45 reports is quite small – less than 1.5 million acres. In contrast, 12 million acres of "cotton, soybeans" cropland and 1.2 million acres of "corn, soybeans" have been infested

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[4] EA at 236.
[5] Note that acreage infested is not reported for several GR weed populations in non-RR crop settings, so the true total may be a bit higher. Here and throughout, maximum acreage infested figures are cited, for reasons explained in legend to Figure 1 and CFS Science Comments 2010.
[6] EIS at 240.
[7] Id.
[8] APHIS cites Kniss (2010b) for these statements. This is the thoroughly discredited declaration made by Andrew Kniss in the ongoing RR sugar beet litigation that is further discussed in separate CFS legal comments. For the record, Kniss stated that only one weed species had evolved resistance to glyphosate in a two-crop rotation, not two as APHIS states here. Unsurprisingly, Kniss was unable to provide any source for these erroneous claims.

with GR weeds, or over 13 million acres in a two-crop setting. Likewise, five reports list three of four crops (corn, cotton or sugar beets, and soybeans) that are predominantly Roundup Ready as the crop setting, with up to 2 million acres infested.[9] These data clearly demonstrate that the great majority of GR weeds (those infesting 14 million acres or more) have evolved on cropland that is used to grow two and even three crops, contrary to APHIS's assumption that GR weeds arise primarily in single crop situations.

The upshot is clear. Crop rotation offers little or no protection against rapid evolution of glyphosate-resistant weeds when some or all of the crops in the rotation are Roundup Ready.

Comparison of Figures 1 and 3 shows that GR weed acreage is increasing much more quickly than RR crop acreage. Figure 3 shows that by 2007, Roundup Ready crop acreage had already reached a substantial 115 million acres, due to high rates of adoption of HR soybeans (91%) and cotton (70%), and moderate adoption of HR corn (52%). At that time, roughly 2.4 million acres were infested with GR weeds, or 2.1% of overall RR crop acreage.[10] In 2011, RR crop acreage had increased by a modest 28% over 2007 to 147 million acres, versus an over 600% increase in GR weed-infested acreage from 2.4 million to 16.8 million acres. Confirmed GR weeds now infest 11.4% of the acreage planted to RR crops, up from 2.1% just four years ago. Clearly, GR weeds have been expanding at an exponential rate over the past four years, even as RR crop acreage increases at a slow, incremental rate.

While by far the most acreage infested with GR weeds is land planted to cotton and soybeans, many of the more recent GR weed populations have arisen in corn and soybeans. In fact, six of the twelve GR weed populations found in corn have emerged since just 2009 in the Corn Belt and Northern Plains states. Five of the six involved land planted to corn and soybeans, while one emerged in corn, soybeans and sugar beets. Of the 32.6 million acre increase in RR crop acreage since 2007 (Figure 3), over half is RR corn, whose adoption increased from 52% to 72% of corn acres from 2007 to 2011. It would seem that increasing use of RR corn and continued great use of RR soybeans in the Corn Belt and Northern Plains leads to more RR corn/RR soybean acreage, which exerts much more selection pressure for GR weeds than a conventional corn/RR soybean rotation. Thus, we can expect continuing rapid emergence of GR weeds in the large expanse of Corn Belt acreage where corn and soybeans are commonly rotated.

Glyphosate-resistant weed trends in the sugar beet counties of the Red River Valley

The Red River Valley of Minnesota and eastern North Dakota is the largest sugar beet production region in the country, accounting for over half of national sugar beet acreage

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[9] One of these five reports is "corn, soybeans and sugar beets" while the other four refer to "corn, cotton and soybeans."

[10] Assuming that all reported GR weeds have arisen in RR crop systems is very close to reality, given the extremely limited acreage (less than 1%, see discussion of Figure 2 above) reported in non-RR crop or non-agricultural settings.

and production.[11] RR sugar beet adoption has grown rapidly from 49% in 2008 to 88% in 2009 and 93% in 2010.[12] No RR sugar beets were reported in this area in 2007,[13] thus 2008 was the first year of commercial production.[14] The Red River Valley is also the sugar beet region where the most corn and soybeans are grown, predominantly Roundup Ready varieties. According to APHIS and Monsanto, 62% of sugar beet acres in both states are rotated to either RR soybeans or corn.[15] The use of three different Roundup Ready crop systems, often in rotations involving two and sometimes all three, generates tremendous selection pressure for glyphosate-resistant weeds. Therefore, it is not surprising to observe that GR weeds have increased exponentially in this region since 2007, the year before RRSB were introduced on a widespread commercial basis.

As shown in CFS Science Comments – Appendix 2 in the supporting materials, there were only three reports of GR weeds in Minnesota (2) and North Dakota (1) in 2007. By 2011, the number had grown to six (four in Minnesota and two in North Dakota). The number of sites infested increased sharply from 15-60 in 2007 to 1171-2660 in 2011. Total acreage infested with GR weeds increased similarly, from 653-1600 acres in 2007 to 23,006-222,000 acres in 2011. Thus, both the number of sites and acreage infested with GR weeds rose by roughly two orders of magnitude in the four years from 2007 to 2011.

Appendix 3 maps out the occurrence of glyphosate-resistant weeds in the Red River Valley. Only three areas had glyphosate-resistant weed populations in 2007. By 2011, 54 areas had either confirmed or suspected GR weeds. Most of the GR weed foci appear in counties near the Red River, which is where most sugar beets are grown in both Minnesota and North Dakota. According to the weed scientists who put these maps together, Drs. Jeff Stachler and Mike Christoffers: "It is truly astonishing to realize the speed at which these weeds are appearing" (see Appendix 3). This amazement echoes the similar sentiments

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[11] EIS at 108, Table 3-5, EA at 286, Table 3-34.

[12] Stachler, JM et al (2011). "Survey of weed control and production practices on sugar beet in Minnesota and Eastern North Dakota in 2010," http://www.sbreb.org/research/weed/weed10/SurveyOfHerbicideStachler2010.pdf.

[13] Carlson, AL et al et al (2008). "Survey of weed control and production practices on sugar beet in Minnesota and Eastern North Dakota in 2007," http://www.sbreb.org/Research/weed/weed07/NDMNSurveyHerbicide.pdf.

[14] This is true of other sugar beet production regions as well. While APHIS implies that RRSB were introduced commercially in 2005 (e.g. EIS at 538: "H7-1 sugar beets have been widely adopted since initial deregulation (2005)"), EIS at 546: "…continue to experience the weed control observed over the past 5 years and described under Alternative 2" to characterize weed control with RRSB, falsely implying commercial use since 2005), this is not accurate. According to Khan, MFR (2010). "Introduction of glyphosate-tolerant sugar beet in the United States," Outlooks on Pest Management, February 2010: "After several years of testing GT sugar beet in commercial fields, widespread commercial production commenced in 2008…."

[15] EIS at 121-123, Table 3-6.

expressed by weed scientists in southern states at the rapid emergence of glyphosate-resistant weeds in cotton and soybean-growing country.[16]

Glyphosate-resistant biotypes of three weed species are found in Minnesota and North Dakota: common ragweed (*Ambrosia artemisiifolia*), giant ragweed (*Ambrosia trifida*) and common waterhemp (*Amaranthus tuberculatus (syn. rudi)*). All three of these weed species are significant sugar beet weeds.[17]

Although Appendix 2 does not list GR common ragweed as infesting sugar beets, it is apparently already found in fields rotated between RRSB, RR soybeans and/or RR corn. According to Jeff Stachler and colleagues:

"With the rapid introduction of glyphosate-resistant sugar beet and the continued use of glyphosate-resistant corn and soybean in the rotation, glyphosate-resistant common ragweed will become more challenging to control in sugar beet."[18]

In follow-up research, Stachler and colleagues recommend that growers make at least three applications of clopyralid (Stinger) to maximize yield and sucrose production as well as control GR ragweed in RR sugar beets.[19] Interestingly, the authors also acknowledge that: "Clopyralid is the only sugarbeet herbicide available to effectively control glyphosate-resistant common ragweed." Three applications per season would exert considerable selection pressure for evolution of additional resistance to clopyralid, at which point there would apparently be no effective chemical control options for the rapidly spreading GR common ragweed, itself expanding so rapidly because of the frequent post-emergence application of glyphosate to RR crops, including on average 2-3 applications per season to RRSB.

Stachler and colleagues elsewhere provide a clue as to why clopyralid is the only effective herbicide remaining for GR common ragweed. Common ragweed has apparently evolved widespread resistance to all ALS inhibitor herbicides in North Dakota and Minnesota: "[t]he majority of common ragweed populations in ND and MN contain some frequency of biotypes resistant to ALS-inhibiting herbicides."[20] ALS inhibitor resistance in common

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[16] See Haire (2010), Culpepper-Kichler (2009) and Benbrook 13Years2009 – 11-15-09, Chapter 4, in supporting materials.

[17] EIS at 127-128. Note that despite its name, common waterhemp is in the pigweed (*Amaranthus*) genus, and is closely related to the most damaging weed to have developed glyphosate-resistance, Palmer amaranth (*Amaranthus palmeri*).

[18] See Stachler 2010 in supporting materials.

[19] Stachler, Luecke & Fisher (2011). "Common ragweed in glyphosate-resistant sugarbeet," Weed Science Society of America, Abstract No. 253. http://wssaabstracts.com/public/4/abstract-253.html.

[20] NDSU Common Rag (2011). North Dakota Weed Control Guide: Common Ragweed – Weed of the Year, North Dakota State University, p. 133. See http://www.ag.ndsu.edu/weeds/weed-control-guides/nd-weed-control-guide-1/ and http://www.ag.ndsu.edu/weeds/weed-control-guides/nd-weed-control-guide-1/wcg-files/18.4-Corw.pdf.

ragweed and many other weed species emerged in the late 1990s when herbicides of this class were used extensively on sugar beets and other crops. In fact, the epidemic spread of ALS inhibitor resistance in weeds was a major factor driving farmers to adopt Roundup Ready crops (see Owen-Zelaya 2005 in supporting materials).

GR giant ragweed presents similar difficulties in RRSB,[21] compounded here as well by widespread pre-existing resistance to all ALS inhibitors (see Appendix 1 for dual-resistant giant ragweed in Minnesota; also Stachler-Zollinger (2010) in supporting materials).

More challenging still is glyphosate-resistant waterhemp. A substantial population of GR waterhemp on hundreds of sites covering up to 10,000 acres was recently confirmed in the North Dakota county of Richland, which had 29,350 acres of sugar beets in 2007 (see report below and Appendix 3 for location, acreage data from 2007 Census of Agriculture). The GR waterhemp is thus infesting a sizeable proportion of the sugar beets in that county. Appendix 3 shows a startling increase in the number of GR waterhemp foci (mostly suspected) in sugar beet counties since just 2009, suggesting that this is the most aggressively expanding GR weed in sugar beet country of the Red River Valley.

QUIK STATS (last updated Nov 14, 2011)	
Common Name	**Common Waterhemp**
Species	*Amaranthus tuberculatus (syn. rudis)*
Group	Glycines (**G/9**)
Herbicides	glyphosate
Location	USA, North Dakota
Year	2010
Situation(s)	corn, soybean, and sugarbeet
Sites	101-500
Acres Infested	1001-10000
Contributors	Jeff Stachler
Input Data	Edit this Case | Add New Case of Resistance | Add Note

Accessible at: http://www.weedscience.org/Case/Case.asp?ResistID=5575, last visited Dec. 12, 2011

Management of GR waterhemp in Roundup Ready sugar beets is considered "difficult," and will require combinations of herbicides, though research is required to determine which will work best.[22] Outlook herbicide, a trade name for dimethenamid-P, is recommended at present.[23] With

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[21] Fisher et al (2009). "Management of glyphosate-resistant giant ragweed in sugarbeet," 2009 North Central Weed Science Society Proceedings 64: 109, http://www.ncwss.org/proceed/2009/Abstracts/109.pdf.

[22] SBREB (2011). "Sugarbeet Production Guide: Weed Control," Sugarbeet Research and Education Board of Minnesota and North Dakota 2011, at http://www.sbreb.org/production/production.htm and http://www.sbreb.org/production/2011/Weed.pdf.

potentially three applications of clopyralid to control GR common and giant ragweed, and lay-by applications of dimethenamid-P to control GR common waterhemp, weed management in RRSB will rapidly become more complex,[24] soon coming to resemble weed control on conventional beets, as the GR weed epidemic spreads.

Waterhemp is remarkable for its ability to evolve resistance to multiple herbicides. Biotypes in Missouri (2005) and Iowa (2011) have evolved resistance to three modes of action – glyphosate, ALS inhibitors and either PPO inhibitors or HPPD inhibitors (see CFS Science Comments – Appendix 1), while Illinois weed scientists have confirmed "quad-resistant" waterhemp that are additionally resistant to atrazine (see Tranel 2010). Patrick Tranel and colleagues are concerned that multiple herbicide-resistant waterhemp is on the threshold of becoming an unmanageable problem in soybeans; and if these weeds also evolve resistance to glufosinate, the last post-emergence option for control of these multiple-resistant weeds, "soybean production may not be practical in many Midwest U.S. fields" (see Tranel et al waterhemp 2010). Glyphosate-resistant waterhemp is likely to continue to spread in the Red River Valley due to rotations of RRSB, RR soybeans and/or RR corn.[25] Weed scientists in the Minnesota and North Dakota have similar concerns, recognizing that today's solution rapidly becomes tomorrow's problem: "Genetically engineered crops resistant to glyphosate and glufosinate may be used to control weeds resistant to other herbicides. However, heavy selection pressure from these herbicides may cause selection of multiple resistant biotypes."[26]

Thus far, however, the most problematic weeds in the Red River Valley are kochia, pigweeds and lambsquarters.[27] One reason kochia is so problematic in sugar beets is that virtually all of it in Minnesota and North Dakota has evolved resistance to triflusulfuron,[28] and it is now resistant to all members of this large class of ALS inhibitor herbicides.[29] Kochia would of course become considerably more difficult to control in RRSB if it also evolves glyphosate-resistance. GR kochia and lambsquarters (see below) have been considered likely in North Dakota since at least 2009.[30] It was recently located in two counties of southern North Dakota, one of them a sugar beet-growing county (Sargent),[31] and will have a substantial impact when it does evolve glyphosate resistance (see Anonymous 2010 in supporting materials). The first GR kochia biotype emerged in western Kansas in 2007, infesting cotton, soybeans and corn. It has

[23] Id.
[24] EIS at 140.
[25] See Bayer GR Waterhemp MN-ND 2011.
[26] Stachler-Zollinger (2010).
[27] Stachler JM et al (2011), op. cit., Table 26.
[28] Dexter, Alan G., et al., "Postemergence Herbicides in Sugarbeets, 2000" In 2000 Sugarbeet Research and Extension Reports, North Dakota State University.
[29] Stachler JM et al (2011), op. cit.
[30] Mikkelson, J (2009). "Proper management can delay the spread of resistant weeds," AgWeek June 8, 2009.
[31] Hildebrant, D. (2011). "Kochia could become region's next glyphosate resistant weed," Farm and Ranch Guide, Feb. 8, 2011. http://www.farmandranchguide.com/news/kochia-could-become-region-s-next-glyphosate-resistant-weed/article_30b99054-33c6-11e0-b8c5-001cc4c002e0.html

progressively spread since then. A recent report suggests that GR kochia has spread throughout the entire western third of Kansas:

"The presence of glyphosate resistance in four populations of kochia in western Kansas was confirmed in 2007. The populations were dispersed more than 100 km apart and were considered **to have developed resistance independent of each other**. A few additional reports of lack-of-control of kochia with glyphosate in other regions were received in 2008 and 2009 and **the number of such reports escalated dramatically in 2010**. An extensive driving tour and unscientific field survey in the fall of 2010 confirmed the presence of uncontrolled kochia in many corn, soybean, and fallow fields throughout the western one-third of Kansas that had been sprayed with glyphosate alone **or in mixture with other postemergence herbicides**. Seed was collected from 17 kochia populations dispersed throughout the region that had survived spraying operations. Glyphosate dose-response trials are being conducted to determine if the sampled populations are indeed resistant to glyphosate as suspected. If resistance is confirmed, then glyphosate-resistant kochia is prevalent throughout western Kansas."[32]

Assuming the resistance is confirmed, there are several troubling aspects about this report. First, independent evolution of glyphosate-resistance in four separate populations would suggest that kochia individuals with the capacity to survive glyphosate are not exceedingly rare (as one might assume if only one population had evolved resistance and spread via tumbleweed). Second, the dramatic escalation in number of reports in 2010 (in Colorado as well as Kansas) suggests the problem is worsening. The fact that this kochia survives glyphosate and other postemergence herbicides suggests it may have multiple resistance, perhaps to ALS inhibitors as in Minnesota and North Dakota. Finally, the presence of GR kochia throughout an area as large as the western third of Kansas suggests a capacity for rapid evolution or spread.

RRSB growers have regarded lambsquarters as their worst weed over the past two years (2009 and 2010).[33] Post-emergence use of glyphosate with RR crop systems over years has triggered a weed shift to greater prevalence of common lambsquarters; at the same time, ever higher rates of glyphosate are required to control the weed; a minimum of 1.125 lb. ae/acre is now recommended in North Dakota.[34] This is 50% higher than the rate of glyphosate used by APHIS for its "snapshot" of current herbicide use on RRSB.[35] APHIS justifies the rate of 0.75 lb ae/acre as the most common rate utilized by growers in the Red River Valley in 2010. But APHIS's source (Stachler, JM et al (2011)) shows that in fact 114 RRSB growers use either 1.0 or 1.125 lb ae/acre, versus 161 using 0.75. APHIS should adjust its herbicide use snapshot upwards to reflect higher average use rates of glyphosate. A farmer in nearby South Dakota reported in

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[32] Stahlman GR kochia 2011 in supporting materials, emphasis added. Stahlman, PW et al (2011). "Glyphosate-resistant kochia is prevalent in western Kansas," Abstract 166 at the Western Society of Weed Science 2011 meeting. http://wssaabstracts.com/public/6/abstract-166.html.

[33] Stachler JM et al (2011), op. cit., Table 26.

[34] Lambsquarters 2010 ND in supporting materials, from North Dakota Weed Control Guide: Common Lambsquarters – 2010 Weed of the Year, North Dakota State University, http://www.ag.ndsu.edu/weeds/weed-year.

[35] EIS at 160.

2008 that he had to double the rate of glyphosate he formerly used to gain adequate control of common lambsquarters, another sign of creeping resistance.[36] With RRSB added to rotations of RR soybeans and/or RR corn, one can expect lambsquarters to evolve or shift to still greater resistance or tolerance to glyphosate, leading to higher rates and costs. Like kochia and waterhemp, there are few if any good post-emergence options once glyphosate is lost.

Glyphosate-resistant weeds in Michigan

Two troublesome sugar beet weeds have recently evolved resistance to glyphosate in Michigan. Glyphosate-resistant horseweed was recently confirmed in a stale seed-bed sugarbeet field in Michigan, either in Ionia or Gratiot County.[37] According to weed scientist Christy Sprague, GR horseweed could be problematic in sugar beets, "particularly if sugarbeet is planted into a stale seedbed. If you suspect you may have glyphosate-resistant horseweed in a field that will be planted to sugarbeet, tillage prior to planting is recommended." (Id.). GR horseweed could therefore encourage more tillage and hence soil erosion. However, it does not appear that the stale seedbed practice, in which tillage is undertaken in the fall to encourage weed seed germination, then again in the spring before planting,[38] constitutes a conservation tillage practice or reduces soil erosion at all – despite APHIS's confusing and inconsistent attempts to suggest that it does.[39] APHIS should add horseweed to the list of problematic sugar beet weeds based on the testimony of a Michigan weed scientist.

APHIS suggests that this GR horseweed population dispersed from a population originally identified in a Christmas tree nursery in 2007,[40] but the source it cites does not appear to address this GR horseweed at all. The report on this GR horseweed that CFS found did not state whether it was dispersed from the Christmas tree nursery population or evolved separately from glyphosate selection pressure in the sugar beet field (Sprague horseweed 2011). Independent evolution of glyphosate resistant populations of horseweed and other weeds is quite favored by the frequent rotations involving RRSB and other RR crops. In fact, Michigan has the highest percentage of sugar beet acreage that is estimated to rotate to another RR crop (66%).[41]

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[36] Stalcup, L (2008). "Glyphosate resistance rising," Corn and Soybean Digest, Feb. 1, 2008. http://cornandsoybeandigest.com/ag-issues/glyphosate-resistance-rising-0201/

[37] See Sprague horseweed 2011. Sprague, C. (2011). "Horseweed confirmed resistant to glyphosate in Michigan field crops," Michigan State University Weed Science, April 14, 2011.

[38] EIS at 130, citing May and Wilson (2006). However, this account of the practice is directly contradicted at EIS at 113, where after fall tillage, fields are then "left untouched the following spring when planting begins."

[39] EIS at 113: "The introduction of H7-1 has allowed farmers the option of implementing varying methods of reduced tillage system." "Allowing" an "option" is not the same thing as increasing use of a practice, as APHIS tries to suggest here. If APHIS has no good survey data on the practices of Michigan sugar beet farmers that establish a clear link between RRSB, state seedbed tillage and increased conservation tillage, then this statement should be eliminated. Biased speculations, which amount to inventing benefits for RRSB where none can be demonstrated to exist, have no place in an EIS.

[40] EIS at 236.

[41] EIS at 121, Table 3-6.

This high frequency of RRSB in RR crop rotations is also troubling given the recent confirmation of glyphosate-resistant Palmer amaranth in Michigan.[42] Michigan is by far the northernmost state in which a GR biotype of this mostly southern and lower Midwestern (e.g. Missouri and Illinois) weed has been discovered. While this GR Palmer amaranth was not discovered in a sugar beet production county, in other states GR biotypes have spread in a matter of a few years across many counties to infest millions of acres, and Palmer amaranth has been the most damaging of the GR weeds to date due to its incredibly rapid growth and ability to emerge throughout the growing season.

Glyphosate-resistant weeds in other production regions

Nebraska is also experiencing a surge in glyphosate-resistant weeds. A GR horseweed biotype was first identified in 2006, and multiple giant ragweed populations were identified in four counties just months ago[43] (CFS Science Comments – Appendix 1). Scientists are certain it is more widespread due to complaints from growers, but (a common theme among weed scientists all over the country) they do not have the funding or manpower to follow up on these reports. Weed scientist Stevan Knezevic thinks it is highly likely that GR kochia and waterhemp have also evolved in Nebraska, but the matter is still under study.[44] As noted above, Colorado likely has glyphosate-resistant kochia as well (see Stahlman GR kochia 2011).

Most western states do not have a large Roundup Ready crop presence, so there is less potential for continuous selection pressure from RRSB grown with other RR crop systems in rotation. However, RR alfalfa has the potential to become a major crop in Intermountain and Western states where RRSB is grown. APHIS should assess whether alfalfa is really so little rotated with sugar beets as suggested in Table 3-6, where only a small fraction of sugar beet acreage is rotated to alfalfa in a single state (Idaho), and adjust those figures as needed.

Assessment of Impact of Glyphosate-Resistant Weed Response Measures

Glyphosate-resistant weeds have triggered substantial adverse impacts wherever they have emerged: increased use of glyphosate and other, more toxic herbicides; increased use of tillage and abandonment of conservation tillage; a massive rise in hand-weeding; and skyrocketing weed control costs. This pattern has repeated itself again and again in various states, and is by now too clear and predictable to ignore. (See CFS Science Comments 2010; Benbrook – 13Years2009 – 11-15-09, Chapter 4; Haire 2010; Culpepper-Kichler 2009; NRC 2010; Tranel et al waterhemp 2010; among other supporting materials). Yet APHIS does just this. In every area, its assessment of RRSB's effects is at best a "snapshot" of current practice that willfully ignores not only long- and medium-term consequences, but even trends that are making themselves manifest in just the third and fourth years of RRSB cultivation.

Given the data presented above about the exponential spread of GR weeds, APHIS's refusal to project herbicide use would be equivalent to the insurance industry, in full knowledge of climate destabilization trends, projecting that claims from weather-related disasters will remain the same

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[42] See Sprague pigweed 2011. Sprague, C. (2011). "Glyphosate-resistant Palmer amaranth in Southwest Michigan," Michigan State University Weed Science, April 2011.
[43] See NE Farmer 2011.
[44] Id.

in the long-term as they are today. If the insurance industry were to adopt that approach, of course, it would go bankrupt.

Herbicide Use

In 2010, in just the third year of commercial RRSB cultivation, the average glyphosate use rate in the Red River Valley increased to 2.09 lb./acre/season, up from 1.95 lb./acre (2008) and 1.85 lb./acre (2009), a 7% to 13% rise that was attributed to early planting "and the presence of difficult to control weeds."[45] As one would expect from experience with other RR crop systems, where the first few years of use provide excellent weed control, 30% of MN-ND RRSB growers reported "none" as their "worst weed problem" (Id., Table 26). However, it is significant that nearly twice as many growers made this response in 2008 (54%), dropping to 39% in 2009. These two findings suggest that glyphosate's efficacy is already beginning to slip, in just the third year of use. While APHIS assumes RRSB growers will follow stewardship recommendations and diversify their weed control measures, the facts demonstrate the opposite. In fact, just 5% of total herbicide treatments involved a non-glyphosate herbicide, meaning near total reliance on two to three post-emergence applications of glyphosate for weed control.[46]

With this degree of reliance on glyphosate, the GR weed trends discussed above will continue to manifest and accelerate in sugar beet cropland, especially where other RR crops are in the rotation. APHIS needs to supplement its herbicide use snapshot with a projection of herbicide usage trends at least 10 years into the future, to account for inevitably rising weed resistance. For instance, APHIS should factor in usage of the dimethenamid-P recommended to control GR waterhemp, rather than ignore this herbicide.[47] As noted earlier, the glyphosate rate utilized by APHIS appears to be too low even for the "snapshot" of current practices, and should of course be scaled gradually upward to account especially for increasing tolerance in common lambsquarters, which both has a history of "creeping resistance" to glyphosate and is regarded as the worst weed by Red River Valley RRSB growers (a substantial 23% in 2010, Stachler, JM et al (2010), Table 26). In addition, Sequence (a premix of S-metolachlor and glyphosate) appears to be registered for RR sugar beets, and will likely be used much more in the coming years, given resistance to other popular herbicides besides glyphosate. The increased use of these additional herbicides should also be factored into projections of the toxicity comparison between conventional sugar beets and RRSB.

Other practices

Tillage and hand weeding will likewise increase with GR weed presence, just as it has in Missouri, Arkansas, Tennessee, Mississippi, Georgia and other states afflicted with GR horseweed and pigweed (see Neuman-Pollack 2010 & Kilman 2010). Failure to make reasonable projections of increased use of these practices in response to expanding GR weed populations would be irresponsible in light of these foreseeable medium- to longer-term impacts

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[45] Stachler, JM et al (2011), op. cit.

[46] Id., Table 3: 16.4% = the sum of "acres treated, % of total" for treatments involving any non-glyphosate herbicides; 247.6% = the sum of all herbicide treatments in that same column. 247.6% acres treated means that the average acre was treated 2.476 times.

[47] EIS at

of RRSB deregulation. The additional costs of these various practices to farmers also need to be accounted for, as well as the RRSB technology fee.

Weed Resistance to Other Herbicides

Much of APHIS's discussion of weed resistance is cloaked in the language of diversity. That is, APHIS speaks as if the RRSB system were merely a valuable addition that enriches the existing toolkit of weed control measures in that it "affords growers with another herbicide mechanism of action."[48] APHIS takes the fantasy of diverse weed control so far as to predict that under Alternative 2, unconditional deregulation: "All regions are expected to see a net decline in the development and dispersal of herbicide resistant weeds due to the introduction of an additional mechanism of action for weed management."[49]

This conclusion is, of course, absurd. The first problem is that RRSB does not provide "another herbicide mechanism of action." Rather, it essentially replaces all other weed control measures, as indicated by the fact that 95% of all herbicide treatments in the Red River Valley sugar beets were glyphosate alone (the other 5% are mostly glyphosate mixed with other herbicides, like clopyralid). RRSB does not enrich the weed control toolbox, it destroys it and all the tools in it, just as other RR crops have done before it.

The second problem follows from the first. When sugar beet growers use (essentially) only glyphosate for weed control, it is glyphosate resistance in weeds that will be selected for – not resistance to ethofumesate, or desmedipham, or any of the other conventional sugar beet herbicides, whose use has already shrunk to the 7% of acres that are still conventional. For APHIS's prediction that there will be a net decline in herbicide-resistant weeds to be true, there would have to be massive expansion of weeds resistant to non-glyphosate herbicides to counteract the tidal wave of glyphosate resistance that the data discussed above represents. (Recall that GR weeds have increased in scope by roughly two orders of magnitude over just the past four years, and that the appearance of new populations is accelerating (CFS Science Comments – Appendix 3)). APHIS did not present any data to support such a trend. At most, there are tables that contain reports of sugar beet weeds that have evolved resistance to various non-glyphosate herbicides, mostly in the 1990s, with no indication of whether these HR weeds are increasing in scope, on the decline, or have entirely disappeared (HR weed populations are sometimes less fit and so recede in competition with fitter non-HR weeds when use of the corresponding herbicide is curtailed). In any case, one would expect that any "legacy" weeds resistant to non-glyphosate herbicides that infest conventional sugar beets would have been suppressed, over the past 5-15 years, in those hundreds of thousands of sugar beet acres that are rotated to an RR crop and thus treated with glyphosate. APHIS does not anywhere discuss this scenario. In contrast, GR weed selection pressure in RRSB is amplified by post-emergence glyphosate use on those same 600,000 plus RR crop rotation acres, as crop rotations already overly centered on glyphosate become still less diverse.

APHIS is also inconsistent on the scope of weed resistance to non-glyphosate herbicides, hyping the threat when it comes to justifying unconditional deregulation of RRSB, then blandly

[48] EIS at 537.
[49] EIS at 546.

assuming alternate herbicides will always be available to control already-resistant weeds that acquire additional resistance to glyphosate. For instance, APHIS presents a dire portrait of weeds resistant to other herbicides threatening sugar beet production (citing the discredited Sexton, see CFS legal comments),[50] but then happily assumes that any glyphosate-resistant weeds that evolve will be easily handled with alternative herbicides,[51] which of course would not be the case if the pre-existing resistances were so prevalent that glyphosate selection pressure would almost always be an additional resistance atop the many others. In this latter, much more realistic scenario, where glyphosate resistance is the straw that broke the camel's back, one might well suppose existential threats to RRSB growers, just as cotton growers in southern states are near bankruptcy due to glyphosate resistance, often doubled up with resistance to ALS inhibitors, in Palmer amaranth and other weeds (Haire 2010; see Appendix 1, GR Palmer amaranth report, 2009 in Tennessee).

Finally, APHIS's comfortable acceptance of glyphosate-resistance in important weeds because the herbicide will still be effective on others, or can still be used in product or tank mixes with other herbicides, is of course just the attitude taken by the pesticide firms, for whom resistance means big business (see Kilman 2010). Others who appreciate the ability of glyphosate to kill a broad spectrum of weeds and wish to preserve its efficacy, such as Dr. Stephen Powles, eminent Australian weed scientist, think differently. According to Dr. Powles: "Within the cotton, corn and soybean belt the massive reliance on glyphosate means it will be driven to redundancy because many of the big driver weeds such as Palmer pigweeds, waterhemp, ragweed and johnsongrass will be resistant. There may be many weed species still controlled by glyphosate, but glyphosate will fail on the driver weeds and that means overall failure."[52]

APHIS must provide a serious, rational assessment of herbicide-resistant weeds. As noted in the legal comments, the Alternative 2 assessment must set off the short-term benefits of glyphosate use against the longer-term impacts of its rapid loss of efficacy. The EIS must account for foreseeable long-term adverse impacts of the full deregulation by projecting increased use of glyphosate and non-glyphosate herbicides, greater soil erosion from increased use of tillage, and increased use of manual weeding – and costs associated with these measures – to respond to the inevitable continued emergence of GR weeds.

APHIS should also propose a new alternative that provides for long-term efficacy of glyphosate, for instance by limiting the frequency with which an RR crop can be grown over time, at field or farm scale, as we suggested a year ago in CFS Science Comments 2010. Other measures such an alternative might include are planting of green manure or cover crops for weed suppression as well as multiple other benefits (Lilleboe 2006).

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[50] EIS at 537.
[51] EIS at 539.
[52] Laws (2010). "Diversity key to glyphosate issue," Southeast Farm Press, January 25, 2010. http://southeastfarmpress.com/management/diversity-key-glyphosate-issue.

CFS cannot support Alternatives 2 or 3, as both will perpetuate rapidly worsening weed resistance that calls for responses that are harmful to the interests of agriculture, the environment, and ultimately public health. CFS urges APHIS to adopt Alternative 1.