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Crop duster spraying pesticides in North America.

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who benefits from gm crops?

the rise in pesticide use

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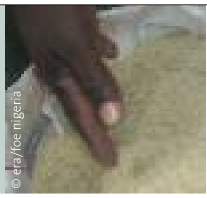

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friends of the earth Friends of the Earth International is the world's largest grassroots environmental network, uniting 70 diverse national member groups and some 5,000 local activist groups on every continent. With approximately 1.5 million members and supporters around the world, we campaign on today's most urgent social and environmental issues. We challenge the current model of economic and corporate globalization, and promote solutions that will help to create environmentally sustainable and socially just societies.

our vision Our vision is of a peaceful and sustainable world based on societies living in harmony with nature. We envision a society of interdependent people living in dignity, wholeness and fulfilment in which equity and human and peoples' rights are realized.

This will be a society built upon peoples' sovereignty and participation. It will be founded on social, economic, gender and environmental justice and free from all forms of domination and exploitation, such as neoliberalism, corporate globalization, neo-colonialism and militarism.

We believe that our children's future will be better because of what we do.

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1. *To collectively ensure environmental and social justice, human dignity, and respect for human rights and peoples' rights so as to secure sustainable societies.*
2. *To halt and reverse environmental degradation and depletion of natural resources, nurture the earth's ecological and cultural diversity, and secure sustainable livelihoods.*
3. *To secure the empowerment of indigenous peoples, local communities, women, groups and individuals, and to ensure public participation in decision making.*
4. *To bring about transformation towards sustainability and equity between and within societies with creative approaches and solutions.*
5. *To engage in vibrant campaigns, raise awareness, mobilize people and build alliances with diverse movements, linking grassroots, national and global struggles.*
6. *To inspire one another and to harness, strengthen and complement each other's capacities, living the change we wish to see and working together in solidarity.*

friends of the earth has groups in: Argentina, Australia, Austria, Bangladesh, Belgium, Belgium (Flanders), Bolivia, Brazil, Bulgaria, Cameroon, Canada, Chile, Colombia, Costa Rica, Croatia, Curaçao (Antilles), Cyprus, Czech Republic, Denmark, El Salvador, England/Wales/Northern Ireland, Estonia, Finland, France, Georgia, Germany, Ghana, Grenada (West Indies), Guatemala, Haiti, Honduras, Hungary, Indonesia, Ireland, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Macedonia (former Yugoslav Republic of), Malaysia, Mali, Malta, Mauritius, Nepal, Netherlands, New Zealand, Nigeria, Norway, Palestine, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Scotland, Sierra Leone, Slovakia, South Africa, Spain, Sri Lanka, Swaziland, Sweden, Switzerland, Togo, Tunisia, Ukraine, United States, and Uruguay.
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the rise in pesticide use

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introduction

Biotechnology proponents claim that genetically modified (GM) crops are good for consumers, farmers and the environment, and that they are growing in popularity around the world. Unfortunately, journalists often report such claims as fact, without first subjecting them to critical scrutiny. As in past editions of "Who Benefits from GM Crops?" we here attempt to provide a nuanced, fact-based assessment of GM crops around the world, and to clear up common misconceptions about their nature and impacts. In this 2008 edition, we report on new trends and findings, particularly the rise in pesticide use with GM crops.

1.1 the status of gm crops in the world: four crops, two traits, and a handful of countries

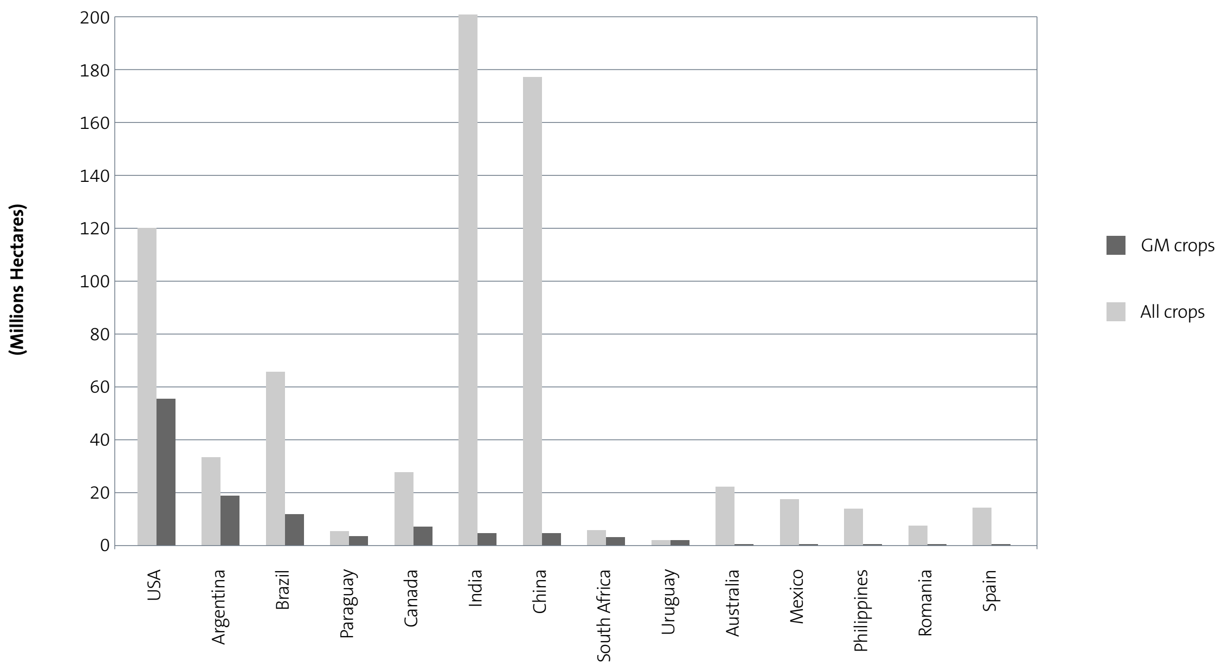
Although more than a decade has passed since genetically modified (GM) crops first entered the world's food and feed supply, they continue to be the province of a handful of nations with highly-industrialized, export-oriented agricultural sectors.

Over 90% of the area planted to GM crops is found in just 5 countries located in North & South America: the US, Canada, Argentina, Brazil and Paraguay. One country alone, the United States, produces over 50% of the world's GM crops; the U.S. and Argentina together grow over 70% of all GM crops.

After more than a decade of commercialisation, GM crops continue to occupy just a small share of the total crop area harvested in the world. ISAAA ranks some 14 countries as "biotech mega-countries" (see Table 1), each of which plants at least 50,000 ha. Although the designation "mega" implies these countries sow vast tracts of land with GM crops, in fact the 50,000 ha threshold is so low that GM plantings make up less than 3% of the total agricultural crop land in most of the "mega-biotech countries" (see Figure 1). Only four countries plant GM crops on more than 30% of their arable land: the US, Argentina, Paraguay and Uruguay. The arable land in Paraguay and Uruguay is so small that even these high percentages amount to comparatively little GM crop area.

FIGURE 1

TOP GM CROP PRODUCERS. MEGA-BIOTECH COUNTRIES?
TOTAL CROP AREA HARVESTED PER COUNTRY VS. AREA PLANTED WITH GENETICALLY MODIFIED CROPS, 2006.



Source: *Friends of the Earth International, 2007. Based on data from FAOSTAT, 2007; ISAAA. 2006a.*

Notes 1: *The table compares the total crop area harvested in 14 countries, -which have been classified by ISAAA in January 2007 as "Mega-biotech" countries- to the total hectares, which are estimated, to be planted to GM crops in each of the 14 countries. The 14 so called "Mega-biotech" countries are U.S, Argentina, Brazil, Paraguay, Canada, India, China, South Africa (SA), Uruguay, Australia, Mexico, Philipinnes, Romania and Spain.*
Notes 2: *Data from FAOSTAT is based on ProdSTAT, Crops, Subject: Area Harvested: Countries: USA, Argentina, Brasil, Paraguay, Canada, India, China, South Africa, Uruguay, Australia, Mexico, Philipinnes, Romania, Spain. Commodities: data on all crops includes the total harvested area in million ha of the following main crops groups: cereals, fruits, fibres vegetal origin, oilcrops, nuts, spices, stimulants, pulses, roots and tubers, selected fodder crops, sugarcrops, tobacco and vegetables. Year: 2006 (last accessed 13 December 2007).*

TABLE 1 **THE "MEGABIOTECH COUNTRIES"*: TOTAL AREA OF CROPS HARVESTED VERSUS GM CROPS PLANTED IN 2006 BY COUNTRY (MILLION HECTARES)**

RANK	COUNTRY	AREA PLANTED WITH GM CROPS	TOTAL AREA HARVESTED WITH ALL CROPS**	GM CROPS
1	USA	54.6	118.6	Soybean, maize, cotton, canola***
2	Argentina	18.0	32.3	Soybean, maize, cotton
3	Brazil	11.5	64.2	Soybean, cotton
4	Canada	6.1	27.09	Canola, maize, soybean
5	India	3.8	199.7	Cotton
6	China	3.5	176.1	Cotton
7	Paraguay	2.0	4.5	Soybean
8	South Africa	1.4	5.05	Maize, soybean, cotton
9	Uruguay	0.4	0.95	Soybean, maize
10	Philippines	0.2	12.9	Maize
11	Australia	0.2	21.1	Cotton
12	Romania	0.1	7.04	Soybean
13	Mexico	0.1	16.8	Cotton, soybean
14	Spain	0.1	12.5	Maize

***Source**: FAOSTAT;2007**; ISAAA, 2006a.*

** 14 so-called "biotech mega-countries" growing 50,000 hectares or more of biotech crops*
*** Data from FAOSTAT is based on ProdSTAT, Crops, Subject: Area Harvested: Countries: USA, Argentina, Brasil, Paraguay, Canada, India, China, South Africa, Uruguay, Australia, Mexico, Philipinnes, Romania, Spain. Commodities: data on all crops includes the total harvested area in million ha of the following main crops groups: cereals, fruits, fibres vegetal origin, oilcrops, nuts, spices, stimulants, pulses, roots and tubers, selected fodder crops, sugarcrops, tobacco and vegetables. Year: 2006 (last accessed 13 December 2007).*
**** Some extremely low but unknown area is also planted to GM squash and papaya*

There has also been a decade-long stagnation in the diversity of GM crops. As in the mid to late 1990s, only four crops – soya, maize, cotton and canola – comprise virtually 100% of biotech agriculture, as even ISAAA is forced to concede. Biotech versions of rice, wheat, tomatoes, sweet corn, potatoes and popcorn have been soundly rejected as unacceptable in the world marketplace (Center for Food Safety, August 2006). The initial approval of GM alfalfa in the U.S. was reversed in 2006 by a federal judge, who castigated the US Dept of Agriculture (USDA) for failing to conduct a serious assessment of its environmental impacts.

Perhaps most surprising is the stagnation of GM traits. Despite more than a decade of hype and failed promises, the biotechnology industry has not introduced a single GM crop with increased yield, enhanced nutrition, drought-tolerance or salt-tolerance. Disease-tolerant GM crops are practically non-existent. In fact, biotech companies have made a commercial success of GM crops with just two traits – herbicide tolerance and insect resistance – which offer no advantages to consumers or the environment. In fact, GM crops in the world today are best characterized by the overwhelming penetration of just one trait – herbicide tolerance – which is found in over 80% of all GM crops planted worldwide, and which as we explore further below is associated with increased use of chemical pesticides

TABLE 2 **GM CROPS AND TRAITS IN THE WORLD**

GM CROP	AREA PLANTED (MILLION HA)	PERCENTAGE
Soybean	58.6	57%
Maize	25.2	25%
Cotton	13.4	13%
Canola	4.8	5%
	102	100
GM TRAITS		
Herbicide Tolerance	69.9	68
Bt crops	19	19
HT + BT (Stacked traits)	13.1	13
Total	101	100

***Source**: ISAAA, 2006a*

gm crops in the united states: the chemical assault on weeds

Bill Freese, Center for Food Safety, United States

Over a decade of experience in the United States demonstrates that GM crops have contributed substantially to rising pesticide use and an epidemic of herbicide-resistant weeds. Resistant weeds have prompted biotechnology firms to develop new GM crops that promote pesticide use still more. The use of mechanical tillage to control resistant weeds is also increasing, contributing to greater soil erosion and global warming gas emissions. At the same time, even ISAAA admits that long-promised yield increases have not materialized. The growing control of the U.S. and world seed supply by a handful of chemical-biotechnology firms has restricted seed choices and raised seed prices for U.S. farmers, and shifted breeding efforts still more in the direction of high-profit biotech seeds designed for use with agricultural chemicals. Finally, Monsanto continues to aggressively prosecute U.S. farmers for the millenia old practice of seed-saving.

1. biotech industry continues to develop pesticide-promoting, herbicide-tolerant gm crops

Pesticides are chemicals that target weeds (herbicides), insects (insecticides) or other pests. Pesticide-promoting, herbicide-tolerant crops continue to dominate agricultural biotechnology. As ISAAA statistics show, GM soybeans, corn, cotton and canola engineered for herbicide-tolerance alone comprised 68% of world biotech crop acreage in 2006; cotton and corn "stacked" with both herbicide-tolerance and insect-resistance made up 13%; while insect-resistant corn and cotton comprised 19%. Hence, 4 of every 5 hectares (81% = 68% + 13%) of biotech crops wordwide were engineered for heavy applications of chemical herbicides. Agricultural biotechnology is essentially pesticide-promoting technology.

Significantly, the biotech industry has still not introduced a single GM crop that has enhanced nutrition, higher yield potential, drought-tolerance, salt-tolerance, or other promised traits. As before, biotech agriculture consists of four crops with just two traits, herbicide-tolerance and/or insect-resistance (see Table 2).

In the U.S. herbicide-tolerant crops were planted on more than 116 million acres in 2006, an area larger than the State of California (Monsanto, June 28 2007).[1] The biotechnology industry has continued to focus its development efforts on new pesticide-promoting crop varieties. Of the four new biotech crops approved by USDA from November 2006 to December 2007, two were herbicide-tolerant (soybeans and rice). One insect-resistant corn and one virus-resistant plum variety were also approved (APHIS, 5 October 2007).[2]

The most significant development in biotech agriculture is new GM crops that tolerate heavier applications of chemicals, and that tolerate two herbicides rather than just one. As discussed further below, this is the biotechnology industry's short-sighted "solution" to the epidemic of herbicide-resistant weeds that are plaguing American (and world) agriculture. Of the 12 GM crops awaiting USDA commercial approval, nearly half (5) are herbicide-tolerant (see Table 3). Two (corn and soybeans) have dual herbicide-tolerance, while three others are tolerant to a single herbicide (cotton, alfalfa and golf-course grass). None of the others represent beneficial new traits. Three varieties of insect-resistant (IR) corn (2) and cotton (1) are minor variations on existing IR crops. Virus-resistant papaya and soybeans with altered oil content are already approved, though not grown to any significant extent. Carnations engineered for altered color are a trivial application of biotechnology. Finally, corn engineered to contain a novel enzyme for "self-processing" into ethanol presents potential risks to human health and is a totally unnecessary development, given the huge amounts of existing corn already devoted to ethanol production.

TABLE 3 THE 12 GM CROPS PENDING DEREGULATION (COMMERCIAL APPROVAL) BY USDA (AS OF OCTOBER 5, 2007)

TRAIT	NO.	NOTES
Tolerate 1 herbicide	3	All glyphosate (Roundup) tolerant: cotton, alfalfa, creeping bentgrass. A federal court judge reversed USDA's commercial approval of Roundup Ready alfalfa in 2006 due to USDA's failure to examine its environmental impacts.
Tolerate 2 herbicides	2	Tolerate glyphosate and either ALS inhibitors (soy) or imidazolinone (corn), both Pioneer
Insect-resistant	3	Corn (2), cotton (1)
Virus-resistant	1	New version of old papaya trait
Enzyme added	1	Syngenta, corn w/ alpha-amylase enzyme derived from deep sea microorganism 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
Color alteration	1	Carnation

Source: *APHIS, October 5, 2007 (last accessed December 10, 2007).*

1 This refers to Monsanto's Roundup Ready herbicide-tolerant crops, which comprise roughly 99% of all GM herbicide-tolerant crops.
2 See Petition Nos. 04-264-01p, 04-362-01p, 06-178-01p and 06-234-01p.

The longer-term future of biotech agriculture is also dominated by pesticide-promoting crops. Field trial permit figures are the best predictor of trends in GE crop development. Over one-third (36.3%) of active field trial permits for GE crops in the U.S. involve one or more HT traits.[3] These 352 active permits for field trials of HT crops encompass 18 different plant species and tolerance to more than eight different herbicides. Glyphosate-tolerance is by far the most common HT trait in field tests, though others, especially crops tolerant to dicamba herbicide, are also being extensively tested.

2. gm crops have increased pesticide use in the u.s.

The biotechnology industry asserts that reduced use of pesticides (i.e. herbicides, insecticides and fungicides) is one of the most valuable benefits of its technology, particularly in connection with GM soy (FoEI, 2007). Yet independent studies have demonstrated not only that these pesticide reduction claims are unfounded, but that GM crops have substantially increased pesticide use, particularly since 1999. Dr. Charles Benbrook, a leading U.S. agricultural scientist, conducted an exhaustive analysis of USDA data on pesticide use in agriculture from 1996 to 2004. His conclusion is that over this nine-year period, adoption of GM soy, corn, and cotton has led to use of 122 million more pounds of pesticides than would have been applied if these GM crops had not been introduced. A small decrease in insecticide use attributable to insect-resistant corn and cotton (-16 million lbs.) has been swamped by a much larger increase in herbicide use on herbicide-tolerant crops (+138 million lbs.) (Benbrook, C. 2004).

Much of this increasing herbicide use is attributable to a dramatic rise in application of glyphosate (Roundup) on Monsanto's glyphosate-tolerant (Roundup Ready) crops. In 1994, the year before the first Roundup Ready crop (RR soy) was introduced, 7.933 million lbs. of Roundup were used on soybeans, corn and cotton. By 2005, glyphosate use on these three crops had increased 15-fold, to 119.071 million lbs. (Table 4). Over the same period, Roundup Ready crop acreage[4] in the U.S. increased from 0 acres (1994) to 102 million acres (2005), an area larger than the state of California. In 2006, Roundup Ready crop acreage rose 14% more, to 116 million acres.

TABLE 4 **ADOPTION OF HERBICIDE-TOLERANT (HT) 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, Monsanto's 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.	

***Source**: Center for Food Safety, 2007. Figures represent pounds of glyphosate applied.*

[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 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.

3 As of August 23, 2007, 352 of 970 active permits (36.3%) involved an HT trait. Some permits involve multiple traits. (Information Systems for Biotechnology, 23 August 2007).

4 Roundup Ready soybeans, corn and cotton. We exclude Roundup Ready canola, which was planted on 0.5 million acres in 2006, because USDA has not reported the amount of glyphosate used on canola.

Initially, the rising use of glyphosate on Roundup Ready crops was more than offset by reductions in the use of other pesticides. Beginning in 1999, however, weeds that could no longer be controlled with the normal dose of glyphosate began to emerge, driving farmers to apply more of it (see Section 2.2). Thus, the widespread adoption of Roundup Ready crops combined with the emergence of glyphosate-resistant weeds has driven a more than 15-fold increase in the use of glyphosate on major field crops from 1994 to 2005. The trend continues. In 2006, the last year for which data are available, glyphosate use on soybeans jumped a substantial 28%, from 75.743 million lbs. in 2005 to 96,725,000 million lbs. in 2006.[5]

2.1 herbicide-resistant weeds and pesticide use

Just as bacteria develop resistance to overused antibiotics, so weeds develop resistance to chemicals designed to kill them. Weed resistance to chemical herbicides first emerged in the United States in the 1970s, and has been growing ever since. From the 1970s to the present day, weeds with documented resistance to one or more herbicides have been reported in up to 200,000 sites covering 15 million acres.[6] The problem is likely far worse, since these figures include only documented resistance and exclude numerous field reports of suspected weed resistance. The first major wave that began in the late 1970s involves 23 species of weeds resistant to atrazine and related herbicides of the photosystem II inhibitor class, which have been reported to infest up to 1.9 million acres of cropland in the U.S. The second major wave began in the 1980s, and involves 37 species of weeds resistant to ALS inhibitors, which have been reported in up to 9.9 million acres. The third major wave involves glyphosate-resistant weeds, to which we turn in the next section.

It is important to understand two key facts about weed resistance. First, resistance is defined as a weed's ability to survive more than the normal dose of a given herbicide rather than absolute immunity. Higher doses of the herbicide will often still kill the resistant weed, at least in the short term. The second fact follows from the first. Weed resistance is not only the result of using an herbicide excessively, it often leads to still greater use of that herbicide.

2.2 glyphosate-resistant weeds

Monsanto first introduced glyphosate in the U.S. in 1976 (Monsanto, 2007b), and for two decades there were no reports of glyphosate-resistant weeds. By 1998, only rigid ryegrass had developed resistance to the chemical in California. Extensive weed resistance first developed only several years after the introduction of Monsanto's Roundup Ready soybeans in 1995, Roundup Ready cotton and canola in 1997, and Roundup Ready corn in 1998 (Monsanto, 2007b). Scientists who first identified glyphosate-resistant horseweed in Delaware in 2000 attributed their evolution to the continuous planting of Roundup Ready crops (University of Delaware, 22 February 2001). Ten prominent weed scientists confirmed this assessment in 2004:

"It is well known that glyphosate-resistant horseweed (also known as marestail) populations have been selected in Roundup Ready soybean and cotton cropping systems. Resistance was first reported in Delaware in 2000, a mere 5 years after the introduction of Roundup Ready soybean. Since that initial report, glyphosate-resistant horseweed is now reported in 12 states and is estimated to affect 1.5 million acres in Tennessee alone." (Hartzler et al., February 20 2004)

TABLE 5 **DEVELOPMENT OF WEEDS RESISTANT TO GLYPHOSATE IN THE UNITED STATES: 1998-2007**

SPECIES	YEAR - US STATE
Amaranthus palmeri Palmer Amaranth	2005 - USA (Georgia) 2006 - USA (Arkansas) 2006 - USA (Tennessee)
Amaranthus rudis Common Waterhemp	2005 - USA (Missouri), includes weeds resistant to glyphosate and one or 2 other herbicides 2006 - USA (Illinois) includes weeds resistant to glyphosate and one other herbicide 2006 - USA (Kansas) 2006 - USA (Kansas)
Ambrosia trifida Giant Ragweed	2004 - USA (Ohio) 2005 - USA (Indiana) 2006 - USA (Kansas)
Ambrosia artemisiifolia Common Ragweed	2004 - USA (Arkansas) 2004 - USA (Missouri) 2007 - USA (Kansas)
Conyza bonariensis Hairy Fleabane	2007 - USA (California)
Conyza canadensis Horseweed	2001 - USA (Tennessee) 2002 - USA (Indiana) 2002 - USA (Maryland) 2002 - USA (Missouri) 2002 - USA (New Jersey) 2002 - USA (Ohio) 2003 - USA (Arkansas) 2003 - USA (Mississippi) 2003 - USA (North Carolina) 2003 - USA (Ohio) 2003 - USA (Pennsylvania) 2005 - USA (California) 2005 - USA (Illinois) 2005 - USA (Kansas) 2007 - USA (Michigan)
Lolium multiflorum Italian Ryegrass	2004 - USA (Oregon)
Lolium rigidum Rigid Ryegrass	1998 - USA (California)

Source: *Weedscience, 2007. Glycines resistant weeds by species and country. http://www.weedscience.org/Summary/UspeciesMOA.asp?lstMOAID=12&FmHRACGroup=Go*

5 Soybean acreage increased 5% from 2005 to 2006, explaining only a small portion of this increase.
6 Based on Center for Food Safety's analysis of herbicide-resistant weed data downloaded from www.weedscience.com on Nov. 21, 2007.

Weeds with documented resistant to glyphosate now infest an estimated 3,251 sites covering 2.37 million acres in 19 states (Weed Science, 2007). Multiple populations of 8 different weed species have developed resistance in the U.S.: Palmer amaranth, common waterhemp, common ragweed, giant ragweed, horseweed, Italian ryegrass, rigid ryegrass and hairy fleabane (Weed Science, 2007). Five additional weed species have developed glyphosate-resistance overseas. Out of the 58 cases of new glyphosate-resistant weeds identified in the last decade around the world, 31 were identified in the US (Table 5). Thirty of those appeared in the US between 2001 and 2007.

Since glyphosate-resistant weeds can usually still be killed by higher than normal doses of the herbicide, farmers began to apply more glyphosate to kill resistant weeds. USDA data confirm these trends. From 1994 to 2006, glyphosate use per acre of soybeans increased by more than 2.5-fold, from just 0.52 to 1.33 lbs./acre/year. Glyphosate use on corn rose only slightly from 1994 (0.67 lbs./acre/year) to 2002 (0.71 lbs./acre/year). Yet during the period of rapid Roundup Ready corn adoption from 2002 to 2005, usage jumped from 0.71 to 0.96 lbs./acre/year, a hefty 35% increase in just three years (NASS, 2007). These are clear signs of escalating weed resistance to glyphosate.

Agricultural scientists are sounding the alarm. North Carolina weed scientist Alan York has called glyphosate-resistant weeds “potentially the worst threat [to cotton] since the boll weevil,” the devastating pest that virtually ended cotton-growing in the U.S. until an intensive spraying program eradicated it in some states in the late 1970s and early 1980s (Minor, December 18, 2006). York concedes that: “Resistance is not unique with glyphosate,” but goes on to state that: “What makes glyphosate resistance so important is our level of dependence on glyphosate” (emphasis added, Yancy, June 3, 2005). Weed scientists report that there are no new herbicides with different “modes of action” on the horizon. Thus, the loss of glyphosate as an effective means of weed control poses extremely serious problems for U.S. agriculture (Roberson, R., October 19, 2006). Agronomist Stephen Powles of the Western Australian Herbicide Resistance Initiative reinforces the threat from glyphosate-resistant weeds, stating: “Glyphosate is as important to world agriculture as penicillin is to human health” (Service, R.F May 25, 2007).

Several factors make it virtually certain that glyphosate-resistant weeds will become much worse in the future. These factors include: 1) More weed species developing resistance; 2) More planting of glyphosate-tolerant crops in rotation (every year); 3) New glyphosate-tolerant crops on the horizon; and 4) New crops that withstand higher doses of glyphosate.

First, weed species with suspected resistance to glyphosate including velvetleaf (Owen, 1997), cocklebur and lambsquarters (Roberson, R., October 19, 2006), morning glories (UGA, August 23, 2004), and tropical spiderwort (USDA ARS, August 24, 2004). Annual grasses such as goosegrass, foxtails, crowfootgrass, signal grasses, panicums, and crabgrasses, all have a history of developing resistance to multiple herbicides (Robinson, E. February 16, 2005), making development of glyphosate-resistance more likely in these species. Glyphosate-resistant Johnsongrass is rapidly becoming a huge threat to Argentine agriculture (see Chapter Three), and will likely develop in the U.S. as well.

Second, there is a growing trend to planting Roundup Ready crops in rotation, ensuring faster development of resistant weeds from application of glyphosate every year. This is particularly a concern with the popular soybean-corn rotation. While 89% of U.S. soybeans were Roundup Ready in 2006, only one-third of corn was Roundup Ready. However, acreage planted to Roundup Ready corn has been increasing rapidly in recent years: from just 7.8 million acres in 2002 to 32.7 million acres in 2006 (Monsanto, October 11, 2006), or more than a four-fold increase in just four years. According to Iowa State University weed expert Michael Owen, this rapid adoption of Roundup Ready corn will lead to “an increasing number of crop acres where glyphosate will follow glyphosate” in the popular corn-soybean rotation (Owen, 2005), vastly increasing selection pressure for glyphosate-resistant weeds.

Third, more glyphosate-resistant crops are on the horizon. Sugarbeet growers plan to start growing Roundup Ready sugarbeets in 2008 (Pollack, November 27, 2007). Roundup Ready alfalfa and creeping bentgrass are awaiting approval by USDA (Table 3). USDA field trial figures show that biotechnology companies are experimenting with glyphosate-resistant versions of many other crops. In fact, 62% of ongoing field tests of herbicide-tolerant crops involve plants resistant to glyphosate (Information Systems for Biotechnology, 23 August 2007). The expanding use of glyphosate on millions of acres of new Roundup Ready crops is another factor that will speed development of weed resistance.

Finally, biotechnology companies are developing crops with enhanced tolerance to glyphosate to enable farmers to apply still more of the chemical to kill resistant weeds. In 2006, Monsanto introduced Roundup Ready Flex cotton, a new version that tolerates higher rates of glyphosate than the original Roundup Ready cotton, and allows farmers to apply it over the entire growing season instead of only in the early life of the plant. (Bennett, D. February 24, 2005). Other companies are also getting involved. DuPont-Pioneer is poised to introduce GAT soybeans, which are tolerant to both higher doses of glyphosate as well as to a second class of herbicides, ALS inhibitors. The company has proposed to “enhance” the glyphosate-tolerance of GAT soybeans still further by combining up to three different mechanisms of glyphosate tolerance in a single crop (Center for Food Safety, 4 December 2007). DuPont-Pioneer is also awaiting USDA approval of a dual-herbicide tolerant corn variety, which like GAT soybeans tolerates both glyphosate and imidazolinones, a class of ALS inhibitor herbicide (Table 3).

Ironically, the most prevalent herbicide-resistant weeds in the U.S. survive application of normal doses of precisely these two classes of herbicide: ALS inhibitors (#1) and glyphosate (#2). Weeds that tolerate multiple herbicides are a growing problem in American agriculture. Thus far, such “cross-resistant” weeds have been documented on roughly 1500 sites covering a quarter of a million acres, including weeds resistant to glyphosate and one or two other herbicides.[7]

The vastly increased glyphosate use from introduction of these new crops is clearly not sustainable. Epidemic weed resistance to the chemical will soon render it ineffective. Monsanto is already preparing for the demise of Roundup Ready technology. In a recent issue of Science, the company reports that it is developing a new generation of crops resistant to the herbicide dicamba (Behrens et al, May 25, 2007). Dicamba belongs to the same class of phenoxy herbicides as 2,4-D, a component of the Vietnam War defoliant Agent Orange, and is known to have genotoxic and cytoxic effects (Gonzalez et al, 2007). In mixtures with other herbicides, it has also been associated with failed pregnancies in mice at very low doses (PAN, 2002).

2.3 gm crops increase use of other leading herbicides

When forced to admit that herbicide-tolerant crops increase overall pesticide use, biotech industry apologists quickly fall back on a second claim: the increasing use of glyphosate has reduced use of more toxic herbicides, and so is a benefit to the environment. While this was true in the first few years of Roundup Ready crops, a look at recent trends in herbicide use undermines this claim.

More and more, farmers are being told to combat glyphosate-resistant weeds by applying other chemicals, often in combination with higher rates of glyphosate. As early as 2002, Ohio State University agricultural advisers recommended using 2,4-D plus metribuzin plus paraquat as pre-emergence chemicals to control glyphosate-resistant marestail in Roundup Ready soy (Loux, and Stachler, 2002). In September 2005, reports of glyphosate-resistant Palmer amaranth in Georgia cotton fields prompted Monsanto to recommend that farmers use several additional herbicides with Roundup, including Prowl (pendimethalin), metolachlor, diuron and others. The company also suggested that farmers planting any RR crops use pre-emergence residual herbicides in addition to Roundup (Monsanto, September 13, 2005). In the same year, weed scientists in Tennessee noted that Palmer amaranth in the state survived applications of up to 44 ounces per acre of Roundup, and so recommended that farmers use additional herbicides such as Clarity, 2,4-D, Gramoxone Max or Ignite (Farm Progress, September 23, 2005).

In June 2006, reports of widespread populations of lambsquarters that were not controlled even with application of up to 48 ounces per acre of Roundup prompted Iowa State University experts to recommend farmers use additional applications of Roundup and/or other chemicals, including Harmony GT, Ultra Blazer, and/or Phoenix herbicides (Owen, June 15, 2006). Also in 2006, it was reported that farmers would rely increasingly on older herbicides such as paraquat and 2,4-D to control glyphosate-resistant weeds (Roberson, 2006).

In 2007, Monsanto recommended that farmers use tillage and apply a pre-emergence herbicide in combination with Roundup to kill resistant weeds (Henderson & Wenzel, 2007. By 2007, the American Soybean Association was advocating that farmers return to multiple-herbicide weed control systems on their Roundup Ready soybeans (Sellen, February 7, 2007).

TABLE 6 USAGE OF LEADING HERBICIDES OTHER THAN GLYPHOSATE ON CORN AND SOYA IN THE U.S.: 2002 TO 2006

CROP	SOYA	CORN				NOTES
Active ingredient	2,4-D	Atrazine	Acetachlor	Metalachlor/ S-metalachlor	Top corn herbicides combined	
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 last table) 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 soya rose by more than 2.6-fold from 2002 to 2006. Over the same period, glyphosate use on soya rose 43% (see last table). Glyphosate is clearly not displacing use of 2,4-D.

Source*: Center for Food Safety, 2007. Figures in pounds of active ingredient.*
Based on "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 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.*

7 Based on Center for Food Safety's analysis of herbicide-resistant weed data downloaded from www.weedscience.com on Nov. 21, 2007.

USDA statistics confirm increased use of other leading herbicides (Table 6). For instance, 2,4-D is the second most-heavily used herbicide on soybeans (after glyphosate). 2,4-D is a phenoxy herbicide that formed part of the Vietnam War defoliant Agent Orange, and 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 applicators. 2,4-D is also a suspected endocrine disruptor (Beyond Pesticides, July 2004). From 2002 to 2006, 2,4-D use on soybeans more than doubled from 1.39 to 3.67 million lbs., while glyphosate use on soybeans increased by 29 million lbs. (43% rise). Clearly, glyphosate is not displacing 2,4-D, but rather both are being used at ever higher rates to kill resistant weeds.

Atrazine is the most heavily applied herbicide on corn, followed by acetochlor and S-metolachlor/metolachlor. Use of atrazine has been linked to endocrine disruption, neuropathy, breast and prostate cancer, and low sperm counts in men. Atrazine causes sex change and/or hermaphrodism in frogs and fish at extremely low levels. Based on this evidence, and the widespread presence of atrazine in drinking water supplies, the European Union announced a ban on atrazine in 2006 (Beyond Pesticides, 2003; LoE, 2006). At the same time that glyphosate use on corn climbed five-fold from 2002 to 2005, atrazine use rose by nearly 7 million lbs. (12% increase), and aggregate applications of the top four corn herbicides rose by 5% (Table 6). Clearly, glyphosate is not displacing use of atrazine or other leading corn herbicides. All four are being used in larger quantities to kill glyphosate-resistant weeds.

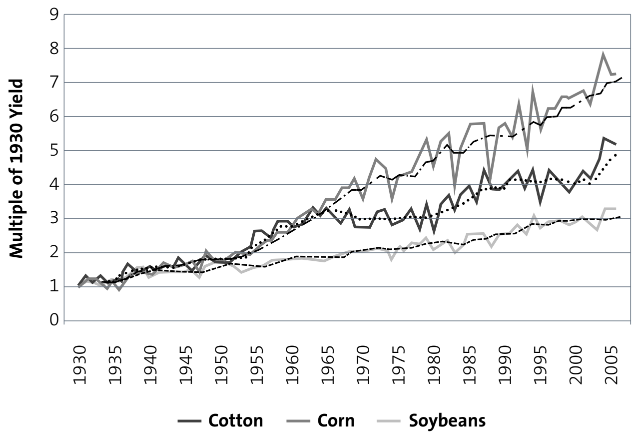
The biotechnology-chemical companies that increasingly dominate world agriculture have "solutions" to resistant weeds: new crops that tolerate multiple herbicides and higher doses of glyphosate; and use of older more toxic herbicides in combination with glyphosate. Not surprisingly, these short-term fixes ensure a future of rising pesticide use and the further spread of weeds resistant to ever higher doses of one or more pesticides.

3. gm crops do not yield more and often yield less than conventional crops

3.1 yield gains from conventional breeding

Yield is a complex phenomenon that depends on numerous factors, including weather, availability of irrigation and fertilizers, soil quality, farmers' management skills, and level of pest infestation. But crop genetics are considered the most important factor. In the U.S., it is estimated that genetic improvements through conventional breeding are responsible for more than half of the three to seven-fold yield gains of soya, cotton and maize from 1930 to 1998 (Fernandez-Cornejo, January 2004, see Figure 2 above).[8] Significantly, overall soybean yields went flat in the years following the introduction of GM soya in the mid 1990s, while stagnation in cotton yields persisted well into the period of massive GM cotton adoption. Only maize shows a persistent trend of yield increase into the biotech era, but even here the rate of increase is no greater after than before biotech varieties were introduced. While no firm conclusions can be drawn from these observations, they suggest that genetic engineering has been at best neutral with respect to yield. This is consistent with the fact that genetic engineering has not increased the yield potential of any commercialized GM crop (Fernandez-Cornejo & Caswell, April 2006).

FIGURE 2 **YIELD INCREASE OF CORN, COTTON AND SOYBEANS IN THE U.S.: 1930-2006**



Source: *USDA-ERS*
Notes: *Average yields of each crop expressed as multiple of the 1930 yield (i.e. "2" = twice the 1930 yield, "3" = triple the 1930 yield, etc.). Colored lines represent average annual yields. Dotted/dashed lines represent 5-year moving averages calculated by averaging the yield multiples for the year in question and the four preceding years. Based on data from U.S. Dept. of Agriculture's National Agricultural Statistics Service: http://www.nass.usda.gov/QuickStats/indexbysubject.jsp?Pass_name=&Pass_group=Crops+%26+Plants&Pass_subgroup=Field+Crops.*

3.2 gm soya suffers from "yield drag"

However, there is abundant evidence that GM soya has significantly lower yields than conventional varieties, in direct contradiction to ISAAA's claim that HT technology has been neutral with respect to soya yields. Virtually all GM soya is Monsanto's Roundup Ready, glyphosate-tolerant varieties, which were planted on 54 million hectares worldwide in 2006 (Monsanto, June 28, 2007), making it by far the most widely planted GM crop. Thus, even small drops in yield attributable to genetic modification technology would translate into huge production losses. According to numerous agricultural experts, this is precisely what has happened. According to agricultural scientist Dr. Charles Benbrook (Benbrook, C., May 2001):

"There is voluminous and clear evidence that RR [Roundup Ready] soybean cultivars produce 5 percent to 10 percent fewer bushels per acre in contrast to otherwise identical varieties grown under comparable field conditions."

A carefully controlled study by University of Nebraska agronomists found that RR soya varieties yielded 6% less than their closest conventional relatives, and 11% less than high-yielding conventional lines (Elmore et al, 2001). This 6% "yield drag" was attributed to genetic modification, and corresponds to a substantial loss in production of 202 kg/ha. This yield drag of RR soya is reflected in flat overall soybean yields from 1995 to 2003

8 In Figure 2, we use USDA yield data to update Figure 4 in Fernandez-Cornejo (2004), which charts yield gains only through 1998.

(Figure 2), the very years in which GM soya adoption increased from nil to 81% of U.S. soybean acreage. By one estimate, stagnating soybean yields in the U.S. cost soybean farmers $1.28 billion in lost revenues from 1995 to 2003 (Ron Eliason, 2004).

USDA data show that conventional soybeans planted in Brazil outperformed Roundup Ready varieties grown in the US (Osava, Mario, October 8 2001), while a 2004 study found that conventional soy in Brazil yielded 13% more than Roundup Ready soy grown in Argentina (Fundacep, ANO XI, no 14, Aug. 2004). Gustavo Grobocopatel, a major Argentine soya producer, reports that he gets consistently higher yields in fields with conventional soybeans, compared to fields with Roundup Ready soybeans (Benbrook, C. 2005).

A 2007 study by Kansas State University agronomist Dr. Barney Gordon suggests that Roundup Ready soya continues to suffer from a yield drag: "GR [glyphosate-resistant] soybean yield may still lag behind that of conventional soybeans, as many farmers have noticed that yields are not as high as expected, even under optimal conditions" (Gordon, B., 2007).

Dr. Gordon found that glyphosate applied to Roundup Ready soybeans inhibits the uptake of manganese and perhaps other important nutrients essential to plant health and performance. His field research showed that Roundup-treated RR soya yielded 9% less than a close conventional relative, a substantial yield gap that was only closed with application of manganese sulfate. Other scientists have reported that some of the glyphosate absorbed by Roundup Ready soya is leaked from the roots to spread throughout the surrounding soil (Motavalli, P.P. et al., 2004; Neumann, G. et al., 2006). This root zone is home to diverse soil organisms, such as bacteria and fungi, that play critical roles in plant health and disease; and it is also where the roots absorb essential nutrients from the soil, often with the help of microorganisms.

The presence of glyphosate in the root zone of RR soy can have several effects. First, it promotes the growth of certain plant disease organisms that reside in the soil, such as Fusarium fungi (Kremer, R.J. et al., 2005). Even non-RR crops planted in fields previously treated with glyphosate are more likely to be damaged by fungal diseases such as Fusarium head blight, as has been demonstrated with wheat in Canada (Fernandez et al., 2005). This research suggests that glyphosate has long-term effects that persist even after its use has been discontinued. Second, glyphosate can alter the community of soil microorganisms, interfering with the plant's absorption of important nutrients. For instance, glyphosate's toxicity to nitrogen-fixing bacteria in the soil can depress the absorption of nitrogen by RR soybeans under certain conditions, such as water deficiency, and thereby reduce yield (King, A.C., L.C. Purcell and E.D. Vories, 2001). Some scientists believe that this and other nutrient-robbing effects may account for the 5-10% yield drag of RR soya (Benbrook, 2001). Other research shows that glyphosate inside Roundup Ready plant tissues can make such essential minerals unavailable to the plant. (Bernards, M.L, 2005). The resultant mineral deficiencies have been implicated in various problems, from increased disease susceptibility to inhibition of photosynthesis. Thus, the same factors implicated in the GM soya yield drag may also be responsible for increased susceptibility to disease.

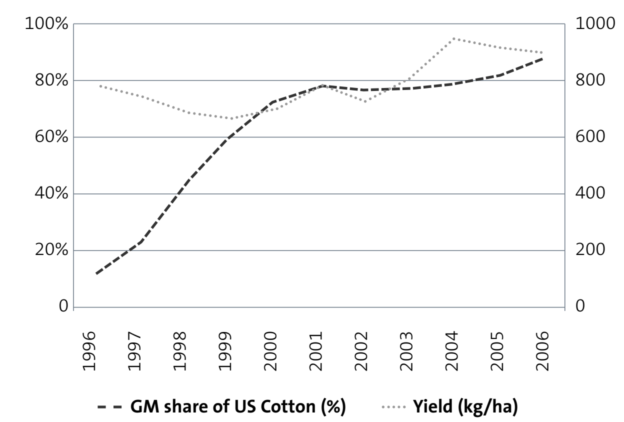
3.3 gm cotton has not contributed to yield gains

Figures 3 below shows clearly that overall cotton yields in the U.S. were stagnant over the seven years from 1996, when GM cotton was first introduced, to 2002, when it comprised 76% of U.S. cotton acreage. The increase in average yields over the past few years is attributed to several factors, including increased proportion of cotton-growing land under irrigation, more intensive management systems, improved varieties produced through conventional breeding, continuing success in eradicating the boll weevil, and most importantly, optimal weather conditions (Meyer et al., 2007):

"Weather is a chief determinant of upland cotton yields. Excellent growing conditions in 2004 and 2005, along with improved varieties, produced a record yield in 2004 (fig. 9) and a record crop in 2005. The yield of 843 pounds per harvested acre in 2004 was well above the preceding 3-year average of 689 pounds. In 2005, additional area, a second consecutive season of favorable growing conditions, and a very low abandonment rate (3 percent) pushed upland production to more than 23 million bales."

Average cotton yields have increased 5-fold since 1930, and staged an impressive surge from 1980 to the early 1990s (Figure 2). Cotton yields then went flat, and continued to stagnate during the seven years of biotech cotton's rise to dominance. The steep yield and production increases in 2004 and 2005 were chiefly attributable to excellent weather conditions, and to a lesser extent to other non-biotech factors. The fact that most GM cotton in the U.S. is Roundup Ready[9] raises the question of whether a yield drag similar to that documented with Roundup Ready soybeans has suppressed cotton yields below what they would have been otherwise.

FIGURE 3 **AVERAGE COTTON YIELD VERSUS GM SHARE OF U.S. COTTON: 1996 TO 2002**



Source: *Source is USDA/ERS*

9 In most countries of the world, GM cotton means Bt (insect-resistant) cotton. In the U.S., however, 99% of GM cotton acreage in 2006 was planted to herbicide-tolerant varieties: either HT alone (25%) or HT + Bt (74%). Only 1% of biotech cotton had just the insect-resistance trait. Monsanto's Roundup Ready trait accounted for 96% of HT cotton, with the rest planted to Bayer's LibertyLink varieties (see Freese 2007, p. 14). Please note that the oft-cited figures for GM crop adoption published by the USDA's Economic Research Service are badly in error with respect to the breakdown of traits in GM cotton. More reliable figures are provided by USDA's Agricultural Marketing Service. For details, see Freese, B., February 2007.

Herbicide-tolerant crops are adopted chiefly because they simplify weed management and allow farmers to cultivate more land with less labor. Reduced yields are accepted as the price to be paid for this "convenience effect" – though it is being progressively eroded now by the spread of difficult to control, herbicide-resistant weeds.

3.4 the bt trait has a minor influence on yield

Before the introduction of Bt corn in the U.S., only 5% of corn acres were sprayed for European corn borer (ECB), the main insect pest killed by most varieties of Bt corn (Board on Agriculture and Natural Resources, 1999). This is because in most years and in most areas, ECB cause little or no damage, meaning little or no adverse impact on yield. Rigorous, independent studies comparing the yield performance of Bt and isoline (highly similar) non-Bt crops under controlled conditions are rare. One such study conducted in the U.S. demonstrated that Bt corn yields anywhere from 12% less to the same as near-isoline (highly similar) conventional varieties (Ma & Subedi, 2005).

Cotton is afflicted with numerous insect pests that can reduce yield. However, while the insecticide in Bt cotton is highly effective against the tobacco and pink bollworm caterpillars, it is only partially effective against "some of the most damaging insect species," such as cotton and American bollworms (May et al. 2003). It provides no protection against other pests, such as the boll weevil, stink bugs, plant bugs and mirids. Outbreaks of these secondary pests that are not killed by the Bt insecticide have rendered Bt cotton ineffective in China (Connor, S., July 27, 2006), and are also becoming a problem in North Carolina (Caldwell, D. 2002) and Georgia (Hollis, P.L., 2006). In any case, as we have seen, cotton yields in the U.S. stagnated precisely during those seven years when Bt cotton (the great majority stacked with HT) became prevalent, suggesting no positive yield impact. For more on cotton yields, see Chapter Four.

To sum up, Roundup Ready soya and perhaps other Roundup Ready crops suffer from a "yield drag" attributable to the genetic modification process. Production losses from this effect in Roundup Ready soya are estimated to have cost U.S. soybean farmers in excess of $1 billion in lost revenue from 1995 to 2003. Some Bt corn hybrids have been shown to have up to 12% lower yield than highly similar conventional varieties. Bt crops may reduce yield losses under conditions of heavy infestations of pests the Bt insecticide is able to kill. But cotton is often afflicted by secondary pests that are unaffected by the Bt insecticide, and infestation of corn by the major pest targeted by Bt corn (European corn borer) is seldom serious enough to significantly impact yield. Yield is most heavily influenced by crop genetics as developed through conventional breeding, as well as weather conditions, use of irrigation, and other non-biotech factors.

4. monopolization of the seed supply

Farmers, small seed firms, and public sector breeders once developed a multitude of new seed varieties best suited to local conditions (Fowler, Cary, 1994). Today, a handful of multinational firms control the majority of the world's seeds, and offer ever more restricted and expensive choices to farmers. Based on 2006 revenues, the top ten seed firms control 57% of the world's commercial seed supply (see Table 7), up substantially from a top ten market share of 37% in 1996 (ETC, 2006). Four of the 10 largest firms are agrichemical companies – Monsanto, DuPont-Pioneer, Syngenta and Bayer – which together sell 41% of the world's commercial seeds. Monsanto is the world's number one seed firm, with leading shares in the seed markets for soybean, maize, canola, vegetable, fruit and other crop varieties. The company recently became the world's leading cotton seed firm through its controversial 2007 acquisition of Delta and Pine Land Company (Freese, February 2007). Monsanto is even more dominant in GM traits, which are offered not only in its own seed varieties, but in those of other leading firms (e.g. DuPont-Pioneer, Bayer) through licensing arrangements. Monsanto GM traits are found in an estimated 86% of the world's biotech crops,[10] which gives the company a virtual monopoly in the market for GM traits incorporated into seeds.

This growing concentration in control of the world's seeds has already had serious negative impacts on the world's farmers and the environment. These include dramatically rising seed prices, fewer seed choices, and increasing pollution of the environment with agricultural chemicals. Continuing consolidation could endanger the world's food security through radically diminished diversity in the world's crop germplasm, and hazardous reliance on a handful of profit-maximizing biotechnologies.

TABLE 7 WORLD'S TOP 10 SEED COMPANIES (BASED ON 2006 SEED REVENUES)

COMPANY	2006 SEED SALES US $ MILLIONS
1. Monsanto + Delta & Pine Land (US) pro forma	$4,446
2. Dupont (US)	$2,781
3. Syngenta (Switzerland)	$1,743
4. Groupe Limagrain (France)	$1,035
5. Land O' Lakes (US)	$756
6. KWS AG (Germany)	$615
7. Bayer Crop Science (Germany)	$430
8. Takii (Japan) estimate*	$425
9. Sakata (Japan)	$401
10. DLF-Trifolium (Denmark)	$352
Commercial Seed Market Worldwide	$22,900

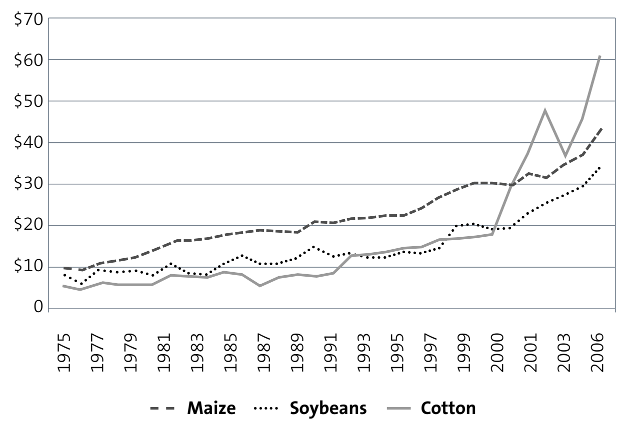
***Source**: Adapted from: ETC Group (2007), "The World's Top 10 Seed Companies – 2006"*

3 Monsanto reports that one or more of its traits were found in biotech crops planted to 217.4 million acres in 2006 (see Monsanto, June 28, 2007). ISAAA reports GM crops planted on 252 million acres in 2006. ISAAA's estimates have been criticized as inflated, so Monsanto's share of GM traits is probably even higher.

4.1 seed prices on the rise

One well-known effect of concentration is rising prices. Fewer suppliers means less competition, and more "market power" to set prices. Figure 4 shows a dramatic rise in average seed prices paid by American farmers since the advent of the biotech era in the mid 1990s. The average cost to farmers for seed to plant an acre of corn, soya and cotton rose by 4.7-fold, 4.1-fold and over 10-fold, respectively, from 1975 to 2006. The bulk of these price hikes, however, has occurred since the mid 1990s, and is clearly attributable to the much higher cost of GM vs. conventional seeds. For instance, GM cotton seed costs from two to over four times as much as conventional seed (Freese, February 2007).[11] Trends are similar in maize and soybeans. Companies normally charge a premium or "technology fee" for each "trait" (e.g. herbicide-tolerance or insect-resistance) in a seed. At present, most seeds are "stacked" with two traits, though Monsanto is beginning to sell "triple-stack" corn, and recently announced plans to collaborate with Dow on introduction of corn bearing 8 traits. One analyst notes that elite triple-stack corn already sells for more than $200/bag, and predicts that the 8-trait stack corn will likely cost $300/bag (Davidson, Dan, September 17, 2007). At typical seeding rates, $300 a bag corn translates to $100 per acre seed costs, well over twice the average price of corn seed in 2006. As University of Kentucky agronomist Chad Lee put it: "The cost of corn seed keeps getting higher and there doesn't appear to be a stopping point in sight" (Lee, C., March 2004). While some farmers might be willing to pay such high prices, growing concentration in the seed supply means that others may soon have no other choice. The dramatic rise in seed prices has coincided with rising fuel, fertilizer and other costs, making it very difficult for many farmers to survive.

FIGURE 4 **AVERAGE COST OF MAIZE, SOYBEAN AND COTTON SEED IN THE U.S.: 1975 TO 2006 ($ PER PLANTED ACRE)**



Source: *USDA-ERS, 2006.*

11 See appendix 3.

4.2 reduced seed choices

Biotechnology companies are rapidly phasing out more affordable seed varieties in favor of seeds with the maximum number and latest generation of traits. As Monsanto put it in a presentation to investors on its (then) prospective acquisition of Delta and Pine Land, the world's largest cotton seed company, its goal was to "invest in penetration of higher-[profit-]margin traits in Delta and Pine Land offerings" (Monsanto, August 15 2006). This means phasing out conventional and less expensive single-trait GM seeds in favor of more profitable double-, triple- and perhaps even eight-traits "stacks." This trend is already apparent. The number of cheaper conventional cotton seed varieties offered in the U.S. fell steeply, by more than half, in just the 4 years from 2003 (78) to 2006 (36) (Freese, February 2007). Anecdotal reports from farmers suggest that high-quality conventional corn and soybean seeds are also becoming much more difficult to find (Center for Food Safety, 2005). Similarly, high-quality varieties of GM cotton and other crops with just one trait are becoming much harder to find. Increasingly, companies like Monsanto are offering their best (e.g. highest-yielding) seed varieties only in costly double- and triple-stack versions (Freese, February 2007). This means that farmers who would prefer single-trait seed often end up purchasing stacked varieties to get the yield or other non-biotech characteristics they want.

Even economists at the USDA, which has been notoriously accommodating to the biotechnology industry, have observed that the extreme concentration in the seed industry is reducing choices for farmers:

"[C]onsolidation in the private seed industry over the past decade may have dampened the intensity of private research undertaken on crop biotechnology relative to what would have occurred without consolidation, at least for corn, cotton and soybeans. .... Also, fewer companies developing crops and marketing seeds may translate into fewer varieties offered (Fernandez-Cornejo, J. and D. Schimmelpfennig, 2004)."

4.3 seed industry concentration

The predominance of herbicide-tolerance technology (81% of world biotech acreage) becomes more understandable when one notes that four of the top ten seed firms are agrichemical companies (Table 7). Monsanto, DuPont-Pioneer, Syngenta and Bayer had combined seed revenues of $9.4 billion dollars in 2006, or 41% of the entire commercial seed market. It makes perfect business sense for seed companies that also sell agrichemicals to engineer seeds that promote use of their chemicals. But this business logic threatens environmental disaster. In 2001, 433 million lbs. of herbicide "active ingredient" were applied agriculturally in the U.S., or nearly 2/3 of the 675 million lbs. of overall agricultural pesticides applied in that year (US EPA, 2004). The growing concentration of the seed supply in the hands of agrichemical-biotechnology giants promises a future of ever more chemical-dependent, pesticide-promoting agriculture, and all the negative human health and environmental impacts that entails.

5. the assault on u.s. farmers continues[12]

Farmers have saved seed for millenia. The practice of saving superior seed from one's harvest and replanting it is the oldest form of crop breeding, and is practically synonymous with agriculture. Modern maize, soybeans, cotton and other crops are unthinkable without this long history of farmer-led crop improvement. Specialized crop breeders in small, regional seed firms and in the public sector made additional contributions over the past century. Throughout this history of crop improvement, the right of farmers to save and replant seed has been either implicit or guaranteed.

In the 1980s, the U.S. Patent and Trademark Office (USPTO) granted the first seed patent. The USPTO's initial ruling was eventually appealed all the way to the Supreme Court. In a tight 5-4 decision, the Supreme Court affirmed seed patents, in a decision written by former Monsanto attorney Clarence Thomas. For two decades, seed firms have been able to secure patents on seeds, patents which give them the right to legally prohibit seed-saving, and to sue farmers who do save seed. It is important to note that the U.S. Congress never authorized seed patents. In fact, the Plant Variety Protection Act that Congress DID pass in 1970 explicitly permits seed-saving, and is designed chiefly to give seed firms protection from their corporate competitors.

Monsanto has made abundant use of its numerous patents to aggressively investigate, harass and/or prosecute thousands of U.S. farmers for infringing its patents by (allegedly) saving and replanting its patented Roundup Ready seed. Monsanto has 75 employees and an annual budget of $10 million devoted to this effort, and pursues roughly 500 farmers a year. Farmers report that the company's hired private investigators typically show up at a farmer's home unannounced and scare him with threats of lawsuits into signing papers that give Monsanto access to his seed, chemical and other records. According to farmers, Monsanto uses tactics such as surreptitious surveillance (photos, videos), trespass on farmers' land, hiring agents who solicit farmers to illegally sell them patented seed, and reduced fines in return for information on other farmers, among other unsavory tactics.

The Center for Food Safety recently published an update to our 2005 report, Monsanto vs. U.S. Farmers, in which we analyze data from Monsanto Company documents (Center for Food Safety, 2007). This analysis indicates that the scope of Monsanto's legal actions against U.S. farmers is much broader than previously realized.

Public court records show that Monsanto has filed at least 112 lawsuits against a total of 372 farmers and 49 small farm businesses. Farmers were forced to pay Monsanto over $21 million in 57 court-imposed judgements, for average damages of $385,418. However, this is just the tip of the iceberg. Our analysis of Monsanto's documents suggests that the company has collected from $85 to $160 million from U.S. farmers in anywhere from 2,391 to 4,531 confidential "out-of-court" settlements, which the company refers to as "seed piracy matters." That is, the great majority of farmers choose to settle with Monsanto before a case goes to court to avoid an expensive legal battle with the company that they are likely to lose. Monsanto normally imposes a gag order on the victims of these settlements, so they cannot reveal the true magnitude of their losses without subjecting themselves to further prosecution by the company.

The Center for Food Safety maintains a "hotline" for farmers in trouble with Monsanto. In our experience, farmers have a variety of motives for saving seeds. Some are taking a principled stand against patents they believe are deeply unjust; others are uninformed that seed-saving had been made illegal; still others saved seeds to save money, because they are struggling to survive financially in a brutal agricultural world of rapidly rising seed, fertilizer and fuel costs. Usually, farmers have several of these motives. Though Monsanto was once known to target the largest and most prestigious growers in a region, many small farmers are also being pursued. Some are financially ruined by their confrontation with the company, and either go bankrupt, sell off their land, or give up farming. Nearly all farmers feel intimidated, and undergo considerable stress from their confrontations with the company, which is not surprising when one considers their future in farming could be at stake. Monsanto's snitch line encourages farmers to "inform" on their neighbors, which contributes to a poisonous atmosphere of suspicion and distrust in rural communities. There are also a substantial number of cases in which farmers are wrongly accused of saving the company's patented seed. In many of these cases, a farmer has grown both conventional and Roundup Ready seed, and saved only conventional seed, which is perfectly legal. However, Monsanto will still try to extract money from such farmers, and often succeeds, given farmers' understandable reluctance to face the multinational giant and its attorneys in court.

It is clear that the main beneficiaries of the GM crops planted in the past decade in the United States have been the corporations that market them, and in particular the Monsanto Corporation. Monsanto's growing control over the seed supply, its aggressive investigation and prosecution of farmers for alleged patent infringement, and its astonishing influence over government policies and regulations have been the context for the GM revolution in US agriculture. This revolution is characterized not by an improvement in the quality of food, nor by an increase in the sustainability of farming, but by the transformation of agriculture into a concentrated industry in which ever fewer corporations are gaining overwhelming control over US farms and their farmers.

12 See Center for Food Safety, 2005, 2007.

6. some reasons for optimism

The USDA is the U.S. regulatory agency with primary responsibility for biotech crops. It has come in for unusually harsh criticism from the National Academy of Sciences (NAS, 2002), its own Inspector General (USDA IG, December 2005), and many farm and public interest groups for failing to adequately assess and regulate biotech crops. Since just 2006, three federal courts have also found USDA's regulation of GM crops to be grossly deficient and not compliant with U.S. environmental laws.[13] In one case, USDA was found to have violated both the National Environmental Policy Act and the Endangered Species Acts for allowing several companies to grow GM crops that harbor untested pharmaceuticals in Hawaii without first conducting an environmental assessment. Two other cases involved Roundup Ready crops. In one, the U.S. District Court for Northern California reversed USDA's approval of Monsanto's Roundup Ready alfalfa, which can no longer be grown commercially, because of gross deficiencies in USDA's cursory environmental assessment of the crop. Among the Court's concerns were contamination of conventional and organic alfalfa by the Roundup Ready variety, as well as the potential for RR alfalfa to increase the prevalence of glyphosate-resistant weeds, another concern that USDA ignored (U.S. District Court for the Northern District of California, February 13 2007):

"The Court notes, however, that it is unclear from the record whether any federal agency is considering the cumulative impact of the introduction of so many glyphosate resistant crops; one would expect that some federal agency is considering whether there is some risk to engineering all of America's crops to include the gene that confers resistance to glyphosate."

The hope is that the combined influence of the nation's top agricultural scientists, the USDA's internal inspectors, the federal courts and public opinion may persuade USDA to begin basing its regulatory decisions somewhat more on science and the nation's environmental laws than on the interests of the agricultural biotechnology industry.

More likely cause for hope, perhaps, is the steady growth in the organic foods market. Increasingly, consumers are turning away from foods produced using chemical-intensive, industrial farming practices, and hazardous genetic manipulation technologies, and to healthy foods grown without chemicals and insertion of foreign genes.

13 For a summary of these three cases, see Center for Food Safety, 2007b.

soybeans in south america: weed resistance to glyphosate on the rise

By Juan Lopez Villar, Friends of the Earth International

1. few producers in an export-oriented business

Soybeans are one of the most highly concentrated and heavily traded commodity crops in the world. Just three countries – the U.S., Brazil and Argentina – accounted for over 80% of world soybean production in 2007. Over half of the world's soybeans and soy derivatives (soymeal and soy oil) are exported, mainly to feed livestock and poultry in rich nations. Soya remains a key agricultural export crop for three countries in South America –Brazil, Argentina and Paraguay - which together accounted for over 45% of the world's land planted to soybeans in 2007.

TABLE 8 **TOP PRODUCERS AND EXPORTERS OF SOYBEAN IN THE WORLD 2006/07 (000 MT)**

	COUNTRIES	2005/06 PRODUCTION IN 000 MT	2006/07 PRODUCTION IN 000 MT	EXPORTS OF SOYBEAN IN THE WORLD 2006/07		
				Soybean	Soy meal	Soy oil
1	US	83,368	86,770	30,428	8,029	862
2	Brazil	57,000	59,000	23,485	12,715	2,462
3	Argentina	43,500	47,200	8,700	25,608	5,975
4	China	16,350	16,200	-	-	-
5	India	7,000	7,690	-	3,461	-
6	Paraguay	3,640	6,200	4,600	1,050	247
7	Canada	3,161	3,460	1,683	-	-
	Other nations	6,419	9,253	1,786	2,855	966
	TOTAL	220,438	235,773	70,682	53,718	10,512

Friends of the Earth International, 2007.
***Source**: Based on data from USDA, November 2007. Oilseeds: World Markets and Trade.*

Herbicide-tolerant soybeans are the number one commercialised GM crop in the world, and account for over 90% of all GM crops commercialized in South America. The percentage of soy that is genetically modified is estimated to be over 40% in Brazil, around 90% in Paraguay, and nearly 100% in Argentina.

2. argentina

2.1 reaching the limits of soybean expansion

In 2007, land planted to soybeans in Argentina expanded 5.4% to cover an area of 16.15 million ha. The record soya harvest of 47 million MT is due to the expansion of the area planted, as well as good weather conditions (SAGPYA, August 2007). For the 2007/08 season, the government foresees another increase in the planting area, most of which will occur in northern provinces. Because these lands are generally less fertile, it is expected that yields will be lower (USDA, October 2007).

Area planted to soybeans in Argentina has nearly tripled since 1995/96, when it was 6 million ha. Forests and savannahs have been cleared to make way for soybeans. In addition, land previously devoted to pasture and major food crops like maize, sunflowers, sorghum, and wheat has also been converted to soya production (Benbrook 2005). This rapid soya expansion has been accompanied by soil erosion, land concentration and the progressive reduction of the number of family farms, reducing Argentina's food security (Loensen, L., S. Semino and H. Paul, 2005). The proportion of Argentine soya that is Roundup Ready has increased dramatically from just 2% (1996/97) to virtually 100% today. The country's heavy reliance on Roundup Ready GM soybeans is rapidly intensifying the twin problems of glyphosate-resistant weeds and increased pesticide use.

2.2 the rapid spread of glyphosate-resistant johnsongrass

For many years, Monsanto discounted the possibility that its Roundup Ready crops would promote the development of weeds resistant to glyphosate. Monsanto claimed that it was "unlikely that resistant plants will appear over time in a weed population" due to "the mode of action unique to glyphosate" (Monsanto, 21 April 1997). But a growing worldwide epidemic of glyphosate-resistant weeds has decisively refuted this self-serving prediction.

Johnsongrass (Sorghum halepense) is a monocot weed in the Poaceae family that is considered one of the worst weeds in the world. It was already considered a problematic weed in Argentina during the 1930s (Passalacqua, 2006; Leguizamón, November 2006; Olea, 2007).

Farmers first reported failure to control Johnsongrass with glyphosate in the late 1990s (Valverde & Gressel 2006), though it appears that glyphosate-resistant Johnsongrass was first confirmed in 2003 (Infocampo, 19 october 2007; El enfiteuta). According to Monsanto, the first complaint of poor glyphosate performance was received in December 2003; during 2004, various field tests conducted by the company suggested that older weeds were more resistant to glyphosate than younger ones; and that some weeds tolerated up to 3.5 times the normal dose of glyphosate (Valverde & Gressel, 2006).

2.3 late response to the weed resistance problems

Despite reports to Monsanto of glyphosate-resistant Johnsongrass in Argentina by no later than 2003, Argentine agricultural officials at the National Service of Agriculture, food & health and quality (SENASA) professed only indirect knowledge of this case of resistance over two years later, in January 2006, after a presentation given by Monsanto Argentina at an FAO seminar about weed resistance in Colonia, Uruguay in December 2005 (Passalacqua, 2006).

It was only after this two-year delay that SENASA commissioned agricultural consultants Johnathan Gressel and Bernal Valverde to study the weed resistance problem. These experts confirmed the existence of glyphosate-resistant Johnsongrass in the provinces of Salta and Tucumán, with the suggestion that it is spreading to other provinces, in mid-July 2006 (SENASA, 28 de Septiembre 2006):

"the field data leave no doubt that resistance has evolved. Resistance seems widespread in Salta and a focus has been detected in Tucuman. Unconfirmed reports suggest that the situation in Tucuman is much worse and that there are already spreading resistant populations in Rosario." (Valverde & Gressel 2006).

Valverde and Gressel also express concern about possible cross-resistance to both glyphosate and other widely used herbicides (ACCase and ALS inhibitors), which would make these weeds still more difficult to control, and concede that both the mechanism of resistance and the routes by which the resistant weeds are spreading are unknown. Based on their observations, "farmers have not been successful in limiting spread within fields from resistant clumps despite widely used spot herbicide treatments." (Valverde & Gressel, 2006). The seriousness of the problem is indicated by their two pages of detailed recommendations for controlling this threat to Argentine agriculture, which include a requirement that Roundup Ready soybeans be rotated with non-Roundup Ready crops, quarantine measures to prevent spread of seeds from resistant Johnsongrass, and an aggressive monitoring and farmer education program.

A month after the Valverde and Gressel report, the Argentine Chamber of Agriculture and Fertilizers (CASAFE) and the Argentine Chamber of Fertilizers and Agrochemicals (CIAFA) announced the existence of glyphosate-resistant Johnsongrass in a joint press release dated August 2006 (CASAFE & CIAFA, 16 August 2006). CASAFE and CIAFA estimated that resistant Johnsongrass infested between 7,000 and 10,000 ha. It is unclear why they took so long to acknowledge this extremely serious threat to Argentine agriculture, especially given the fact that Monsanto had already confirmed the existence of a glyphosate-resistant biotype of Johnsongrass in 2005 (Weedscience, 2005; Proyecto de Ley, 19 September 2007).

"This is confusing, given the fact that Monsanto had already confirmed the existence of a glyphosate-resistant biotype of Johnsongrass in 2005, as reported on: http://www.weedscience.org."

Argentine Congressman Alberto Cantero, 19 September 2007

The extremely slow response of the Argentine government and agribusiness representatives to the threat posed by glyphosate-resistant Johnsongrass is inexcusable. As discussed below, Argentine farmers will pay the price for this negligence.

2.4 taking action: weed resistance intensifies herbicide use

In 2005, the Weed Science Society of America estimated that 11 to 50 sites covering an area of 405 to 4050 hectares in the province of Salta alone were infested by glyphosate-resistant Johnsongrass (Weedscience, 2005). By October 2007, SENASA estimated that 120,000 ha, or roughly 100-fold more land, was infested with the resistant weed. SENASA now reports glyphosate-resistant Johnsongrass not only in Salta, but in Tucuman, Corrientes, Santiago del Estero, Cordoba and Santa Fe provinces as well (Olea, 2007; Sellen 2007).

The major recommendation to control resistant weeds is to use a cocktail of herbicides other than glyphosate, including more toxic weedkillers such as paraquat, diquat and triazine herbicides such as atrazine (Valverde & Gressel, 2006). It is estimated that an additional 25 million liters of such herbicides will be needed each year to control resistant weeds, resulting in an increase in production costs of between $160 to $950 million per year (Proyecto de Ley, 19 September 2007). SENASA agricultural expert Daniel Ploper estimates that herbicide costs will double in the affected areas (Sellen, 2007).

Resistant Johnsongrass is such a serious threat to Argentine agriculture that Congressman Alberto Cantero introduced a bill to eradicate the weed in September 2007. The bill recognizes that market forces cannot control this pest, and that the State needs to take action. Amongst other measures, the bill calls for creation of a special fund to support measures needed to eradicate resistant Johnsongrass. Such a fund would be comprised of public treasury funds and other contributions from unspecified international organizations (Proyecto de Ley, 19 September 2007).

The cost of weed control has significantly increased due to Johnsongrass. The costs of production to control it may increase from 500 to 3000 million pesos per year, depending on the degree of infestation and the possible measures of control that are needed. Simply considering the vast area planted with RR soy, the increase will be higher than 500 million pesos per year... the consequences to the environment will be of similar magnitude, though this is difficult to evaluate at this point. Nevertheless, the increase in the quantity of herbicides applied to control resistant Johnsongrass should serve as a warning about potential environmental damage. If resistant Johnsongrass becomes widespread, there will be a substantial increase in the amounts of glyphosate and other herbicides applied to control them.

Proyecto de Ley "Erradicación de Sorghum Halepense resistente al glifosato", 19 de Septiembre 2007

In any case, it seems clear that the rapid emergence of resistant weeds on such a large scale will exacerbate the massive and growing use of pesticides associated with the expansion of Roundup Ready soya monoculture in Argentina. While herbicides are also sprayed on other crops, soya has spearheaded the intensification of agrochemical use in Argentina. Overall glyphosate use more than tripled from 65.5 million liters in 1999/2000 to over 200 million liters in 2005/06, while over the same period it appears that 2,4-D use has increased still more dramatically, to an estimated 20-25 million liters in 2005/06 (Benbrook 2005; Lapolla, 2007). Lapolla estimates that 6 million liters of endosulfan and 6 millions litres of atrazine were also used in 2005/06. As we have seen, it is predicted that an additional 25 million liters of non-glyphosate herbicides each year will be needed to control resistant Johnsongrass.

In August 2007, the Argentine government also approved a Roundup Ready maize variety that is expected to be planted widely in the Pampas in 2007/08 (Sellen, 2007). This development will increase reliance on glyphosate still more, and likely accelerate the spread of glyphosate-resistant Johnsongrass. It is becoming increasingly evident that after a decade of commercialization, GM crops like herbicide tolerant soya and maize are not reducing pesticide use, but on the contrary greatly increasing it.

2.5 monsanto loses court cases against argentina in europe

In 2005, Monsanto filed lawsuits regarding the shipment of Argentine soy meal to Europe, arguing a possible infringement of its patent rights on the RR gene in Europe, since Argentine farmers did not pay patent royalties for GM soy. Monsanto advanced its patent claims not just with respect to whole soybeans, but also with regard to derived products like soy meal in Europe. In 2007, courts ruled against Monsanto in the first two cases, which were brought in the UK and Spain, rejecting the company's claims and making it pay for the costs (High Court of Justice Chancery Division (Patents Court), 10 October 2007; Reuters, 7 September 2007).

3 brazil

3.1 after 4 years of crisis, good weather conditions boosts soya production

Since the official approval of GM soya in 2004, Brazilian farmers have been caught up in a crisis situation due to low international soy prices, weather factors, and a strong real. In that context, in 2007 Brazil reduced the area planted to soya for the second consecutive year: from 22.749 ha in 2005/06 to 20.69 million hectares in 2006/07 (CONAB, September 07). Excellent weather conditions, however, boosted the yields from an average of 2,419 kg/ha the previous year to 2,812 kg/ha, and gave Brazil a record harvest of 58.391 MT, an increase of 16.2% (CONAB, July 2007).

First of all, the old claim by the biotech industry that GM crops increase productivity is not borne out by production figures in Brazil over the past few years. ISAAA maintains that the herbicide-tolerance of GM soya has been neutral with respect to yield in Brazil (ISAAA, January 2006b), but as we have seen in the U.S., accumulating research suggests that Roundup Ready soya suffers from a "yield drag" of 5-10%. Secondly, since the official adoption of GM soya in 2004, the crop harvests that followed the next three years were bad for most farmers, and in general GM soya seem to perform worst than conventional soya in drought conditions. Poor performance of GM soya under drought conditions is supported by experiences in other countries, such as Paraguay, and research on Roundup Ready soya conducted in the United States. In addition, most small farmers' livelihoods were adversely affected by low prices, high input costs and other factors.

The main reports from CONAB identifies good weather conditions as the main reason for the yields improvement in the 2006/07 campaign. Another record harvest is expected in 2007/08, which CONAB attributes to "expansion of the area of planting, stimulated by the remunerative prices of the market". However once again, the final expectations are put on hold "depending on the weather variations in the next months" (CONAB, 8 November 2007). Weather conditions and prices seem to be the main factors affecting farmers' livelihoods and driving farmer decisions, not the GM technology.

3.2 weed resistance increasing in brazil

As in Argentina, Brazilian researchers from Embrapa are acknowledging the appearance of glyphosate-resistant weeds this year, particularly in Rio Grande Do Sul where the adoption of RR soya is almost 100%. In 2005 and 2006, three new types of weed have developed resistance to glyphosate in the southern parts of Brazil (Weedscience, 2007). For the first time, researchers of Embrapa have confirmed in a peer reviewed article in the Journal of Environmental Sciences and Health that four weed species have evolved resistance to glyphosate in Brazil, concluding that "this has a great potential to become a problem" (Cerdeira et al, 2007).

Unfortunately, once again farmers are blamed for the rapidly decreasing efficacy of glyphosate, when the truly responsible parties are the seed and chemical companies that push the unsustainable model of pesticide-promoting GM crops that necessarily create such problems for the environment and agriculture (Gazeta Mercantil, 9 august 2007).

TABLE 9 AREA, YIELD AND PRODUCTION OF SOY IN BRAZIL 2001-2007

	2001/02	2002/03	2003/04	2004/05	2005/06 (PRELIMINARY)	2006/07 (FORECAST)
Area (in thousand hectares)	16,386.2	18,474.8	21,375.8	23,301.1	22,749.4	20,686.8
Yield (kilogram/hectare)	2,577	2.816	2,329	2,245	2,419	2,823
Production (in thousand metric tonnes)	42,230.0	52,017.5	49,792.7	52,304.6	55,027.1	58,391.8

Source: *CONAB, Novembre 2007. Soja Brazil. Serie historica de area plantada, produtividade, produçao.*

TABLE 10 HERBICIDE RESISTANT WEEDS IN BRAZIL

	WEEDS IN BRAZIL	COMMON NAME	YEAR	SITES	ACRES	MODE OF ACTION
1.	Conyza canadensis	Horseweed	2005	2-5	51-100	Glycines (G/9)
2.	Conyza canadensis	Horseweed	2006	11-50	101-500	Glycines (G/9)
3.	Conyza bonariensis	Hairy Fleabane	2005	2-5	51-100	Glycines (G/9)
4.	Conyza bonariensis	Hairy Fleabane	2005	6-10	51-100	Glycines (G/9)
5.	Euphorbia heterophylla Multiple Resistance	Wild Poinsettia	2006	11-50	101-500	ALS inhibitors (B/2) Glycines (G/9)
6.	Lolium multiflorum	Italian Ryegrass	2003	2-5	51-100	Glycines (G/9)

Source*: Weedscience.*

"Probably the highest agricultural risk in adopting GRS in Brazil is related to weed resistance. Weed species in GRS fields have shifted in Brazil to those that can more successfully withstand glyphosate or to those that avoid the time of its application. These include Chamaesyce hirta (erva-de-Santa-Luzia), Commelina benghalensis (trapoeraba), Spermacoce latifolia (erva-quente), Richardia brasiliensis (poaia-branca), and Ipomoea spp. (corda-de-viola). Four weed species, Conyza bonariensis, Conyza Canadensis (buva), Lolium multiflorum (azevem), and Euphorbia heterophylla (amendoim bravo), have evolved resistance to glyphosate in GRS in Brazil and have great potential to become problems"

Cerdeira et al., 2007. Journal of Environmental Sciences and Health

3.3 rr soya increases agrochemical use in brazil

Besides their human health impacts, it is also well known that the introduction of agrochemicals in the environment has undesirable effects on ecosystems. According to a 2006 study by EMBRAPA, approximately 130 thousand tonnes of agrochemicals -active ingredients- are used each year in Brazil. This represents a 700% increase in agrochemical use in Brazil over the last 40 years, in comparison to an increase in agricultural area of only 78% (EMBRAPA, December 2006).

Soya is the main crop in Brazil, and more agrochemicals are used on it than on any other crop in 1998, more than 30% of all agrochemicals were applied to soya (EMBRAPA, December 2004), and that trend has continued with the significant expansion of area planted to soy in recent years. According to data from the Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA), Brazil´s environmental enforcement agency, use of the 15 main active ingredients in the most-used soya herbicides increased 60% from just 2000 to 2005 – from 59.5 thousand to 95.2 thousand metric tonnes (Valor Económico, 24 April 2007; IDEC 27 April 2007). The increase is attributable mainly to rising use of glyphosate on Roundup Ready soybeans. Glyphosate use grew 79.6% within the period 2000-2005 (See Figure 5).

"There is a large increase in glyphosate use, well above the expansion of planted area and to a greater extent than other herbicides"

Rubens Nodari, Specialist in Genetics and manager of Genetic Resources in the Brazilian Environmental Ministry, 2007.

Anecdotal evidence collected in 2007 from farmers' associations and the private-sector corroborates this trend of increasing agrochemical use. For example, the agrochemical supplier BASF had great difficulty meeting the demand for its products in 2007, and is ending 2007 with its agrochemicals stocks almost totally depleted. Two key factors driving the increased sales of agrochemicals in 2007 were the 7% increase in the area planted with soya after the favourable harvest of the 2006/07 season, and the recent use of herbicide in corn planting (Valor Economico, 7 November 2007).

By the end of 2007, increased agrochemical demand coincided with rising glyphosate prices, which have climbed substantially in comparison to the prices of herbicides used on conventional crops. For example, according to an analyst from Agra-FNP, Fábio Turquino Barros, the price of herbicides for GM soya in Mato Grosso, the biggest soy-producing state in Brazil, had risen by 44% by the end of 2007, while the price of herbicides used on conventional soya has declined by 45% from the 2006/07 season.

"GM crops will not reduce the use of herbicides. In Rio Grande Do Sul, herbicide use rose from 9,000 to 20,300 metric tonnes between 2000 and 2004. This increase is 4 times larger than the increase in planted area".

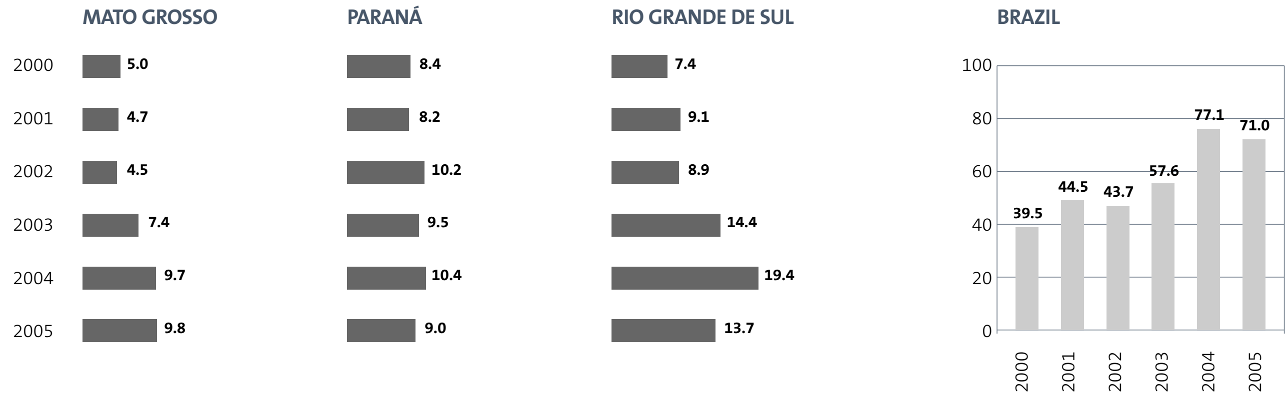
Luiz Carlos Balcewicz, specialist from Biodiversity Conversation of IBAMA (Valor Economico, 24 April 2007)

3.4 parana moves towards conventional soya

According to official sources from the Government of Parana, the elevated costs of inputs, and the lower performance of the GM soya, has reversed the trend of increasing adoption of

FIGURE 5

CONTINUED GROWTH OF GLYPHOSATE COMMERCIALIZED IN BRAZIL 2000-2005 (000 MT OF ACTIVE INGREDIENTS)



Source: *Ibama**
******* *Note: the reduction of glyphosate use in 2005 is consequence of the soya crisis and the reduction in planted area and input use*

transgenic soya. The Secretary of Agriculture of Paraná, Valter Bianchini, has said that in 2006/07 the soya crop was 53% conventional and 43% transgenic, but for 2007/08 it is expected to be 60% conventional and 40% transgenic (Gazeta Mercantil, 31 August 2007).

"If the price of glyphosate continues to rise, increasing overall production costs, a lot of farmers will think twice about that [i.e. Roundup Ready] technology and may come back totally or partially to planting conventional crops."

Luís Nery Ribas, technical manager of the Associacion of Soya Producers of Mato Grosso (Aprosoja), (Gazeta Mercantil, 28 August 2007)

The preference of Parana farmers for conventional soya is also reflected in data on pesticide use from IBAMA. Between 2000 and 2005, the increase in glyphosate use is much lower in Parana (7%) than in states that have strongly embraced GM soya and its associated glyphosate, such as Mato Grasso (94% increase) (Valor Económico, 24 April 2007).

"The number of farmers who have stopped planting GM soya because they are seeing better financial results with conventional production is significant".

Agência Estadual de Notícias do Paraná, 6 November 2007

3.5 conflict between small farmers and biotech companies: mst member killed by syngenta security guard

In 2007, Brazil experienced one of the most dramatic cases of confrontation between small farmers´ movements and biotech promoters. The Brazilian Landless Rural Workers' Movement (MST) and the international Via Campesina protested GM crop experiments by occupying a 128 ha GM experimental farm located just four kilometres from the Iguaçú National Park – which has been declared a Natural World Heritage site by UNESCO. The MST's protest highlighted the fact that this research facility violated a law which prohibits GM field trials within a 10 km buffer zones around nature reserves (MST, 23 October, 8 November 2007; Via Campesina, 21 October 2007; Ribeiro, 24 November 2007; IPS, 1 November 2007; Swissinfo, 23 October 2007; Global Research, 6 November 2007;).

On October 21st, forty security guards working for Syngenta appeared at the camp, which was occupied by 200 members of MST and the international Via Campesina, and trained machine gun fire in the direction of the occupiers, killing one of the MST members. An official inquiry has been launched to investigate this murder, which is still underway as of this writing. Amnesty International and numerous other human rights organizations in Brazil and abroad have already expressed their grave concern about Syngenta's use of armed militia.

"How is possible that no action is taken when a multinational company operates in the buffer zone of protected nature reserves, breaching environmental rules and laws?"

Roberto Baggio, national leader of the MST and Via Campesina.

3.6 federal judge orders syngenta to stop planting gm crops in the facility near iguazu national park

On the 30th of November 2007, a Federal Judge ruled against Syngenta's request to continue planting GMOs in the proximity of Iguazu National Park . The judge ruled that Syngenta's activities breached a legal requirement not to plant GM crops in the proximity of National Parks (Gazeta do Povo, 5 December 2007).

3.7 organic and agroecological crops contaminated

Brazilian experience in 2007 proved beyond doubt that GM crops are extensively contaminating conventional and organic soya. In Parana, 283 tones of conventional seed were found to be contaminated by GM soya. In some of the soya bags, the contamination reached levels of 9% (Central de Associaçoes da Agricultura familiar do Oeste de Parana, 2007).

Other farming systems have been also affected by GMO contamination. Agroecological and organic agricultural systems are growing around the world and have the potential to feed the growing population of the planet without pesticides and GMOs (FAO, May 2007). In Brazil, for example, organic farming grew by 21% in 2005/06. GMO contamination of those crops is threatening the livelihoods of organic and conventional farmers, since organic producers normally have contracts guaranteeing the GMO-free status of their harvests with certain companies that specialize in supplying organic products. One of those companies, called Gebana, has its headquarters in Capanema, in the Western area of Parana. Gebana identified four cases of contamination in 2006, and the number increased to 9 cases in 2007.

the cost of contamination: the case of ecological farmers in medianeira, brazil

Ademir and Vilma Ferronato live in Medianeira, a region in the Western part of Paraná, where they cultivate around 16 ha of organic crops. Besides the production of soya and maize, they have a very diversified farm that also produces vegetables, fruits and livestock. All of their production is ecological, though there are conventional and transgenic soya farmers close by.

In 2006/07, Ademir was surprised when part of his production of organic soya was rejected by Gebana, the company that buys the family's produce for use in organic products. Gebana's tests detected the presence of GM soya mixed in with their production. The seeds were provided by Gebana itself, so the presence of GM soya couldn't be due to contaminated seed. In the opinion of Ademir and Vilma, contamination occurred at the time of harvest. They planted soya in two periods. The first harvest from 7 hectares was tested and sold as organic. The second harvest from around 4 hectares was contaminated.

The same machine was used to harvest their soya in both cases. The difference is that in the second harvest, the machine had previously been used to harvest GM soya grown by other farmers. Even though the machine was cleaned according to the instructions of the certifying companies, it was apparently not sufficient to prevent contamination. The damage was then unavoidable. The 280 bags harvested in the first crop were sold at 40R$ per bag. The 140 bags produced in the contaminated second crop could only be sold at R$28.50 per bag. Thus, the family lost R$ 1610.

***Source:** ASPTA, June 2007*

4. paraguay

4.1 bumper soy crop due to good weather

As in Brazil, after a few years of crisis in the soy sector, Paraguay had a bumper crop of 6.5 million tonnes of soy during 2006/07 thanks to good weather conditions. In the beginning of the season, the cereal exporter CAPECO foresaw a production of 5 millions tones, but after intense rains in the beginning of the year, the forecasts increased to 6 millions tones (El Clarín, 3 June 2007). Approximately 80% of Paraguayan soy is destined for export markets, with only around 19.8% for industrial uses and 0.2% for seed multiplication (IICA, 2007). In 2007, soya provided the bulk of Paraguay's commodity export revenues comprising 44% of the country's total external trade. Soybeans alone secured 787 million $, while soy meal and soy oil brought in another 248 million $ (La Nación, 2007).

4.2 gm soy performs poorly in paraguay

As with Argentina and Brazil, GM soy has not had a positive impact on yield relative to conventional soy. In fact, several reports from Brazil and Paraguay since 2004 have indicated that RR soy performs worse than conventional soy in drought conditions (FoEI, 2006). In the 11 years from 1991 to 2001, largely before the introduction of Roundup Ready soy,[14] soya yields in Paraguay ranged from 2500 to 3000 kg/ha (see Figure 6). The period of heavy adoption of RR soy coincided with several consecutive seasons afflicted by drought. The greater vulnerability of RR soy to drought has contributed to the dramatically lower soya yields in Paraguay from 2002 to 2006.

4.3 rural poverty increases while soya expansion continues

Soya cultivation is projected to expand to 2.8 million ha in 2007/08, with production estimated at close to 7 million tonnes (La Nación, 2007). This continuing soya expansion is causing great hardship in rural Paraguay.

Since the 1960s, the government of Paraguay has promoted an export-oriented agricultural model focused on soybeans and ranching. This agribusiness approach is bringing no benefits and causing great hardship to the majority of the rural population and indigenous communities. The impacts on the small farmer sector – approximately 1.5 million people – and the indigenous communities – roughly 87,000 individuals – have been enormous, from loss of land, forced displacement, urban migration, and deforestation, to name a few. All of this occurs in a context of deep inequality. For instance, the disparity in land ownership is huge, with just 2% of the landowners controlling 70% of the land (Mesa DRS, 2007).

From 1999 to 2006/07, the area planted to soy monocultures more than doubled, from 1,176,460 ha to 2,500,000 ha. Soya plantations now represent an astonishing 56% of the 4.5 million hectares of planted cropland in Paraguay (Biopact, March 2007).

14 Roundup Ready soy was officially approved for cultivation in Paraguay in 2004, but had been unofficially grown for several years prior to this (FoE I Who Benefits 2007, Section 5, Chapter Three)

Roughly 90% of Paraguayan soy is genetically modified. Is this expansion helping the rural population to improve their livelihoods? According to a report prepared by a coalition of civil society groups in Paraguay called the Mesa de concertación para el Desarrollo Rural Sostenible in Paraguay, which was presented at a United Nations meeting on socio-economic rights in November 2007, the dizzying expansion of soybean monocultures coincides with a period of rapid increase in extreme rural poverty (Mesa DRS, 2007). The proportion of the population living below the poverty line has increased in Paraguay from 33.9% in 2000 to 39.2% in 2005 – with levels even higher, up to 40.1%, in rural areas (La Nación, 14 November).

In Paraguay less than 2% of the landowners control more than 70% of the land:

- 270,157 farms from 0 to 20 ha occupy 4% of the lands.
- 3,794 farms of over 1000 ha occupy 78% of the lands.

***Source:** Censo Nacional de Población y Vivienda del año 2002 (DGEEC, 2003)*

It is becoming obvious that the export-oriented GM soy model is not alleviating the poverty suffered by the majority of the population in the rural areas. On the contrary, the introduction of GM soya and the increasing dominance of corporate agribusiness is increasing land concentration and jeopardizing the very survival of Paraguayan small farmers (MESA DRS, 2007)

Paraguay will not be able to sustain its soy model any longer. It is clearly "inadequate and unsustainable" from the social and environmental point of view, due to the lack of control in its rapid growth.

Igor Bosc, Representative of the United Nations Programme for Development in Paraguay, ABC, 1 November 2007.

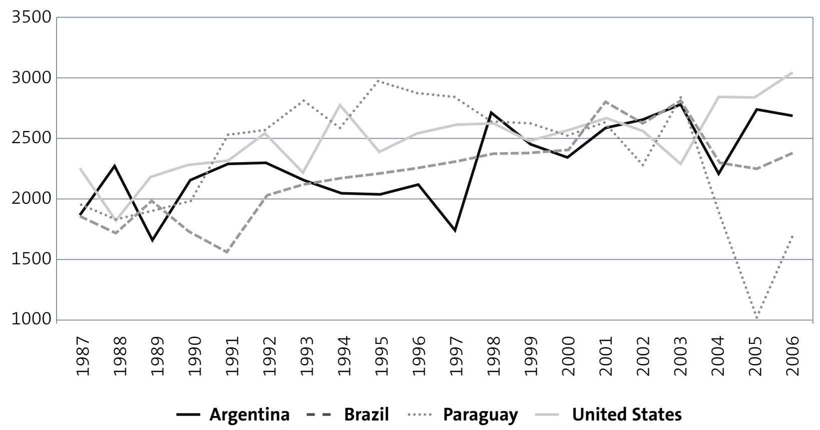
4.4 conflicts between soy landowners and local communities

The destruction of ecosystems due to large-scale planting of soybeans has been very serious in Paraguay and strife between between small local farmers and big soy landowners has become increasingly common in 2007 (IPS, 8 November 2007).

The Paraguayan Mesa DRS has presented a complaint against Paraguay at the UN for the indiscriminate use of agrochemicals in the country by soy landowners, which is causing the death of children, abortions and birth defects. Local communities continue to protest the indiscriminate aerial spraying of herbicides, which impacts schools, churches and other public places (ABC, 7 November 2007). Negotiations between villagers and soy landowners were begun at the end of 2007 in towns such as San Cristobal, Alto Paraná. In November, it was reported that the indigenous community of kuetuwyve succeeded in stopping a soy landowner from illegally planting soy near the community's land. The authorities of the National Service for Seed, Crop Health and Quality (SENAVE) proceeded to destroy all soy illegally planted near the indigenous community (ABC, 6 November 2007).

A new conflict has arisen between the local population and the multinational agribusiness Cargill, which controls over 30% of the national Paraguayan production of soy, corn and wheat. Cargill is planning to construct a huge harbour in the Paraguay River to export over a million metric tones of grain. This has prompted strong opposition from Paraguayan civil society. The area where construction is planned is home to a great number of traditional fisherpeople and is 500 meters upstream from the public company that distributes water to the capital city of Asunción and its surroundings. Construction of the harbour is opposed by the Paraguayan Assembly of Citizens for Life and Health, which fears the project will cause huge environmental problems, such as water pollution (Asamblea Ciudadana por la Vida y la Salud, 9 October 2007; Pulsar, 10 October; Camara de Diputados, República de Paraguay, 2007).

FIGURE 6 SOYBEAN YIELDS IN THE TOP 4 SOYBEAN PRODUCERS 1987-2006 (KG/HA)



***Source:** Friends of the Earth International, 2007. Based on FAO data. Based on data from FAOSTAT, ProdStat, Crops, Subject: Yield per hectare (kg/ha), Commodity: soybeans; Country: United States, Argentina, Brazil, Paraguay; Year 1987-2006, (last accessed 1 December 2007).*

cotton around the world

By Juan Lopez Villar, Friends of the Earth International

Million of small farmers around the world plant cotton. A detailed analysis of farmers' experience with GM cotton around the world can be found in the two previous editions of the "Who Benefits from GM crops?" series (FoEI, 2006, 2007). The current edition provides an updated assessment of the performance of GM cotton around the world in 2007. This Chapter particularly questions three of the main benefits directly attributed to the introduction of GM cotton: increased yields, reduction of pesticide use, and improvement of the livelihoods of small cotton farmers.

1. cotton in india

Despite the decline in agriculture's share of India's gross domestic product – from 50% in 1970 to 20% in 2007 – it still constitutes the backbone of the Indian economy. Almost 60% of the population is dependent on agriculture-related activities (Reddy, November 2007). Water scarcity, low crop prices, poor infrastructure, poor access to credit, and lack of rural employment have plagued rural areas in India over the past few years.

Most GM cotton outside of the U.S. is engineered to contain an insecticide that kills selected insect pests.[15] The insecticide is derived from a soil bacterium, Bacillus thuringiensis (Bt), and is thus known as "Bt cotton." Bt cotton has been heralded in the media as a key factor for the increase of cotton production in Indian agriculture in the past three years and as an important contribution to the improvement of the livelihoods of small farmers in the country (ISAAA, 2006a). In previous editions of "Who Benefits from GM Crops?", we explored in detail the intense controversies generated by the introduction of Bt cotton in India, including numerous reports of crop failures, poorer-than-advertised performance, and the slanting of data by Monsanto-Mahyco, Monsanto's Indian distributor of Bt cotton, to cover up these problems (FoEI, 2006, 2007). Those reports also address the high price of Bt cotton seeds and cases of debt-driven suicides by Indian cotton farmers. Additional insight into the substandard performance of Bt cotton in India is provided by an article in Nature Biotechnology, which notes that Bt cotton varieties used in India (which were developed for the short U.S. growing season) lose their insecticidal properties late in India's longer growing season, and that the Bt cotton insecticide is not expressed in 25% of the cotton bolls of India's preferred hybrid cotton varieties (Jayaraman, K.S., 2005). In this section, we will show how Bt cotton's role in Indian agriculture has been greatly exaggerated by industry sources. The monsoon and weather factors are the main factors behind the productivity increase, which has boosted not only cotton production but also that of several other crops. Furthermore, Bt cotton has not contributed to helping most small cotton farmers escape the agrarian crisis that continues to threaten their livelihoods.

15 In the U.S., Bt cotton is nearly always "stacked" with herbicide tolerance.

1.1 ideal weather in India boosts cotton production

Indian crops are heavily dependent on the rain-bearing monsoon due to insufficient irrigation. The success or failure of crops is closely associated with the spatial and temporal distribution of rainfall during the south-west monsoon – June to September – since it brings about 80% of the total annual rainfall in India (RBI, November 2007).

Cotton is no exception, and its output heavily depends on the monsoon. Since 2005-06, the monsoon rains have been very favorable for cotton production, as seen in Table 11. For instance, the performance of the south-west monsoon during the 2005/06 and 2006/07 seasons was satisfactory, with the seasonal rainfall during June to September at 99 per cent of its Long Period Average (LPA). Late monsoon rains during September 2006 brightened production prospects, and rains during the second week of February 2007 further enhanced production (Ministry of Agriculture of India, Annual Report 2006/07).

TABLE 11 **SOUTH-WEST MONSOON RAINFALL AND KHARIFF PRODUCTION**

YEAR	IMD'S FORECAST (%OF LPA)	ACTUAL RAINFALL (%OF LPA)	KHARIF FOODGRAINS PRODUCTION (% CHANGE)
1997	92	102	-2.4
1998	99	106	0.5
1999	111	96	2.5
2000	99	92	-3.2
2001	98	92	9.8
2002*	101	81	-22.2
2003	96	102	34.1
2004	100	87	-11.7
2005	98	99	6.3
2006	92	99	0.6
2007	93	105	1.6

**: Drought year*
***Source**: IMD, Ministry of Agriculture, Government of India.*

1.2 continued production growth in most indian crops in 2007/08. is bt cotton or weather the reason for the India's increased cotton production?

Timely rain throughout the season has made this year's growing season "almost ideal with the continued arrival of timely showers across most of the Maharashtra cotton belt." The moderate rains, which occurred throughout most of the month of September, have raised considerable optimism about crop yields for 2007/08 (Globecot Special Report, 10 October 2007; Reuters, 5 July 2007). A November report of the Reserve Bank of India also affirms that the situation in sown area for many crops has notably improved during the 2007/08 season due to "the satisfactory monsoon and prevailing remunerative market prices". The cumulative rainfall during the South-West monsoon season in 2007 was 5 per cent above normal in comparison with the corresponding period of the previous year (RBIb, November 2007).

As can be seen below in Table 12, these ideal weather conditions favour not only cotton, but also the production of food grains like rice and pulses, and some non-grain food crops like sugarcane, which have enjoyed a growth in production similar to that of cotton in the past few years (RBIa, November 2007). Besides cotton, no other genetically modified crop is planted for commercial purposes in India.

Increased overall cotton production over the past two years has also expanded due to an increase in the area planted to cotton, which went from 8.9 million ha in 2006/07 to an estimated 9.3 million ha sown in 2007/08 (see Table 13).

ISAAA claims "that most of the increase in yield of up to 50% or more" in India is to be attributed to Bt cotton, and it is one of the main reasons why farmers are adopting it (ISAAA, 2006a). This claim is not only made suspicious by its extreme vagueness ("most of," "up to 50% or more"), it is directly contradicted by numerous reports attributing production gains in many crops, including Maharashtran cotton, to favorable weather. The weather factor has been underlined by official governmental institutions as a key reason for productivity increases. For example, the Indian Reserve Bank affirms that the main factor driving production increases over the last few years is favorable weather, including "almost ideal" weather conditions in the 2007/08 season. Such production gains have been achieved not only with cotton (whether GM or conventional), but with many other crops, none of which are genetically modified, such as rice, wheat and sugarcane (Table 12).

Secondly, such vague and unfounded claims have the pernicious effect of misleading the public to believe that Bt cotton increases yields per se, when in fact the genetic modification process used to create Bt cotton has absolutely nothing to do with enhancing yield, but rather protects cotton against the bollworm caterpillars. Furthermore, ISAAA's analysis fails to recognize that bollworms will not attack all cotton fields every year at the same scale, and when there are no attacks or minor attacks, there will be little or no yield impact whatsoever. One indepth study of Indian cotton farmers, which will be described in the next section, recognizes that "erratic insect outbreaks ... vary in location, severity, timing and response to pesticides." For example, data collected by the Warangal Agricultural Research Station show that outbreaks of American bollworms have in recent years moved from October to August; but with Bt cotton's loss of its insecticidal characteristics after 100 days in the long Indian growing season, "it seems likely that the outbreaks will eventually shift back to the later time" (Stone, 2007; Jayaraman, 2005).

TABLE 12 — AGRICULTURAL PRODUCTION IN INDIA

CROP	2003-04	2004-05	2005-06	2006-07	2007-08	
					T	A@
Rice	88.5	83.1	91.8	92.8	93.0	
Kharif	78.6	72.2	78.3	80.1	80.0	80.2
Rabi	9.9	10.9	13.5	12.7	13.0	
Wheat	72.2	68.6	69.4	74.9	75.5	
Coarse Cereals	37.6	33.5	34.1	34.3	37.5	
Kharif	32.2	26.4	26.7	25.7	28.7	26.6
Rabi	5.4	7.1	7.3	8.6	8.8	
Pulses	14.9	13.1	13.4	14.2	15.5	
Kharif	6.2	4.7	4.9	4.7	5.5	5.5
Rabi	8.7	8.4	8.5	9.5	10.0	
Total Foodgrains	213.2	198.4	208.6	216.1	221.5	
Kharif	117.0	103.3	109.9	110.5	114.2	112.2
Rabi	96.2	95.1	98.7	105.6	107.3	
Total Oilseeds	25.2	24.4	28.0	23.9	30.0	
Kharif	16.7	14.1	16.8	13.9	18.5	16.1
Rabi	8.5	10.2	11.2	9.9	11.5	
Sugarcane	233.9	237.1	281.2	345.3	310.0	345.6
Cotton #	13.7	16.4	18.5	22.7	22.0	22.9
Jute&Mesta ##	11.2	10.3	10.8	11.3	11.0	11.3

T: Target.
**: Fourth Advance Estimates as on July 19, 2007.*
#: Million bales of 170kgs each.
A: Achievement.
@: First Advance Estimate as on September 19, 2007.
##: Million bales of 180kgs each.

***Source**: Ministry of Agriculture, Government of India.*

TABLE 13 — AREA PLANTED TO MAJOR INDIAN CROPS: 2006/07 TO 2007/08 (MILLION HECTARES)

CROP	NORMAL AREA	AREA COVERAGE (as reported on October 19)			
		2007-08	2006-07	DIFFERENCE	% CHANGE
Rice	38.2	37.3	37.1	0.2	0.5
Coarse Cereals	22.9	22.0	22.1	-0.1	-0.3
of which:					
Jowar	4.4	3.6	3.8	-0.2	-5.7
Maize	6.2	7.5	6.8	0.6	8.9
Bajra	9.4	8.7	9.3	-0.6	-6.3
Total Pulses	10.9	12.5	11.4	1.2	10.3
Total Kharif Oilseeds	15.4	17.8	16.8	0.9	5.5
of which					
Sunflower	0.5	0.7	0.9	-0.1	-14.3
Sesamum	1.5	1.7	1.8	-0.1	-7.5
Groundnut	5.5	5.4	4.8	0.6	12.3
Soyabean	6.6	8.8	8.1	0.6	7.9
Sugarcane	4.2	5.1	4.8	0.3	5.6
Cotton	8.3	9.3	8.9	0.4	3.9
All Crops	**100.8**	**104.9**	**102.1**	**2.8**	**2.8**

***Source**: Ministry of Agriculture, Government of India.*

Thirdly, bollworms are not the only pest affecting Indian cotton fields, and Bt cotton does not protect against secondary pests. If there are attacks of other pests, like the mealy bug this year in the Punjab, yields will be lower and pesticide use will increase. Long-term and systematic studies need to be done at the national level to determine the precise contribution, if any, of Bt cotton with respect to yield, pesticide use, and insect resistance, in Indian Bt cotton. Such analyses should also examine whether any benefits yielded by Bt cotton are worth the several-fold increased price of Bt cotton seeds.

Finally, organizations like ISAAA, with a mission to promote GM crops, often provide faulty figures. For instance, the figures of Bt adoption quoted by the Indian Government and ISAAA do not correspond. According to government data , the area planted to Bt cotton has was almost 3.4 million ha in 2006/07, or 37% of the total cotton area (Ministry of Agriculture of India, 3-4 April 2007), while the Bt cotton area reported by ISAAA for the same year was 3.8 million ha, or 400,000 ha above the official government figure (ISAAA, 2006a).

1.3 are bt cotton "benefits" the reason for farmer's adoption?

Companies like Monsanto and organizations like ISAAA have claimed that farmers are adopting Bt cotton due to the recognition of its benefits (ISAAA, January 2007). However, various studies from the field show that such assertions are not correct.

A 2007 study by Professor Glenn Davis Stone at Washington University concludes that the rapid adoption of GM crops tells us little about their benefits. According to Stone, who undertook considerable fieldwork in Warangal and Hyderabad, Bt cotton adoption was consistent with a "strange and disquieting pattern of localized cotton fads." Farmers tend to switch very frequently from one seed type to another, seed choices that are apparently unrelated to actual yields. When vendors and farmers were asked about the reasons for these frequent shifts from seed to seed, a "frequent response to the question why a particular seed was chosen was that it was new in the market." Stone also points out that "none of the seed vendors interviewed were aware of any agroecological rationale, and the farmers too were consistently unable to justify the seed fads on the basis of seed traits". Stone describes Indian farmers' adoption of Bt cotton as a "stampede" or a "fad," which implies unreasoned or socially driven – rather than empirically based – decisions on which seeds to purchase and plant (Stone, 2007).

> We cannot exclude that Monsanto –through its local subsidiary Mahyco- knew the characteristics of this market and wisely exploited the characteristics of seed fads in Warangal District to create this rapid diffusion. Stone is right in rejecting the standard explanation for the diffusion of Bt cotton. This diffusion is not due to its obvious intrinsic superiority and to the wisdom of small farmers".
>
> **Pierre-Benoit Joly, INRA/TSV, Ivry, France commenting on Stone Report, 2007 (Stone, 2007)**

Stone recognizes that seed company advertising campaigns are a possible factor in adoption:

"Indian seed companies also are well aware of the social component of adoption and go to lengths to manipulate it even as their public rhetoric dismisses it. For instance, companies often donate seeds to selected farmers for demonstration plots... The company may then bus in farmers to inspect the field, inciting them with a spread of food. Demonstration plots may have real impacts on seed adoption."

> "the evidence on the economics of Bt cultivation in India is chaotic: studies contradict one another, many are self-interested, few are methodologically sound"
>
> **Ronald J.Herring, Department of Government, Cornell University, 2007 (Stone, 2007)**

1.4 is bt cotton improving the livelihoods of indian small farmers?

ISAAA claims that 2.3 million small holder farmers in India benefited from planting GM crops in 2006 (ISAAA, 2006a). ISAAA's report does not acknowledge any failures or problems related to the adoption of Bt cotton in India, even those documented by Indian government officials and published in leading scientific journals (e.g. Jayaraman, 2005). ISAAA's deeply biased treatment ignores not only scientific and agronomic deficiencies of GM cotton, but also fails to account for broader socioeconomic impacts, such as those related to the extremely high cost of Bt cotton seed and the continuing tragedy of debt-driven farmer suicides. For a balanced treatment of Bt cotton in the context of the agrarian crisis gripping India, and the many failures and problems affecting the majority of India's small farmers, see previous issues of the Who Benefits from GM Crops? series.[16]

The livelihoods of small farmers are deeply affected by many factors beyond production and yield. These include seed prices, the costs of other inputs, credit support, irrigation facilities, etc. Until these issues are properly addressed, life will remain very difficult for India's small cotton farmers, with or without Bt cotton.

1.4.1 the failures of bt cotton in southern punjab: increase in pesticide use

Bt cotton seeds have been advertised in Punjab, as in many other parts in India, as the perfect solution for farmers, with higher yields, rising net incomes, and savings on agrochemicals. However, in 2007 farmers in the Indian State of Punjab did not realize any of these advertised benefits, and Bt cotton in fact led to directly opposite results.

The Malha district in the cotton growing belt of southern Punjab was acclaimed as a success story for Bt cotton due to bumper yields and returns since 2005. However, in 2007 the mealy bug devastated Malha's cotton fields. Bt cotton protects the crop against one pest, but of course cotton is attacked by over 150 pests, so if a resurgence of secondary pests occurs it is

16 See FoEI, 2006, Chapter 4; See FoEI, 2007,Chapter Four.

highly probable that farmers will end up spraying the same quantity of pesticide or more on their crop (Goswami, 6 September 2007).

It is a tragedy that two years back the Punjab Government had published similar advertisements having photo of then Chief Minister Capt Amarinder Singh, describing the introduction of Bt cotton as great achievement. At that time government advertisement has made tall claims about advantages of Bt cotton, stating increase in yield by 25% to 28% per hectare, net increase in income by Rs 10,000/- to 15,000 per hectare; and savings on agro-chemicals up to Rs 1000/- per hectare. But, this season, which is the third year of Bt cotton introduction in Punjab, the things goes just opposite way.

Umendra Dutt, Executive Director of Kheti Virasat Mission, Punjab, (Dutt, 2007)

The attack of the mealy bug has forced farmers to purchase and apply more pesticides than expected initially. It is estimated that the cost of additional pesticides applied to control mealy bugs is $120 million. This extra expenditure represents a disaster for farmers in those affected districts, who will suffer losses this year. (The Economic Times, 2 September 2007; Countercurrents, 31 August 2007; Dutt, Umendra, 22 August 2007; Tribune News Service, 2 July 2007; The Indian Express, August 31).

New data from Andhra Pradesh on pesticide use on Bt cotton during the 2004-05 season published in 2007 by the Agro-Economic Research Centre (AERC) of Andhra University concluded that although the average number of pesticide applications was reduced, this was accompanied by an increased quantity of pesticides used for each application. Thus, "as a result the total quantum sprayed per hectare has not fallen much and the farmers continue to spend the maximum on pesticides than on any other input" (Commodity online, 30 August 2007). This is another confirmation that pesticide use is not being reduced; on the contrary, the rise of secondary pest attacks and resistance is driving increased use of pesticides.

Global crop protection chemicals major, Dupont, has admitted that there is currently "no perfect solution" to deal with the new bugs attacking Bt cotton crops across the country: "it is true that new technologies give rise to a new set of problems, including pest shifts."

Ram Mudholkar, Dupont's South Asia business manager, The Economic Times, 2007.

1.4.2 the rise of suicides in the farm fields of vidarbha continues

Over the past years, small/scale Indian farmers have faced hard times due to rising input prices combined with falling output. In 2007, cotton farmer suicides continued to rise in some of the main cotton growing areas of India. The states of Andhra Pradesh and Maharashtra have experienced the highest number of cotton farmer suicides. Vidarbha, a region in the eastern part of the State of Maharashtra, also called India's cotton belt, has become widely known again this year for the large number of suicides that have occurred.

Today the farmers usually get less than 2,000 rupees [below the cost of production] and it is impossible to make even 10,000 rupees a year from a 8-hectare plot. That is just $200 for your entire family to live on.'

Swift, April 2007

The reasons for cotton farmers' livelihood struggle. Can Bt cotton address any of these problems?

1. Input costs such as seeds, fertilizers and pesticides have risen substantially while world cotton prices have steadily declined. In 1994, a pound of raw cotton fetched $1.10. In 2006, the same pound fetched 54 cents. Today, most Indian cotton farmers cannot make ends meet.

2. Farmers in Maharashtra, specifically, have also had to cope with the removal of a government safety net that guaranteed them fixed cotton prices. Starting in the 1970s, the state of Maharashtra purchased all cotton production at a price independent of world market prices. This program was called the Monopoly Cotton Procurement scheme. This program guaranteed cotton farmers a fixed price for their entire crop. Mismanagement and financial losses led the state to open up cotton trade to private traders in 2003 and to discontinue the monopoly scheme. The state still purchases some raw cotton from farmers, but the average prices it offers are below the average cost of production.

3. Government support has declined. The extension centers run by the local government have not been able to provide farmers with adequate information and training regarding the new varieties of cotton. To choose seeds, many farmers rely on often highly biased information provided by private seed companies.

4. Access to formal credit has become more difficult. The Indian rural credit system has faced a financial crunch that has led state banks to tighten their lending requirements. Many farmers have to resort to informal sources of credit. Farmers borrow funds from moneylenders, friends and relatives. Moneylenders tend to charge usurious rates and have draconian collection tactics that can lead farmers to despair.

5. The many farmers who lack irrigation have to rely on the monsoon to water their fields.

6. Years of heavy chemical fertilizer use have exhausted the soil. Most cotton farmers do not rotate crops or leave enough fallow time for the soil to naturally replenish. Instead, farmers hope additional fertilizer will improve the quality of their soil.

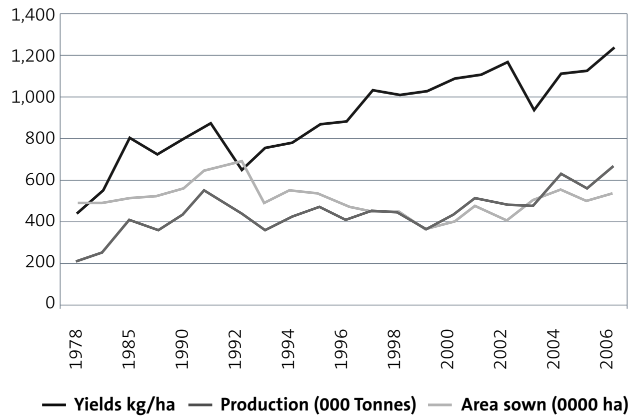
Source: *Wide Angle. 2007.*

TABLE 14 **FARMER SUICIDES IN VIDARBHA 2007**

MONTHS IN 2007	FARMER SUICIDES
January	99
February	107
March	113
April	97
May	102
June	82
July	75
August	95
September	106
October	67
Total	942

Source: *Vidarbha Janandolan Samiti, 24 October 2007.*

FIGURE 7 **COTTON AREA, PRODUCTION AND YIELDS IN CHINA 1978-2006**



Source: *Friends of the Earth International, 2007. From 1978 to 2005 data is based on the National Bureau of Statistics of China, Agriculture, Output of Major Farm products; Output of Major farm products per Hectare; and Total area sown. Data from 2006 is based on Globecot, and USDA..*

By the end of October 2007, it has been estimated that there have been over 900 cotton farmer suicides, or an average of three suicides a day (ENS, 3 October 2007; Wide Angle, 2007; Petition to Indian Prime Minister, October 2007; Swift, April 2007). Despite the increase in adoption of Bt cotton, this trend has not diminished, and farmers´ livelihoods are under dire threat. In addition, many reports of poor performances of Bt cotton have been registered in the area (The Hindu, 16 February 2007).

2 china

2.1 is bt cotton the reason for overall yield increase in china?

ISAAA claims that Bt cotton is the key reason for the increase in overall Chinese cotton yields of 8% to 10% (ISAAA, 2006b). While yields have increased during the period that Bt cotton was introduced (see figure 7), that increase is not necessarily explained by the adoption of Bt cotton.

First of all, it is important to underline again that Bt crops have not been modified for increased yield, and their effectiveness each year will vary depending on the degree and type of pest infestation, area of planting, weather conditions, and other factors. Bt cotton is not useful if the particular pest targeted by the Bt insecticide is not affecting a crop in a certain area. Secondly, it is illegitimate to attribute yield increases to a certain factor without careful consideration of the full range of yield-impacting factors that obtain in any given area or production system. For example, Xinjiang province in the Northwest of China, which has the largest cotton acreage in the country, accounting for more than one-third of China's cotton production (see figure 8), was reported as not planting Bt cotton in early 2000 because it is not affected by the pests targeted by Bt cotton (Tachikawa, 2002).

The USDA acknowledged in 2007 that most of the cotton area in the region was planted with conventional cotton, since "Bt varieties are reportedly not planted" due to few outbreaks of diseases/pests. Despite the fact that most cotton planted in Xinjiang is conventional, the province obtains the highest yields in China, well above the average of the other top cotton-producing provinces (see figures 9 and 10). Xinjiang's high cotton yields are attributed to the planting of conventional varieties with specific traits, such as dwarf plant size and early maturity, as well as to new agronomic practices, including "high density sowing, plastic sheet covering and drip irrigation" (USDA, 1 May 2007). The

FIGURE 8 **CHINA COTTON PRODUCTION MAP**

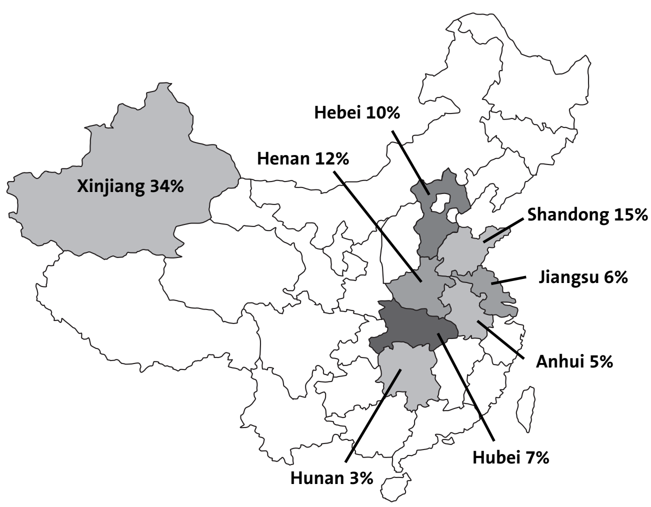
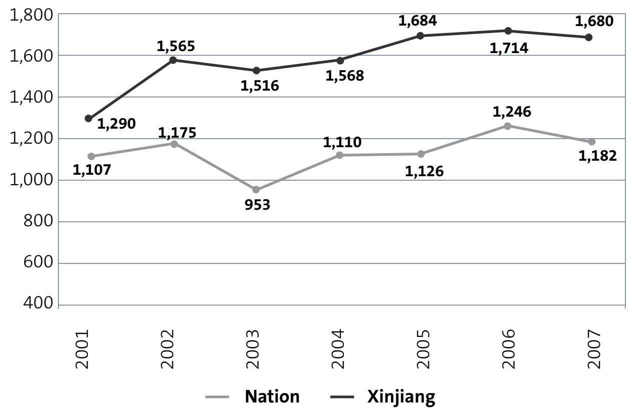


FIGURE 9

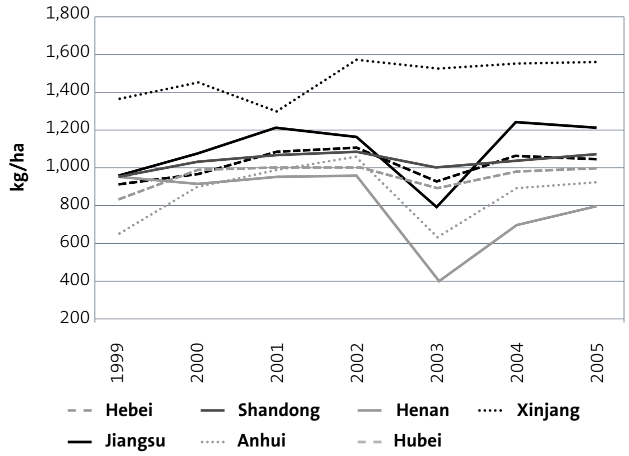
CHINA´S NATIONAL AND XINJIANG´S AVERAGED YIELDS FROM 2001 TO 2007 (KG/HA)



Source: *USDA, 2007.*
Notes: *2007 yield is a Post forecast.*

FIGURE 10

CHINA COTTON YIELD PROVINCE 2005 FORECAST



Source: *USDA/FAS/PECAD - May 2005*

example of Xinjiang is instructive, as it shows some of the many different approaches that can be pursued to increase cotton yields, approaches that are in danger of being neglected in the fad-driven adoption of the latest technology, such as Bt cotton.

In 2006, Xinjiang achieved record cotton yields, exceeding the average of the other main cotton producing provinces in China. However in 2007, though yield levels still were above China's national average, they were not as high as in 2006 (see figure 9). According to a survey by Xinjiang´s Academy of Agriculture Sciences in 2007, the main cause was linked to the reduction of irrigation supplies (Globecot, 28 September 2007). No factor related to GM crop technology seems to have influenced yield performance in Xinjiang, the Chinese province with the largest cotton area and the highest cotton yields in the country.

Reasons for the decrease in yields in Xinjiang province in 2007

The academy survey found several factors behind the reduction in cotton yields. First, it appears that the reduced irrigation supplies had a larger impact than earlier expected. In those fields using drip irrigation, an average of only 8 to 10 applications occurred this season, which is below the normal average of 10 to 12. The yield reduction on the larger farms was linked to their receipt of only 50 percent of the water they needed. Power shortages also contributed to problems for the users of drip irrigation. This year's lower water supplies were exacerbated by this year's expansion in cotton acreage. Another problem that emerged in the survey was that the southern cotton belt experienced excessive winds throughout the season. In the Bazhou area, cotton fields lost leaves, buds and bolls from the high winds that have reduced yields. In the northern cotton belt, prolonged periods of low temperatures early in the season appeared to have triggered a wilt problem that impacted yields. Finally, the survey revealed that there were issues with boll weevils and spider mites in some cotton fields.

Source: Globecot, 2007.

2.2 is bt cotton more profitable for small farmers than conventional cotton?

A key question that still remains to be answered is whether Bt cotton is providing economic benefits to small farmers in comparison with conventional cotton. ISAAA continues to assert that Bt cotton is improving the livelihoods of millions of small cotton farmers in China, due to higher yields and reduced pesticide use. However several studies have contradicted those claims.

An important 2006 study found that, due to attacks of secondary pests not killed by the Bt cotton insecticide, Bt cotton farmers in some areas of the country were earning less than conventional cotton farmers (FoEI, 2007). Further research covering a wide array of environmental, agronomic and socio-economic factors over time is required to determine whether Bt cotton provides sustainable benefits versus conventional varieties to small cotton farmers in China and other countries.

3. south africa

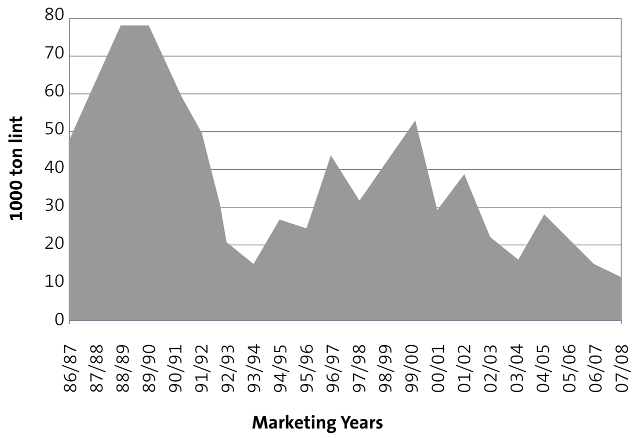
3.1 gm cotton no solution to small farmers in africa

The 2006/07 season marked the worst cotton crop in the history of South Africa for the last 30 years, with production area down 24% from the previous season (see Figure 11). For the coming 2007/08 season, the forecast is a further decrease from 18,114 ha to 11,363 ha (see table 15). The main reasons for this, according to Cotton South Africa (Cotton South Africa, 2 November 2007), are:

1. "low international cotton prices in recent years partly due to subsidies provided by the governments of many cotton producing countries;
2. the Rand which remains relatively strong against the US Dollar;
3. more favorable prices for other competing crops
4. the fact that local cotton farmers effectively have no tariff protection as 99% of all imports are from Southern Africa Development Community (SADC) in terms of the free trade agreement which has a zero tariff for cotton".

2007 has confirmed again without doubt that Bt cotton is no solution for small farmers in Africa. The socio-economic conditions surrounding cotton production are not favourable and Bt cotton offers no solutions to tackle this. The small farmer experiences with cotton in the Makhatini Flats (Kwazulu Natal) was portrayed internationally as the success story that proved the benefits of Bt cotton for small farmers in Africa. However, since the adoption of Bt cotton the number of small cotton farmers has trended downward from 3229 in 2001/02 to a low of 353 the next year. In 2006/07, only 853 small farmers planted cotton in Kwazulu Natal (see table 15).

FIGURE 11 **SOUTH AFRICA COTTON PRODUCTION**

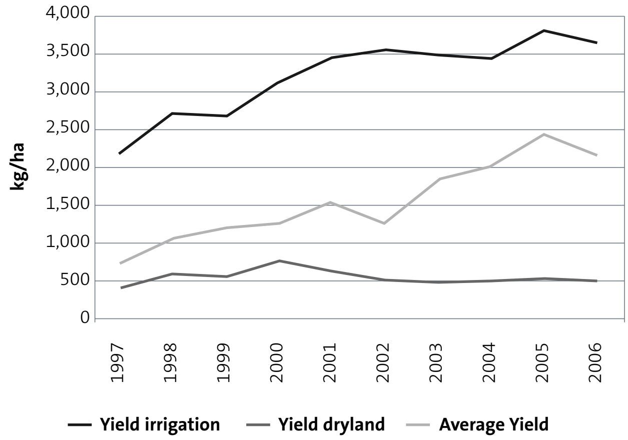


Source: *Cotton South Africa, October 2007*

3.2 mixed results with bt cotton yields

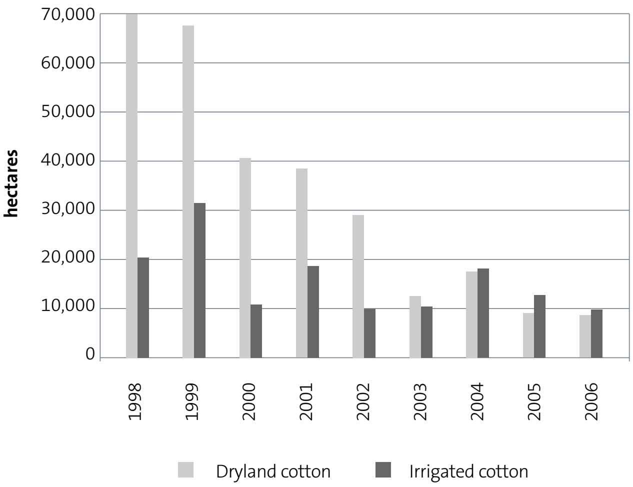
ISAAA claims that increased yields is a net benefit derived from the adoption of Bt cotton in South Africa, with "annual average increase of yields of about 24%" (ISAAA, 2006b). These claims are directly contradicted by data from Cotton South Africa, which show constant yield levels before and after adoption of Bt cotton (Witt et al 2005, cited in FoEI Who Benefits 2007). A close examination reveals that a substantially increased proportion of cotton land under irrigation has been the primary factor behind increased average cotton yields in South Africa. This increased proportion of irrigated cotton land has come primarily from a steep plunge in

FIGURE 12 **YIELDS OF IRRIGATED AND DRYLAND COTTON IN SOUTH AFRICA 1997-2005**



Source: *Friends of the Earth International, 2007*
Based on data from Cotton South Africa.

FIGURE 13 **COTTON AREA PLANTED IN SOUTH AFRICA WITH IRRIGATED AND DRYLAND COTTON 1998-2006**



Source: *Friends of the Earth International, 2007*
Based on data from Cotton South Africa.

TABLE 15 **AREA PLANTED WITH COTTON AND NUMBER OF COTTON SMALL FARMERS, SOUTH AFRICA 2000-2007**

COTTON IN SOUTH AFRICA	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08 ESTIMATED
Area planted in ha	50,768	56,692	38,688	22,574	35,719	21,763	18,114	11,363
South Africa small cotton farmers	3,312	3,688	465	1935	1,737	2,849	2,305	N/A
KwaZulu-Natal small cotton farmers	3,000	3,229	353	1594	598	2,260	853	N/A

***Source**: Cotton South Africa.*

TABLE 16	AREA PLANTED WITH IRRIGATION AND DRYLAND COTTON IN SOUTH AFRICA 1997-2006 (HA)									
	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Hectares irrigation	15,954	20,361	31,263	10,486	18,539	9,791	10,322	18,269	12,897	9,720
Hectares dryland	67,017	69,578	67,356	40,282	38,153	28,897	12,252	17,450	8,866	8,394

***Source**: Cotton South Africa.*

dryland cotton area, accompanied by a sharp decline in the number of small dryland cotton farmers. Seen properly in this context, Bt cotton has done little or nothing to help small South African dryland cotton farmers, many of whom have stopped growing cotton altogether, as discussed above. At best, Bt cotton has provided some marginal benefits to a handful of large cotton growers. However, even the higher yields of these growers are primarily attributable to irrigation.

It is important to note that irrigated cotton in general always provides much higher yields than dryland cotton, with yield multiples ranging from two to fully six times the yields achieved in dryland cotton (see Figure 12). Thus, calculation of average yields without distinguishing between irrigated and dryland cotton masks important disparities that fall along the same line that divides richer from poorer farmers.

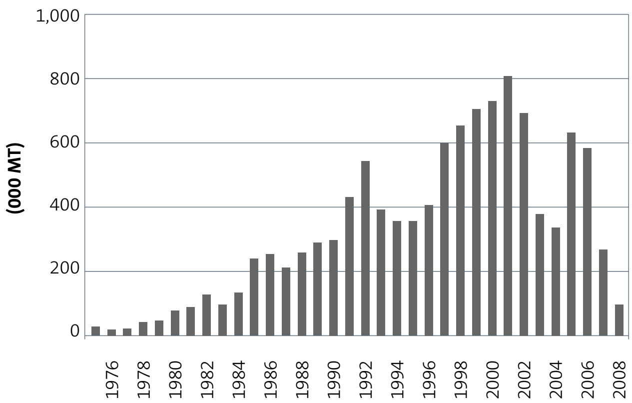
In the case of South Africa, the area under dryland cotton has greatly diminished over the past 10 years, from 67017 ha in 1997 to just 8394 ha in 2006 (Cotton South Africa), while the area under irrigation has declined at a much slower rate (see Table 16 and Figure 13).

Back in 2001, a three-year study in South Africa found no significant yield difference between Bt and conventional seed cotton when grown under dryland conditions, while Bt seed cotton yields were somewhat higher under irrigated conditions (Joubert et al. 2001). There seems to be significant consensus that large-scale irrigation farmers are the ones that capture the benefits from Bt cotton (Gouse et al. 2004), not the small-holder farmer, who normally will be farming under dryland conditions. The reduction of the number of small cotton farmers in South Africa described in the previous section confirms such indications.

4. australia: cotton at the lowest production level in 25 years

After the lowest cotton plantings on record in 2006/07 (147,000 ha), projections for the 2007/08 season predict another severe curtailment of the production area by 56% to 63000 ha. As in the previous year, continued dry conditions and low water reserves are to blame for this (Abare, September quarter 2007). Bt cotton, which was introduced in 1996, has not offered a boost to the cotton sector in Australia, and since its adoption has not provided improvements in either yield, or quality (ISAAA, 2006b).

FIGURE 14 AUSTRALIAN COTTON PRODUCTION



***Source:** Abare*

TABLE 17	AREA OF COTTON IN AUSTRALIA 1997-2007										
COTTON IN AUSTRALIA	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2005-07	2007-08 ESTIMATED
Area (000 ha)	438	562	464	527	409	224	198	321	336	144	**63**

***Source**: Abare*

4. Pakistan: Bt cotton fails while pesticide use increases

Cotton is a key crop for the Pakistani economy (ICAC, November 2007). For the first time in 2007, the Ministry of Food, Agriculture and Livestock in Pakistan authorized Bt cotton for the 2007/08 season. It is estimated that 40% of the 2007/08 crop is Bt cotton. The large adoption of Bt cotton varieties in 2007 coincides with an estimated 10% decrease in cotton production at 2.04 million MT, due to poor germination, water shortage, high temperatures and pest attacks (USDA, 7 November 2007).

Bt cotton protects only against bollworms, and this year two other pests, the mealy bug and the Cotton leaf curl virus, have ravaged cotton fields in Pakistan. Pakistani growers have stated that the 25% shortfall of cotton yield this season was mainly due to those two pests (Daily Times, September 19). Due to those attacks, it is predicted that Pakistan will not meet its cotton production targets for this season (Thrakika Ekkokistria, 13 November, 2007).

In addition, as in India, the pest attacks have boosted the demand for pesticides and increased the prices of inputs. The large demand for pesticides to tackle the mealy bug has nearly doubled the prices of agrochemicals to control this pest (Daily Times, 27 August 2007). The mealy bug is not new to Pakistan this year. Reports confirm that it has been a serious threat to the cotton crop since 2005, when it infested about 3,000 acres of cotton in Sindh province; in 2006, it was recorded at epidemic scale in Punjab and Sindh, while in Balochistan it also damaged the horticultural crops, and destroyed the cotton crop completely (Pakistan Textile journal, November 2007).

"..the private companies were asked to import additional quantities of pesticides for the control of mealy bug within one week's time. .... 107 tonnes of pesticide was available with private companies and they were asked to import an additional 1400 tonnes of pesticides within one week".

Daily Times, 23 August 2007

What is the impact of mealy bug?

It feeds on the sap of the plant and releases toxic substances causing injury, curling and drying of leaves which damages fruiting and drastically decreases the yield. Mealy bug also attacks the roots just below the level of the soil, especially where the root and the stem meet. Root mealy bugs lay their eggs in sacs of interwoven filaments that resemble cotton wool. Mealy bugs also excrete large quantities of honeydew onto the plant that in turn attracts ants and sooty mould. Keep ants under control as they may distribute the pests to other plants. It is also spread by wind, or it can be stuck on clothing or on the hair of animals. Mealy bug can spread rapidly once introduced in an area

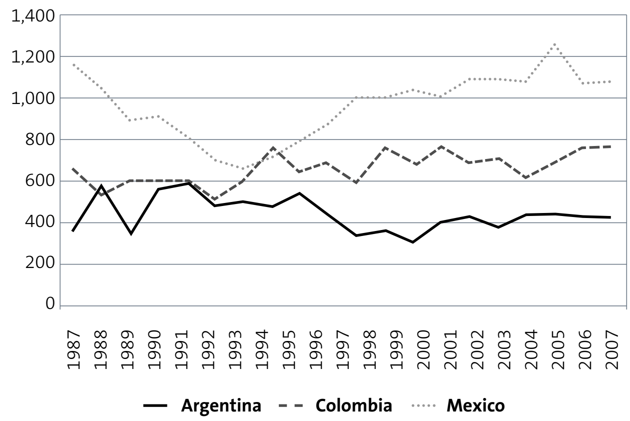
Ali Khaskheli, 2007.

5. latin america cotton: more research needed on yield impact of bt cotton

Genetically modified cotton has been grown for commercial purposes in Latin America in Argentina, Colombia and Mexico for a number of years. It is estimated that around 70% of the cotton in Argentina is genetically modified (ICAC, October 2007b), and commercialization was authorized in the 1995/96 season. In Colombia, genetically modified cotton now comprises around 42% of all cotton, and was authorized for the first time in 2002 (CONALGODON, October 2007). In Mexico, GM cotton was first approved in 1996.

ISAAA claims that yields are a main benefit from adoption of Bt cotton in the three Latin American countries, with estimated yield gains of 35% for Argentina; 11.5% for Colombia, and 14% for Mexico. However, these purported yield increases are not reflected in the overall cotton yield figures for any of these countries, particularly Argentina and Colombia.

FIGURE 15 **YIELDS OF COTTON IN ARGENTINA, COLOMBIA, AND MEXICO 1987-2006**



Source: *Friends of the Earth International, 2007. Based on data from FAOSTAT, ProdStat, Crops, Subject: Yields, Commodity: cotton lint; Country: Argentina, Colombia, Mexico; Year 1986-2006, (last accessed 2 December 2007).*

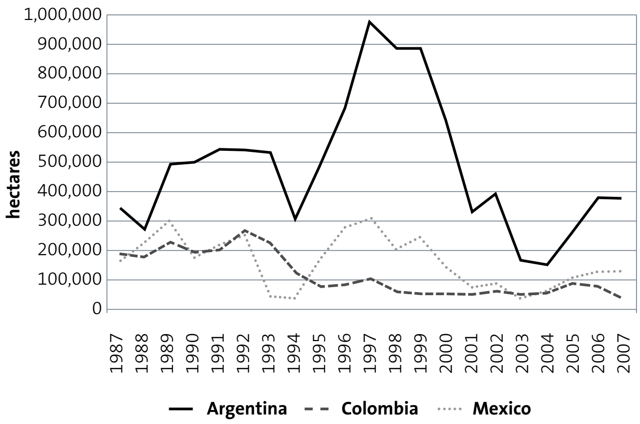
As shown in Figure 15, overall cotton yields have stagnated in both countries since the introduction of Bt cotton. This evidence of stagnating yield is particularly telling for Argentina, which has grown GM cotton for a decade, and has an adoption rate now estimated at 70%. Even a slight yield advantage from GM cotton should have increased overall cotton yields by now, which as demonstrated in Figure 15, has not occurred. On the contrary, average cotton yields in Argentina were higher from 1987-1996, in the decade before adoption of Bt cotton, than they have been since that period. If anything, this suggests a negative impact on yield from Bt cotton. Colombia also shows stagnating cotton yields since the introduction of Bt cotton, though here the shorter period of time (4 years) and lower adoption rate precludes any conclusions as to the impact of Bt cotton on yield.

Only Mexico shows a marginal trend of yield increase since Bt cotton was introduced, though the causes remain unclear. In addition, it should be observed that comparably high yields were achieved in 1987 and 1988 in Mexico.

In general, to legitimately attribute yield increases to Bt cotton would require systematic and independent studies comparing the performance of Bt and conventional cotton, taking into account the numerous variables affecting yields, including quality of cotton seed, weather factors, pest infestation, etc. As we have seen, ISAAA has shown no scruples about falsely attributing yield gains to Bt cotton in other regions of the world, when in fact other factors, most importantly weather and irrigation, have been responsible. Here too, we see no convincing documentation for ISAAA's claims regarding yield benefits from Bt cotton.

One thing is clear. The cotton sectors of all three countries are suffering, as evidenced by declining acreage planted to cotton, and accompanying drops in cotton production, over the past decade. The UN's FAO reports that overall area planted to cotton has declined by more than half in Argentina, Colombia and Mexico since 1996 (see Figure 16). As in other areas of the world, low international cotton prices and other structural problems are chiefly responsible for the decline in cotton-growing, none of which factors are altered by adoption of Bt cotton.

FIGURE 16 **AREA HARVESTED WITH COTTON IN ARGENTINA, COLOMBIA, MEXICO 1989-2006**



Source: *Friends of the Earth International, 2007. Based on data from FAOSTAT, ProdStat, Crops, Subject: Area harvested, Commodity: cotton lint; Country: Argentina, Colombia, Mexico; Year 1986-2006, (last accessed 15 December 2007); Data from Colombia in 2006 is based on CONALGODON, 2007.*

europe: a closed door to gm crops

By Helen Holder, Friends of the Earth Europe, and Clare Oxborrow, Friends of the Earth England, Wales and Northern Ireland

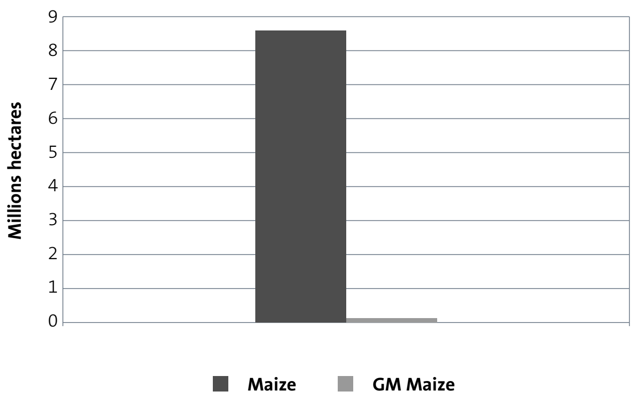
1. introduction

In Europe, the public has consistently opposed GM food for more than 10 years (Eurobarometer, 2005), and there is a large political movement opposing its cultivation. Although there have been marginal increases in the area of transgenic crops grown in Europe, the long-term prospects for GM seeds look bleak. The continuation of national bans in 2007, the lack of markets, poor economic performance and new evidence of environmental damage is sending a strong signal that one of the world's biggest markets will remain a disaster zone for the biotech industry.

After 10 years of commercialisation of GM crops, only one crop, Monsanto's Bt maize MON810 is planted for commercial purposes on around 100,000 ha in the European Union (EU). Although the industry has boasted a 77% increase in the area of cultivation in 2007 (Europabio, 2007) this still represents less than 2% of the total maize crop area in the EU which is over 8 million ha (Europabio, 2007; FAOSTAT; Agroinformación, 31 October 2007).

No new GM crops have been approved for cultivation in the EU since 1998. Although a few new import applications have been authorised, EU member states have yet again failed to approve a single one. Therefore all decisions have reverted, as per EU decision making rules, to the unelected administrative body of the EU, the European Commission, which has chosen to approve them. This is not exactly a democratic seal of approval for GMOs.

FIGURE 17 GM MAIZE AREA PLANTED VERSUS TOTAL MAIZE AREA HARVESTED IN THE EUROPEAN UNION



Source: *Friends of the Earth International, 2007. The table compares total maize area harvested in the European Union based on data from FAOSTAT to the total area planted in the European Union based on Agroinformación, and Europabio. FAOSTAT data is based on ProdSTAT, Crops, Subject: Area harvested, Commodity: Maize; year: 2006; Country: European Union 27+ (last accessed 15 December 2007)*

Only two countries in the EU - Spain and France - grow a significant amount of GM maize. It is estimated that Spain planted around 70,000 ha, followed by France with around 20,000 ha. In France, it is only in 2007 that this quantity of GM maize was planted; previous years had seen only tiny amounts grown. Even this minimal progress for the industry in France appears to be short lived. At the end of 2007 the French Government, using EU legislation, announced a suspension of all commercial growing of the only GM crop in cultivation after a meeting on Environmental issues in "Le Grenelle". The French President, Nicolas Sarkozy stated that "in compliance with the precautionary principle" he was calling for "the commercial production of pest-resistant GMOs to be suspended pending the conclusions of an investigation to be carried by a new body to be created before the end of the year..." (Le Grenelle Environment, 25th October 2007)

> "The truth is that we have doubts about the current benefits of pest-resistant GMOs; the truth is that we have doubts about the controlled dissemination of GMOs; the truth is that we have doubts about the health and environmental benefits of GMOs"
>
> **French President, 25th October 2007**

The same week, for the first time in history, the European Commissioner for the Environment, Stavros Dimas made a proposal to not allow the cultivation of two GM maize varieties in the EU. The crops, Pioneer/Dow's line 1507, and Syngenta's Bt11, are already approved for import into the EU. The proposal was made on the basis of new scientific evidence that shows potential damage to the environment and biodiversity from Bt maize. (European Commission a, b, 2007).

This proposal is still under consideration within the European Commission and is likely to be strongly opposed by the pro-GM and pro-industry Trade and Agriculture departments. However this issue has raised significant scientific controversy because the European Food Safety Authority (EFSA) had given both crops a positive opinion. In just over one month, 100,000 citizens had written to the European Commission in support of Commissioner Dimas' proposal. These environmental concerns over Bt crops also raise new questions about whether Monsanto's GM maize, also a Bt crop, should be grown in Europe. This is likely to become an important issue as Monsanto attempts to gain re-approval for MON810 in 2008.

In a new report on the biotech industry lobby's influence at the European Commission, Friends of the Earth highlighted just how many parts of the EU executive body are pushing for GM food and crops in Europe, often without any solid evidence that this is the right direction to take in order to fulfil EU policy requirements on sustainable development and competitiveness (FoEE, October 2007).

2. gm food and crops in europe: not competitive and few jobs

2007 saw the European Commission carry out a mid-term review of the EU Biotechnology Strategy which was adopted in 2002 for a period of 8 years. Heavily biased towards industry interests, the review ignored the reality that GMOs have failed to deliver on the EU's own goals for competitiveness, despite high levels of funding and political support. By merging analysis of GM crops and foods with "biotechnology" more widely, the review masked the sectors' poor performance. Whilst the biotechnology industry's response to the poor economic performance of GM food and crops is to request even more public funding support, a new analysis by Friends of the Earth Europe showed that environmentally-friendly farming, like organic, will in fact create more jobs, help reinvigorate rural communities and make the EU more competitive than if it grows GM crops. GM food and crops on the other hand have led to virtually no jobs, de-investment and lack of profits for the companies developing them (FoEE, March 2007).

Meanwhile, despite the European Commission's repeated attempts to force countries to lift their national bans on particular GMOs, all these bans remain in place. Member States failed to support the lifting of bans in Austria at the end of 2006 and in Hungary at the beginning of 2007. Bans in Poland and Greece also remain in place whilst France, as mentioned above has imposed a freeze and the Bulgarian Parliament has indicated its wish for a national ban on the same genetically modified maize. More than 200 regions across the EU have declared their wish to be GMO free, and a network of 43 Regions has been established to advocate for the right to have GMO free farming, having most recently organised a major conference on GMfree sourcing for animal feed (soy).

Final outcome of the WTO dispute on GMOs

At the International level, the World Trade Organisation (WTO) panel issued its final ruling on the GMO dispute, that the US, Canada and Argentina – under pressure from the biotech industry - had brought against the EU. There were no clear winners or losers in the case, despite the US Government announcing that it had won.

The WTO Panel in charge of deciding the case concluded that there had been "undue delay" for both national bans and the moratorium (a delay that cannot be justified). It found that that according to its narrow interpretation of the WTO's Sanitary and Pytosanitary (SPS) Agreement, and of what constitutes a risk assessment, the specific bans concerned by the dispute could not be justified.

However, significantly, the WTO panel did question the EU's regulatory and precautionary policy, nor the right of countries to introduce strict regulatory frameworks at the national level. The moratorium on new GMO authorisations in place at the time was found not to be illegal per se. Furthermore, the WTO panel of experts did not question the right of EU member states to ban individual GMOs. This has important implications for countries in all regions of the world that want to have strict biosafety laws for health and environmental reasons.

Despite the clear failure of GM crops in Europe, Monsanto and the other GM crop corporations continue to turn a blind eye to this reality. At its 2007 shareholders meeting, and against all the evidence to date, Monsanto attempted to persuade its investors that the GM crop sector in Europe would represent an area of over 15 million hectares in years to come (Monsanto, 26 September 2007).

3. creating new myths: eu gmo policies and animal feed

2007 has also seen a new PR push by the industry to convince European public to embrace GM crops because they were needed to supply Europe with animal feed.

The biotech industry is using scare tactics (with the full support of the European Commission Directorate Generals for Agriculture and Trade) claiming that if the EU doesn't drop its "zero tolerance" policy on contamination by GMOs not authorized in the EU, and if it doesn't approve GM maize and soy imports more quickly, we will run out of animal feed. The biotech industry has even been threatening that EU farmers would be forced into the wholescale slaughter of [livestock] due to a shortage of animal feed (Mitchell P, 2007).

At a biotech lobby event in Brussels in summer 2007, the European Commissioner for Trade, Peter Mandelson, supported the industry line, warning that "unless we can close the gap between GMO approvals in the EU and in feed-exporting countries such as US, Argentina and Brazil we may have hungry cows and struggling farmers" (Mandelson, 2007).

However, the threat of animal feed shortages is highly exaggerated and rising feed prices are not caused by the EU's strict GMO standards. The European Commission's own analysis shows that the EU could source sufficient maize from within Europe and from other countries (European Commission DG Agriculture, 2007).

Furthermore, evidence clearly points to other factors influencing price increases and availability of crops. Rising feed costs are being blamed for serious problems facing producers in Canada (The Amhurst Daily News, 2007), Australia (Infarmation, 2007), the US and China (China Daily, 2007) and is therefore not a EU-specific problem. Rising feed prices in the pig industry are actually due to the recent price hikes in the cost of wheat and barley (Bounds, 27 November 2007), and shortages of feed wheat. In its most recent analysis, the UN's Food and Agriculture Organisation stated that current high cereal prices are related to recent poor harvests in several food exporting regions (FAO, November 2007). These factors have nothing to do with the adventitious presence of GM material.

Prior to the US governments mandates targets on ethanol production, the price of maize was tied to the price of food, but it is now strongly linked to the price of crude oil (Virginia Tech, 2007), and as oil prices rise, so have maize prices. However, in comparison to wheat, prices for maize in the EU have not risen to the same extent (UK DEFRA, 2007). This suggests that adventitious presence of unapproved GM materials in certain maize producing countries is not driving up the cost of this commodity more generally. In the case of soybeans, the FAO concludes that the recent high prices are due to increased demand worldwide for animal feed and the rising demand for the production of biodiesel (FAO, November 2007). Again, this is unrelated to the adventitious presence of GM material in animal feed supplies. In fact, the policies most responsible for the current problems facing the feed industry are the US government's promotion of ethanol and the EU's biofuels targets, which has led to significant promotion of biodiesel production (See FoEE, December 2007).

4. the push for agrofuels in the european union

2007 has also seen a new PR push by the industry to convince European public to embrace GM crops because they were needed to supply Europe with animal feed.

The rush for agrofuels (also known as biofuels) is also providing new hope to the biotechnology industry. The industry, led by lobby group Europabio and supported by the European Commission, is using the climate crisis to promote its GM crops as a source of agrofuels. But there is no advantage to using GM crops as a feedstock to make agrofuels, and despite the vast resources being invested in second generation GM technology, it remains to be seen whether these processes can produce fuel in an energy efficient and environmentally sustainable way.

The EU has now proposed a 10% biofuels target which is facing growing opposition due to mounting evidence of negative impacts of biofuels on biodiversity and on local communities around the world. A report from the OECD found that the environmental impact of agrofuels can be even worse than that of petrol and diesel and that large scale expansion of agrofuels will lead to increased food prices.

"Biofuels and industrial biotechnology constitutes a key strategic sector for the biotech industry. Their alleged role in combating climate change is being exploited to resurrect the reputation and expanding the planting of GM crops globally" (Maynard & Thomas, 2007).

conclusions

The 2008 edition of the "Who Benefits from GM crops?" series has analyzed a substantial amount of documentation from scientific technical bodies, industry, academia, governments, and civil society from around the globe, and concludes that after more than a decade of worldwide commercialization of GM crops and increased penetration of GM crops in a few countries has failed to deliver the benefits that is proponents claim.

1. four crops, two traits and a handful of countries

Genetically modified (GM) crops continue to be the province of a handful of nations with highly-industrialized, export-oriented agricultural sectors. Over 90% of the area planted to GM crops is found in just 5 countries located in North & South America: the US, Canada, Argentina, Brazil and Paraguay. One country alone, the United States, produces over 50% of the world's GM crops; the U.S. and Argentina together grow over 70% of all GM crops.

As in past years, genetically modified soya, maize and cotton comprise over 95% of world GM crop acreage (virtually all the rest is GM canola). Soya and maize are used mainly as animal feed in wealthy countries.

Significantly, biotechnology companies have not introduced a single GM crop with increased yield, enhanced nutrition, drought-tolerance or salt-tolerance. Disease-tolerant GM crops are practically non-existent. As in the past, virtually 100% of world acreage planted to commercial GM crops have one or both of just two traits: herbicide-tolerance (HT) and insect-resistance (IR). In 2006, according to ISAAA, 68% of the world's GM crops were HT alone; 13% had both HT and IR traits; and 19% were insect-resistant.

Herbicide-tolerant versions of soya, maize, cotton and canola represent 4 of every 5 hectares (81%) of GM crops worldwide (68% HT alone + 13% HT/IR). As discussed further below, herbicide-tolerant crops are "pesticide-promoting." They foster development of herbicide-resistant weeds, which in turn encourage still more pesticide use.

2. the rise in pesticide use

Herbicide-tolerant crops are designed to permit "over-the-top" application of chemical weedkillers without killing the crop itself. Their chief benefit has been convenience. HT crops allow farmers to spray a particular herbicide more frequently and indiscriminately without fear of damaging the crop. They also permit larger, wealthier farmers to cultivate more acres with less labor, facilitating the world-wide trend to fewer and bigger industrial-style farms. It is no accident that GM soya is most prevalent in Argentina, a country known for some of the largest soya plantations in the world.

Just as bacteria develop resistance to antibiotics, so weeds have become resistant to weedkillers. Resistant weeds are not new, but they have become much worse in the era of GM crops. Roughly 99% of the world's GM HT crops are Monsanto's Roundup Ready varieties, tolerant to the herbicide glyphosate. The dramatically increasing reliance on glyphosate with the Roundup Ready system has spawned an epidemic of glyphosate-resistant weeds. In addition, there is increasing evidence that insect-resistant Bt crops do not provide a sustainable means to decrease use of insecticides.

Though comprehensive data on pesticide use are difficult to obtain in most countries, the available data and anecdotal evidence demonstrate that pesticide use is on the rise.

Huge increase in glyphosate use in the U.S. In the United States, the widespread adoption of Roundup Ready crops combined with the emergence of glyphosate-resistant weeds has driven a more than 15-fold increase in the use of glyphosate on major field crops from 1994 to 2005. In 2006, the last year for which data are available, glyphosate use on soybeans jumped a substantial 28%, from 75.743 million lbs. in 2005 to 96.725 million lbs. in 2006 (see Table 1). The intensity of glyphosate use has also risen dramatically. From 1994 to 2006, the amount of glyphosate applied per acre of soya rose by more than 150%, from just 0.52 to 1.33 lbs./acre/year.

Glyphosate is not replacing other herbicides in the U.S. While farmers growing Roundup Ready crops initially used lesser amounts of herbicides other than glyphosate, that trend has changed in recent years. Increasingly, farmers find it necessary to apply both increased rates of glyphosate and large quantities of other herbicides to kill resistant weeds. From 2002 to 2006, use of the second-leading soya herbicide, 2,4-D, on soybeans more than doubled from 1.39 to 3.67 million lbs., while glyphosate use on soybeans increased by 29 million lbs. (43% rise). Atrazine, banned in 2006 in the EU due to its link to several health problems like endocrine disruption, breast and prostate cancer, is the most heavily applied corn herbicide in the US. At the same time that glyphosate use on corn climbed five-fold from 2002 to 2005, atrazine use rose by nearly 7 million lbs. (12% increase), and aggregate applications of the top four corn herbicides rose by 5%. Clearly, glyphosate is not displacing the use of atrazine or other leading corn herbicides.

Steep increase in glyphosate-resistant weeds in the U.S. Of the 58 cases of new glyphosate-resistant weeds identified in the last decade around the world, 31 were identified in the US, which has the largest area in the world devoted to herbicide-tolerant crops. Thirty of those cases occurred between 2001 and 2007. Experts agree that continuous planting of Roundup Ready crops and overreliance on glyphosate are to blame. Documented glyphosate-resistant weeds now infest an estimated 3251 sites covering 1 million hectares. This estimate does not include weeds with suspected resistance, which likely infest a much larger area.

Rise of glyphosate use and weed resistance in Brazil Data from Brazilian government agencies show that the consumption of the 15 main active ingredients contained in the most heavily used soya herbicides increased by 60% from 2000 to 2005. Use of glyphosate grew 79.6% during this period, much faster than the increase in area planted to Roundup Ready soya. In 2005 and 2006, three new weed species have evolved resistance to glyphosate in Brazil. Brazilian authorities have already recognized glyphosate-resistant weeds as a major threat to the country's agriculture.

Rise of glyphosate use and weed resistance in Argentina In Argentina, herbicide use has increased dramatically in the last decade with the progressive expansion in the area planted to soya, nearly all of it Roundup Ready soya. In 2007, Argentine agricultural experts reported that a glyphosate-resistant version of Johnsongrass now infests over 120,000 ha of the country's prime cropland. According to the UN's Food and Agriculture Organization, Johnsongrass is one of the worst weeds in the subtropics, and resistance to glyphosate will make it all the harder to control. Experts estimate that an additional 25 million liters other than glyphosate will be needed to control the resistant weed, resulting in an increase in production costs of between 160 to 950 million $ per year. Despite this threat, Argentine officials recently approved a new variety of glyphosate-resistant maize, which will likely exacerbate the problem.

Bt cotton does not reduce pesticide use in India. In 2007, the Agro-Economic Research Centre of Andhra University published a new study on pesticide use on cotton during the 2004-05 season in the Indian State of Andhra Pradesh. The study concludes that Bt cotton farmers apply the same quantity of pesticides, and spend the same amount on them, as conventional cotton farmers.

Secondary pests increase pesticide use in Pakistan and Indian Punjab. In 2007, infestation of cotton by secondary pests not killed by the Bt cotton insecticide in Pakistan and the Indian State of Punjab have dramatically increased the use of pesticides and increased input costs for farmers,

3. feeding the world's poor... but do gm crops increase yields?

The biotech industry continues to insist that GM crops are needed to tackle the food needs of a growing population, yet provides no evidence to support this claim. First of all, hunger is mainly attributable to poverty; lack of access to credit, land and inputs; and other political factors. Secondly, the majority of GM crops are not destined for hungry people in developing countries, but are used to feed animals, generate biofuels, and produce highly processed food products in rich countries. These facts suggest that GM crops have not increased food security for the world's poor. Third, none of the GM crops on the market are modified for increased yield potential, and as noted above research continues to focus on new pesticide-promoting varieties that tolerate application of one or more herbicides.

Yield depends on numerous factors, including weather, availability of irrigation and fertilizers, soil quality, and farmers' management skills, to name a few. Crop genetics are also important. In the U.S., for example, conventional breeding for increased yield is responsible for more than half of the three to seven-fold yield increases of corn, cotton and soybeans from 1930 to 2006 (Figure 2). Significantly, the trend of increased yields for these crops has not accelerated during the biotech era, suggesting that genetic modification is at best neutral with respect to yield.

HT crops suffer "yield drag": ISAAA maintains that HT crops are neutral with respect to yield, but many studies of Roundup Ready soya, the most widely planted GM crop, suggest that it has on average 5-10% lower yield than equivalent conventional varieties. Recent research has identified at least one cause of this yield drag. Glyphosate hinders uptake of essential nutrients like manganese in Roundup Ready soya, both reducing yields and making plants more susceptible to disease. Moreover, some countries like Paraguay have experienced record low yields due to drought during 2005 and 2006, corroborating several reports that indicated that RR soya was performing worse than conventional soya in dry conditions. Figure 3 confirms stagnating yield in countries that have heavily adopted Roundup Ready soya.

Insect resistance of Bt crops has a minor influence on yield: Before the introduction of Bt corn in the U.S., only 5% of corn acres were sprayed for European corn borer (ECB), the main insect pest killed by Bt corn. This is because in most years, ECB cause little or no damage, meaning little or no adverse impact on yield. As noted above, yield is more heavily influenced by other factors, such as crop genetics, weather conditions, availability of irrigation, and soil quality. Rigorous, independent studies comparing the yield performance of Bt and non-Bt crops under controlled conditions are rare. One such study conducted in the U.S. demonstrated that Bt corn yields anywhere from 12% less to the same as similar conventional varieties. Until more reliable studies are conducted under a broad range of conditions, it is premature to attribute yield increases to the "Bt factor."

Is Bt cotton the key factor for yield gains? Industry often claims that Bt cotton has boosted overall cotton yields in all countries where it has been planted with the exception of Australia. However, close examination of these claims reveals a disturbing pattern of dishonesty. In most cases, it appears that the yield increases were not due to the "Bt factor," but rather to favorable weather conditions, a shift from dryland to irrigated acreage, the introduction of improved conventional seeds, or innovative cultivation techniques. In other cases, Bt cotton appeared to fare worse than or the same as conventional cotton. Ironically, in several countries where cotton was infested by secondary pests not killed by the Bt insecticide, farmers who had paid a premium for Bt cotton seeds had to spend as much on chemical insecticides as conventional cotton farmers. In light of these facts, and the absence of comprehensive and systematic comparative studies on the yield performance of Bt versus conventional cotton, it is highly questionable to attribute yield increases to the "Bt factor." A look at cotton yield data from national governments, UN agencies and expert bodies in the top Bt cotton producing nations supports this assessment. For example, average cotton yields have stagnated since the adoption of Bt cotton in the U.S., Argentina and Colombia. While cotton yields have increased in China, it is still questionable whether the increased productivity is attributable to Bt cotton. For example, Xinjiang, the Chinese province with the greatest cotton production and the highest average yield in the nation, grows mostly conventional cotton, and its positive yield performance is due to other production factors not related to Bt technology.

TABLE 18 **HAS ADOPTION OF BT COTTON INCREASED YIELDS?**

COUNTRY	ISAAA CLAIMS OVER BT COTTON YIELDS		OVERALL PERFORMANCE OF COTTON SECTOR	
US	"The primary benefit has been increased yields (by 9%-11%)"	⇑	US cotton yields stagnated from 1997 to 2002 during the first six years of GM cotton cultivation. Yield gains since then are due to increased land under irrigation, more intensive management, and most importantly, optimal weather conditions in 2004 and 2005.	⇔
Colombia	Estimated 11.5% yield increase	⇑	Since the adoption of Bt cotton in 2002, Colombia's overall average cotton yields have remained constant	⇔
Argentina	"yield gains of about 35%"	⇑	Since the adoption of Bt cotton in 1996, overall average cotton yields have remained constant	⇔
South Africa	"significantly higher yields (an annual average increase of about 24%)	⇑	Mixed results. No yield gains from Bt cotton in comparison with conventional cotton in rainfed conditions. Only under irrigation does Bt cotton appear to yield more.	⇑ ⇔
Australia	No yield gains	⇔	No yield nor quality gain	⇔
China	"higher yields of 8% to 10%" due to Bt cotton	⇑	In Xinjiang, which has the highest cotton production and yields of any province in China, farmers grow mostly conventional cotton, and its positive yield performance is due to production factors not related to GM technology.	⇑
Mexico	"yield improvements of about 14% per year"	⇑	High yields similar to those seen in 2006 had already been achieved in the 1980s before introduction of Bt cotton.	⇑
India	"major increases in yield"	⇑	Most data indicate that the yield gains in the 2005 and 2006 seasons were attributable to ideal crop conditions provided by good monsoons.	⇑

⇑ yields increase
⇔ yields remain constant

***Source**: Friends of the Earth International, 2007*

4. environmental, social and economic benefits from gm crops: gm crops fail to deliver

In 2007, the available evidence suggests that GM crops have had mostly neutral or negative environmental, social and economic impacts on the farmers and countries that have adopted them.

GM crops increase pesticide use. Pesticide-promoting herbicide-tolerant crops, which comprise 81% of world GM crop acreage, have spawned an epidemic of chemical-resistant weeds in the U.S., Argentina and Brazil, thereby encouraging still greater use of chemicals to control them. Pesticides have adverse health and environmental impacts that GM agriculture is worsening.

GM crops have done nothing to alleviate hunger and poverty and are not benefiting small-scale farmers. The most widely planted GM crop, Roundup Ready soya, is grown mainly by large industrial farmers in a handful of nations for export to feed animals in rich countries. GM soya monocultures in Latin America are driving small farmers off the land and displacing acreage planted to food (vs. feed) crops, reducing food security. Bt cotton is not a food crop, and its seeds are extremely expensive, exacerbating farmer indebtedness. Its adoption has been driven by hype-based "fads." Moreover, it has performed poorly in many areas due to secondary pest infestations, which in turn lead to substantial expenditures on pesticides. The small farmer experience with Bt cotton in the Makhatini Flats (Kwazulu Natal) region of South Africa was portrayed internationally as the success story that proved the benefits of GM crops for small farmers in Africa. However, since the adoption of Bt cotton, the number of small cotton farmers has plummeted from 3229 in 2001/02 to just 853 farmers in 2006/07. Neither Bt cotton nor other GM crops can cope with the structural problems that are the chief causes of rural poverty, factors such as low commodity prices, lack of credit, and declining government support of agriculture.

Neither consumers nor the feed industry has benefited from GM crops. No GM product commercialised today offers any benefits to the consumer in terms of quality or price, a key factor for European consumers' rejection. GM feed does not even offer an advantage to the feed industry, since GM maize and soy do not improve yields, nor quality, and neither are cheaper than conventional crops.

Growing control of the seed supply by a handful of agrichemical-biotechnology giants is raising seed prices, reducing seed choices, and exposing farmers to ruinous lawsuits for the "crime" of seed-saving. Farmers, small seed firms, and public sector breeders once developed a multitude of new seed varieties best suited to local conditions. Today, Monsanto, DuPont-Pioneer, Syngenta, Bayer and a handful of other multinationals own most of the world's commercial seed. As even the U.S. Dept. of Agriculture admits, this seed industry concentration has slowed development of useful new crop varieties. Seed prices have risen dramatically in the U.S. as companies push expensive biotech seeds to maximize profits. Farmers have ever fewer alternatives, as these same firms phase out more affordable conventional seeds. It is no accident that agrichemical-biotech companies focus development efforts on pesticide-promoting, HT crops: they lead to increased sales of the chemicals these firms also sell. Monsanto became the world's largest seed firm in 2005, and in 2007 increased its control through the purchase of the world's largest cotton seed company, Delta and Pine Land. Misguided U.S. court decisions permitting seeds to be patented have virtually outlawed the millenia-old practice of farmer seed-saving in the U.S., at least for GM varieties. Monsanto has exploited its seed patents to extract tens and perhaps hundreds of millions of dollars from U.S. farmers for the "crime" of saving seed. Officials in other nations contemplating support for biotech agriculture would do well to carefully consider the implications for their country's farmers.

Large-scale farmers in major producing countries have benefited from a convenience effect. Large-scale farmers in the US and Argentina, who represent a small minority of the world's farmers, have benefited from GM crops due mainly to "the convenience effect." This includes reductions in farm labour and increased flexibility in the timing of herbicide applications. The ability to farm more acres with less labor with HT crops has facilitated the world-wide trend to fewer and bigger industrial-style farms. However, increased weed and pest resistance to these GM crops is already eroding this "convenience effect".

There is a lack of rigorous, independent studies on the performance of GM crops in every country that has commercialised them, and this consequently calls into question their claimed benefits. Analysis of the pros and cons of GM crops is a highly complex issue that requires rigorous, independent research. Too often, decision-makers rely on the findings of organizations like ISAAA, which are funded by the biotech industry and have a clear interest in promoting the products of their sponsors. As this reports shows, ISAAA's claims with respect to the pesticide use and yield impacts of GM crops are either false or at best highly dubious. The most widely planted GM crops are associated with rapidly growing use of pesticides, while their yield effects are either negative or uncertain.

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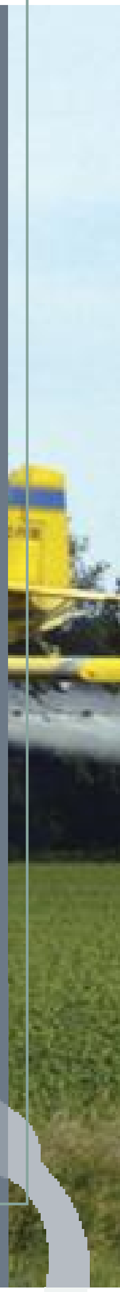

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