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Crop duster spraying pesticides in North America.

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executive summary

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Friends of the Earth International

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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.

our mission

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.*

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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

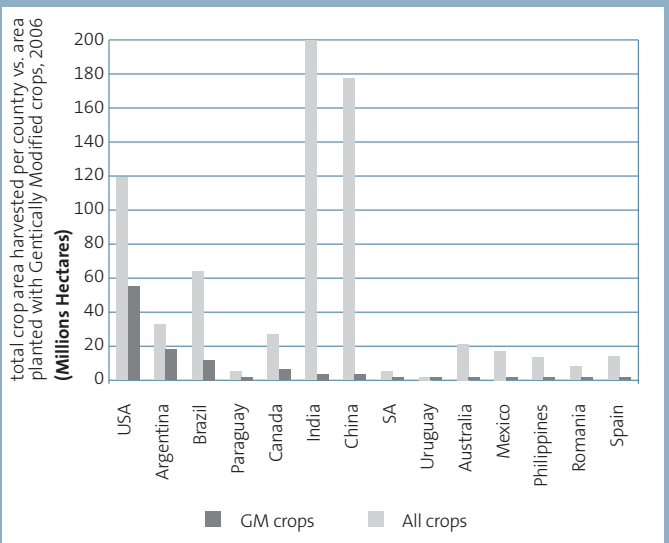
Biotechnology proponents claim that genetically modified (GM) crops are good for consumers, farmers and the environment, and that they are growing in popularity around the world. However, such claims are seldom subjected to scrutiny. As in past editions of "Who Benefits from GM Crops?" we here provide a fact-based assessment of GM crops around the world, and address common misconceptions about their impacts. In this 2008 edition, we report on new trends and findings, particularly the rise in pesticide use with GM crops.

key findings: gm crops fail to deliver environmental, social and economic benefits

1.1 the status of gm crops in the world in 2007: 4 crops, 2 traits, and a handful of countries

Production of GM crops continues to take place primarily in a handful of countries with highly industrialized, export-oriented agricultural sectors. Over 90% of the area planted with GM crops is in just five North and South American countries: the United States, Canada, Argentina, Brazil and Paraguay. The US alone produces over 50% of the world's GM crops. The U.S. and Argentina together grow over 70% of all GM crops.

FIGURE 1 TOP GM CROP PRODUCERS. MEGA-BIOTECH COUNTRIES?



Source: *Friends of the Earth International, 2007. Based on FAOSTAT and ISAAA. For figure details see full report*

The industry-funded International Service for the Acquisition of Agri-biotech Applications (ISAAA) refers to 14 biotech "mega-countries"(figure 1). But in most of these top 14 GM producer countries, GM crops represent less than 3% of the total crop area harvested. In only four countries – the U.S., Argentina, Paraguay and Uruguay – are GM crops planted in more than 30% of total cropland. The main GM crop grown in the latter three South American countries is soya, most of which is exported. In Europe, the GM industry's claims of a 77% increase in GM maize cultivation in 2007 still amounts to less than 2% of the total maize production area.

As in past years, GM soya, corn (maize) and cotton comprise over 95% of world GM crop acreage (virtually all the rest is GM canola or oilseed rape). Soya and corn are used mainly as animal feed in wealthy countries. For instance, Argentina exports much of its GM soya to feed livestock in Europe. In the U.S., over 20% of the corn harvest is devoted to ethanol production.

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 with commercial GM crops have one or both of just two traits: herbicide-tolerance and insect-resistance.

In the U.S., the world leader in GM crop production, companies are focusing their development efforts on producing new herbicide-tolerant (HT) crops. Two of the four GM crops approved over the past year and five of 12 new GM crops awaiting commercial approval from the U.S. Dept. of Agriculture (USDA) are herbicide-tolerant. Two of these crops in the pipeline are tolerant to two herbicides rather than one, a new development driven by the spread of herbicide-resistant weeds.

1.2 gm crops increase pesticide use

Pesticides are chemicals that target weeds (herbicides), insects (insecticides) or other pests. HT versions of soya, corn, cotton and canola represent 4 of every 5 hectares (81%) of GM crops worldwide. HT crops are 'pesticide-promoting' – that is they encourage the development of herbicide-resistant weeds, which in turn lead to yet more pesticide use.

HT crops allow farmers to spray a particular herbicide more frequently and indiscriminately without fear of damaging the crop. They also allow larger, wealthier farmers to cultivate more acres with less labor, advancing the world-wide trend towards fewer and bigger industrial-style farms.

Pesticide-promoting HT crops have spawned an epidemic of herbicide-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 exacerbating.

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.

1.3 alleviating hunger and poverty?

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 – mainly for consumption in rich countries. GM crops have not increased food security for the world's poor. None of the GM crops on the market are modified for increased yield potential and research continues to focus on new pesticide-promoting varieties that tolerate application of one or more herbicides. Monsanto's Roundup Ready soya is modified for resistance to the herbicide glyphosate. It is the world's most widely planted GM crop and it suffers from a "yield drag" due in part to reduced uptake of essential nutrients.

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. Bt cotton cannot 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.

1.4 seed control and prices

Increased 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. 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.

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. Even the U.S. Department of Agriculture admits that 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.

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.

1.5 lack of independent evidence

There remains a shortage of rigorous, independent studies examining the performance and claimed benefits of GM crops in those countries that have commercialised them. Analysis of GM crops is a highly complex issue that requires independent, scientific research. Too often, decision-makers rely on the findings of organizations like the ISAAA, which is funded by the biotech industry and has a clear interest in promoting the products of their sponsors. As this reports shows, ISAAA's claims with respect to 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.

the rise in pesticide use

Herbicide-tolerant crops are designed to permit "over-the-top" application of chemical weed killers 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 allow 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 herbicide tolerant crops are Monsanto's Roundup Ready varieties, tolerant to the herbicide glyphosate (marketed by Monsanto as Roundup). The dramatically increased 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 GM crops, which produce a toxin derived from Bt (Bacillus thuringiensis) bacteria, do not provide a sustainable means of decreasing the use of insecticides.

Although 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:

- **the huge increase in glyphosate use in the united states.** In the US, 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% (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. per acre per year.

TABLE 1

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	% = HT	Glyphosate applied	% = HT	Glyphosate applied	% = 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	75,743,00	87%	26,304,00	26%	17,024,00		119,071,00	More than 15-fold increase in glyphosate use on soybeans, corn and cotton from 1994 to 2005.
2006	96,725,00	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. Based on USDA data. For detailed references see full report*

- **glyphosate is not replacing other herbicides in the united states.** While farmers growing Roundup Ready crops initially used lower quantities 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. While glyphosate use on corn increased 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.

TABLE 2 **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	61,710,00	32,045,00	27,511,000	121,266,00	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 represent pounds of glyphosate applied. Based on USDA data. For detailed references see full report.*

- **steep increase in glyphosate-resistant weeds in the united states.** 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 HT crops. Thirty of those cases occurred between 2001 and 2007. Experts agree that continuous planting of Roundup Ready crops and over-reliance on glyphosate are to blame. Documented glyphosate-resistant weeds now infest an estimated 3,251 sites covering 1 million hectares. This estimate does not include weeds with suspected resistance, which are likely to infest a much larger area.

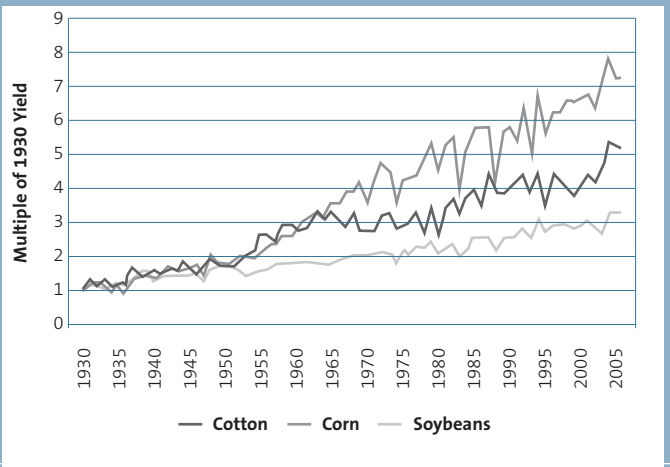
- **rise of glyphosate use and weed resistance in brazil.** Data from Brazilian government agencies show that the consumption of the 15 main active ingredients contained in the most heavily used soya herbicides increased 60% from 2000 to 2005. The use of glyphosate increased 79.6% during this period, much faster than the expansion 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.
- **increase in 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 GM Roundup Ready soya. In 2007, Argentine agricultural experts reported that a glyphosate-resistant version of Johnson Grass now infests over 120,000 ha of the country's prime cropland. According to the UN's Food and Agriculture Organization, Johnson Grass is one of the worst weeds in the subtropics, and resistance to glyphosate will make it all the harder to control. Experts estimate that 25 million litres of herbicides 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 corn, which is likely to 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 GM 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.

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 it provides no evidence to support this claim. Hunger is mainly attributable to poverty; lack of access to credit, land and inputs; and other complex political factors. Furthermore, 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 – mainly for consumption in rich countries. These facts suggest that GM crops have not increased food security for the world's poor. 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. 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.

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

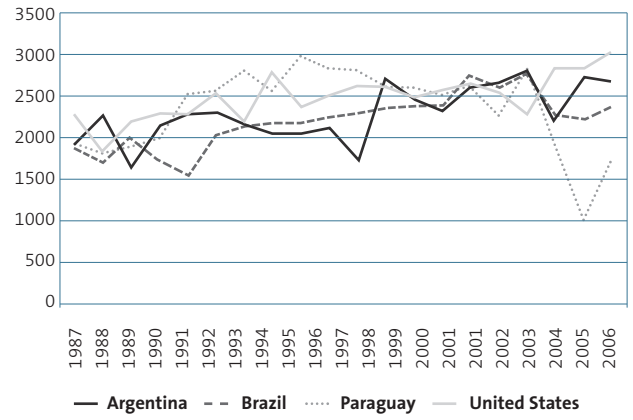


Source: *USDA-ERS*

- **herbicide-tolerant 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.

FIGURE 3

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



Source: *Friends of the Earth International, 2007.*
Based on FAO data. For detailed references see full report

- **insect resistance of bt corn has a minor influence on yield:** Before the introduction of Bt corn in the U.S., only 5% of corn acres were sprayed for the European corn borer, the main insect pest killed by Bt corn. This is because in most years, the European corn borer caused little or no damage, meaning little or no adverse impact on yield. As noted above, yield is more heavily influenced by other factors. 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 3 shows a summary of the performance of Bt cotton by country, along with the claims made by the ISAAA.

TABLE 3 **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*

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