GM cotton harvesting in the Makhathini Flats of South Africa.

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who benefits from gm crops?

an analysis of the global performance of gm crops (1996-2006)

executive summary

january 2007

Friends of the Earth International

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who benefits from gm crops?

an analysis of the global performance of gm crops (1996-2006)

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executive summary

This is the executive summary of a full-length publication by the same title. The full-length version of Who Benefits from GM Crops? can be obtained by contacting Friends of the Earth International, *info@foei.org*.

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introduction

Genetic engineering is a radical new technology used by scientists to manipulate the DNA of living organisms. The genetic engineering or modification of plants began in laboratories in the 1980s with grand promises of feeding the world and abolishing malnutrition. In this report, we undertake a critical analysis to sort out the reality from the myths surrounding genetically modified (GM) crops, focusing on the decade of their introduction into the food and feed supply, from 1996 to the present.

1.1 a decade of commercialization: few crops, few countries

The first significant planting of GM crops took place in 1996 in the United States. Today, only four crops – soybeans, maize, cotton and canola – represent virtually 100% of the world's GM crop acreage. During the first seven years of cultivation, between 1996 and 2002, over 90% of the global surface of GM crops was concentrated in the United States, Argentina and Canada. In 2004, more than 84% of GM crops were still concentrated in these same three countries, although the areas under cultivation in Brazil, China, and India have grown over the past three years. Over 80 million hectares of GM crops are planted today in the world; however, they occupy just a small share of total global crop land, about 1.5%.

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1.2 the benefits of gm crops: what is real and what is hype?

Since the early 1990s, the biotech industry and organizations such as the International Service for the Acquisition of Agribiotech Applications (ISAAA) have been advocating the rapid adoption of GM crops around the world, claiming that they benefit the environment, farmers, consumers (with cheaper and healthier food) and that they will contribute to the fight against hunger and poverty. Since 1996, ISAAA has issued an annual report that evaluates the "global status of commercialized biotech/GM crops". This report has become widely accepted at the international level as the authoritative reference for the global deployment of GM crops, influencing numerous governments, academics, prestigious institutions, and United Nations organizations such as the Food and Agriculture Organization.

In its January 2006 report, ISAAA claimed that "the continuing rapid adoption of biotech crops reflects the substantial and consistent improvements in productivity, the environment, economics, and social benefits realized by both large and small farmers, consumers and society in both industrial and developing countries". The report gives a rosy picture of the benefits provided by GM crops, never citing or quoting the substantial obstacles related to their introduction around the world. However, a hard look at the cumulative facts from various countries reveals that GM crops have been associated with strong opposition, serious problems, and unfulfilled claims.

Since 2005, Friends of the Earth groups together with our allies around the world have engaged in a thorough global evaluation of the performance and the impacts of GM crop releases. Our objective is to provide a more accurate picture of the global reality of these crops, and to separate the hype from reality. This report intends to help answer two critical questions: What benefits have GM crops brought to the world? And for whom?

the united states: few traits and few crops commercialized

2.1 limited range of gm crops

A very limited range of GM crops has been grown in the United States, even though the US Department of Agriculture (USDA) had approved 71 distinct biotech 'events' for commercial use as of December 2006. These 71 varieties are combinations of 14 different crops and 10 different traits or trait combinations (see table 1). Despite this seeming diversity, only four crops – maize, cotton, soy and canola – with only two traits – herbicide tolerance and insect resistance – have been grown to any significant extent.

Herbicide-tolerant crops are engineered to survive the application of a powerful herbicide that would kill a non-engineered crop, making it easier for farmers to use more herbicide to control nearby weeds. Insect-resistant crops are engineered with an insecticidal protein from a soil bacterium, Bacillus thuringiensis (Bt), that kills certain insect pests when they eat the leaves or grain of the plant. In 2005, herbicide-tolerant versions of all four crops comprised 71% of world GM crop acreage; insect-resistant (also known as 'Bt') corn and cotton made up another 18%. The remaining 11% consisted of 'stacked' varieties of corn and cotton that are both herbicide-tolerant and insect-resistant. Monsanto's RR soy, corn, cotton and canola, engineered for use with the company's Roundup (glyphosate) herbicide, comprise the lion's share of herbicide-tolerant GM crops.

TABLE 1 — **GM CROPS APPROVED FOR COMMERCIAL PRODUCTION (+ BOXES) VERSUS THOSE ACTUALLY GROWN FOR COMMERCIAL USE (SHADED + BOXES)**

CROP	HT	IR	HT / IR	STERILE POLLEN	HT / STERILE POLLEN	VR	IR / VR	DELAYED RIPENING	ALTERED COMPOSITION	LOW NICOTINE
ALFALFA	+									
BEET	+									
CANOLA	+				+				+	
CHICORY				+						
CORN	+	+	+	+	+					
COTTON	+	+	+							
FLAX	+									
PAPAYA						+				
POTATO		+					+			
RICE	+									
SOYBEAN	+								+	
SQUASH						+				
TOBACCO										+
TOMATO		+						+		
TOTAL	8	4	2	2	2	2	1	1	2	1

This table portrays the universe of genetically engineered (GE) crops that have been deregulated (i.e. approved for commercial cultivation and sale) by the US Department of Agriculture as of November 17, 2006, and the subset of these approved GE crops that are actually being grown to any significant extent for commercial use in food products. GE crops are broken down by trait or trait combination (see Legend below). Tinted boxes represent the GE crop types that comprise virtually 100% of those that are commercially grown and in the food supply. An empty box signifies that there are no approved versions of the pertinent crop-trait combination.

Legend: *HT = herbicide-tolerant; IR = insect-resistant; VR = virus-resistant; HT/IR, HT/Sterile pollen & IR/VR = 'stacked' crops with both of the indicated traits. Sterile pollen corn is used for breeding purposes. Altered composition indicates altered oil composition (soybeans and canola) or altered protein composition (corn). Note that "+" boxes in some cases represent several GE crop 'events' - or differing versions of the same basic crop-trait combination - approved in the pertinent category. Based on USDA data, current as of December 5, 2006, from www.aphis.usda.gov/brs/not_reg.html.*

Some deregulated crops have been a complete failure. For example, since GM papaya was first introduced in Hawaii in 1998 to protect against the ringspot virus, the Hawaiian papaya industry has been in a tailspin. Production, papaya prices, the number of papaya farmers, and acreage under production have all dropped sharply, largely due to the rejection of the crop by Japan and other major export markets. Hawaii is the only place in the world where GM papaya is grown (on just a few hundred hectares), and other major producers such as Mexico and Brazil have thrived by shunning GM papaya and increasing production of conventional and organic papaya.

The number of permits granted for field trials of GM crops in the US climbed steadily from 1987 to 2002, but has since leveled off.

2.2 monsanto at the helm of a concentrated seed sector

The US seed industry is becoming increasingly concentrated. In 1997, three companies – Monsanto, Pioneer and Novartis[1] – accounted for nearly 70% of US corn seed sales. In 2005, Monsanto became the world's largest seed company through its acquisition of vegetable seed giant Seminis. Monsanto is now attempting to gain further control of the seed sector in some strategic crops like cotton. In the United States, over 80% of cottonseed is sold by just three companies: Delta and Pine Land, followed by Bayer CropScience and Stoneville. Monsanto acquired Stoneville in 2005, and is in the process of acquiring Delta and Pine Land. If this merger goes through, Monsanto could control over 60% of the US cottonseed market.

Monsanto, based in St. Louis, Missouri, has also spearheaded the development of the new technologies that have led to the widespread commercialization of four GM crops in North America. Some 90% of all commercialized GM varieties in the world have Monsanto traits.

The increasing power of a few biotech corporations and agribusinesses is affecting farmers, who are being harassed and sued by companies like Monsanto for doing what they have been doing for centuries: saving seeds. Farmers' choices are also being narrowed, and US farmers have reported that it has become difficult if not impossible to find high-quality, conventional varieties of corn, soy, and cottonseed. The American Antitrust Institute believes that "the merger – between Monsanto and Delta Pine – could also reduce choices available to cotton farmers by hastening the elimination of conventional (non-genetically modified) cottonseed".

2.3 gm crops: neither higher yields nor reduced pesticide use

The measurement of the benefits of GM crops to farmers is a complex issue that is influenced by many factors, including the crop, prices, the size of the farm, the degree of insect infestation, and the weather. Non-economic factors must also be considered. The biotech industry claims that GM crops in the US have provided "significant yield increases, significant savings for growers and significant reductions in pesticide use". But do these claims accurately reflect the reality in the field?

A compelling number of studies by independent scientists demonstrate that GM crop yields are lower than, or at best equivalent to, yields from non-GM varieties. Reduced yields have in particular been found with Roundup Ready (RR) soy. The fact that GM crop yields are not greater than those of conventional crops is even recognized in an April 2006 USDA report stating that "currently available GM crops do not increase the yield potential of a hybrid variety. [...] In fact, yield may even decrease if the varieties used to carry the herbicide-tolerant or insect-resistant genes are not the highest yielding cultivars."

The most comprehensive independent study of US government statistics shows that the three major GM crops have led to a 122 million pound increase in pesticide use since 1996, with the huge increase in herbicides applied to herbicide-tolerant soy, cotton and corn offset slightly by a small decrease in insecticides applied to insect-resistant corn and cotton. Until the widespread adoption of RR crops, there were just two confirmed cases of glyphosate-resistant weeds. But by 2005, many different weeds had become resistant in the United States.

1 Pioneer has since been acquired by chemical giant DuPont, and Novartis's agricultural operations have since been acquired by Syngenta.

2.4 what are the benefits of gm crops in the united states, and for whom?

While biotech industry supporters claim increased profits from growing GM crops, non-industry sources like the USDA have concluded that conventional farming is as profitable as, or even more profitable than, the cultivation of GM crops. As we have seen, independent studies have also demonstrated that GM crops are associated with greater pesticide use and equivalent or lower yields vis-à-vis their conventional counterparts, contrary to the claims of the biotech industry. As for consumers, there is no benefit from increased use of pesticides or equivalent/lower yields, and genetic modification has not improved the quality of food.

The adoption of GM maize, cotton, soy and canola crops has advanced at a very rapid pace in the United States, chiefly due to the 'convenience' of operations with herbicide-tolerant varieties. Most reports agree that GM crop systems lead to reductions in farm labor and increased flexibility in the timing of herbicide applications. These two benefits, however, facilitate the ongoing consolidation of farmland in the hands of fewer and fewer corporate farmers.

In addition, flexibility and reduced labor expenditures for larger growers do not always translate into higher economic returns. The USDA recognized early on that "the adoption of herbicide-tolerant soybeans did not have a significant impact on net farm returns in either 1997 or 1998", and that even "adoption of Bt corn had a negative impact on net returns among specialized corn farms".

With the growing problem of Roundup-resistant weeds, the 'convenience' effect of the RR system is beginning to disappear, and costs are rising as more herbicide applications are necessitated.

It appears that the main beneficiaries of the GM crops planted in the past decade have been the corporations that market them, and in particular Monsanto. This company's growing control over the seed supply, its aggressive investigation and prosecution of farmers for alleged patent infringement, and its astonishing influence upon government policies and regulations have been the context for the GM revolution in US agriculture.

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south america: soybeans

3.1 the export-oriented soy business

Soy is the main agricultural crop for some of the most advanced economies in South America, including Brazil and Argentina, which rank second and third in global soy production after the United States. The soybean grown in South America is mainly destined for export markets. In Paraguay, 65% of the total production of soybean is exported, and these percentages are even greater in Brazil, where 72.4% of the soy crop is exported, and Argentina, where the total is a whopping 92%.

TABLE 2 **SOYBEAN PRODUCTION AND EXPORTS 2005/06 (IN THOUSAND METRIC TONNES)**

TOP PRODUCERS	PRODUCTION	EXPORTS	% OF EXPORTS
1. US*	83,368	33,443	> 40%
2. Brazil*	55,000	39,850	> 70%
3. Argentina*	40,500	37,575	> 95%
4. China	16,350	-	
5. India	6,300	-	
6. Paraguay	4,000	2,600	> 60%

** Includes soybean, soy meal and soy oil in the export products.*
Source: *Based on USDA figures, 2006g.*

The majority of the genetically modified crops that have been introduced in Latin America are soy. The percentage of soy that is genetically modified is estimated to be over 30% in Brazil, around 80% in Paraguay, and nearly 100% in Argentina.

3.2 argentina: reaching the limits of soybean expansion

The introduction of GM soy in Argentina was accomplished very quickly, from less than 10% of the total area in 1996 to over 90% in 2001. However, the move from 6 million hectares in 1997 to 14.2 million hectares in 2004 has been accompanied by significant negative environmental and social impacts. Deforestation, soil erosion, increased use of glyphosate, land concentration, and the progressive reduction of the number of family farms have all accompanied the soy expansion in Argentina.

Argentinian farmers, unlike their North American counterparts, were able to plant GM soy with no intellectual property rights restrictions or royalties attached. Although Monsanto applied for patent protection of its RR soy in Argentina in 1995, this was never granted. The conflict has heated up since June 2005, when Monsanto filed lawsuits regarding the shipment of Argentinian soy meal to Europe, arguing a possible infringement of its patent rights on the RR gene in Europe. Monsanto was able to stop an average of one ship per week over a several month period in 2006, and subsequently filed several court cases: three in Spain, one in the Netherlands, and one in Denmark. In August 2006, the Argentinian government reported that the European Commission's legal experts had found that EU law does not extend to derivatives of patented products. However, since the opinion is not binding on national courts, Monsanto has dismissed its significance. Thus far no agreement has been reached, and Monsanto continues to claim property rights not just over 'live' soybeans but over derived products like soy meal in Europe.

3.3 brazil: stagnated soy production

3.3.1 hard times for brazilian soy farmers

The soybean sector in Brazil is in crisis, and soy farmers are having a tough time sustaining their livelihoods. The cause of the crisis is a combination of low international soy prices, rising costs for inputs and transportation, and a strong Real, which makes exports cheaper. In 2005, the area planted with soybeans in the country was reduced for the first time in eight years, and yields have declined significantly since 2002/03.

TABLE 3 AREA, YIELD AND PRODUCTION OF SOY IN BRAZIL, 2000- 2006

	2000/01	2001/02	2002/03	2003/04	2004/05 PRELIMINARY	2005/06 FORECAST
Area (in thousand hectares)	13,969.8	16,329.0	18,474.8	21,375.8	23,301.1	22,229.2
Yield (kilogram/hectare)	2,751	2,567	2,816	2,329	2,208	2,403
Production (in thousand metric tonnes)	38,431.8	41,916.9	52,017.5	49,792.7	51,452.0	53,426.0

Source: *CONAB, 2006a.*

In response to these problems, the federal government adopted an emergency credit package of US$8 billion in 2006 to help farmers cope with the crisis. This will cost Brazilian taxpayers an estimated US$705 million.

3.3.2 gm planting banned on indigenous lands

To date, two GM varieties have been authorized in Brazil. In addition to soy, a Monsanto GM cotton was legalized in March 2005; this crop is however on hold as the National Technical Commission on Biosafety has obliged Monsanto to prepare an impact study on its effects. GM corn has been authorized for import, but only as animal feed and not for planting. In October 2006, the government introduced new restrictions that forbid the planting of GMOs in indigenous territories.

3.3.3 monsanto lowers expectations for brazilian royalties

In 2006, some 20% of Monsanto's total royalties on GM crops were obtained from new seed sales, and the remaining 80% were collected when harvests were delivered to grain elevators. Due to lower yields in the most recent harvest, Monsanto did not earn the expected revenues from royalties upon delivery at the grain elevator, and has had to scale down its expectations in Brazil in the short term.

Monsanto believes that the best way to tackle these low revenues lies in "increasing penetration". A key strategy for the company in its further penetration of the Brazilian soy market is the creation of a new incentive system that entices farmers to purchase new certified seed, since profits from royalties on new seed sales are more secure than the collection of royalties at grain elevators.

3.3.4 moratorium on soy trade from the amazon

Several reports in 2006 confirmed that cropland expansion, particularly soy, has been a major cause of new deforestation in the Amazon in recent years. In July 2006, a two-year moratorium on soybeans from deforested areas of the Amazon was accepted by major soybean traders, including ADM, Cargill and Bunge. As a result, farmers who own land cleared after 24 July 2006 in the Amazon forest zone will not be able to sell their soybeans to those companies. While this may slow the planting of soy in the Amazon, this measure has been criticized by some Brazilian sectors as weak, and not a solution to the unsustainable soy production in the entire country.

3.3.5 decreased yields and more pesticides

Soy yields in Brazil have been declining since 2002, corresponding to the period of introduction of RR soy. One contributing factor may be that RR soy is not as resistant to heat and drought as conventional soy varieties. For instance, growers in the southern state of Rio Grande do Sul reported that RR soy suffered greater losses in yield than conventional soy during the 2004/05 drought, the season with the lowest recorded yields since 2000/01 (see table 3).

A study by the Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA), Brazil's environmental enforcement agency, shows that the introduction of GM soy has augmented the use of agrochemicals in the country. According to the study, the consumption of glyphosate increased by 95% in Brazil between 2000 and 2004. Over the same period, the use of all other herbicides together increased by 29.8%.

Meanwhile, as spraying increased, local soybean prices declined throughout 2006 and farmers reportedly started to use cheaper and natural low-input methods, including lime and bone meal phosphate, in place of agrochemicals.

Deforestation for soy plantations in South America.

3.4 paraguay: roundup ready soybean does not offer salvation

In 2006, an estimated 80% of the two million hectares cultivated in Paraguay were genetically modified varieties. Ironically, the year that RR soy was legalized was also the start of three consecutive poor years for agricultural production due to drought. Some municipalities were forced to declare a 'state of emergency' in 2006. The harvest forecast for the 2005/06 season was 4.04 million tonnes from 2 million hectares of soy, down from an expected 5.5 million tonnes.

Higher soybean yields were expected in 2006, an increase of 2,700 kilograms per hectare from the 2,000 kilograms per hectare obtained in 2004/05. Again, however, productivity was very low in 2006, with only around 800 kilograms per hectare produced in some areas. The Paraguayan Ministry of Environment has detected higher losses in RR soy yields than in the conventional varieties, verifying that the GM varieties were highly sensitive to drought; some areas experienced production losses of between 60% and 90%.

As a result, echoing the Brazilian situation, Monsanto Paraguay was forced to publicly announce a reduction in the royalties they demanded from soy producers from February 2006 onwards.

The destruction of ecosystems due to the large-scale planting of soybeans has been very serious in Paraguay. In 2006, the Ministry of Environment initiated numerous complaints and actions against soy landowners for the violation of forest laws. Social unrest has ended in numerous violent confrontations between small local farmers and big soy landowners, and some municipalities have even issued ordinances in order to put the brakes on the expansion of intensive soy monocultures.

3.5 what are the benefits of gm soy in south america, and for whom?

Despite repeated claims of benefits, it is clear that most peasants and small-scale farmers, consumers and the environment in South America have not profited from the introduction of GM soybeans.

In Brazil and Paraguay, the soybean sector has been in crisis since 2004, with many farmers highly indebted and unable to profit from soybean production. The introduction of RR soy has done nothing to solve the existing problems of low international prices, drought, and rising costs of inputs and transportation. On the contrary, Monsanto's high-tech soybeans have performed worse than conventional varieties during drought conditions in both southern Brazil and Paraguay, as predicted by US researchers as long ago as 1999. As the New Scientist reported: "...hot climates don't agree with Monsanto's herbicide-resistant soy beans, causing stems to split open and crop losses of up to 40 percent. This could be a serious blow to the St. Louis-based company, which sees Brazil and other Latin American countries as major markets for its soy beans".

Although the livelihoods of many farmers are at risk, thanks in part to lower yields from Monsanto's drought-susceptible soy, the company is pushing hard to increase penetration of RR soy in South America. The company's strategy involves shifting its collection of royalties from payment upon delivery at the granary to a premium on the price of new certified 'legal' seed, which it hopes will end the age-old practice of saving and replanting seeds.

Despite these ambitions, the situation of Brazilian and Paraguayan soy farmers was so critical in 2006 that Monsanto and its agribusiness allies were unable to squeeze them for more royalties, forcing the company to reduce its short-term profit forecasts from Brazil and Paraguay.

In addition, soybean is produced mainly for export feed markets, and not as food for South American people. This consolidation of agribusinesses and concentration of land in rural areas of South America is also contributing to the further erosion of the food sovereignty of local peasant communities.

If small farmers, consumers and the environment are not benefiting from GM crops, then who is? In the case of Argentina, where taxes are high for soybean products, the government's coffers have gained from soybean exports. Large-scale farmers have also profited from the convenience effect, although whether they have benefited economically from RR soy in comparison with conventional varieties is not clear. In the case of Brazil and Paraguay, biotech corporations and large agribusiness are driving the further adoption of RR soy in order to profit from royalties on GM seed, expanded soybean area for exports, and of course future expectations of the increased sales that would result from ending the practice of saving, selling and replanting seeds.

RR soy has brought few benefits to people in Brazil and Paraguay due to the above-mentioned factors. Furthermore, if Monsanto and other big seed companies succeed in ending the practice of seed saving, small-scale farmers will face increased dependency on seed suppliers and increased expenses for costly GM seed, and will continue to lose control over their farming systems. It is difficult to see any benefits for small-scale farmers in this potential future.

cotton around the world

Cotton is produced in over 60 countries around the world, but 75% of its production, 71% of its area and 70% of its consumption is concentrated in just five countries: China, India, Pakistan, the United States and Uzbekistan. Nine countries allow GM cotton cultivation: Argentina, Australia, China, Colombia, India, Indonesia, Mexico, South Africa and the United States.

4.1 china: gm cotton attacked by pests

China is the largest cotton producer in the world, with over 5 million hectares planted in 2005/06. It also has the largest number of cotton farmers in the world, an estimated 14 million. Beginning in 1997, Bt cotton was adopted very rapidly, and several studies initially reported benefits in terms of net returns for farmers, pesticide reduction, and better yields.

However, according to a recent study by Cornell University, the trends that signalled a win-win situation for Chinese farmers seem to be reversing. The study, focusing on hundreds of farmers in five Chinese provinces, showed that in 2004 the net revenue of Bt farmers was significantly lower than that of non-Bt farmers. The reasons are reportedly linked to the emergence of secondary pests such as mirids, and the need for Bt cotton farmers to spray 15-20 times more pesticide than was previously needed to kill these pests. A previous study based on data collected in 2002 also found high levels of pesticide use despite the adoption of Bt cotton .

The appearance of secondary pests should not be a surprise, since the use of Bt technology indirectly creates a safer environment for the growth of non-bollworm pests. Entomologists have suggested that it takes 5-10 years for such a secondary pest population to grow to a level that poses a significant economic threat. The authors of the Cornell study recognize that if secondary pests are not adequately taken into consideration, new technologies like Bt cotton could “only serve to exacerbate problems associated with poverty and scarcity”.

The solution proposed by some authors to this problem is to invest in education for farmers so that they set aside refuges of conventional cotton amidst their Bt cotton to reduce the threat of secondary pests. However, experience in the US suggests that even with education, many farmers will not take the time and trouble to plant refuges of conventional plants. In addition, refuges are difficult to implement effectively on small farms like those that predominate in China.

The Cornell University assessment also contrasts sharply with data presented by ISAAA in 2005, which made a general claim that 6.4 million farmers benefited from Bt cotton. This was in fact 600,000 farmers fewer than the 7 million that ISAAA had claimed the previous year in its 2004 report.

4.2 india: aggressive marketing of bt cotton amidst poverty and debt

Cotton is an important commercial crop for India, with over 9 million hectares of land currently under cultivation. However, the country is undergoing an agrarian crisis, which is particularly acute in the cotton growing regions of Andhra Pradesh, Karnataka and Maharashtra where “a spate of suicide deaths among farmers” has resulted. Over the past years, small-scale Indian farmers have faced hard times due to rising input prices combined with falling output prices, exacerbated by frequent crop failure due to unfavorable weather. The Indian Ministry of Agriculture recognizes that the result is a situation in which the majority of small farmers “seem to be badly trapped in poverty and indebtedness”.

Bt cotton was introduced amidst controversy and a contamination episode at the end of 2001, catalyzing its approval a few months later in 2002. The following years saw an aggressive Bt cotton marketing campaign that played out in parallel to high prices, agronomic failure, inadequate financial returns for farmers, and constant protests. In May 2005, India’s Genetic Engineering Approval Committee refused to renew Monsanto’s licenses to sell the first three GM cottonseed varieties authorized for Indian commercialization in Andhra Pradesh. An Indian government study, reported in a prominent biotechnology journal in 2005, found substantial late-season pest damage to Bt cotton grown in India due to a decline in the levels of the cotton’s built-in insecticide; the result was low yields.

In recent years, Monsanto and its local subsidiaries have been actively promoting the commercialization of Bt cotton, which the company has presented to Indian cotton farmers as a magic bullet. These efforts have been supported by US government departments including the USDA, USAID and the State Department, all of which have all been highly engaged in promoting biotech commercialization among Indian regulators. In short, the adoption of Bt cotton in India has more to do with an aggressive lobby and media campaign offering false promises than with the genuinely adequate performance of a technology that benefits farmers and tackles the main challenges affecting their livelihoods.

In June 2006, agricultural ministers and officials of seven cotton growing regions (Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Madhya Pradesh, Tamil Nadu and West Bengal) adopted a unanimous resolution to jointly fight a legal battle against Monsanto for charging excessive royalties for Bt cotton. As of December 2006, the case is still pending in the Indian Supreme Court.

4.3 indonesia: monsanto abandons commercialization of bt cotton

Bt cotton was also a dismal failure in Indonesia, despite Monsanto's promises and propaganda. Many of the Indonesian farmers who experienced the poor performance of Bt cotton first-hand were sharply critical of the company for its false pledges, particularly given the exorbitant price of the seed. In 2003, Monsanto abandoned the commercialization of Bt cotton in the country, and in 2004 Indonesia disappeared from ISAAA's country map without explanation, in keeping with the organization's refusal to deal objectively with the failures of GM technology.

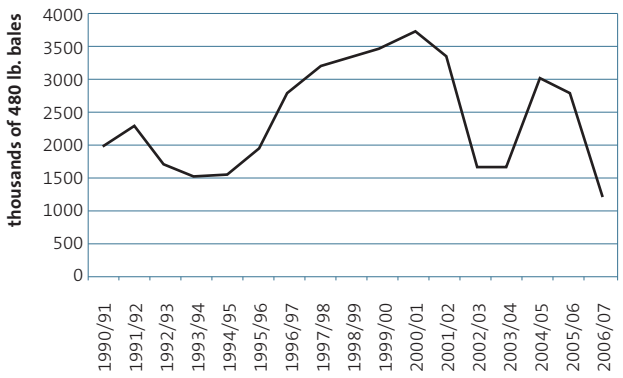
An investigation by the US Securities and Exchange Commission revealed that Monsanto paid over US$700,000 in bribes to at least 140 current and former Indonesian government officials and their family members between 1997 and 2002, financed through the improper accounting of the company's pesticide sales in Indonesia.

4.4 australia: cotton sector struggling

Cotton production in Australia is highly industrialized and export-oriented, with over 90% of the country's cotton sent overseas. Australia is home to around 1500 cotton farmers who cultivate a total area of roughly 500,000 hectares.

The Australian cotton sector has undergone a rough period, with significant drops in production over the last four years. Drought and low prices severely affected cotton planting. Some of the coldest and driest conditions for decades were recorded in June 2006, seriously affecting the availability of irrigation water in catchment dams. At the end of November, with planting of the 2006/07 crop almost complete, the acreage planted was forecast to be just 147,000 hectares, which will mean the lowest production levels in 15 to 20 years.

FIGURE 1 **AUSTRALIAN COTTON PRODUCTION**



Source: *Globecot, 2006a.*

According to the USDA, "the successful introduction of genetically modified varieties has benefited Australia's cotton yield and production". However, Bt cotton has provided no improvements in either yield or quality. Cotton consultants in Australia have shown that yields of Bt cotton have stayed relatively constant since its introduction in 1996 in comparison with conventional varieties

In the first few years, farmers made no profit from Bt cotton; the situation was so bad that companies marketing the product had to lower the technology fee on Bt cottonseed in order for planters to obtain any economic benefit. There is no publicly available comprehensive study about the economic returns of Australian farmers over the last years.

A key lesson from the Australian experience is that when the most challenging factors for cotton growers are drought and low prices, a technology like Bt cotton can do little or nothing to help the situation. Taking into account the severe drops in production over the last years, and with the 2006/07 harvest projected to be the lowest in a decade, it is difficult to believe that GM cotton has improved the livelihood of Australian farmers.

4.5 africa: gm cotton is no solution to hunger or poverty

4.5.1 south africa: cotton production decreases with bt cotton

South Africa planted around 21,000 hectares of cotton in 2005/06, 39% less than the previous year due to low international prices and a strong Rand against the US dollar at the time of planting. Production estimates for 2006/07 are 18,114 hectares, a 20% decrease from the previous season.

An analysis of cotton production reveals the following data related to Bt cotton:

- The number of small cotton farmers has decreased since the early 2000s. For example, in the Makhatini Flats area in Kwazulu Natal, the most widely publicized example of a small Bt cotton farmer success story, the number of small farmers has decreased from over 3,000 in 2001/02 to 353 in 2002/03 and to 598 in 2004/05. ISAAA has inflated the number of small cotton farmers in South Africa, and has hyped the impact of Bt cotton on their livelihoods. For example, whereas ISAAA's 2003 report featured small farmers in the Makhatini Flats as a strong example of "resource-poor farmers" benefiting from GM crops, Cotton South Africa has asserted that the number of farmers planting cotton there that same year hit a record low of only 353.

TABLE 5 AREA PLANTED WITH COTTON IN SOUTH AFRICA

	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07
Area planted in hectares	90,418	82,971	89,939	98,619	50,768	56,692	38,688	22,574	35,719	21,763	18,114

Source: *Cotton South Africa, 2006c.*

TABLE 6 NUMBER OF SMALL-SCALE COTTON FARMERS IN KWAZULU-NATAL

2001/02	2002/03	2003/04	2004/05
3229	353	1594	598

Source: *Cotton South Africa, 2006b.*

- GM cotton planting is decreasing in South Africa. GM cotton production declined from 86% of all commercial cotton in 2004/05 to 77% of total cotton in 2005/06.
- Contrary to what Monsanto claims, Bt cotton yields are not higher than yields of conventional varieties.
- Most small cotton farmers in South Africa have accumulated massive debts and lost money in Bt cotton production.

Despite these realities, the Bill Gates Foundation recently hired Rob Horsch, former Vice President of Monsanto, who is quoted on Monsanto's website as saying that his passion for the developing world increased when "he was visiting cotton growers in South Africa, and seeing and hearing first-hand what success with Bollgard insect-protected cotton meant to them". Horsch has recently been promoted to a senior position at the Gates Foundation, which has the mission to "improve crop yields via the best and most appropriate science and technology, including biotechnology, for problems in regions including sub-Saharan Africa".

4.5.2 subsidies: the curse of west african cotton farmers

The economies of several West African countries are highly dependent upon cotton production. Global cotton prices have fallen by 54% since the mid-1990s, and these lower prices threaten the local communities that depend on cotton farming. Numerous factors triggered the decline in prices, but the most relevant was the increase in subsidies paid to cotton farmers in the United States, making it extremely difficult for African farmers to sell into the highly protected American market. Along with the other major West African cotton producing countries, Burkina Faso is now under increasing pressure from the US government and multilateral organizations to rapidly introduce GM cotton. But if low prices and US subsidies are the problem, how will Bt cotton change anything?

4.6 latin america

Genetically modified cotton has been authorized for commercialization in Argentina, Colombia and Mexico. There is also pressure to approve it in other countries, namely Brazil and Paraguay.

4.6.1 argentina: gm cotton does not drive production growth

Around 60% of the area of cotton planted in Argentina is genetically modified. The last decade of cotton in Argentina has been characterized by a significant decrease in the area of production, from over 1 million hectares planted during the 1995/96 season to just 158,209 hectares in 2002/03. Low international prices and lack of financing devastated the local cotton sector, and Argentinian farmers chose to plant soybeans rather than cotton. The decline in cotton hectarage after 1998, coinciding with the adoption of genetically modified cotton, indicates that GM cotton does not drive Argentinian farmers' production. Once again, prices lie at the heart of the decision. Better prices are helping to increase the production area in recent years, and it is estimated that cotton hectarage will grow due to expectations of future cotton subsidy reductions in the US. However, the increase in production area will be spearheaded by large-scale cotton producers, capable of substantial capital investments. The financial situation of small and medium-sized farmers is more precarious.

TABLE 7 COTTON PRODUCTION AREA IN ARGENTINA, 1995-2006.

COUNTRY TOTAL	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06
Area planted in hectares	1,009,800	955,560	1,133,500	750,930	345,950	410,905	174,043	158,209	266,387	406,215	315,000

Source: *SAGPYA and USDA, 2005l.*

4.6.2 mexico: a decade of crisis for the cotton sector

In 1996, the same year that GM cotton was approved in Mexico, total cotton production in the country began to decline and farmers were faced with one of the most serious crises ever experienced in the country's cotton sector. Over the past decade, the most serious problems for Mexican cotton farmers have been low prices and low levels of governmental support, combined with increased production costs.

TABLE 8 **AREA CULTIVATED IN MEXICO WITH COTTON, 1996-2006.**

COUNTRY TOTAL	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006 ESTIMATE
Area planted in 1,000 hectares	315	214	250	149	80.2	91.9	40.5	62.9	110	130	115

Source: *Servicio de Información Estadística Agroalimentaria y Pesquera SIAP/SAGARPA and USDA, 2006r.*

The challenging situation for farmers during this first eight years of Bt cotton indicate that this GM crop has played little or no role in improving their livelihoods. The production of GM cotton is expected to drop to 50,000 metric tonnes in 2006/07, a substantial decline from 70,000 metric tonnes in 2005/06.

4.6.3 colombia: unsuccessful bt cotton

The economic situation of the cotton sector is not very promising in Colombia, either. Colombian farmers cultivated a total of 57,424 hectares of cotton in 2006, a decrease of 21.7% from 2005. The government estimates that 25,083 hectares of cotton, or 43.7% of the total cotton area, have been planted with the GM Bollgard I cotton. The decrease can be explained by low international prices for cotton, the revaluation of the national currency, higher production costs, and restricted access to credit. Farmers are concerned about the high cost of the GM seeds, the inadequate biosafety measures for GM technology, and the high susceptibility of the seeds to weather impacts. Despite having planted Bt cotton, small-scale farmers are having problems with pest attacks, which damage their crops and increase production costs.

TABLE 9 **COTTON PRODUCTION IN COLOMBIA, 2005-2007**

COUNTRY TOTAL	2005	2006	2007 ESTIMATED
Area cultivated (hectares)	73,306	57,424	51,883

Source: *Republica de Colombia, 2006.*

4.7 the growth in organic cotton

Over the past five years, the organic cotton sector has grown exponentially in many parts of the world. Despite a relatively small total area cultivated with organic varieties, organic cotton acreage has experienced a bigger increase – 292% between 2000 and 2005 – over the past few years than either conventional or GM cotton, and future prospects for growth are very good.

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4.8 what are the benefits of gm cotton, and for whom?

ISAAA claims that over 7 million small-scale farmers in China, India and South Africa are benefiting from GM cotton. None of ISAAA's recent briefs mention any problems with Bt cotton anywhere in the world. In other words, ISAAA completely ignores the widespread evidence of Bt cotton's failures, simply asserting that every single farmer who has grown it has benefited.

However, the recent Cornell University study documenting the financial losses suffered by Bt cotton farmers in China due mainly to secondary pests; the ban of the first commercialized varieties in Andhra Pradesh and the continuous livelihood challenges for Indian farmers; and the rejection of Bt cotton by Indonesian farmers all indicate that there are serious problems associated with the release of GM cotton. The South African cotton crisis shows that Bt cotton has been unable to improve the livelihoods of small farmers in the Makahatini Flats of South Africa.

In Argentina, Mexico, and Colombia, cotton production in general has declined sharply over the past decade, with low international prices posing the main challenge for farmers. Transgenic technology has been of little or no use in these contexts. In Mexico, the area planted with Bt cotton is expected to significantly decrease in 2006/07, and in Colombia farmers complain about the high costs of GM cotton. It has been reported in some areas that the use of GM cotton does not preclude severe pest attacks. In India, cotton farmers face high levels of poverty and indebtedness, and Bt cotton has been ineffective in addressing drought, plunging cotton prices, the rising cost of inputs, and mounting debt.

Bt cotton has improved neither yields nor the quality of cotton fiber. In Australia, for instance, yields have remained constant since the introduction of Bt cotton, which has contributed nothing to ameliorating the drought and low prices faced there.

Experience on the ground shows that claims of reduced pesticide use with GM crops are simply not true. On the contrary, exhaustive analysis of US government data shows that the introduction of GM soybeans, corn and cotton have led to a substantial increase in the overall use of pesticides (herbicides and insecticides) on these crops. Recent studies in China show that insecticide use on Bt cotton has increased sharply in recent years due to the rapid emergence of secondary pests unaffected by the Bt toxin. Anecdotal evidence in South Africa, and India suggests that GM cotton has not reduced pesticide use there either.

Transgenic cotton has not and can not do anything to address the most pressing issue facing the world's cotton farmers: low prices. For example, West African leaders have identified low international prices as the main obstacle to pulling their 2 million farmers out of poverty. In this situation, the promotion of a technology like Bt cotton by the US government can only be viewed as a dangerous distraction. Instead of pushing countries like Burkina Faso to adopt transgenic cotton, as the USDA did at a high level ministerial in 2004, the US government should be reducing or eliminating price-lowering subsidies for its 25,000 cotton farmers.

Transgenic cotton also presents increasingly worrying environmental problems that have emerged most clearly in the United States, but are likely to occur around the world in coming years. Glyphosate-resistant weeds are rapidly becoming a serious and expensive headache for growers of RR cotton and soybeans. In order to control these problematic weeds, US farmers are forced to purchase and apply much greater quantities of Roundup, to switch to more toxic herbicides in some cases, and also to abandon erosion-reducing conservation tillage practices - ironic, since RR technology has long been touted as promoting conservation tillage.

The US experience, as well as the failure of Bt cotton in China, India, Indonesia and other countries, offers a strong argument for a 'time out' in the biotechnology industry's headlong rush to introduce and expand plantings of transgenic cotton around the world. Issues like the growing resistance of weeds to RR cotton and the secondary pest outbreaks linked with Bt cotton require thorough investigation by independent researchers. The substantially greater cost of transgenic versus conventional cottonseed is also of great concern to farmers, especially in the developing world, and particularly when the GM cotton does not live up to its promises.

Related to this is Monsanto's prospective acquisition of the world's largest cottonseed company, Delta and Pine Land, which has substantial sales not only in the US but also in India, Australia and increasingly in Africa. This merger will likely lead to the decreased availability and increased cost of conventional cottonseed. Perhaps most alarming is the possibility that Monsanto will release Delta and Pine Land's patented 'Terminator' sterile seed technology into the world's cottonseed. This would eliminate the option of seed-saving, of great concern to developing country farmers in particular.

Finally, more attention is needed for sustainable non-transgenic alternatives such as organic cotton, the demand for which has increased dramatically in recent years.

europe: a closed door to gm crops

In Europe, the public is solidly against eating GM food, and there is a remarkably large political movement opposing its cultivation. Although there have been marginal increases in the areas of transgenic crops grown in Europe, the long-term prospects for Monsanto's GM seeds look bleak. A lack of markets, national bans, and evidence of environmental damage ensure that one of the world's biggest markets will remain a disaster zone for the biotech industry.

An EU-wide survey of public views in 2006 reconfirmed the public's opposition to GM food. The majority of Europeans think that GM food "should not be encouraged", and the survey concludes: "GM food is seen by them as not being useful, as morally unacceptable and as a risk for society". In November 2005, the people of Switzerland voted in a referendum to ban GM crops for the next five years. Over 55.7% of the public voted in favor of the moratorium across all of the country's 26 regions.

After nine years of commercialization, only Spain grows a significant amount of GM maize, but reports suggest that the cultivated area may have decreased for the second consecutive year from around 57,000 hectares in 2005 to approximately 53,000 hectares in 2006.

Despite the clear opposition to GM foods and crops in Europe, Monsanto continues to attempt to persuade its investors of its eventual success there. At its November 2006 Investor Day, Monsanto once again outlined ambitious plans for expanding its control of agriculture in Europe over the coming years.

Monsanto is also increasing its market share for conventional maize seeds, currently controlling 15% of the French market, 21% of the Italian market, 32% of the Hungarian market and 21% of the Turkish market. The takeover of the conventional seed market is a worrying sign, especially from a company determined to restrict choice by introducing predominantly GM varieties.

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new crops and the contamination paradigm

Despite the fact that very few GM crops have succeeded commercially, the biotech industry and some institutions have been experimenting with other crops including wheat, rice, potatoes, cassava and sorghum.

A recurring phenomenon connected with the release of GMOs into the environment, whether for experimental or commercial purposes, is the inability or unwillingness of government regulators and others to control them once they are released. One GM crop that was intended solely for animal feed managed to contaminate the food supply. Others that were meant only for experimental purposes appeared in the environment and food supply years later. The type and extent of the contamination identified since 1996 clearly suggests that the biotechnology industry's headlong rush to commercialize its transgenic crops has been undertaken without regard for the often serious impacts on markets and farmers that want nothing to do with GM crops.

6.1 experimental rice contaminates food supply in america, asia, europe and africa

The release of experimental GM rice is at the center of the most recent case of contamination of our food supply. In August 2006, the USDA revealed that the US rice supply had been contaminated by an experimental Bayer GM rice variety unapproved for human consumption, known as LL601. More than 15 countries in Europe have identified the experimental GMO in their rice supplies, and Europe is testing all imports to prevent further contamination.

A round of monitoring activities was undertaken in Ghana and Sierra Leone by local chapters of Friends of the Earth Africa. The samples sent to an independent laboratory in the United States confirmed the presence of the illegal GM rice in nine samples. Two bags of US food aid and one commercial rice product in Sierra Leone were tainted. Six different types of commercial rice from the US also tested positive. The experimental rice LL601 has since been given ex post facto approval by the USDA, a controversial decision that has drawn much criticism.

Despite the USDA's announcement, the USA Rice Federation announced a plan of action to eliminate the illegal variety from the rice supply in November 2006.

6.2 biofuels: syngenta's gm corn unnecessary

Within the current global energy debate, the topic of biofuels has received tremendous media attention. In the US, the major 'energy crop' by far is corn, which is processed into ethanol and then blended with gasoline as a fuel for motor vehicles. At present, there is not a single approved GM corn variety, nor any other GM crop, that has been engineered for use in the production of biofuels. Although conventional crops work just as well as GM crops engineered for herbicide tolerance or insect resistance in the production of biofuels, some companies are developing new GM crops specifically for this market.

Not wanting to miss a PR opportunity, the biotech industry has been prominent in pushing for the expansion of biofuels, and is now claiming that biofuels will help to address the urgent issue of climate change. Whereas the seed industry sees this as a new opportunity to expand markets in for example corn for ethanol production, the biotech industry is now genetically engineering corn specifically for biofuel. Syngenta is furthest along in this respect, with a recent application to the USDA for its 3272 line of corn, which has been genetically modified to contain an enzyme used in the ethanol production process. However, there are concerns that this industrial enzyme – which would be a completely new ingredient in the food and feed supply – could cause allergic reactions in those who consume or inhale it. In addition, a nearly identical enzyme, which can be added to corn at the ethanol refinery, is already available. In light of the risks and a readily available alternative, there seems to be no need to introduce GM corn specifically engineered as a biofuel feedstock.

6.3 gm bentgrass for golf courses

Monsanto and the Scotts Company are developing a genetically modified variant of bentgrass that will resist spraying from the Roundup herbicide. While this GM bentgrass has not been approved for commercial use by the USDA, it is still intended for use on golf courses. In 2006, scientists with the US Environmental Protection Agency reported that RR bentgrass had escaped from a testing area, showing up at distances of up to 3.8 kilometers from an old test plot. The incident has been called the first confirmed 'escape' of a GM crop into the wild in the United States. If approved for golf course use, RR bentgrass would broadly spread its seeds and cross-pollinate with closely-related grasses, some of which are weeds. These new 'superweeds' would no longer be controllable with the weed-killer glyphosate, creating serious problems for turfgrass growers and managers of natural lands. The USDA's decision on RR bentgrass is still pending.

6.4 cassava trials fail in nigeria

Traditional crops from developing countries are also in the pipeline for GM experimentation, including GM cassava with resistance to mosaic disease. GM cassava has been created at the Donald Danforth Center in St. Louis, and sent to Nigeria for experimentation at the International Institute for Tropical Agriculture (IITA). In a letter to ERA/Friends of the Earth Nigeria in 2006, however, the Nigerian Ministry of Environment confirmed that the application to test the GM cassava was withdrawn by the IITA due to its failure to achieve resistance to cassava mosaic disease.

6.5 gates foundation sorghum project rejected in south africa

The Africa Harvest Biotech Foundation International secured US$18.6 million for five years from the Gates Foundation to develop new sorghum varieties with elevated levels of iron, zinc and vitamins. The organizations applied for greenhouse trials in South Africa, but the authorities rejected this application in July 2006 due to concerns that GM sorghum could contaminate wild varieties.

6.6 potato push in the european union

An application to grow a GM potato has been made by the German-based BASF. The potato has been engineered to increase its production of amylopectin, a key component for starch production. In the first vote among European Union states in eight years on a GM crop for cultivation, the industry failed to gather enough votes for the introduction of the potato. In the meantime, some starch companies have publicly stated that they will not buy these potatoes if they are grown.

Cassava, Nigeria.

© foe nigeria

conclusions: gm crops fail to deliver benefits

Experiences after more than a decade of commercial planting of GM crops lead to the following conclusions:

The GM crops commercialized on a large scale in a few countries in the world since 1996 have not addressed the main agricultural problems and challenges facing farmers in most countries of the world, and have not proven to be superior to conventional crops. Despite Paraguay and Brazil's massive adoption of GM soy, farmers in those countries are still in deep crisis, and production has gone down in the last two years due to low prices and increased costs for inputs, such as transgenic seeds. GM cotton farmers in South Africa, Colombia, Argentina, Mexico, and Australia have been severely affected by low prices and weather conditions like drought. GM cotton has not contributed meaningfully to their livelihoods, and the crisis of the cotton sectors in those countries has continued despite the introduction of GM cotton. Bt cotton does not address the key challenges facing Indian cotton farmers, including drought, the rising costs of inputs, falling cotton prices, and mounting debt. Consequently, a large number of small-scale cotton farmers in the country are trapped in poverty and indebtedness. In short, GM crops have contributed little if anything towards addressing the major challenges faced by farmers in most countries.

GM crops have been released quickly and widely without an adequate evaluation and understanding of their performance or of their health, environmental and socio-economic impacts. The discovery of GM rice in the food chain in the US, Europe, Africa and Asia, stemming from experimental trials in the US that were supposed to have ended in 2001, shows the inability or unwillingness of the industry to control its products. The increased susceptibility of GM soy to drought went unheeded in Brazil and Paraguay, where farmers suffered greatly from the huge losses in their GM soy harvests due to recent droughts. The rapid introduction of GM cotton has caused severe problems with herbicide-resistant weeds (United States), poor performance (India and Indonesia), and secondary pests not killed by Bt cotton (China). For instance, the introduction of inferior Bt cotton varieties in India's Andhra Pradesh, ultimately banned due to poor performance, illustrates the hazards of the premature, profit-driven adoption of poorly-tested GM crops. The belated 'fix' that is only now being suggested to remedy Bt cotton's recent failures in China – the planting of refuges to stave off future insect attacks – vividly demonstrates the lack of foresight in those promoting transgenic technologies.

Small-scale farmers and consumers have not benefited from the introduction of GM crops. GM crops have not improved the livelihoods of small farmers in a sustainable manner. On the contrary, data from across the world demonstrates that GM crops have often performed worse than conventional varieties in countries including India, Indonesia, Brazil and Paraguay. In recent years, small farmers in China have earned more planting conventional cotton than the Bt variety. In India and Indonesia, many small farmers have suffered from the agronomic failure of Bt cotton. In South America, GM crops have contributed to the further concentration of land and the displacement of small-scale farmers. No GM product commercialized today offers any benefits to the consumer in terms of quality or price. GM feed does not even offer an advantage to the feed industry.

GM crops commercialized today have on the whole increased rather than decreased pesticide use, and do not yield more than conventional varieties. The environment has not benefited, and GM crops will become increasingly unsustainable over the medium to long term. Data from the United States, Australia and Brazil indicates that GM crops do not yield more than comparable conventional varieties. Even the USDA has recognized this fact. Comprehensive and independent analysis from the US, and indications from countries such as South Africa and Brazil, indicate that GM crops do not reduce pesticide use, and may even lead to increased chemical use for some GM varieties. With the appearance of pest and weed resistance, the unsustainability of the GM crop model will increase in the medium to long term. Further soybean expansion in South America will increase deforestation in critical areas such as the Amazon, leading to the displacement of poor rural families and a reduction in food security as crops for domestic consumption are replaced by export-oriented soybean monocultures.

To date, GM crops have done nothing to alleviate hunger or poverty. The great majority of GM crops cultivated today are used as high-priced animal feed to supply rich nations with meat. More than four out of every five hectares of GM crops are engineered to withstand the application of proprietary herbicides sold by the same company that markets the GM seed, and have little if any relevance to farmers in developing countries who often cannot afford to buy these chemicals. The experience with Bt cotton in South Africa, the most widely-touted example of a small-scale farmer success story; the ongoing fights in India over pricing and the agronomic failures of Bt cotton; the recent reports documenting the losses suffered by Bt cotton farmers in China; the inability of Bt cotton to address the main problems of small-scale cotton farmers in India; all of these cases strongly suggest that GM crops are not an effective tool for addressing hunger and poverty. Yet despite these failures, charitable groups like the Gates Foundation are funding transgenic plant research that is very unlikely to yield any significant benefits to the world's small farmers.

Monsanto has been the main beneficiary of the commercialization of GM crops in the United States. Through constantly acquiring new seed companies, Monsanto has gained enormous control over the world seed business, creating a platform for the widespread introduction of its GM traits into exorbitantly priced seed. Further 'monopolistic' consolidation of that trend in the US will further reduce choices for farmers and consumers, and will likely lead to the disappearance of conventional – non genetically-modified – varieties of seed for key crops like cotton, soybeans and maize. Monsanto's strategy is to "increase penetration" of its GM crops in the key strategic markets: GM soybeans in Brazil, GM cotton in India and Africa, and GM corn in the United States and Europe. However, the soybean crisis in Brazil, the current controversy over GM crops in India, and continued market opposition to GM food in Europe have all forced the company to lower its expectations.

Large-scale farmers in the US and Argentina have benefited from a 'convenience effect', particularly in soybean production. However, it is questionable whether this 'convenience effect' means greater net economic returns compared to those derived from conventional soybean production. Large-scale farmers in the US and Argentina, who represent a small minority of the world's farmers, are the main beneficiaries of GM crops due to a 'convenience effect' that includes reductions in farm labor and increased flexibility in the timing of herbicide applications. However, increased weed and pest resistance to these GM crops is already eroding this 'convenience effect'. Additionally, these small convenience benefits do not apply to large-scale growers of cotton in Australia or soybean farmers in Brazil and Paraguay, due to the crises in their respective sectors.

There are a lack of comprehensive studies on the performance of GM crops in every country that has commercialized them, and this consequently calls into question their claimed benefits. No country in the world has produced a comprehensive study of the real impact of GM crops at the farm level. There is no adequate analysis of pesticide use, yields, weed/pest resistance, or effects upon smaller growers over the short, medium or long term that includes a comparison with existing conventional varieties and other agricultural methods such agroecology or organic food production. Incredibly, industry-funded organizations like ISAAA have been accepted as the official source for evaluations of the performance of GM crops, though they often employ dubious data and flawed methodologies. Furthermore, ISAAA and other industry-funded organizations virtually never confront or even acknowledge problems with GM technology, thus making their conclusions biased.

The world needs sustainable agricultural approaches, and it is high time that governments and agricultural specialists devote their energies to developing techniques and policies that can provide people with healthy food and sustain the world's small farmers.

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