Dispelling the myths

The real facts about agricultural biotechnology and biotech food

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Executive summary

***Dispelling the Myths: the real facts about agricultural biotechnology and biotech food* is an update to *Correcting the Myths* which the American Soybean Association and eight other major U.S. farm organizations published in 2003.**

We felt it necessary to produce a new edition of *Correcting the Myths* because so much information has since entered the public domain thanks to the work of scientists, economists and other researchers across the globe. Agricultural biotechnology is probably the most intensively studied agricultural innovation of all time. Yet almost without exception, the new data has confirmed the old, and allow us to conclude without hesitation that ag biotech has been measurably and valuably beneficial in every sense, highly successful as a farm tool, and has the potential to be even more outstanding in the years ahead.

Yet the old myths continue to circulate. Often they rely on information that is not only out of date but misconstrued, misapplied or invented. We have provided detailed rebuttals, supported by more than one hundred references, in the pages that follow. In summary, however, we can say with confidence that all the evidence has shown that:

- Biotechnology, far from being a disaster for U.S. farmers, has come to dominate production of the three big commodity crops: soybeans, corn and cotton. It has raised farmer incomes, saved them time and input costs, and maintained their competitiveness in world markets.
- It has increased net yields by reducing losses due to weed pressure and insect attack.
- It has cut pesticide use and substituted benign herbicides for environmentally harmful chemicals.

It has enabled farmers to expand greatly their use of conservation tillage, which is better for insect and bird life, reduces soil erosion, and cuts the amount of CO_2 farming releases into the atmosphere.

- It has made imported U.S. commodity crops cheaper for developing countries.
- It is proving even more advantageous when grown in developing countries, giving substantially greater yields and dramatic reductions in the use of dangerous chemicals compared to traditional methods (in China alone, Bt. cotton has probably saved several hundred farmers' lives).
- It has made corn safer to eat by reducing the risk of mycotoxin poisoning, a serious problem in many developing countries where storage conditions are primitive.
- It has been confirmed as making food as safe, if not safer, than conventional agricultural methods, by all the world's leading scientific institutions.

American Soybean Association, 2005

"The myths are no longer sustainable"

Foreword from Kimball Nill, technical director, American Soybean Association

The advent of ag biotechnology has been memorable for many reasons. One of the most curious, and for me, the saddest, is the contagion of misunderstandings, half-truths and sometimes blatant falsehoods spread by its critics and rivals during the past decade. These "myths" – for often, that is all they are – have poisoned honest debate and corrupted the judgements of politicians, journalists, consumers, farmers, and tragically, the governments of some of the world's poorest countries.

In 2003, the American Soybean Association (together with eight other leading U.S. farm organizations) published *Correcting the Myths*. We wanted to add the rational, independent farmers' voice to the world's biotech debate, a viewpoint often unheard, and certainly often ignored, in Europe and elsewhere. We sought to communicate the facts about ag biotech, in part based on our own experiences, to counteract some of the most egregious propaganda ever to emanate from environmental and organic farming lobbyists.

Two years on, we realise our document needs to be updated - because the facts just got better. Since 2003, global biotech crop acreage has increased by 30%.[1] Many more countries have joined the biotech revolution. Millions more gallons of pesticide have stayed in the warehouse or not been manufactured. Thousands more tons of soil have been conserved. Hundreds more developing world farmers are saved from chemical poisoning.

For the doomsayers, we can also present much more unarguable data and supporting evidence. Since 2003, dozens of scientific papers and agronomic studies have been published, validating what we had always known or suspected: that biotechnology really is helping farmers save money (the poorest ones most of all), really is protecting the environment, really is increasing food production, really is as safe as any other way of growing food.

In 1999, Patrick Holden, head of Britain's leading organic farming organization, the Soil Association, and one of ag biotech's most resolute critics, famously told *Reuters* that Americans would reject ag biotech with "massive opposition within a year."[2] Today, biotech varieties dominate U.S. crop farming with soybean, cotton and corn production at record levels.[3] At the same time, Britain's organic farming sector appears to be faltering, with the amount of land under organic production falling 5% in a single year.[4] Meanwhile British farmers, like those in most of the rest of Europe, continue to be denied access to a technology used successfully by their competitors in North and South America, Asia, India, South Africa, and Australia.

With this in mind, and after studying the masses of new evidence, of which this document has space to cite merely a sample, we decided that our old title, *Correcting the Myths* was no longer adequate.

The myths, to borrow a favorite word of biotech's critics, are simply no longer sustainable.

The facts have dispelled them.

Kimball Nill
Technical Issues Director
American Soybean Association

May 2005

Let the facts dispel the myths

Agricultural practice

Myth 1: Biotechnology has been a bad deal for American farmers.

Reality: Biotech has transformed American farming, making commodity crops cheaper and easier to grow as well as reducing chemical use.

For a technology that is meant to have been an economic disaster, American farmers have been remarkably enthusiastic about agricultural biotechnology. Less than ten years ago biotech seeds did not exist commercially, yet in 2004, they were planted on more than 85% of U.S. soybean acres, 76% of U.S. cotton acres and 45% of U.S. corn acres (USDA estimates).[5] Moreover, every year since 1996, the acreage sown to biotech crops has increased substantially.

The rapid take-up of ag biotech cannot be put down to farmers' blind enthusiasm. The simple reason is that biotech crops have saved them money and reduced their workload. In October 2004, a National Center for Food and Agricultural Policy (NCFAP) study calculated that the six main biotech crops together increased grower income by $1.9 billion in 2003, as well as boosting net yields by 5.3 billion pounds and cutting pesticide use by 46.4 million pounds.[6]

The NCFAP study also found that

- Biotech soybeans resulted in the greatest reduction in pesticide use, 20.1 million pounds, which produced the greatest economic return for growers — an additional $1.2 billion in income.
- Biotech corn (especially European corn-borer resistant) produced the highest yield gains — 4.9 billion pounds — which helped save $258.4 million in farmers' production costs.
- Biotech cotton led to a significant reduction in pesticide use, 12.9 million pounds, which led to an additional $413.13 million in income for farmers.
- Biotech canola led to a reduction in pesticide use of 152,740 pounds, which helped farmers save some $9 million in production costs.

In a study, albeit limited, of biotech crop adoption during 1997 and 1998, commissioned by the U.S. Department of Agriculture[7], herbicide-tolerant crops saved significant amounts of (uncosted) farmer time and effort, which helps to explain their immense popularity.

Furthermore, we know from experience that herbicide-tolerant varieties such as soybeans lead to cleaner crops with fewer weeds, which makes the crop worth more to the farmer at sale, garnering higher prices[8] due to minimal foreign matter.[9]

Biotech crops have the potential to help farmers even more. An earlier NCFAP study[10] estimated that if growers adopted 40 biotech cultivars, either already commercialized or under development, the total net economic impact would be $2.5 billion per year, an annual increase in production of 14 billion pounds and a pesticide reduction of 163 million pounds per year.

A 2003 USDA study[11] study of how the economic benefits of biotech crops are distributed found that producers and seed companies are far from the only ones to gain in measurable ways. Indeed, for some biotech crops, consumers, U.S. and foreign, have benefited even more than producers, thanks to lower commodity prices, which result from increased supplies.

Nor, as some predicted, have biotech crops made farming less profitable, if the price farmers are willing to pay for land is any measure. In Iowa, America's leading soybean and corn producing state, farm land prices are at record levels, and rose 15% during 2004, the largest annual increase for eight years.[12]

Myth 2: Farmers have become dependent on biotech "seed giants".

Reality: The large and vigorous industry of traditional seed suppliers - some 100 in America alone - underlines the fact that non-biotech seeds remain freely available and widely used. All seeds compete on performance.

In the case of soybeans, around two thousand varieties are sold, of which approximately 1,200 are biotech-derived varieties.

There are also around 100 independent (not owned by biotech firms) seed companies currently marketing soybean seed with which the 12 seed firms acquired by biotech companies have to compete.

There are no national "recommended variety lists" for soybeans in the U.S. because climate/soil, etc. conditions vary so much geographically that a high performance variety in one state might not be suitable in another. However, when yield comparison field test plots are published, the yield performance potential of the top five biotech (herbicide-tolerant) and non-biotech soybean varieties tend to be very similar.

Myth 3: Biotech crops only suit U.S. agriculture

Reality: Biotech crops are widely grown outside the U.S. One third of the world's biotech crop acreage lies in developing countries where the take-up of ag biotech is now moving twice as fast as in industrial countries.

Countries which are major producers of biotech crops include Canada (canola, corn and soybeans), Argentina (soybeans and corn), Brazil (soybeans), China (cotton and corn) and South Africa (cotton and corn). Some 6% of Spain's corn is biotech, and Australia and India have emerged as important new growers of biotech cotton. The Philippines, Uruguay, Romania, Colombia and Honduras have also recently started growing biotech crops on a commercial scale (James, 2004).[13]

A detailed study of Argentinean grain production (Trigo and Cap, 2004) concluded that biotech crops 'have played a strategic role in the growth of the [agricultural] sector - not only because of their direct impact, but also due to their interaction with other technologies and their global macroeconomic effect through their impact on the country's agricultural exports.[14] In China, the introduction of Bt. cotton has saved not only farmers' money but also lives by the hundreds, by reducing the risk of misuse of poisonous pesticides (Hossain, Pray, Huang, Fan, Hu, 2004).[15]

Australia's authoritative Bureau of Agricultural and Resource Economics (ABARE) calculated that far from harming its agriculture, biotech crops could cost the combined economies of Australia and New Zealand up to U.S. $1.4 billion a year if they were NOT adopted. It said that, with ag biotech proceeding rapidly in China, India, South Africa and North and South America, non-adopting countries could be forced out of world markets within ten years.[16]

Several studies of European farming have shown that producers benefit when they are allowed to plant biotech crops. One such investigation, of Britain's sugarbeet production (May, 2003), concluded that without herbicide-tolerant (HT) sugar beet, weeds will soon make the industry uneconomic, putting at risk 23,000 farming jobs. HT sugar beet on the other hand would keep production costs competitive with world sugar prices, by requiring 80% less herbicide.[17]

Two other studies of small farmers in north east Spain (Brookes, 2003; Demont & Tollens, 2003), showed that because of its built-in protection from the European Cornborer (*Ostrinia nubilalis*/Pyralis), Bt. corn stopped losses of up to 15% of the harvest while saving on pesticides and reducing mycotoxin contamination.[18], [19]. Moreover, according to Demont & Tollens, 75% of the profit gain from growing Bt. corn went to the farmers.

Myth 4: Biotech crops have ruined U.S. commodity markets.

Reality: U.S. crops continue to be sought by customers in the domestic U.S. and international marketplace in increasing quantities.

Over the past five years, sales of commodity crops such as corn and soybeans have increased both in the U.S. and in overseas markets. Corn exports for the marketing year ended August 2004 showed an increase to 48.2 million tons from 39.9 million tons in 2003. U.S. soybean exports also showed record exports in four out of the past five years.[20] For example, when the EU was at the height of its anti-biotech scaremongering in 2001 and 2002, U.S. soybean exports to the European Union were 14% higher at 7.7 million tons at the end of 2002 compared to 2001.

Only in the 2004 marketing year did soybean exports to the EU decline. This change in direction – interestingly despite several earlier years of much higher alleged consumer hostility – was probably a result of buyers fearing legal enforcement penalties on U.S. soybean purchases once discriminatory traceability and labeling legislation came into force in April of that year. However, while the EU reduced purchases, this has been broadly compensated by imports by other countries. For example, China bought 8.23 million tons in the 2004 marketing year, compared to 7.68 million tons in 2003.[21]

Myth 5: Biotechnology has failed to increase yields.

Reality: Biotech crops do increase yields by reducing the amount lost as a result of insect damage and weed proliferation. They also reduce costs per acre/crop weight, therefore increasing economic yield.

Herbicide-tolerant crops allow farmers to better control weeds which would otherwise compete with the crop plants and prevent them growing properly. Insect-resistant plants protect the crop from attack, especially of those insects such as corn borer and bollworm which are notoriously difficult to control with sprays. In both cases, biotech crops provide a means to control yield threats with less cost, less effort (e.g. fewer sprayings) and less chemical use.

Herbicides have proved essential in maintaining yields without driving up costs prohibitively. A National Center for Food & Agricultural Policy (NCFAP) study (Gianessi, 2003) calculated that without herbicides, crop producers could employ six million more workers to pull up weeds and still lose 20% of their crop to weed pressure.[22]

In the case of Bt. cotton, which has built-in protection against insect attack, yield gains have been noted in several studies, ranging from 5-10% in China, to over 10% in the U.S. and over 20% in other countries (James, 2002).[23] A recent report from India found average yields of Bt. cotton hybrids up to 80% higher than non-Bt. hybrids (Qaim and Zilberman, 2003).[24] In Bt. cotton trials conducted by the Australian government's research body CSIRO in Western Australia, yields were as much as 8.3 bales per hectare, compared to just 1 bale or less for unsprayed conventional plants. Cotton production in the area had to be abandoned in the 1970s due to insect problems needing unsustainable levels of pesticides.[25]

In the U.S., where 45% of all corn planted is biotech, yields rose to an estimated record of 158.4 bushels an acre in 2004.[26] Farmers reported that the latest biotech varieties proved better able to withstand environmental stresses such as the severe drought of 2003.

According to an ISAAA study (James, 2004); yield gains for Bt. corn over traditional varieties have been 5% higher in the United States, 6% higher in Spain, and about 10% higher in Argentina and South Africa. In field trials, Bt. corn yields were up to 24% higher in Brazil, between 9 and 23% higher in China and 41% higher in the Philippines.[27]

Commercialization of Bt. corn helped Argentina to produce a record corn harvest in 2004, sending it on the way to regaining its position as the world's second-leading exporter of corn.[28]

In Romania, Europe's third largest soybean producer, yield increases averaging 31% have been reported from farmers growing herbicide-tolerant beans, due to better weed control (Brookes, 2003).[29]

Myth 6: Biotechnology offers at best only minor benefits

Reality: The transformation of the economics of soybean, cotton and corn production, with reduced costs, increased farmers' profits and lower chemical use, are hardly minor gains. In the case of the U.S. grown papaya, biotechnology has saved an entire industry.

Biotechnology saved Hawaii's papaya industry from economic disaster. In 1992 ringspot virus (PRSV) was discovered in the key papaya growing area of Puna on Hawaii Island. Within three years the industry was in crisis. Scientists at Cornell University developed two transgenic varieties, Rainbow and SunUp, which were resistant to PRSV and could be planted without farmers first having to clear their land of infected trees. Today, biotech varieties constitute 60% of today's crop, and have so reduced the PRSV 'viral load' in Hawaii that production is back to 1992 levels and even non-resistant varieties, including organic ones, can be grown with confidence. Several other papaya-growing countries, such as Thailand, are now adapting the technology for their own producers.[30]

Using similar techniques, scientists are working to produce grapevines resistant to Pierce's Disease which has wiped out almost one-third of production in some parts of California.[31]

Myth 7: Farmers lose out because they cannot save biotech seeds.

Reality: Seed is not only a relatively small part of a modern farmer's total cost of production, but the benefits of getting the latest varieties, selected to suit weather and soil conditions or expected pest pressures, and guaranteed by the breeder, invariably outweigh the savings and hassle of retaining enough seed from the previous harvest. All these considerations existed long before biotechnology came along.

There is no requirement for farmers to buy seed. They do so because it makes production sense. For modern open-pollinated field crops to which hybridization imparts a significant yield advantage (as a result of "hybrid vigor"), saving seeds is actually a disadvantage for most commercial farmers who gain more from buying new seed each year.

ISAAA (International Service for the Acquisition of Agri-biotech Applications) has estimated that 80% of the world's 345 million acres cultivating corn is sown to improved varieties, two-thirds to hybrids, 13% to open pollinated varieties. In industrialised countries, 94% is sown to hybrids and 4% to OPVs. Even in developing countries 70% of corn cropland is sown with improved varieties - again, mainly hybrids (James, 2003).[32]

Seed companies are better able to prevent plant-disease-transmission via seed and are better able to preserve quality via scale economies in storage infrastructure. Seed companies also continually improve seed genetics to increase yield and disease resistance. These benefits are missed by farmers who save-back their own seed, although it is recognized that some impoverished farmers in developing countries have little choice. Nonetheless, even farmers in some poor countries which have invested in biotech variety seeds, which are quite expensive for them, have reported their profound satisfaction with the results.[33]

Every commercial farmer knows that the most important factor is not the cost of the seed but the net value of the resulting crop. In the U.S., less than 5% of soybean is grown from previously saved seed even though, being a self-pollinated crop, farmers can easily and legally save-back non-patented/non-PVP seed varieties.

Myth 8: Biotech crops threaten organic farmers.

Reality: First, the U.S. experience shows that organic and biotech farming can both thrive in the same place. Second, the 'organic' label identifies only a system of farming, not what is present or absent from produce. The detection of occasional minute traces of biotech pollen or seed can be no more an issue for organic certifiers and producers than, say, the detection of pesticide residues on what should be "pesticide-free" produce (a problem which affects around 25% of organic produce sold in the U.S.A., according to Consumers Union[34]).

The largest and most detailed independent study of biotech, conventional and organic farming coexistence in the U.S. (Brookes and Barfoot, 2004) concluded that there have been no significant economic or commercial problems for any of the three sectors. It noted that U.S. farmers have been growing specialist crops near to crops of the same species for many years without compromising the high purity levels required. It also cites surveys of organic farmers which have found that the vast majority (92%) have not incurred any direct, additional costs or losses – including not even testing - due to biotech crops grown near their crops.[35]

Recent studies have reached similar conclusions for Europe's agriculture, even after taking into account that continent's tough rules on the traceability and labeling of biotech food and feed. Looking at Bt. corn, an agricultural experts committee, the POECB, confirmed that biotech/non- biotech coexistence was possible in France.[36] A wider study looking at all crops (Brookes, 2004), concluded that, with sensible farm practices and shared responsibilities, there is nothing to stop successful coexistence of biotech, non-biotech and organic agriculture throughout Europe.[37]

Myth 9: Farmers are often sued by seed firms.

Reality: Only a handful of farmers have breached their license agreements. Moreover, it is very easy for biotech firms and farmers alike to differentiate between accidental contamination and deliberately grown seed.

Fifty eight countries have acceded to the International Union for the Protection of New Varieties of Plants (UPOV).[38] UPOV, established in 1961, comprises countries that have jointly agreed to mutually protect the intellectual property of people/companies who are willing to invest the effort and resources to develop novel plant varieties (thereby benefiting mankind through greater agricultural productivity).

Patents are among the methods used by seed companies to protect the intellectual property inherent in their proprietary crop varieties. Patents can be used to protect novel varieties that were developed through either biotechnology or traditional plant breeding methods. A farmer purchasing the seed of a patented variety signs a license to that patent, agreeing to only plant it for one season.

Some farmers have claimed that their "traditional-variety seed" became contaminated with biotech varieties through cross-pollination, only to be subsequently sued by the biotech-patent-holding seed company.

Such cross-pollination would be irrelevant for self-pollinated crops such as the soybean, but even for open-pollinated crops, any such cross-pollination would be very small at most.

The most prominent of the farmers who have claimed to be "innocent" victims of traditional-variety seed "contaminated" through cross-pollination, Percy Schmeiser of Canada, was found by the court to have seed bearing the patented biotech trait at nearly 100 percent levels in his crop. Further, it was uniformly "contaminated" across his fields, which is the opposite of what would be the result of cross-pollination. Unsurprisingly, this farmer comprehensively lost the original case, his first appeal and his appeal to the Supreme Court of Canada.[39],[40], [41]

Myth 10: Biotech has nothing to offer developing countries.

Reality: All developing countries already benefit from biotechnology through cheaper commodity imports, lower mycotoxin levels, and higher and cleaner crop yields in domestic planting. Countries that grow biotech crops also benefit from reduced chemical use, higher yields and a more competitive agriculture.

Developing countries, which tend to be major soybean importers, have benefited from the lower prices that accompanied most years' record U.S. soybean production. These lower prices have tended to occur frequently since a significant amount of biotech herbicide-resistant soybean seed became commercially available. The reduction in cost of inputs enabled U.S. soybean producers to expand soybean acreage even while receiving a lower price per ton for their harvested soybean crop.

Corn-importing countries that procure their corn from countries where Bt. corn is planted (e.g. U.S., Argentina, Canada) have benefited since 1996 from the significant reduction in mycotoxin content of Bt. corn varieties. Bt. corn greatly reduces field formation of aflatoxin and other mycotoxins (formerly) produced in corn plants by fungi under certain environmental conditions.

Additionally, several developing countries depend on their own export of agricultural products for income and jobs. Argentina, for example, exports most of its (almost 100% biotech) soybeans. Its former Secretary of Agriculture Marcelo Regúnaga said in July 2002 that Argentine soybean producers saved about U.S. $400 million in crop production costs by cultivating biotech soybeans that year, and Bt. corn farmers realized savings of up to 15 percent.[42]

Contrary to the claims of critics, small-scale farmers in developing countries are proving to be major beneficiaries of biotech crops, because 'in-seed' pest and disease protection saves on expensive and often hazardous chemicals, as well as reducing the effort of cultivation.

In China, biotech cotton is called the "miracle crop" because it has helped farmers cut costs by 28% and reduce their exposure to hazardous chemicals.[43] From 2005, China will be spending U.S. $500 million on biotech crop research, more than the U.S. government, with biotech rice expected to be commercialized within three years.

In South Africa, 90% of small-scale farmers grew biotech cotton in 2001/2002, compared to just 7% in 1997/98. The rapid take-up was due to large savings on pesticide – most do not now spray their biotech crops at all.[44]

Thanks largely to the increased sowing of Bt. cotton, India's cotton industry is expecting a bumper cotton crop for 2004.[45] A poll of Indian farmers early in the year revealed an average 30% yield increase for certified Bt. Bollgard (Monsanto) seed over conventional seed, and increased net profits averaging 80%.[46] India is now planning to develop biotech varieties of 14 crops important to its farmers.[47]

Meanwhile for rice growers in the Philippines and Vietnam, Bt. varieties are predicted to save at least U.S. $500 million annually.[48]

A wide-ranging paper by Britain's independent Nuffield Council on Bioethics[49] concluded that, on a case by case basis, biotechnology is not only already benefiting small farmers, but has the potential to do much more if crops such as bananas modified to resist serious fungal diseases, and plants that are drought- and salt-tolerant, reach farmers.

Anybody who wishes to know more about the potential for biotechnology in developing countries is recommended 'Genes For Africa: Genetically Modified Crops In The Developing World' by Jennifer A. Thomson University of Cape Town Press (2002). Professor Thomson is a professor of microbiology at Cape Town University, South Africa.

Myth 11: Organic farming offers a better future than biotechnology.

Reality: Biotech crops are crucial if the food needs of the world's growing population are to be met reliably and without unacceptable encroachment on bio-diverse habitats.

Most U.S. farm organizations such as the American Soybean Association have farmer members who use organic, conventional, and biotech methods. While we all support the option of organic agriculture, we recognize that its strengths are concentrated in the low-yield production of food for those consumers willing to pay substantial premiums for a more labor-intensive product.

For price-sensitive commodity crops such as wheat and cotton, and soybeans and corn for animal feed, all of which comprise a major part of U.S. farming, organic methods are too costly, too variable in yield, and too prone to insect and weather problems to work on a mass scale.

Several (sometimes contradictory) comparative studies of organic and conventional farming methods have been produced recently, but all admit to a significantly reduced yield (when measured over several years without excluding fallow or "difficult weather" periods) as well as increased labor input for the organic systems. The experience of Mr. Lynn Jensen of South Dakota is probably typical when he reported to *Soybean Digest* that not only do his organic soybeans require three to four times the amount of tillage as biotech varieties, but that they result in a 30-40% yield drag.[50]

For this and many other reasons, we believe modern no-till farming using biotechnology such as herbicide-tolerant crops approaches the epitome of *low impact, sustainable,* and *affordable* agriculture.

The environment

Myth 12: Since biotech crops were introduced, pesticide use has increased.

Reality: If this were true, why is the U.S. agrochemical industry experiencing its first ever decline in demand for farm chemicals at the same time that agricultural output is increasing?

Monsanto told investors to expect farm chemical sales to fall $1 billion, or 28%, by 2008 because biotech crops are reducing demand.[51] Bayer similarly blamed its third quarter loss in 2003 on worldwide weakness in its farm chemicals business and specifically on the increased acreage of biotechnology-derived crops which require less chemical pesticides.[52]

Agribusiness consulting firm, Kline & Company, predicted corn, cotton and soybean farmers will spend $1 billion less on chemicals between 2004 and 2009 because of biotech varieties, while sales of conventional pesticides for corn will plummet, from $300 million in 2002 to just $70 million in 2012.[53]

In Canada, between 1995 and 2000 when the proportion of the canola (oilseed rape) crop that was biotech rose from 10% to 80%, the amount of herbicide used fell by 40%, equivalent to a 36% reduction in environmental impact (calculated by human and animal toxicity and environmental persistence).[54]

In Brazil, Aprasoja (the Federation of Soybean Producers) reported a 50% reduction in the use of agrochemicals despite producing a record crop in 2003.[55] According to the president of Brazil's Farsul Grains Commission, while producers of conventional soybeans use 2 litres of glyphosate, and another 5 or 6 litres of other herbicides per hectare, those growing transgenic soybeans needed **only** between 3 and 4 liters of glyphosate, which has the added advantage of being more/faster bio-degradable than the herbicides it displaces.

In Argentina, farmers adopting Bt. corn varieties are using 50% less pesticides (Qaim, 2003).[56]

In Australia, a new 'double trait' variety of Bt. cotton is being commercialized which in field trials has cut pesticide use by 80% compared to conventional varieties.[57]

A major study of pesticides and conventional farming across Europe (Phipps and Park, 2002) calculated that if 50% of the corn, oil seed rape, sugar beet and cotton grown in the EU were existing biotech varieties, pesticide use per year would fall by 14.5 million kg of formulated product (4.4 m kg active ingredient) and the reduction in spraying would save 20.5 million litres of diesel and keep 73,000 tons of carbon dioxide from being released into the atmosphere.[58]

Myth 13: Gene flow from biotech crops threatens biodiversity.

Reality: ***Out-crossing and herbicide resistance is a well-understood crop management problem that has occurred long before biotechnology was developed. There is no evidence that biotech crops are, or will be, any less manageable than their conventional counterparts.***

Before the commercialization of biotechnology derived crops in the mid-1990s, approximately 188 proven incidences in 42 separate countries of weeds becoming resistant to herbicides (that had formerly controlled those weeds) had been officially documented.[59] To prevent such natural adaptation of weed populations to resist the herbicides applied, farmers need to use several *different* herbicides (possessing dissimilar chemical modes of action) in consecutive herbicide applications to their crops.

By enabling the use of a herbicide that could not previously be applied to a given crop, biotechnology-derived herbicide-tolerant (HT) crops have increased the number of dissimilar herbicides in farmers' arsenals against weeds; thereby *decreasing* the probability for herbicide-tolerant weeds to arise via the historical mode of selective pressure/adaptation.[60]

There is no credible evidence that those biotech crops in development or commercial use are, or could become, more difficult to control, or that there would be any more troublesome weeds than any other crop plants. The UK publication, *New Scientist,* reported in July 1999 that conventional sugarbeet in Europe had already out-crossed during the 1980s – i.e., *before* biotech crops had been developed - with a native weed to produce a resilient and troublesome "superweed". Systemic or other herbicides cannot be used as they would also kill the crop. A biotech herbicide-tolerant sugarbeet could help solve this problem.

On the other hand, a 10-year-study by a respected British ecologist found that biotechnology-derived herbicide-tolerant crops did not survive well in the wild and were no more likely to invade other habitats than other, unimproved crop plants. The plants did not become self-seeding, self-sustaining plants, and they did not spread into surrounding areas.[61]

As a group of scientists at Britain's respected John Innes Centre concluded in a paper on the environmental impact of biotech crops (Dale, 2002), "we can find no compelling scientific arguments to demonstrate that biotech crops are innately different from non- biotech crops."[62] The recently completed long-term British BRIGHT experiment into the impact of herbicide-tolerant biotech crops confirmed that HT crops are just as good as conventional crops in maintaining biodiversity.[63]

Myth 14: Biotech corn threatens the Monarch butterfly.

Reality: Extensive scientific study has concluded that Bt. crops have had no measurable effect on the Monarch. Indeed, it stands to benefit from reductions in pesticide spraying.

A single controlled laboratory experiment showed that one kind of pollen from Bt. corn could harm Monarch caterpillars if fed to them directly. However, no reputable entomologist or crop scientist takes such claims seriously anymore. An extensive series of field experiments and observations have shown that Bt. crops have had no measurable effect on the Monarch butterfly population and are not expected to do so in the future.

Because the Monarch butterfly winters in Mexican forests and migrates annually to the U.S., numbers are heavily affected by weather and habitat loss in Mexico. In 2000, 28 million Monarchs wintered in Mexico, but in 2001 nearly 100 million did.[64] The main impact from Bt. crops, mainly Bt. cotton, was to reduce the application of chemical insecticides by approximately one million liters per year in the southern United States. This undoubtedly helped preserve the lives of migrating Monarch butterflies.

For an objective and scientific overview of the Monarch controversy, written by scientists with the U.S. Department of Agriculture, Cornell University, University of Guelph, Iowa State University, University of Maryland, University of Nebraska, Purdue University, and MonarchWatch, visit www.ars.usda.gov/sites/monarch/index.html

Since the Monarch episode, there have been claims that Bt. cotton has harmed beneficial insects in China. In fact the reverse has been found. A recent study (Kongming Wu, 2003) discovered that the diversity of the arthropod community in Bt. cotton fields was higher than in conventional cotton, as are bollworm insect predator levels, due to the much reduced use of insecticide.[65]

Concerns about effects on bees have also been allayed. Trials[66] have found no effect on the health of bees which had been fed purified proteins of toxins expressed by Bt. plants (designed to control caterpillars) or biotin-binding proteins (for general insect control), and only a slight effect with protease inhibitors (used for caterpillar and beetle control). Even then, these tests are extreme since flowering biotech plants produce only minute quantities of the new proteins in pollen and none in nectar, which is what bees eat.

Myth 15: The herbicides used on biotech crops damage the environment.

Reality: Biotech herbicide-tolerant crops not only reduce herbicide application, resulting in cleaner soil and water, they aid no-till farming which minimizes soil erosion and the release of climate-changing carbon into the atmosphere.

In general, the only herbicides that can be applied to biotech herbicide-tolerant crops are those that have fewer adverse environmental impacts than the "older" herbicide(s) they are replacing, which are being progressively prohibited both in Europe and the U.S. The new generation of herbicides has reduced longevity in the environment, lower toxicity to wildlife and/or humans, and adhere so tightly to soil particles that they do not leach into drinking water supplies.[67]

A modelling study of U.S. agriculture's likely impact on drinking water quality (Wauchope, 2002) found that herbicide-tolerant (HT) corn would 'dramatically reduce' herbicide concentrations in vulnerable watersheds, because HT crops need only be sprayed once, after planting, rather than twice (before and after).[68]

Far from harming the environment, HT crops have transformed much of U.S. agriculture by reducing the need to till (plow) the land. Thanks to no-till and other forms of 'conservation tillage', soil erosion and movement are minimized, soil health and water retention ability is maximized.[69] Of increasing importance, more carbon is prevented from escaping from the tilled soil and contributing to global warming gases in the atmosphere. In addition, this helps in the reduction in CO_2 and other pollutants formerly emitted by plowing operations. No-till is also energy saving because with just one operation seed drilling can be undertaken rather than conventional planting which needs three operations -- plowing, harrowing, and drilling.

Research published by G. Phillip Robertson, Eldor A. Paul, and Richard R. Harwood of Michigan State University has calculated that "no tillage" methods of crop production reduce modern agriculture's impact on global warming by approximately 88%.[70]

The rate of global warming (i.e. the postulated increase in the Earth's average temperature resulting from activities of mankind) is directly impacted by activities that place more carbon dioxide (a "greenhouse gas") in the atmosphere. However, the increased use of "no tillage" and "low tillage" methods of crop production—facilitated by the new herbicide-tolerant biotech crops[71] —removes net carbon dioxide from the atmosphere by sequestering it into the soil of cropland, while at the same time helping to reduce fuel consumption.

Modern agriculture accomplishes control of weeds either through mechanical cultivation or through the application of herbicides. Weed pressure will vary by location, but the corn and soybean farmers who use only mechanical cultivation (e.g., "organic" farmers in America) need to cultivate their fields as many as fourteen times per growing season.[72]

By contrast, the "no tillage" and "low tillage" crop production methods use one and 2-4 cultivation applications respectively, which decrease soil erosion (wind & water) by 90% or more.[73]

When a farmer switches from intensive mechanical cultivation to "no tillage" or "low tillage" crop production, the population of earthworms subsequently increases in direct proportion to the amount by which mechanical cultivation is avoided. [74] A study of conservation tillage by the American Soybean Association (ASA) found that three quarters of growers who plant biotech varieties find that there is more crop residue on the soil surface using biotech varieties.[75] Year after year, and layer after layer, this old crop residue breaks down to form new humic matter which is incorporated into the soil.

The switch in crop production methods also helps remove carbon dioxide from the Earth's atmosphere, because avoidance of over-cultivation allows the natural fungi that grow on plant roots to produce glomalin, a protein that naturally sequesters carbon and keeps it within the soil. Glomalin helps to improve the fertility of soil by acting as a sort of "glue", causing soil particles to clump together properly. It creates subsurface spaces that allow water, oxygen, and plant roots to permeate the soil. The presence of glomalin is one of the main differences (apart from water) between fertile cropland soil and lifeless desert sand.

The more that 'healthy' cropland soil is disturbed by mechanical cultivation, the more that the glomalin is broken-up and its (formerly sequestered) carbon allowed to re-enter the atmosphere in the form of the "greenhouse gas" carbon dioxide.

Myth 16: Biotech crops are inherently risky to the environment

Reality: There is no evidence, other than extrapolations of hypothetical risks, to show that biotech crops are by definition more "risky" than their conventional or organic equivalents.

Probably the most thorough review of this controversial matter is that conducted by New Zealand scientists Tony Conner and Travis Glare and their Dutch colleague Jan-Peter Nap.[76] After reviewing 250 published research papers which studied a wide range of environmental impacts, weediness, horizontal gene flow, ecological, biodiversity and other concerns about gene technology, they concluded that many of problems which have come to be blamed on biotech crops do not exist, and those that do are equally applicable to conventional or organically grown plants.

Major conclusions[77] of the review are:

• Biotech crops are no more likely than traditional crops to lead to super pests and diseases.

• Biotech crops are no more likely to become weeds outside farming situations than other cultivars.

• Biotech crops are no more invasive, persistent or likely to become weeds than conventional counterparts.

• Biotech crops are no more likely to transfer transgenes, or any other gene, than other crop cultivars.

• Horizontal gene transfer can occur at exceptionally low frequencies and therefore deserves less attention than it gets but potential for development of resistance to useful antibiotics should be avoided.

• Generally no undesirable effects have been found on insect predators from biotech crops modified for insect resistance compared with traditional crops.

• It's too early to draw conclusions about secondary ecological impacts. The examples of secondary effects which have been discovered to date have not disclosed problems at an ecosystem level.

• The use of biotech crops has led to huge reductions in pesticides which is likely to have a positive impact on agro-biodiversity.

• Biotech crops are no more likely than any other change in agriculture to affect biodiversity negatively.

• When measuring impacts of biotech crops the appropriate point of reference is a comparison with other plants which have been modified using traditional breeding methods.

• The risk of not using biotech crops should also be part of the risk assessment.

Myth 17: Biotech crops offer no environmental benefits.

Reality: This is true only if one ignores: more insect and bird life because of reduced insecticide spraying, less pressure on wilderness because of more productive farmland, reduced carbon emissions and less soil loss from herbicide-driven conservation tillage, and reduced impact of animal agriculture from low nitrogen/low phosphorous feed crops.

All but the last point have been addressed in detail elsewhere in this document. The impact of biotech crops on making animal farming less polluting is often ignored, yet by lowering the amount of excess protein and phosphorous fed to poultry and livestock, biotechnology can make a dramatic difference to the amount of pollution emitted by animal agriculture.

A 2002 paper published by The Council for Agricultural Science and Technology (CAST) calculates that new technologies such as low-phytate corn and soybeans, could help decrease nitrogen and phosphorus excretion by swine and poultry by up to 40%and 60%, respectively. New metabolizable protein systems could decrease nitrogen excretion by up to 34% from beef and dairy cattle, while more precise feeding of phosphorus can cut in half their phosphorus excretion.[78]

Myth 18: Biotech crops are not necessary for no-till agriculture

Reality: Although no-till has been attempted since chemical herbicides were introduced, it was seldom easy or cost-effective until biotech varieties became available.

An analysis of surveys conducted since the introduction of herbicide tolerant (HT) crops (Fawcett, 2002) "strongly supported" the conclusion that biotech crops have facilitated the 35% expansion of conservation tillage since 1996, thereby saving one billion tons of soil per year and an associated $3.5 billion in the costs of removing sedimentation, providing a much more nutritious habitat for birds and mammals, and reducing phosphorous and nitrogen run-off, and added atmospheric carbon dioxide through escaping soil carbon and tractor fuel used for plowing.[79]

The U.S. National Cotton Council reported that conservation tillage acreage increased to 59% of all cotton acres since herbicide-tolerant cottons became widely available in 1997. Roundup-Ready cotton accounted for 77% of total cotton acres grown in 2002.[80]

In its 17th annual conservation tillage survey, America's Conservation Tillage Information Center (CTIC) reported that the percentage of U.S. corn acres in conservation tillage (epitomized by no-till) had actually declined between 1997 and 1998. This time period predated widespread availability of herbicide-resistant corn (e.g. Roundup Ready corn seed first became available in limited quantities in 1998). In a 1998 interview, agronomist David Schertz, of the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS), said "that U.S. agriculture will have difficulty reaching the national goal of 50% of cropped acres in (conservation tillage practices) by 2002."

The critical difference made by the availability of biotech herbicide-resistant crop varieties is revealed in an interview one year later by the same NRCS agronomist, who noted that "U.S. soybean hectares planted in conservation tillage practices jumped to a new record total in 1998." Because biotech herbicide-resistant soybean seed was first commercialized in 1996, 1998 was the first year that a large enough quantity of that seed was available to make such an impact (U.S. no-till soybean acres increased by 1.5 million acres between 1997 and 1998).[81]

As the "easy" soils/fields were naturally placed into no-till production practices first, there were indications of a likely plateau effect for total U.S. no-till acres at a disappointingly small total by the mid-1990s. For example, on the rolling red clay soils of south-western Kentucky, soybean producer Maurice Chester began experimenting with no-till in the 1970s. He was not always successful initially because he did not have the herbicides to make it work on his soil and weeds.[82] (Note: glyphosate-based herbicides could not be applied over the top of soybeans until 1996 when the biotech herbicide-resistant soybeans were introduced.)

Following the introduction of the herbicide-resistant soybeans, Maurice Chester said "planting has become so simple (with no-till soybeans), because I can leave all of the residues from the previous crop on top of the ground without interfering with planting or weed control."

It is important to realize that prior to the availability of the herbicide-resistant soybeans, such farmers had to use soil-applied herbicides, which were sprayed onto the field prior to planting, and whose efficacy was often reduced by the presence of prior-crop residues inherent in no-till production practices.

Other inherent no-till limitations prior to 1996 included:

> (a) Narrow "time windows" during which a farmer could apply the (few) herbicides then available over the top of growing soybeans. Spraying too early could damage or kill the soybean plants; spraying too late risked a lack of weed control because the too-large weeds would not be killed by the herbicides that were used. Thus a week or two of rainy weather could have proven devastating to weed-control efforts in pre-1996 no-till soybeans.

(b) High risk for utilizing the emerging production practice known as narrow-row soybeans (i.e. closer planting more efficiently utilizes sunlight and conserves more topsoil moisture by shading the ground with leaf canopy). Since the farmer cannot fall back on mechanical tillage for weed control (as he cannot drive between the rows), his agrochemical weed control must be reliable for narrow-row soybeans to work.

In the words of Mississippi University Agricultural and Forestry Experiment Station researcher Dr. Norman Buehring, "Narrow-row soybeans can bring with them yield increases, but not without (reliably) winning the war against the weed known as sicklepod, which can also reduce yields by as much as 35% (if not controlled).[83]

Safety and health

Myth 19: Biotech food is inherently unsafe and untested.

Reality: Agricultural biotechnology is much more specific and controlled than previous crop breeding and helps to decrease the risk of allergens, known and unknown, entering the food supply.

Safety concerns are fundamentally based on the belief that biotechnology methods for introducing traits into plants might somehow be riskier than so-called "traditional plant breeding methods".

During the 1960s, a new potato variety (Lenape) was developed using traditional plant breeding methods that contained a near-lethal level of solanine, a natural alkaloid toxin that is naturally produced in the wild ancestor (relative) of the domesticated potato plant. The first person to eat one of the Lenape variety potatoes almost died as a result. Then, during the 1980s, a new celery variety was similarly developed using traditional plant breeding methods that contained high levels of psoralen, a natural toxin that is a skin irritant and has been shown to cause cancer in laboratory mice. Before it was withdrawn from the market, the field workers who picked that celery crop suffered great pain in the skin of their hands.

Both of these incidents occurred because traditional plant breeders cross domesticated crop varieties with their wild relatives in order to introduce certain desirable traits (e.g. disease resistance, higher yield, etc.) into the crop gene(s). Because such a cross is a mixture of the genes from both plants, the resultant offspring plants inevitably contain some undesirable genes along with the desired ones. Due to that fact, the U.S. government's Food and Drug Administration (FDA) requires testing of new crop varieties for the presence of such toxins, whether the new variety was developed through biotechnology methods or "traditional plant breeding methods".[84]

The FDA's requirements, coupled with the potential for financial liability, has ensured that seed companies planning to introduce a new biotechnology-derived event in the U.S. also thoroughly test all newly introduced proteins for allergenicity.[85] For example, one seed company had begun work using biotechnology methods to develop a soybean variety that would contain a gene from the Brazil nut tree (to impart a higher methionine content), but all work on that new soybean variety was halted when allergy testing indicated that it could trigger reactions in consumers who are allergic to Brazil nuts.[86]

The commercialized glyphosate-tolerant soybean has been shown to contain an average of one-third fewer weed seeds and weed seed/plant particles when harvested.[87] Some types of weed seeds contain toxins and some are allergenic. The reduction in weed seed content is even more dramatic for canola crops, because the most toxic weed seeds that tend to appear in harvested canola (*Brassica napus/campestris*) are those from the wild mustard (*Sinapis arvensis*) weed, which is so closely related to canola that—prior to the introduction of biotechnology derived herbicide-tolerant canola varieties in Canada in 1995--- any herbicide that harmed wild mustard plants also tended to harm canola plants. Due to the rapid increase in acres planted to herbicide-tolerant canola since 1995, the content of toxic wild mustard seeds in North America's harvested canola has been reduced significantly.[88]

As for the concerns expressed regarding the "new" proteins introduced into those biotechnology derived herbicide-tolerant soybean and canola varieties, those "new" proteins were originally discovered in several strains of common soil-dwelling bacteria (*Agrobacterium tumefaciens)* for the glyphosate-herbicide-tolerant soybean and *Streptomyces hygroscopicus/wiridochromogenes* for the glufosinate-ammonium-herbicide-tolerant canola) that humans have breathed-in for millennia on windy dusty days when some field dirt was carried into the air.[89]

We should not take the allergen problem out of proportion. Serious reactions such as anaphylaxis are very rare, even though much of the food eaten in the U.S. and Europe is "foreign" or non-native. Tomatoes (related to the poisonous Deadly Nightshade plant), potatoes and corn were all foreign before the 17th Century, as were most tropical fruits and nuts. This means that it is likely we have been exposed to new allergens in the not so distant past. Meanwhile longstanding foods including milk, egg-white, soy and gluten-containing grains such as wheat are common sources of "natural allergenicity". The kiwi fruit, rhubarb, and mango are potentially allergenic foods, but this has not stopped them being widely eaten – and without health warnings.

Scientific investigations in the past few years have confirmed the assumption that biotech foods do not behave differently or more riskily when digested than any other food. Animal studies have found identical growth performance and meat quality[90], [91] and no biotech DNA detectable in milk or organs.[92], [93]

Myth 20: Soy allergies have increased with biotech soybeans.

Reality: Untrue.

The claim appears to be based entirely on a report in a British tabloid newspaper, the *Daily Express*, in 1999. The source of the claim – an allergy testing centre in York - issued a statement pointing out that it did not say soy allergies had increased because of biotech varieties, but that it had more customers who had soy allergies, which if accurate, was probably due to the increased consumption of soy in modern food (soy is a well known allergen).

Myth 21: Biotech crops have harmed hundreds of people.

Reality: Again, untrue. There have been no verified links of biotech foods causing any harm.

Even the infamous Starlink episode, when a biotech corn that had not fully completed its U.S. approval process was commercialized for animal feed and subsequently, traces turned up in corn for human food, produced no identifiable health issues. Some 44 people claimed – after reading media reports – to have suffered allergic reactions to eating taco chips containing small amounts of Starlink, but tests of 17 by the U.S. government's Centers for Disease Control (CDC) could produce no antibodies demonstrating an allergic response to Starlink.[94] One of the most vocal complainants was later tested with Starlink corn, another corn and a placebo, and again, no allergic reaction was detected.[95]

The latest such claim has been made by Professor Traavik of Norway in February 2003 who said sick villagers living near a test planting of Bt. corn in the Philippines tested positive for Bt. antibodies.[96] However his data has never been published and no medical authority has accepted his theory, let alone confirmed his conclusion.

Myth 22: Biotech crops increase antibiotic resistance.

Reality: Research regarding the development of antibiotic-resistant bacteria in humans from "marker genes", utilised in a few of the earliest commercialized biotech crops, overwhelmingly proves the near impossibility of such an exchange.

Over-prescribing (i.e. excessive therapeutic use) of a particular commercial antibiotic is the proven source of such antibiotic-resistant pathogenic bacteria.[97],[98] To test whether "marker genes" also could possibly be a source of antibiotic-resistant pathogenic bacteria, scientists in the United Kingdom attempted to cause antibiotic resistance in bacteria within an "artificial cow stomach" in a carefully controlled laboratory experiment by adding to the artificial stomach biotechnology derived corn that contained an antibiotic-resistance "marker gene" within its DNA.[99]

Transfer of antibiotic resistance from that corn to the bacteria growing within the "artificial cow stomach" did not occur in 10^{18} (i.e. 10,000,000,000,000,000,000) generations of the bacteria under conditions that were designed to make that transfer as likely as possible.[100] Therefore, the probability for such transfer of antibiotic resistance occurring (e.g. from Bt. corn to bacteria) is even less likely than 1 in 10^{18} (i.e. 1 out of 10,000,000,000,000,000,000). The odds are small to say the least and amply proven to be a smaller cause of transfer than through the route of over-prescription of commercial antibiotics.

In contrast, the natural bacteria living within human digestive systems have already been shown to exhibit resistance to the relevant commercial antibiotics (i.e., kanamycin and ampicillin) in 20% of typical humans.[101]

All this has been confirmed in subsequent experiments where biotech crops with antibiotic marker genes were fed to chickens. No plant-derived marker was found in the intestines, let alone surviving to be transformed into ampicillin resistance.[102] The Working Party of the British Society for Antimicrobial Chemotherapy reported that it could find "no objective scientific grounds to believe that bacterial antibiotic resistance genes will migrate to bacteria to create new clinical problems."[103]

Myth 23: Biotech crops are making food less safe.

Reality: Biotech crops are making food <u>safer</u>, by reducing pesticide spraying and, in the case of Bt. corn, reducing mycotoxin contamination.

The Union of the German Academies of Science and Humanities' Commission on Green Biotechnology reported, "food from GM corn is more healthy than from conventionally grown corn." [104] It said this is because investigations have shown that contamination of corn by the fungal toxin, fumonisin, is reduced in biotech insect-resistant Bt. corn.

The German Commission also stressed that the dangers of unintentional DNA mutations are much higher in the process of conventional plant breeding, using mutagenic chemicals or energy rich radiation, than in the generation of biotech plants. Furthermore, biotech products are subject to rigid testing with livestock and rats before approval.

The importance of reducing fumonisin levels cannot be over-emphasised. Fumonisin is a mycotoxin, a neurological poison released by a particular fungus which grows inside food plants, either due to poor storage or to insect damage that provide entry for the fungal spores.

In countries with modern agricultural systems, regular testing, good dry storage and judicious use of chemicals keeps mycotoxins to a minimum. In developing countries, where none of these things happen reliably, mycotoxins can be a serious hazard. In Guatemala and elsewhere, babies born to women who eat large amounts of infected corn suffer neural tube defects at rates six times higher than the global average.[105]

Bt. corn is a powerful way of reducing fumonisin to a safe level without chemicals. Its built-in pesticide against the corn borer greatly reduces plant damage, and thereby removes most of the risk of fungal spores getting inside before processing.[106]

Science and medical resources

Transgenic Plants and World Agriculture

Report prepared by the Royal Society of London, the U.S. National Academy of Sciences, the Brazilian Academy of Sciences, the Chinese Academy of Sciences, the Indian National Science Academy, the Mexican Academy of Sciences and the Third World Academy of Sciences. Published 2000 by the National Academies Press (U.S.A.).
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Examination of the risks and safety of biotech food and crops, published September 2004.
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http://www.mfe.govt.nz/issues/organisms/law-changes/commission/

Royal Society (London)

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British Medical Association

Most recent (2004) statement on the safety and regulation of biotech foods.
www.bma.org.uk/ap.nsf/Content/GMFoods

UK Government GM Science Review Panel

Reports commissioned by the British government from its committee of experts during 2003 and 2004.
http://www.gmsciencedebate.org.uk/report/default.htm

Science archives and background material

International Centre for Genetic Engineering and Biotechnology (ICGEB)

Comprehensive bibliographic database on biosafety. Over 4,700 science and policy documents.
http://www.icgeb.org/~bsafesrv/

ILSI International Food Biotechnology Committee

International documents and scientific publications on plant biotechnology and the safety assessment of food products derived from plant biotechnology (September 2004).
http://www.ilsi.org/file/Guide-Rev-Sep04.pdf

U.S. Regulatory Agencies Unified Biotechnology Website

Department of Agriculture (USDA), Environmental Protection Agency (EPA) and the Food & Drug Administration (FDA)
http://usbiotechreg.nbii.gov/

AgBioForum (Journal of Agrobiotechnology, Management, & Economics)

AgBioForum is a free online publishing short non-technical articles on current research in agricultural biotechnology. It is financed by the Illinois Missouri Biotechnology Alliance (IMBA) which is supported by a Congressional Special Grant to provide funding for University biotechnology research. AgBioForum is edited at the University of Missouri-Columbia with the assistance of advising editors from all areas of its intended audience, including academia, private sector, government, and agribusiness media.

http://www.agbioforum.org

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