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Genetically Modified (GM) Crops and Pesticide Use[1]

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Worldwide GM Crop Acreage By Trait or Trait Combination[2]

(expressed as % of total international GM crop acreage)

Trait(s)	1999	2005	2006
Herbicide tolerance (HT)	71%	71%	68%
Insect resistance (IR)	22%	18%	19%
HT and IR	7%	11%	13%
TOTALS	100%	100%	100%
HT alone or HT/IR	78%	82%	81%

- Herbicide-tolerance lends crops the ability to survive direct application of a broad-spectrum herbicide to kill nearby weeds. HT crops encourage greater and more indiscriminate use of weedkillers, and have higher levels of herbicide residues than normal crops[3]
- 4 of every 5 acres of GM crops worldwide (81%) are modified for herbicide-tolerance
- Biotechnology companies have failed to introduce a single GM crop with increased yield potential, enhanced nutrition, drought-tolerance or salt-tolerance. Disease-resistant GM crops are practically non-existent.

[1] This is a revised and updated version of comments delivered at the August 1, 2007 meeting of the USDA's Advisory Committee on Biotechnology and 21st Century Agriculture (AC21).

[2] International Service for Acquisition of Agri-biotech Applications (ISAAA). Note that biotechnology and agricultural chemical companies are major funders of ISAAA, and its statistics and analysis particularly with respect to GM crops in developing countries have been criticized for inaccuracies (see, for example, "Who Benefits from GM Crops?" Friends of the Earth International, 2006, at http://www.foei.org/en/publications/pdfs/gmcrops2006full.pdf). For 2006, see: http://www.isaaa.org/resources/publications/briefs/35/executivesummary/default.html

[3] For two of many examples, see Center for Food Safety's comments on USDA's Programmatic Environmental Impact Statement on GM crops, p. 60. http://www.centerforfoodsafety.org/pubs/USDA%20PEIS%20Comment%20Master%20FINAL%20-%209%2011%2007.pdf

The 12 GM Crops Pending Deregulation (Commercial Approval) by USDA

(as of December 13, 2007)

Trait	No.	Notes
Tolerate 1 herbicide	3	All glyphosate (Roundup) tolerant: cotton (Bayer CropScience), alfalfa & creeping bentgrass (Monsanto)
Tolerate 2 herbicides	**2**	**Soybeans and corn that tolerate glyphosate and ALS inhibitor herbicides,[4] both DuPont-Pioneer**
Insect-resistant	3	Corn (2 – Syngenta & Monsanto), cotton (1 – Syngenta)
Virus-resistant	1	New version of old papaya trait
Enzyme added	1	Syngenta, corn w/ alpha-amylase enzyme derived from deep sea microorganisms for processing into ethanol. First GE industrial crop. Some alpha amylase enzymes cause respiratory allergies. South Africa has refused import clearance on grounds that Syngenta has not provided an adequate analysis of potential health impacts from consumption of this corn.
Oil alteration	1	High oleic acid soy for processing (DuPont-Pioneer)
Color alteration	1	Carnation (Florigene)

Source: Petitions of Nonregulated Status Granted or Pending by APHIS as of December 13, 2007 (last accessed January 7, 2008). See: http://www.aphis.usda.gov/brs/not_reg.html.

- Herbicide-tolerant crops are not only dominant now. They represent the near- and longer-term future of biotech agriculture
- Nearly one-half (5 of 12) of near-future GM crops are herbicide-tolerant; all five are tolerant to glyphosate
- Two of the five HT crops are each modified for tolerance to two herbicides (glyphosate and ALS inhibitors[1]) rather than one, a novel development driven by the dramatic increase in glyphosate-resistant weeds
- In the U.S., an estimated 99% of GM HT crops are glyphosate-tolerant (Roundup Ready)[5]
- Roundup Ready soybeans, cotton and corn are responsible for:
    - Large and accelerating increases in the use of glyphosate (see Appendix 1)
    - An epidemic of weeds with resistance to glyphosate (see footnote 3, pp. 11-19)
    - Constant or rising use of older, more toxic, herbicides such as 2,4-D and atrazine (often in combination with glyphosate), to control resistant weeds (Appendix 2)
- The longer-term future of GM crops is also dominated by herbicide-tolerance. Over one-third of ongoing GM crop field trials involve HT crops; these field trials encompass 18 plant species and tolerance to 8 or more different herbicides (see footnote 3, p. 9).

[4] The USDA lists the dual herbicide-tolerant corn as tolerant to glyphosate and "imidazolinones" – imidazolinones are one class of the acetolactate synthase (ALS) inhibitor group of herbicides. DuPont-Pioneer refers to this dual herbicide-tolerance as "Optimum GAT" in both soybeans and corn.

[5] Freese, B. (2007). "Cotton Concentration Report: An Assessment of Monsanto's Proposed Acquisition of Delta and Pine Land," February 2007, International Center for Technology Assessment/Center for Food Safety, Section 3.6.2. http://www.centerforfoodsafety.org/pubs/CFS-CTA%20Monsanto-DPL%20Merger%20Report%20Public%20Release%20-%20Final%20_2_.pdf

GM Crops Increase Pesticide Use

- According to the most comprehensive, independent analysis of the subject, based on exhaustive analysis of USDA data, GM crops increased pesticide use in the U.S. by 122 million pounds from 1996-2004[6]

  + Herbicide-tolerant: + 138 million lbs.
  + Insect-resistant: - 16 million lbs.
  + NET: + 122 million lbs.

The Myth of Reduced Pesticide Use

- Selective reference to and illegitimate extrapolation from the pesticide use impacts of GM crops in the early years of adoption, before herbicide-resistant weeds led to steadily increasing herbicide use[6]

  + 1996 – 1998: - 20.6 million lbs
  + 1999 – 2004: + 143.1 million lbs
  + 1996 – 2004: + 122.5 million lbs

- Pesticide use reductions from Bt corn sometimes greatly exaggerated by assuming all current Bt corn growers would use insecticides to control European corn borer (ECB) if they switched back to conventional corn. In fact, only 5.2% of corn acreage was sprayed for ECB prior to availability of Bt corn. According to the National Academy of Sciences:

"… the European corn borer, which is the major target of transgenic Bt field corn, has not commonly been controlled with insecticides. A survey of the literature (Gianessi and Carpenter 1999) indicates that across the corn belt only 5.2% of the acreage is sprayed annually for corn borers and in Iowa only 2.6%. Some of the reasons for the lack of chemical control are that the perceived yield loss has always been considered small (estimated at about 4%), the cost of pesticides is high relative to the crop's value, and typical insecticides have not been very efficient at killing the pest after it bores into the plant." [7]

[6] Benbrook, C. (2004). "Genetically Engineered Crops and Pesticide Use in the United States: The First Nine Years," Technical Paper No. 7, October 2004, available at: http://www.biotechinfo.net/technicalpaper7.html. Dr. Benbrook is the former chair of the Board on Agriculture of the National Academy of Sciences.

[7] "Genetically Modified Pest-Protected Plants: Science and Regulation," Board on Agriculture and Natural Resources, National Research Council, National Academy of Sciences, 2000, Section 3.1.2. http://books.nap.edu/catalog/9795.html.

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

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

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

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

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

[4] From USDA's Agricultural Marketing Service, which has more reliable statistics on cotton than ERS. See: "Cotton Varieties Planted: 2006 Crop," http://www.ams.usda.gov/cottonrpts/MNXLS/mp_cn833.xls. Figure calculated by adding percentages of all HT varieties (those with designations R, RR = Roundup Ready or RF = Roundup Ready Flex and LL for LibertyLink). Note that most HT cotton is Roundup Ready (Flex); LL cotton varieties comprised only 3-4% of US cotton in 2006.

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

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

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

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

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

- When biotechnology companies are forced to admit that GM crops do in fact increase rather than decrease overall pesticide use, they often fall back on a second claim – that increased use of glyphosate is good, because it displaces more toxic herbicides. However, recent trends show that this is decidedly not the case for several widely used and toxic herbicides. Use of both atrazine on corn and 2,4-D on soybeans and corn has increased substantially since 2002.
- Increasing use of 2,4-D on soy (and perhaps atrazine on corn) is largely attributable to the need to control glyphosate-resistant weeds.