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# The Bad Seeds: The Broken Promises of Agricultural Biotechnology

Fact Sheet • October 2009

Agricultural biotechnology has been promoted as a key tool to combat global hunger and poverty by increasing the productivity of farmers worldwide. The technology relies on genetically modified (GM) seeds and agrochemicals that are tailored to the genetic traits of the seeds. The biotechnology industry promised that farmers could increase their yields, lower production costs and reduce agrochemical use.[1] Instead, American farmers have faced higher costs without higher productivity, risked lawsuits from seed companies, and applied more agrochemicals as weeds and insects developed resistance to the genetic crop traits.

The real winners have been the handful of biotechnology companies that patent specific genetic crop traits and sell the GM traits in seeds and affiliated agrochemicals to farmers. A few major chemical and pharmaceutical giants now dominate the seed industry, which once relied on universities for most research and development.[2] Between 1996 and 2007, Monsanto acquired more than a dozen smaller companies, and now controls an estimated 70 percent of all GM corn and 99 percent of all soybeans planted in the United States.[3] The few firms that do exist often have cross-licensing agreements for their patents that create partnerships between companies to sell seeds with specific combinations of traits from multiple firms.[4] A high level of concentration and cooperation can raise seed prices for farmers.[5]

Most GM crops are destined for livestock feed, biofuel refineries or processed food ingredients, in part because major U.S. trade partners like Europe and Japan have not authorized the importation of many GM food products because of uncertainty about the possible human health and plant risks.[6] Consumers in these countries do not want to eat GM food.[7] Despite the limited export opportunity, the high cost of the GM seed and agrochemicals, and environmental impacts, international agribusinesses are promoting biotechnology as a key strategy for farmers in the developing world to combat global hunger.

## What are genetically modified crops and where are they grown?

Genetic engineering can create, improve or modify crops by changing a plant's genetic traits.[8] Most commercial biotech crops are either herbicide-tolerant, which allows farmers to apply herbicides to kill weeds without damaging the crops, or insect-resistant, which theoretically protects the plants from destructive pests.[9] Biotech crops became commercially available in 1996, and by 2009, the vast majority of the corn, cotton and soybean crops in America were genetically modified.[10] Although biotech firms have promised high-yield and drought-resistant GM seeds, to date, these traits are not commercially available.[11]

The United States is the global leader in GM production, with half the world's cultivated acres in 2008.[12] Only 25 countries allow the commercial production of GM crops, with the five largest producers accounting for 91 percent of

GM cultivation.[13] In the United States, biotech seeds are grown on nearly nine out of ten acres of corn, soybeans and cotton — 85 percent of corn, 91 percent of soybeans and 88 percent of cotton.[14]

The farmers that plant biotech crops appear to be adopting them despite lower benefits in terms of yields and returns to producers.[15] USDA surveys show that farmers expect improved performance of GM crops.[16] The convenience of some GM crops for farmers – the purported simplicity of applying a single herbicide and the market saturation of GM seeds and affiliated agrochemicals – may explain some of the increasing rates of GM adoption.

But the seed companies spend lavishly on advertising that may influence farmers more than real-world experience with the crops. In 2008, Monsanto spent $95 million on advertising, and German chemical and biotech firm BASF spent an estimated $20 million advertising its agricultural products.[17]

## GM seeds costly for farmers

Biotechnology is not cheap for farmers. GM seeds are more expensive than conventional seeds and most are used with specific herbicides that cannot be substituted with cheaper varieties. Purchasers of GM seeds must pay licensing fees, and North American farmers have faced expensive lawsuits for violating licensing agreements. The yields for GM crops have not lived up to industry promises, especially for the food crops corn, soybeans and canola.[18] Moreover, farmers cannot export their biotech crops to key export markets in Europe and Japan because these governments have not approved GM food. In 2002, USDA found farmers' widespread biotech adoption "puzzling" given the "mixed or even negative" financial returns from GM corn and soybeans.[19]

***High-Priced Biotech Seeds:*** Biotech seeds can be four times as expensive as non-GM seeds.[20] The USDA projected that seed expenses for farmers rose by 66.3 percent from $10.4 billion in 2005 to $17.3 billion in 2009 — more than double the increase in total farm production expenses.[21] In 2009, non-biotech soybean seed cost half as much as Roundup Ready seed — $17 a bag versus $35.[22] Seed prices are likely to continue to rise. Monsanto is planning to charge as much as 42 percent more for its GM seeds in 2010 than in 2009.[23] Monsanto's net income doubled from $993 million in 2007 to $2 billion in 2008.[24] DuPont Pioneer Hi-Bred announced a 20 percent increase for corn seed and 35 percent increase in soy seed in 2009 and is projecting "double-digit seed price increases" between 2009 and 2013.[25]

***High-priced herbicides:*** The price of GM-affiliated herbicides has risen as well; between 2006 and 2009, Roundup prices nearly doubled from between $11-$13 to more than $20 a gallon.[26] Although GM proponents contend that farmers save on herbicides designed for GM crops, the savings per acre may be less than the increased cost of GM seeds. At most, farmers saved from $3 to $20

per acre on lower herbicide costs for GM soybean cultivation,[27] but GM soybean seed can cost about $23 more per acre than conventional seed,[28] meaning the higher seed costs exceed the herbicide savings.

***Patent suits against farmers:*** Farmers pay a licensing fee to use patented seeds and sign a contract with the biotechnology company that gives the farmer limited permission to plant the patented seeds for a single crop season.[29] The licenses typically prohibit the common and traditional practice of saving seeds from harvested crops to plant the next season, require farmers to follow specific farming practices and sell in specific markets, and allow the company to inspect their fields.[30]

The biotech companies zealously pursue anyone that may be violating the license agreement or infringing on their patents. Monsanto has hired private investigators to videotape farmers, infiltrate community meetings and interview informants about local farming activities.[31] Monsanto even has a toll-free 800 number to encourage farmers to rat out their neighbors for "seed piracy."[32] By October 2007, Monsanto had filed 112 lawsuits against farmers for patent infringement, recovering between $85.7 and $160.6 million from farmers in court rulings and out-of-court settlements.[33] It is well-documented that a farmer's field could be inadvertently contaminated with GM material through cross-pollination and seed dispersal, and at least one farmer contends he was sued when his fields were inadvertently contaminated with GM crops from neighboring farms.[34]

***GM Crops have not demonstrated higher yields:*** The USDA has admitted, "Currently available [genetically engineered] crops do not increase the yield potential of a hybrid variety."[35] Theoretically, the pest and herbicide

resistance bred into the crops elevates yields by helping farmers combat yield-depressing insect and weed infestations. Farmers have not seen better yields from GM crops, because the seeds are not designed to increase yields and because weeds and insects are developing resistance to the technology.

Improved yields cannot be attributed to biotechnology since corn and soybean yields have not increased faster since GM seeds were introduced. Average corn yields increased by 2.7 percent between 1995 and 2009, matching the 2.7 percent yield increase between 1981 and 1995, before GM seeds were available.[36] Soybean yields increased faster between 1981 and 1995 (2.1 percent annually) before GM, but yields rose only 1.6 percent between 1995 and 2009.[37] A 2009 Union of Concerned Scientists survey of yield studies found little difference between GM and non-GM crops. It found herbicide-tolerant corn and soybeans had no yield increase over non-GM crops, but found a slight yield advantage (3 to 4 percent) for insect-resistant corn.[38]

These findings are consistent with a decade of research. A USDA survey of yield studies found that herbicide-tolerant biotech corn seeds did not increase yields for farmers.[39] GM soybeans routinely have lower yields than non-GM soybeans. A 2007 Kansas State University study found that conventional fields produced 10 percent more than biotech soybean fields.[40] A 2001 University of Nebraska study found that conventional lines had 5 percent higher yields than GM herbicide-resistant sister soybean lines; high-yield conventional soybean lines had 10 percent higher yields than the GM fields.[41] A University of Saskatchewan study found that conventional canola had 8.2 percent higher yields than Roundup Ready canola.[42]

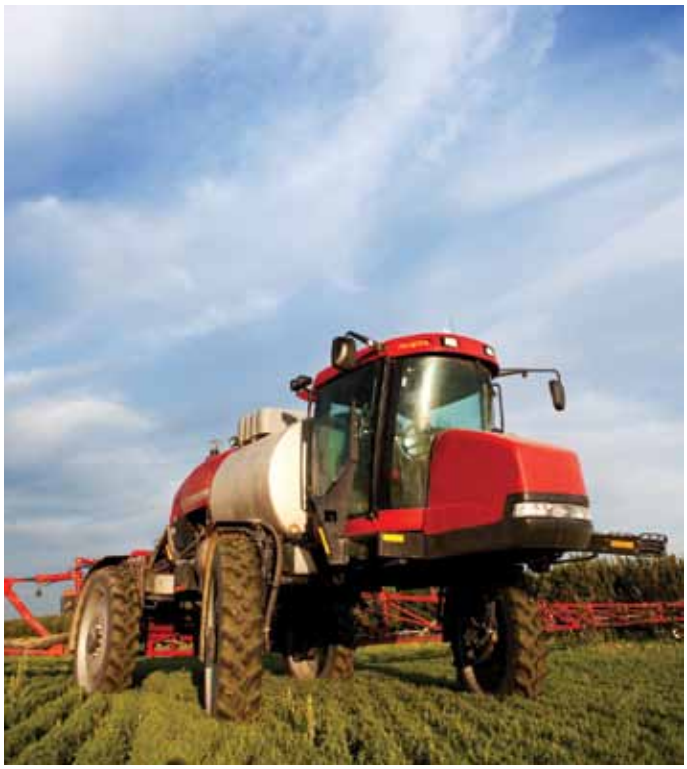
***Exports can be destroyed by accidental GM contamination:*** Despite the U.S.'s advanced grain-handling system, GM crops routinely contaminate non-GM crops, devastating U.S. exports. The Government Accountability Office found six known unauthorized releases of GM crops between 2000 and 2008.[43] In 2000, GM Starlink corn, which had only been approved for animal feed or industrial use, was discovered in retail food products.[44] Although Starlink was less than one percent of corn cultivation, it was found in 70 percent of samples tested by Japan.[45] After the Starlink contamination discovery, Europe banned all corn imports from the United States, costing farmers $300 million annually.[46] In 2005, the United States again inadvertently exported GM corn, igniting a backlash that could have affected $1.9 billion worth of exports.[47] In August 2006, USDA admitted that unapproved GM rice had been found in non-GM rice stocks.[48] Japan immediately halted all U.S. rice imports and Europe imposed heavy restrictions; in total, the event cost the U.S. rice industry $1.2 billion.[49] In 2007, the European Union discovered that certified GM-free corn-based feed tested positive for GM.[50] The frequent regulatory failure to prevent unauthorized releases of unapproved genetically modified food crops is cited as evidence that the United States cannot effectively manage GM crops.[51]

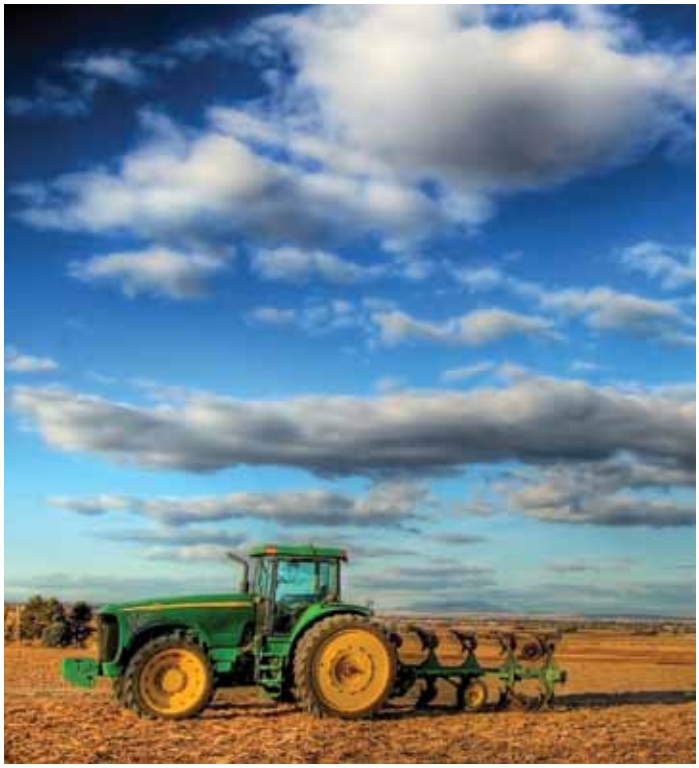
## The heavy ecological footprint of GM crops

Biotechnology proponents contend that GM crops are more environmentally sustainable because the insect- and herbicide-resistant traits reduce the application of agrochemicals and encourage erosion-reducing conservation plowing.[52] The real ecological implications of biotechnology are less rosy. Herbicide-tolerant GM crops are designed to be sprayed with chemical weed killer, most frequently glyphosate, the active ingredient in Roundup.[53] A dozen years after GM crops were introduced commercially, weeds and insects have already become resistant to the genetic traits that are intended to prevent infestations. This reduces farm yields and encourages farmers to apply more and more potent herbicides and pesticides.

***Widespread resistance to GM-affiliated herbicides:*** The most common biotech crops are genetically bred to withstand the application of herbicides. By 2009, glyphosate (Roundup) was applied to 110 million acres of U.S. cropland in America.[54] Ubiquitous glyphosate application has led to widespread weed resistance, which can lead to higher herbicide applications and lower yields.[55]

At least eight weed species in the United States (and fifteen worldwide) have been confirmed to be resistant to glyphosate,[56] including several aggressive crop weeds like ragweed, mare's tail and waterhemp. University of Guelph researchers discovered glyphosate-resistant giant ragweed that can endure herbicide applications that kill off non-resistant ragweed.[57] A 2009 Purdue University study found that glyphosate-tolerant mare's tail could "reach staggering levels of infestation in about two years after it is first detected."[58] Some waterhemp has already become resis-





tant to glyphosate.[59] By 2008, glyphosate-resistant weeds infested at least 2.4 million acres in the United States.[60]

When weeds develop a widespread tolerance to the affiliated GM herbicide, any benefit of the biotech crop evaporates.[61] Glyphosate resistance leaves farmers dependent on an herbicide that is no more effective in controlling weeds like mare's tail than before the herbicide-resistant trait was introduced in 1996.[62] Increased density of glyphosate-resistant weeds in GM fields can reduce yields.[63] Purdue University scientists found that Roundup-resistant ragweed can cause 100 percent corn crop losses in the Eastern corn belt.[64] Cotton farmers in Southern states have increased herbicide applications and abandoned conservation tillage practices to counter glyphosate resistance.[65]

***Insects developing resistance to insect-tolerant GM crops:*** Key crop pests have already developed resistance to the biotech crops spliced with *Bacillus thuringiensis*, a type of soil bacteria known as *Bt* that is toxic to insects. University of Arizona researchers found that seven years after insect-resistant *Bt* cotton was introduced, cotton bollworms were developing resistance to the toxin that was being passed on to offspring — even offspring from *Bt*-susceptible moths, meaning that *Bt* resistance was a dominant trait that could rapidly evolve.[66] A University of Missouri entomologist found that corn rootworms could pass on *Bt* resistance to their offspring that are considerably more resistant to the GM crop than the offspring of corn rootworm beetles that had not been exposed to *Bt* crops.[67]

***Agrochemical applications continue to rise on biotech crops:*** One of the purported benefits of biotech crops is reduced application of agrochemicals. Herbicide-resistant crops rely on affiliated herbicide applications, but proponents contend that these crops use fewer overall applications of herbicides.[68] But total herbicide use can increase with herbicide-tolerant crops. Farmers increase application of the herbicide tied to the crop trait even though they may reduce the application of other herbicides. The 138 million pound increase in herbicide applications overwhelmed the 16 million pound decline in insecticide applications attributable to *Bt* corn and cotton.[69] The former agriculture director of National Academy of Sciences found that Roundup Ready soybeans "clearly require more herbicides than conventional soybeans."[70] USDA found that herbicide-tolerant soybean cultivation increased active pounds of herbicide by 3 percent.[71] Since 1994, glyphosate use on soybeans, corn and cotton increased 15-fold to 119 million pounds in 2005.[72]

Increased weed and pest tolerance to the genetically modified traits has forced farmers to increase agrochemical applications to combat the GM-resistant infestations. Between 2002 and 2006, in addition to glyphosate applications, the amount of the herbicide 2,4-D applied to soybeans doubled to combat weeds.[73] Non-glyphosate herbicide applications on corn rose by 5 percent from 2002 to 2005 — the application of atrazine alone rose by 12 percent.[74] This increased agrochemical use can run off farm fields, pollute water, and degrade soil.[75]

## Consumer choice, food allergies and the uncertainty surrounding the safety of GM food

Most biotech crops are not eaten directly by consumers — they are fed to livestock or manufactured into processed food ingredients. The long-term health effects of consuming biotech foods that have only been on the market a dozen years are unknown. Some studies suggest that there could be uncertain health risks associated with consuming GM foods. Europe and Japan have not approved biotech foods because of uncertainty over the safety of the products for human and animal consumption.[76] Genetically modified food can pose ethical concerns for some consumers. Crossing traits from one plant to another could expose consumers to allergens. Many vegetarians will not eat food genetically modified with genes from animals, while some Jewish and Muslim consumers object to GM for a variety of reasons, including the potential insertion of hog genes into their food.[77]

***Risk of biotech allergic reactions:*** GM crops can cause allergies through the inclusion of foreign proteins that have known or unknown effects on humans. The GM corn variety StarLink was not approved for human consumption because of allergenicity concerns and in 2000 it was found in supermarket products.[78] A *New England Journal of Medicine* study found that soybeans modified with Brazil nut proteins could cause allergic reactions for consumers with Brazil nut allergies.[79] In another case, a harmless protein found in certain beans, which acts as a pest-deterrent, became dangerous once it was transferred to a pea, causing allergic lung damage and skin problems in mice.[80]

***Possible health concerns from GM food:*** Laboratory studies examining possible health impacts have found problems in rats that consumed biotech corn and soy. One study showed high rat pup mortality in litters from mothers fed GM soy flour.[81] Another found irregularities in the livers of rats, suggesting higher metabolic rates resulting from a GM diet.[82] A 2007 study found significant liver and kidney impairment of rats fed GM corn with the insecticidal *Bt* gene and concluded, "with the present data it cannot be concluded that GM corn MON863 is a safe product."[83] Even GM livestock feed may have some impact on consumers of animal products. Italian researchers found biotech genes in the milk from dairy cows fed a GM diet, suggesting transgenes' ability to survive pasteurization.[84]

***Biotech field trials enter food supply:*** Some experimental GM crops or crops unapproved for human consumption have entered the U.S. food supply, with unknown risks to consumers. The Starlink and rice trial contaminations demonstrate the weaknesses of a regulatory barrier that should be impermeable. Since these well-known outbreaks, smaller contamination events allowed trial biotech crops — with unapproved pest-resistant traits — to enter the food supply. In 2008, a small amount of unauthorized GM cotton that contained an unapproved pesticide was harvested with approved GM cotton; about 600 pounds of unapproved cottonseed was sold onto the market and could have been used as livestock feed.[85] In 2008, Dow AgroSciences recalled some of its biotech corn seed lines that contained small amounts of an unregistered biotech pesticide that accidentally was planted on 72,000 acres of corn between 2006 and 2007 and entered the food supply.[86] In both cases, the federal government determined that the contamination presented no food safety, feed safety, plant pest or environmental risks, but these examples demonstrate the inability of the regulators to prevent unapproved biotech traits from entering the food supply.

## Conclusion

The track record of the GM industry is one of expansion throughout the food system, economic damage to farmers, negative impacts on the environment, and unfulfilled promises about sustainability. The unrestrained spread of this technology must come to an end — both in the United States and as a strategy for global agricultural development. U.S. regulators need to rein in GM technology, withdrawing existing approvals for GM crops and basing future decisions about GM technology on the precautionary principle, which prioritizes proving a new technology is safe before it is used. The federal government must launch an antitrust investigation into the anticompetitive market in biotech seeds. Finally, if GM technology is allowed to continue to be used to produce food, consumer labeling should be required so that purchasers of food can decide for themselves if this is a food technology they will support and feed to their families.

### Endnotes


1 Leake, Todd. Dakota Resource Council Statement before the Domestic Policy Subcommittee of the U.S. House Oversight and Government Reform Committee. March 13, 2008 at 2.

2 Howard, Phil. Michigan State University, Assistant Professor. "Seed Industry Structure, 1996-2008." 2009. Available online at https://www.msu.edu/~howardp/seedindustry.html and on file. Accessed September 8, 2009; Fernandez-Cornejo, Jorge.USDA, Economic Research Service. "The Seed Industry in Agriculture." AIB-786. January 2004 at 25-26 and Table 18.

3 Organization for Competitive Markets. "Monsanto Transgenic Trait Dominance in US Market, 1996-2007." June 2008; Fernandez-Cornejo, 2004 at 34.

4 Howard, Phil. Michigan State University, Assistant Professor. "Seed Industry Structure, Cross-Licensing Agreements for Genetically Engineered Traits." 2009.

5 Howard. "Seed Industry Structure, Cross-Licensing Agreements for Genetically Engineered Traits." 2009; Fernandez-Cornejo. 2004 at 40.

6 European Community. Regulation (EC) No. 1829/2003 of the European Parliament and of the Council on Genetically Modified Food and Feed. September 22, 2003; Dr. Sato, Suguro. USDA Foreign Agricultural Service, Global Agriculture Information Network. "Japan Biotechnology Annual Report 2008." July 15, 2008 at 3.

7 European Commission. Directorate General for Research. Special Eurobarometer. "Europeans and Biotechnology in 2005: Patterns and Trends." July 2006 at 17; Sato, Suguro. USDA Foreign Agricultural Service, Global Agriculture Information Network. "Japan Biotechnology Annual Report 2008." July 15, 2008 at 3.

8 Fernandez-Cornejo, Jorge and Margriet Caswell. USDA ERS. "The First Decade of Genetically Engineered Crops in the United States." EIB No. 11. April 2006 at 1.

9 Shoemaker, Robbin, ed. USDA ERS. "Economic Issues in Agricultural Biotechnology." AIB-762. 2001 at 9.
10 USDA, ERS. "Adoption of Bioengineered Crops." Available at http://www.ers.usda.gov/Data/BiotechCrops/ and on file. Accessed September 9, 2009.
11 To date, the United States has only approved herbicide tolerant and insect tolerant canola, corn, cotton and soybeans as well as virus resistant squash and papayas. Fernandez-Cornejo, Jorge. "Rapid growth in adoption of genetically engineered crops continues in U.S." *Amber Waves*. Vol. 6, Iss. 4. September 2008 at 6; International Service for the Acquisition of Agri-Biotech Applications. Press release. "Biotech crops poised for second wave of growth." February 11, 2009.
12 ISAAA. "ISAAA Brief 39-2008: Global Status of Commercialized Biotech/GM Crops: The First Thirteen Years, 1996 to 2008." 2008 at Table 1 of Executive Summary.
13 ISAAA. 2008 at Table 1 of Executive Summary.
14 "U.S. farmers increase adoption of biotech corn, cotton and soybeans." *Food Chemical News*. July 2, 2009.
15 Fulton, Murray and Lynette Keyowski. "The producer benefits of herbicide resistant canola." *AgBioForum*. Vol. 3, No. 2. 1999 at 89.
16 Fernandez-Cornejo and Caswell. 2006 at 9.
17 Monsanto. "Annual Report 2008." 2008 at 81; "BASF Unit Taps Mullen." *Adweek*. July 9, 2008.
18 Although insect resistant cotton has demonstrated some yield advantages, cotton cannot be eaten.
19 Fernandez-Cornejo, Jorge and William D. McBride. USDA, ERS. "Adoption of Bioengineered Crops." AER-810. May 2002 at 24.
20 Clapp, Stephen. "Opponents challenge ISAAA biotech crop forecast." *Food Chemical News*. February 16, 2009.
21 USDA, ERS. "Farm Income and Costs: Farm Sector Income Forecast." August 27, 2009.
22 "Non-biotech soybean acreage increasing in the United States." *Food Chemical News*. August 17, 2009.
23 Clapp, Stephen. "Monsanto to charge up to 42% more for next generation seeds." *Food Chemical News*. August 24, 2009.
24 Monsanto. Securities and Exchange Commission Form 10-K filing. Fiscal year end August 31, 2008 at 18.
25 "Pioneer seed sales up." *Feedstuffs*. June 29, 2009; Kaskey, Jack. "DuPont Raises Corn, Soybean Seed Prices Most Ever." *Bloomberg*. June 12, 2009.
26 Casale, Carl. Monsanto Chief Financial Officer. Presentation, UBS Best of Americas Conference. September 10, 2009 at 11.
27 Price, Gregory K, William Lin et al. USDA ERS. "Size and Distribution of Market Benefits from Adopting Biotech Crops." Technical Bulletin No. 1906. November 2003 at 3.
28 "Non-biotech soybean acreage increasing in the United States." *Food Chemical News*. August 17, 2009; Whigham, Kieth, Iowa State University. "How to lower soybean seed costs." *Integrated Crop Management*. IC-480(23). October 12, 1998; it takes about 1.3 bags of soybean seeds per acre (assuming the most common 3,000 seeds per pound and a target 200,000 seeds per acre).
29 Shoemaker. 2001 at 11; Farmers' Legal Action Group (FLAG). "Farmers' Guide to GMOs." February 2009 at 8.
30 FLAG at 9.
31 Barlett, Donald L. and James B. Steele. "Monsanto's harvest of fear." *Vanity Fair*. May 2008.
32 FLAG at 32.
33 Center for Food Safety. "Monsanto vs. U.S. Farmers." November 2007 at 1-2.
34 FLAG at page 29-31; Ellstrand, Norman. "Going to 'Great Lengths to Prevent the Escape of Genes That Produce Specialty Chemicals." *Plant Physiology*. August 2003.
35 Fernandez-Cornejo and Caswell. 2006 at 9.
36 USDA, National Agricultural Statistical Service. Crop statistical database available at http://www.nass.usda.gov/QuickStats/ downloaded September 25, 2009.
37 *Ibid*.
38 Gurian-Sherman, Doug. Union of Concerned Scientists. "Failure to Yield." April 2009 at 22 and 33.
39 Shoemaker. 2001 at 11.
40 Gordon, Barney. "Manganese nutrition of glyphosate-resistant and conventional soybeans." *Better Crops*. Vol. 91, No. 4. 2007 at 12.
41 Elmore, Roger W. et al. "Production agriculture: Glyphosate-resistant soybean cultivar yields compared with sister lines." *Agronomy Journal*. Vol. 93. 2001 at 408.
42 Fulton and Keyowski. 1999 at 89.
43 Government Accountability Office. "Genetically Engineered Crops: Agencies Are Proposing Changes to Improve Oversight, but Could Take Additional Steps to Enhance Coordination and Monitoring." November 2008 at 14.
44 U.S. Environmental Protection Agency. Draft White Paper. Concerning dietary exposure to CRY9C protein produced by StarlinkÔ corn and the potential risks associated with such exposure. October 16, 2007; Pollock, Kevin. "Aventis Gives Up License To Sell Bioengineered Corn." *New York Times*. October 13, 2000; GAO at 16
45 Carter, Colin A. Professor, Department of Agricultural and Resource Economics, University of California, Davis. Statement before the Domestic Policy Subcommittee of the U.S. House Oversight and Government Reform Committee. March 13, 2008 at 2.
46 Leake. 2008 at 2.
47 USDA Office of Inspector General. "Audit Report USDA's Role in the Export of Genetically Engineered Agricultural Commodities." February 2009 at 9.
48 Howington, Harvey. Vice President U.S. Rice Producers Association. Statement before the Domestic Policy Subcommittee of the U.S. House Oversight and Government Reform Committee. March 13, 2008 at 1.
49 Howington at 3.
50 McConnell, Sean. "Animal feed containing illegal GM maize impounded." *The Irish Times*. May 21, 2007.
51 Carter. 2008 at 7.
52 "Biotech's plans to sustain agriculture." *Scientific American*. October 2009 at 87.
53 Monsanto. "Backgrounder: History of Monsanto's Glyphosate Herbicides." June 2005.
54 DiGiuseppe, Gary. "Bayer hopes its herbicide tolerance trait will catch on with farmers." *Food Chemical News*. August 10, 2009.
55 Binimelis, Rosa et al. "'Transgenic treadmill' Responses to the emergence and spread of glyphosate-resistant johnsongrass in Argentina." *Geoforum*. July 2009 at Introduction.
56 Clapp, Stephen. "Canadian researchers find suspected glyphosate-resistant weed." *Food Chemical News*. May 18, 2009.
57 Clapp. May 18, 2009.
58 Clapp, Stephen. "Herbicide diversity called critical to keep Roundup effective." *Food Chemical News*. July 20, 2009.
59 Wilson, Mike. "Multiple-resistance weeds coming to a field near you?" *Western Farmer Stockman*. February 28, 2008.
60 Clapp, Stephen. "Opponents say biotech crops have failed to tackle hunger." *Food Chemical News*. February 18, 2008.
61 Clapp, Stephen. "Study says farmers relying on Roundup may weaken benefits." *Food Chemical News*. April 20, 2009.
62 DiGiuseppe. August 10, 2009.
63 Clapp. July 20, 2009.
64 Clapp. April 20, 2009.
65 Carol, Brenda. "Preserving glyphosate efficiency vital to San Joaquin Valley growers." *Western Farm Press*. February 25, 2009.
66 "Insect shows resistance to Bt crops." *Appropriate Technology*. Vol. 35, No. 1. March 2008 at 49.
67 Wenzel, Wayne. "Refuge Angst." *Farm Journal*. October 5, 2007.
68 Fernandez-Cornejo and Caswell. 2006 at 11-12.
69 Friends of the Earth International. "Who Benefits from GM Crops." Issue 116. February 2009 at 21.
70 Benbrook, Charles. "Troubled Times Amid Commercial Success for roundup Ready Soybeans." AgBioTech InfoNet Technical Paper Number 4. May 3, 2001 at 2.
71 Price, Lin, et al. 2003 at 18.
72 Friends of the Earth International. 2009 at 21.
73 Clapp. February 18, 2008.
74 Friends of the Earth International. 2009 at 25.
75 EPA. "Managing Nonpoint Source Pollution from Agriculture." Available at http://www.epa.gov/nps/facts/point6.htm and on file. Accessed September 8, 2009; USDA Natural Resources Conservation Services. "Soil Quality Concerns: Pesticides." January 1998.
76 European Community. Regulation (EC) No. 1829/2003.
77 Vegetarian Society. "Information Sheet: Genetically Engineered Food." Availalble at http://www.vegsoc.org/info/genfood.htmland on file. Accessed September 21, 2009; Omobowale, Emmanuel et al. "The three main monotheistic religions and gm food technology: an overview of perspectives." *BMC International Health and Human Rights*. August 22, 2009.
78 EPA 2007; Pollack 2000.
79 Nordlee, Julie et al. "Identification of a Brazil-Nut Allergen in Transgenic Soybeans." *New England Journal of Medicine*. March 14, 1996 at abstract.
80 Young, Emma. "GM pea causes allergic damage in mice." *New Scientist*. November21, 2005.
81 Ermakova, Irina. "Genetically modified organisms could be real threat to the life; Reply to UK Advisory Committee of Novel Foods and Processes on the 'Statement on the effect of GM soy on newborn rats.'" September 18, 2006.
82 Malatesta, Manuela et al. "Ultrastructural Morphometrical and Immunocytochemical Analyses of Hepatocyte Nuclei from Mice Fed on Genetically Modified Soybean." *Cell Structure and Function*. Volume 27, 2002 at Abstract.
83 Séralini, Gilles-Eric, Dominique Cellier and Joël Spiroux de Vendomois. "New Analysis of a Rat Feeding Study with a Genetically Modified Maize Reveals Signs of Hepatorenal Toxicity." *Archives of Environmental Contamination and Toxicology*. Vol. 52. 2007596 and 601.
84 Agodi, Antonella et al. "Detection of genetically modified DNA sequences in milk from the Italian market." *International Journal of Hygiene and Environmental HealthI*. January 10, 2006 at Abstract.
85 Food & Drug Administration. Press release. "FDA, EPA and USDA conclude that accidental release of genetically engineered cotton poses no safety risk to humans or animals." December 3, 2008.
86 Fatka, Jacqui. "Dow recalls unapproved corn." *Feedstuffs*. March 3, 2008.



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