"Let the facts speak for themselves"

# *The contribution of agricultural crop biotechnology to American farming*

Produced on behalf of

American Agri-Women
American Soybean Association
National Chicken Council
National Corn Growers Association
National Cotton Council
National Milk Producers Federation
National Potato Council
National Turkey Federation
United Soybean Board

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“ *We have large and various orchards and gardens wherein we practice all conclusions of grafting and inoculation, whereby we make trees and flowers to come earlier or later than their seasons, and their fruit greater and sweeter and of differing taste, smell, colour, and figure from their nature; and likewise to make one tree or plant turn into another.*”

The English philosopher Sir Francis Bacon predicting the future of agricultural research in 1618 (extract from New Atlantis).

# Introduction

Farmers in the American Midwest have suffered their worst drought in decades this year. Agricultural productivity will be substantially reduced and water reservoirs severely depleted.

Yet the position could have been much more serious had it not been for the uptake of herbicide-resistant biotech crops, which have allowed the increased adoption of no-till farming. No-till allows a farmer to plant a new crop directly into the soil through the residue of the previously harvested crop, breaking down that plant residue and helping to increase soil organic matter.

Traditionally growers would have cleared their previous crop and deep plowed, in part to hinder the re-growth of weeds which would otherwise smother the young crop plants. Deep plowing leads to open fields exposed to wind and erosion. No-till not only minimizes erosion, but also maintains the natural moisture in the soil so crops get a good start with less need for watering.

The widespread adoption of no-till, particularly among soy growers, has been facilitated through the use of herbicide-resistant soybeans. This year's US soybean harvest is expected to be more than 75% biotech, with herbicide-resistant varieties planted on 90% of soybean farms – a clear indication that farmers have adopted a technology that works well in their individual operations.

US farmers are well aware of the debate in the European Union over the adoption of agricultural biotechnology. They are well aware of the many issues and controversies surrounding the debate. They are well aware of the myths and misinformation which have been put forward by opponents of agricultural biotechnology, fueling much of the discussion and often leading to a misunderstanding of the use of the technology and the advantages it can bring.

This report sets out to set the record straight. It aims to address many of the issues and correct the myths – the 'factoids' – about agricultural biotechnology, using the knowledge of our own experience as farmers as well as the numerous scientific
and economic studies published in this area. We hope it will be useful for everyone interested in knowing the facts.

# Correcting the ‘factoids’, myths, and misconceptions about crop biotechnology

> **Factoid**: A piece of unverified or inaccurate information that is presented in the press as factual, often as part of a publicity effort, and that is then accepted as true because of frequent repetition.
>
> *http://www.dictionary.com*

***Below are 22 commonly perpetrated myths, misconceptions, and ‘factoids’ about agricultural biotechnology to which this report responds with the facts.***

1. *“Farmers are losing money growing biotech crops”*

## Fact: No one forces farmers to use biotechnology; farmers use biotech because it offers many advantages.

Biotech crops have only been in widespread use since the late 1990s. As such, accurate comparisons of economic impact when comparing biotech and non-biotech crops possessing different agronomic benefits, such as herbicide tolerance and insect resistance, are somewhat limited. However it is believed that the total economic benefit derived from planting biotech crops was $220 million for US farmers during 1998 alone.[1]

According to a study, albeit limited, of biotech crop adoption during 1997 and 1998, commissioned by the US Department of Agriculture and published in August 2002[2], herbicide-tolerant crops did not apparently increase paper profits. They did save significant amounts of (uncosted) farmer time and effort, which helps to explain their immense popularity.

The same study found that Bt. cotton increased farm profits. Bt. corn appeared not to increase profits, probably because farmers were still learning how to forecast European corn borer infestation levels and thereby how best to deploy the more expensive Bt. seed. However, the study did not mention that the impact of the Round-up Ready biotech soybean was so great when it was launched in 1996 that manufacturers of competing herbicides were forced to make price cuts of 40 to 50 percent, benefiting biotech and non-biotech farmers alike.

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[3] due to minimal foreign matter.[4]

Given that there is a free market in seed in the United States with biotech and non-biotech varieties freely available, the rapid rate of adoption of biotech crops probably speaks for itself (note: percentages cannot simply be added together as varieties with more than one trait will be double counted):

*Herbicide-tolerant soy: from 17% of acreage in 1997 to 75% in 2002*
*Herbicide-tolerant cotton: 10% in 1997 to 56% in 2001*
*Herbicide-tolerant corn: 7% in 2001, 9% in 2002*
*Bt. corn: 15% (1997), 26% (1999), 19% (2000-01), 22% in 2002 – use varies according to predictions of borer infestation levels*
*Bt. cotton: 15% (1997) to 27% (2001)*[5]

2. *"US soy and corn exports have collapsed since biotech varieties were introduced"*

## Fact: US crops continue to be sought by customers in the international marketplace.

The US Department of Agriculture's June 2002 report states that exports of US soybeans are forecast to reach a record high during the 2002 marketing year (October 1, 2001 to September 30, 2002). By the end of August 2002, US soybean exports to the European Union were 14 percent higher than the same period in 2001 at 7.7 million metric tons. Exports of US soybeans to the EU for the 2001 marketing year increased by nearly 15 percent from the previous year.[6]

US corn gluten exports to the EU between January and June, 2002 were 2.142 million metric tons compared with 1.998 million metric tons for the same period in 2001.

US exports of whole corn to the EU of approximately two million metric tons a year, a small proportion of total US corn exports, have been curtailed because of the *de facto* moratorium on approving new biotechnology events in the EU. The European Commission acknowledges that the blocking of the EU's approval process by seven member states runs counter to the EU's legal obligations. [7]

*3. "Biotech crops are less hardy than their non-biotech counterparts"*

**Fact: Untrue. Some biotech crops are even hardier.**

The increasing US adoption of no-till production practices, facilitated by biotech-derived herbicide resistant varieties, has made no-till crops more resistant to the effects of drought.

Meanwhile, farmers who planted biotech-derived Bt. corn have universally reported that their Bt. corn is more resistant to wind damage, as a result of the near elimination of tunnels bored into the stalks of their Bt. corn plants by the corn borer insect. That translates into more corn harvested by those farmers.

*4. "Biotech crops have not increased yields as promised"*

**Fact: Bt crops have effectively increased yields by reducing the amount lost as a result of insect damage. However current approval has extended only to herbicide-tolerant and insect-resistance traits in biotech crops to date. Many other performance and quality traits are in development.**

Further, the current generation of biotech crops was not developed to increase yields but to maintain yields while decreasing the use of insecticides (e.g. Bt. crops) or substituting environmentally preferable herbicides (e.g. Roundup-ready soy). This generation also aimed to reduce the cost of production. Crops that need spraying less often, or do not need tilling before planting, dramatically cut the costs of labor, time and tractor fuel. Nonetheless, no-till cultivation associated with herbicide-tolerant biotech seed will in many cases allow denser planting of soybean fields, which could be expected to increase yield per hectare.[8]

5. *"Biotech crops have failed to reduce pesticide use"*

## Fact: Bt. corn and Bt. cotton have reduced pesticide use dramatically with the added benefit of yield increases.

During average years of insect pest pressure, Bt. cotton yields per hectare have increased by approximately 7%, while the amount of chemical insecticides applied to Bt. cotton fields has decreased by approximately 50% (i.e. 4.5 million liters during 1996-1999 in US).[9]

In years of average insect pest pressure, Bt. corn yields have increased by approximately 10%, while US farmers have reported that they typically do not spray chemical insecticides at all on fields of Bt. corn. One can therefore calculate that for putatively similar insect control, 50,000 tons per year of chemical insecticides would be theoretically avoided if the sixteen largest corn-producing states in America were to convert 80% of their corn hectares to Bt. varieties.[10]

6. *"Farmers are regularly sued by biotech firms for accidental contamination by biotech seeds"*

## Fact: 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.

During 2002, South Korea became the 50th member nation of the International Union for the Protection of New Varieties of Plants (UPOV). UPOV, established in 1961, consists of fifty countries around the world 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).[11]

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 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 both the original case and his appeal.[12],[13]

7. *"It is unfair that farmers are not allowed to save their biotech seeds from year to year"*

**Fact: For practical as well as commercial reasons, it is increasingly rare to save seed. Many varieties of superior non-biotech seeds cannot be saved, and some, such as hybrids, do not thrive from harvested seed.**

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.

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.[14] Every commercial farmer knows that the most important factor is not the cost of the seed but the net value of the resulting crop.

8. *"Farmers are forced to grow biotech crops because the biotech firms control all seed production so non-biotech seeds aren't produced"*

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

In all of the field crops that have been genetically modified so far, there remain numerous suppliers who offer traditional variety (i.e., non-biotech) seed for sale to farmers. In the case of soybeans, a self-pollinated crop, farmers are free to save-back and replant those of their non-patented / non-PVP seed varieties, as always.

9. *"Widespread growing of biotech herbicide-tolerant crops has harmed the environment"*

## Fact: Biotech herbicide-tolerant crops reduce herbicide application, resulting in cleaner soil and water, and aid no-till farming which minimizes soil erosion and 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) that they are replacing, which are being progressively prohibited both in Europe and the US. The new generation of herbicides have 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.[15]

Far from harming the environment, herbicide-tolerant crops have transformed much of US agriculture by reducing the need to till (plow) the land to prevent weeds smothering newly sprouted crops. Thanks to nil or minimal tillage, soil erosion and movement is minimized, soil health and water retention is maximized and of increasing importance, more carbon is prevented from escaping from the soil and contributing to global warming gases in the atmosphere. In addition, this helps in the reduction in CO2 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%.[16]

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[17] —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.[18]

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.[19]

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. [20] 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.[21] Year after year, and layer after layer, new organic matter is being 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.

More details are provided in the next section.

*10. "Herbicide tolerance genes can be transferred via pollen to wild plants thereby creating herbicide-tolerant 'superweeds' "*

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

Rapeseed or canola is a natural hybrid, one ancestor being wild turnip (*Brassica napa*) which is known to cross at very low rates. On the other hand, wild mustard (*Sinapis alba*) has not been found to cross in natural conditions, and can only be crossed by manipulation in the laboratory, as the species are practically incompatible.

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.[22] In order 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 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.

There is no credible evidence that those biotech crops in development or commercial use are, or could become, more difficult to control, or could become more troublesome weeds than any other crop plants. Indeed independent research has shown that the opposite may be true.

A 10-year-study by a respected British ecologist found that biotechnology 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.[23]

*11. "Bt corn is threatening the Monarch butterfly"*

**Fact: Far from being harmed by biotech crops, the Monarch butterfly stands to benefit from improvements in field composition.**

While one controlled laboratory experiment showed that one kind of Bt. pollen could harm Monarch caterpillars if fed to them directly, an extensive series of field experiments and observations have shown that Bt. crops have had no measurable effect on the Monarch and are not expected to do so in the future.

Because the Monarch butterfly winters in Mexican forests and migrates annually to the US, 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.[24] 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.

## 12. *"Bt. crops will hasten insect resistance to the Bt. insecticide and harm organic farmers who depend on Bt. sprays to control pests"*

### Fact: Bt. crops will not hasten insect resistance to the Bt. insecticide. The Bt. insecticide has been killing pests naturally for at least one hundred years with no visible increase in insect resistance.

In the US, laws limit the maximum fraction of corn and cotton hectares planted to Bt. varieties to less than 80%. This is intended to prevent, or at least greatly delay, any emergence of crop-pest insect populations that *could* adapt to become resistant to Bt. toxins through selective pressure. However, any logical discussion of the theoretical potential for crop-pest insects to develop resistance to the commonly used Bt. toxins must take into account the fact that Bt. (i.e., *Bacillus thuringiensis*) bacteria have been documented to be killing such insects since 1901 when the bacteria was discovered by Japanese scientist Ishiwata Shigetane in a dead insect.

Unlike the older man-made chemical insecticides, to which some pest-insect populations have become resistant (via dying-off of the susceptible fraction of the insect population, leaving only the rare naturally-resistant insects to mate with each other and thus become the majority of the population), the "Bt. toxins" have been widely present in the environment for perhaps many thousands of years.

Because pest-insect populations (e.g., Pyralis) have not become resistant to the "Bt. toxins" despite those toxins widespread natural presence in the environment for thousands of years, it is overly simplistic to assume that pest-insect populations will fast become resistant to them now, simply because those "Bt. toxins" are produced in crop plants on a large number of hectares.

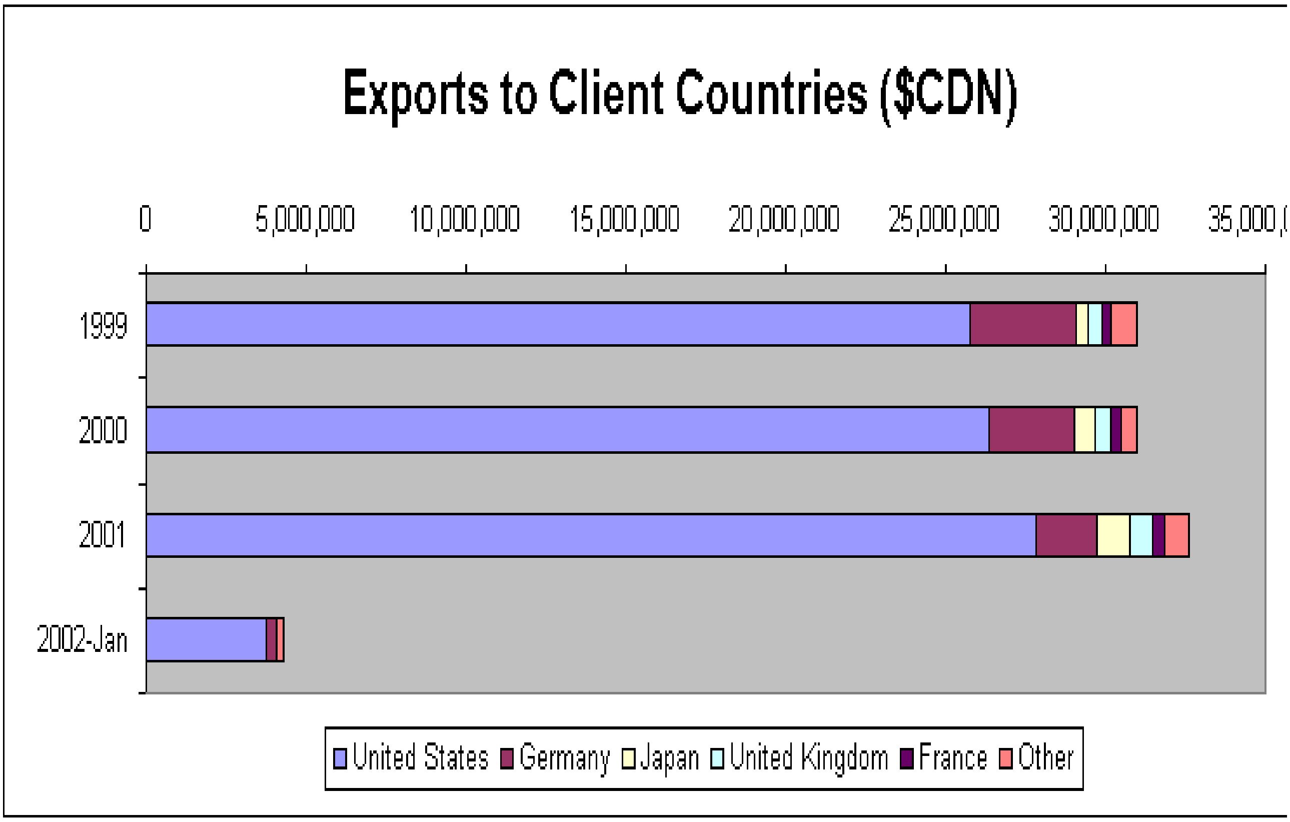
Even when they spray “organic Bt. spore powders” onto their crops, organic farmers cannot achieve anything close to the near-100% control of Pyralis (corn borer) that has been shown for Bt. corn. Inevitably, such a periodic low-dosage insecticide application would tend to allow naturally-Bt.-resistant pest insects to become an increasingly larger fraction of that (pest) insect population, yet that has not occurred during the three decades in which organic farmers have been applying Bt.

More details are provided in the next section.

13. *“Canada cannot export its honey because of contamination with pollen from biotech canola (oilseed rape)”.*

**Fact: Canadian honey exports have increased annually since the planting of biotech canola.**

Planting of biotech (herbicide-tolerant) canola began in Canada in 1997. Figures from the Honey Council of Canada for 1999-2001 (latest available – data for 2002 applies to January only) show that the value of exported honey has actually grown during this period.




*Source: Honey Council of Canada http://www.honeycouncil.ca/stats/exports.htm*

*14. "Only the US grows significant areas of biotech crops"*

**Fact: Argentina grows 22% of the world biotech crop, Canada 6% and China 3%.**

Other countries growing biotech crops during 2001 include South Africa, Australia, Mexico, Bulgaria, Uruguay, Romania, Spain, Indonesia, and Germany. India began to grow Bt. cotton this year.[25]

*15. "The herbicide Round-up (glyphosate) used on biotech soy has poisoned the environment and is a threat to human health through residues and groundwater contamination"*

**Fact: The US Department of Agriculture reported that biotech soybeans has enabled the substitution of glyphosate herbicide for other herbicides that are at least three times as toxic and (unlike glyphosate) persist in the environment.[26]**

*16. "No-till production practices were easily and cheaply implemented prior to the arrival of biotech herbicide-resistant crops"*

**Fact: Although no-till has been *attempted* ever since chemical herbicides were introduced, it was seldom easy or cost effective.**

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

The critical difference made by the availability of biotech herbicide-resistant crop varieties is revealed by the fact that that same NRCS agronomist, who noted that "US 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 (US no-till soybean hectares increased by 600,000 hectares between 1997 and 1998).[27]

As the “easy” soils/fields were naturally placed into no-till production practices first, there were indications of a likely plateau effect for total US no-till hectares at a disappointingly small total by the mid-1990s. For example, on the rolling red clay soils of Southwestern 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.[28] (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 utilize 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.[29]

Other inherent no-till limitations prior to 1996 included:

> 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.
>
> High risk for utilizing the emerging production practice known as narrow-row soybeans (i.e., closer planting more efficiently utilize 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).[30]

In December 1999, Ron Scarborough, the manager of Cargill's elevator in Raleigh, North Carolina, stated "Round-up Ready soybeans have helped soybean producers in North Carolina control sicklepod and decrease their foreign material content in soybeans. Cargill pays 1% bushel premium for low foreign material in the soybeans it buys."[31]

17. *"Agricultural biotechnology is inherently less safe than 'traditional' crop breeding methods and increases the risk of unknown allergens entering the food supply"*

**Fact: 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 US 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".[32]

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 US also thoroughly test all newly introduced proteins for allergenicity.[33] 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.[34]

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.[35] 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 (*Brassica juncea*) 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 hectares planted to herbicide-tolerant canola since 1995, the content of toxic wild mustard seeds in North America's harvested canola has been reduced significantly.[36]

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.[37]

We should not take the allergen problem out of proportion. Serious reactions like anaphylaxis are very rare, even though much of the food eaten in the US 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 label warnings.

More details on health issues are provided in the next section.

*18. "Biotech crops benefit only the biotech companies"*

## Fact: Biotech crops benefit every link in the food chain from the farmer to the consumer. In the future, even more exciting innovations will continue to improve food quality and make farming more sustainable.

New more sophisticated "designer" crops will help increase productivity, reduce pressure on land use and reduce the environmental footprint of agriculture. For example:

***low-phytate soybeans and corn***

Poultry and swine producers in most countries currently add mined and processed phosphate to their feed rations to enable optimal animal growth. That is in addition to the natural phosphate already present in traditional soybean and corn varieties, because the phosphate extant in traditional soybeans and corn exists in the form of an insoluble phytate (chemically bound with phytic acid).

Monogastric animals such as chickens and pigs lack the phytase enzyme needed for digestion of phytate. Virtually all of the extant corn / soy phytate and part of the added (mined) phosphate is excreted by the animals, which can sometimes cause pollution problems.

When low-phytate soybean meal is mixed with low-phytate corn to make animal feed rations, phosphate emissions in swine and poultry manure can be reduced by half. The iron, calcium, and protein in the ration are also absorbed more completely by the animal, which reduces anemia and nitrogen excretion.[38]

***high-phytase soybeans and corn***

In those countries and regions where pollution from manure phosphate causes severe problems (e.g., The Netherlands), it has become common practice to reduce phosphate excretions by including a microbial-source phytase enzyme supplement in animal feed. Research shows that adding the phytase supplement to feed rations can cut phosphate levels in swine and other monogastric animals' manure by as much as half, since the animal is able to digest the extant plant-source phosphorous; thereby allowing less (mined) phosphate to be added an a feed ingredient. Unfortunately, microbial-source phytase is expensive, and is subject to rapid degradation in the feed manufacturing and feed movement processes on modern farms.[39]

The US Department of Agriculture (USDA), and some seed companies have identified new heat-resistant forms of phytase enzyme. Genes for these heat-resistant form(s) of phytase will be inserted into corn and soybean varieties in the future, thereby overcoming the shortcomings of its current form in feed rations mentioned above. Because phytase increases the digestibility of protein in swine feeds, its presence also reduces the amount of nitrogen excreted into the environment.

In 1998, the U.N.'s Food & Agriculture Organization (FAO) issued a report stating that "excessive use of fertilizers, manure and pesticides is causing land degradation on 220 million hectares of farmland in Europe".[40]

***low-stachyose soybeans (also called high-sucrose soybeans)***

Mature soybeans from traditional varieties contain 1.4% to 4.1% stachyose, an oligosaccharide (carbohydrate) that is non-digestible in monogastric animals, including humans. Instead of being digested in the stomach, it passes to the intestines where bacteria ferment it into gases that make animals feel full, and they can be discouraged from eating and gaining weight to their full genetic potential. In low-stachyose soybeans, stachyose is replaced with the easily-digested sugar sucrose, so low-stachyose soybean meal is also higher in energy than traditional soymeal. When low-stachyose soybean meal is added to the first (prestarter) rations for piglets, those animals consume more feed and grow faster, and emit less phosphorous in their manure.[41]

The increased sucrose content means that low-stachyose soybeans are sweeter than their traditional counterparts, so they will also have potential application in some human foods and petfoods.

***high-oleic soybeans***

High-oleic soybeans contain more than 80% oleic acid content in their oil. This contrasts with the 23% oleic acid content of traditional soybean oil. Because oleic acid has greater heat and oxidation resistance than the other fatty acids in soybean oil, high-oleic soybean oil is naturally more resistant to degradation by heat and oxidation / time; so requires less or no hydrogenation, depending on the intended oil application. Other research has shown that feeding of high-oleic soybean meal full-fat (i.e., with the oil in it) to cows and chickens results in a lowering of the saturated fat levels in the milk and poultry meat thereby produced. Such fat changes are also produced through feeding of traditional canola oil.[42]

***high lysine, high-methionine, high-threonine, etc. corn and soybeans***
In the future, American farmers will be able to grow corn and soybean varieties that contain higher levels of the amino acids lysine, methionine, threonine, and cystine. Poultry and swine can only absorb amino acids from their feed protein in highly specific ratios. Those animals metabolize and excrete in the form of nitrogen pollution the amino acids that are caused to be "in excess" by a shortfall in the primary amino acids required in those ratios. The primary requirements for corn/soymeal-based feed rations are usually lysine and methionine. High-lysine & high-methionine corn and soybean meals could allow feed ration formulations that reduce animal nitrogen excretion by providing an improved balance of essential amino acids. That can be accomplished now, but only by adding synthetic lysine and methionine to the feed ration, which increases feed costs.[43]

***oligofructan-containing soybeans***
Future new genetically improved soybean varieties may also be able to improve poultry and swine health. For example, we anticipate new varieties that contain some oligofructan components, which selectively increase the population of beneficial species of bacteria in the intestines of certain animals, and "crowd out" harmful species of bacteria. Thus, those soybeans have the potential to displace some of the antibiotics that were historically added to animal feeds. These soybeans have the potential to keep swine and other animals healthier by lowering the incidence of intestinal pathogens and improving feed conversion and growth rates.[44]

Rather than increasing the prevalence of antibiotic-resistant bacteria, this is an example of a genetically engineered crop that is more likely to <u>decrease</u> their occurrence/prevalence, since the European Union has determined that feeding of therapeutic amounts is a probable cause of antibiotic-resistant bacteria, but failure to use feed antibiotics has been shown to require greatly increased therapeutic antibiotic use—which itself is a cause of antibiotic-resistant bacteria.

***high-isoflavone and high-c.l.a. soybeans***
It is anticipated that by the year 2006, soybeans containing conjugated linoleic acid (CLA) and/or elevated amounts of isoflavones will become available. These compounds help to prevent certain types of cancers, to lower blood cholesterol levels, and promote lean tissue growth in both humans and livestock.[45]

*19. "Biotech crops currently offer no health benefits to consumers"*

## Fact: Biotech crops already offer significant health benefits, including reduction of known cancer-causing molds.

The greatest potential benefit to mankind offered by Bt. crops is the reducing the risk of consuming fatal amounts of naturally-occurring aflatoxin and other mycotoxins. These are toxins produced by fungi in corn and cotton (as the latter is sometimes fed to dairy cows in the form of cottonseed meal, aflatoxin can also get into milk supplies). Due to tight controls and intensive testing developed over many decades, alfatoxins are usually well controlled in developed countries. However, this is not true in the developing world. According to the United Nations' Food & Agriculture Organization (FAO), 25% of the world's food crops are affected with mycotoxins each year. That echoed a similar finding by Mannon and Johnson in 1985.[46]

Most common of the mycotoxins is aflatoxin B1, one of the most potent cancer-causing compounds known to mankind.[47] According to a 1993 World Bank report, '*Investing In Health*', approximately 40% of disability-adjusted life years lost to premature adult death in developing countries were due to diseases linked to consumption of mycotoxins. Insects (e.g., Pyralis, Ostrinia nubilalis) are the primary vectors for (carrying into crop plants) the *Aspergillus flavus* and A. *parasiticus* fungi that produce aflatoxin in. These insects are best controlled by transgenic "Bt. crops", which hold the potential to "reduce or even eliminate mycotoxins in the food supply".[48]

*20. "Antibiotic-resistance 'marker genes' will create antibiotic-resistant bacteria in humans"*

## Fact: Research regarding the development of antibiotic-resistant bacteria in humans from "marker genes" 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.[49] 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.[50]

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.[51] 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.[52]

More details are provided in the next section.

## *21. "Biotech crops are unnecessary. Organic farming can produce similar amounts of food without using any chemicals."*

## Fact: 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 of the organizations supporting this report 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 like wheat and cotton, and soy and corn for animal feed, all of which comprise a major part of US 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 yields (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.[53]

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.

### *22. "Developing countries have not benefited from US biotechnology"*

## Fact: Developing countries benefit from US biotechnology in multiple ways including: lower crop prices for imports, lower mycotoxin levels, and higher and cleaner crop yields in domestic planting.

Developing countries, which tend to be major soybean importers, have benefited from the lower prices that accompanied most years' record US soybean production that has tended to occur frequently since a significant amount of biotech herbicide-resistant soybean seed became commercially available. The reduction in cost of inputs enabled US 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., US, 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. Because approximately 40% of adult premature deaths in developing countries are due to consumption of mycotoxins, it is likely that a significant number of premature adult deaths in such corn-importing nations have already been avoided.

Additionally, several developing countries depend on their own export of agricultural products for income and jobs. Argentina, for example, exports most of its (chiefly biotech) soybeans. Former Argentine Secretary of Agriculture Marcelo Regúnaga said in July that Argentine soybean producers saved about US$400 million in crop production costs by cultivating biotech soybeans in the year 2000, and that those farmers in his country who grew Bt. corn realized a savings of up to 15 percent.[54]

# Further information

## *Glomalin issues*

A cubic centimeter of healthy soil contains hundreds of thousands of individual bacteria. Just like humans or animals, bacteria need air, food, and hospitable "living space". Soils (e.g., farm fields) that possess these attributes in abundance are "healthy" for bacteria, and since many bacteria species help plants to grow better, "healthier soil" is more fertile for production of agricultural crops.

Examples of "unhealthy" soils include desert sand, and alkaline / clay / salt flats, in which few, if any, plants can grow. These unhealthy soils are generally devoid of bacteria, fungi, earthworms, and other subsurface life.

A crucial ingredient in healthy soil is the protein known as *glomalin*, which acts as a sort of "glue" to cause soil particles to glom together in the "clumps" needed for subsurface spaces to be created which allow water and oxygen to permeate the soil, plant roots to penetrate the soil, and carbon to adhere to individual soil particles **(**thereby remaining out of the air**)**. Glomalin is produced by fungi that grows on most plant roots. Those fungi feed on carbon taken-in by plants, in the form of carbon dioxide.

To avoid destroying the glomalin and the fungi that produce it in soil, farmers need to keep the ground covered with plant matter during the growing season for as much of the time as possible; and utilize weed control practices that involve minimal soil disturbance.[55] Known as "no tillage" or "low tillage" practices, such low / no-tillage practices are facilitated by use of herbicide-tolerant crops (i.e., enabling weed control without soil disturbance).

Due to rapid expansion of the hectares planted to the biotechnology-derived glyphosate-tolerant soybean, US farmers utilized "low / " no-till practices on a record number of hectares in the late 1990's plus the following years.[56] As additional hectares are converted to "low / " no-till practices, large amounts of carbon (from "greenhouse gases") are sequestered in the soil; helping to move the World closer to the goal of decreasing the overall level of "greenhouse gases" in the atmosphere.[57]

Switching a farm field to low / no-tillage practices also reduces soil erosion (due to wind and water) by as much as 90%.[58]

## *EPSPS issues*

Like humans or animals, bacteria must be able to "manufacture" amino acids in order to grow. For example, such amino acid "manufacturing" in humans is needed for children to build muscles, skin and other vital tissues. Different species of bacteria, plants, and animals utilize somewhat different enzymes to "manufacture" their needed amino acids (i.e., from the "molecular building blocks" they each derive via photosynthesis or consuming food).

All land plants utilize an enzyme called EPSPS (enolpyruvyl-shikimate phosphate synthase) in order to manufacture the amino acids they need. However, bacteria, humans, and animals utilize different enzymes. Therefore, the two glyphosate-based herbicides that kill plants (e.g., weeds) by specifically impacting EPSPS do not similarly harm bacteria, humans, or animals. A few bacteria utilize enzymes that are quite *similar* in their molecular structure to EPSPS, but those enzymes are not affected by the glyphosate-based herbicides.

The gene for one of those bacterial enzymes **(**known as CP4-EPSPS**)** was inserted by one of the biotech seed companies into the soybean plant (*Glycine max*), so that glyphosate containing herbicides can now be applied to fields of those biotechnology soybean varieties without harming them [but essentially all weeds in field are killed].

Because those glyphosate-based herbicides are very effective at killing virtually all plants other than the soybean varieties specifically engineered to resist herbicides, farmers utilizing this engineered soybean / herbicide combination are able to produce soybeans that contain approximately one third fewer weeds than before.[59]

Since some weed seeds are naturally slightly toxic to humans, this reduction of weed seed production in the field adds an additional safety factor to the soybean processing industry's already excellent screening / sieving machinery & other processes that are in place to remove weed seeds from harvested soybeans. Moreover, this extra layer of safety (due to reduction of weed seed content in field) is far greater for canola (*Brassica napus/campestris*) that is genetically engineered to contain the gene for CP4-EPSPS enzyme. That is because some especially toxic weeds (e.g., wild mustard) that commonly infest canola fields are so *closely related* to canola that it was previously virtually impossible to harm those weeds via herbicide without also harming the canola plants.

Thus, canola farmers had long been forced to live with some presence of toxic weed seeds in their harvested crop. Recognizing that fact, plus the very real potential for harm to animals that is posed by the presence of the weed seed toxins (i.e., glucosinolates), Canada's government long ago enacted laws that prohibit feeding to domesticated animals of canola meal which contains any significant amount of wild mustard seeds.

Because use of the new CP4-EPSPS-containing canola with appropriate herbicide dramatically reduces the presence of wild mustard weed seeds in harvested canola, this canola meal safety improvement via use of biotechnology is very significant.

## *PAT/BAR (glufosinate-ammonium resistance) issues*

The soil bacterium called *Streptomyces hygroscopicus* has a gene **(**known as the "BAR" gene**)** that causes production of the enzyme called phosphinothricin acetyl transferase (PAT). The soil bacterium *Streptomyces wiridochromogenes* has a gene **(**known as the "PAT" gene**)** that causes production of the same enzyme (i.e., "PAT").

When the "BAR" or "PAT" genes from these soil bacteria are inserted via biotechnology methods into crop plants, those (bioengineered) crop plants are essentially immune to herbicides containing the active ingredient known as glufosinate-ammonium. Other plants (i.e., weeds) are killed because glufosinate-ammonium inhibits their "manufacture" of the critical amino acid glutamine in those (nonengineered) weed plants.

Because glufosinate-ammonium-containing herbicides are very effective at killing virtually all plants other than those bioengineered to contain "BAR"/"PAT" genes, farmers utilizing these engineered crop plants (e.g., canola) along with appropriate herbicide are able to produce crop (e.g., canola) that contains significantly fewer weed seeds than they had been able to previously. That is because some especially toxic weeds (e.g., wild mustard) which commonly infest canola fields, are so closely related to canola that it was previously almost impossible to harm those weeds via herbicide without also harming the canola plants. Thus, canola farmers had long been forced to live with some presence of toxic weed seeds in their harvested crop.

Recognizing that fact, plus the very real potential for harm to animals that is posed by the presence of weed seed toxins (i.e., glucosinolates), Canada's government long ago enacted laws that prohibit feeding to domesticated animals of canola meal which contains any significant amount of wild mustard seeds. Because use by farmers of the new CP4-EPSPS-containing canola with appropriate herbicide dramatically reduces the presence of wild mustard seeds in harvested canola, this canola meal safety improvement via use of biotechnology is very significant.

## *Bt. issues*

Soil bacteria compete with each other for their life's requirements: oxygen, water, living space, etc. Because bacteria don't have fangs or claws like the world's large wildlife, bacteria generally utilize "chemical warfare" against each other, and to kill food such as any insects that pass by. One example of such chemical warfare is that of the soil-dwelling bacteria known as *Photorhabdus luminescens*. *Photorhabdus luminescens* naturally colonizes **(**i.e., lives in**)** the gut of a nematode (microscopic worm) called *Heterorhabditis*. When *Heterorhabditis* enters an insect (e.g., cockroaches, mealworms, etc.), the *Photorhabdus luminescens* is released inside the insect. *Photorhabdus luminescens* naturally secretes certain chemical toxins that kill the insect (cockroach, mealworm, etc.), then *Photorhabdus luminescens* **(**and its "children" bacteria**)** consume the dead insect from the inside.

Another example of such chemical warfare is that of the bacteria family known as *Bacillus thuringiensis* or **"**Bt.". They produce compounds known as protoxins, which become insect-species-specific toxins (called δ-endotoxins) after they enter the stomach of those insect species **(**e.g., because those insect species have alkaline stomach chemicals, instead of the acidic stomach chemicals found in mammals**).**

The first Bt. was discovered by Japanese scientist Ishiwata Shigetane in 1901, when he noticed that a particular bacteria (i.e., Bt.) had killed a certain insect. Since that time, approximately 50,000 other strains of Bt. bacteria have been discovered; each of which makes a different protoxin which is specific to a narrow range of target insects. For example, the *Israelensis* variety of Bt. is toxic to mosquitoes and black fly, but the *Kurstaki* variety of Bt. is toxic to the larvae (caterpillars) of certain Lepidopteran insects (e.g., Pyralis). When those particular target insects are major crop pests, that makes the respective Bt. (bacterial genes) potential candidates to be inserted via biotechnology methods into crop plants, in order to protect those crop plants from insect attack.

*Attacking the above-ground portions of the corn plant*

Caterpillars (larvae) of the Lepidopteran pest insect known as *Ostrinia Nubilalis* (Pyralis, or corn borer) used to cause approximately US $ 1 billion of damage each year to corn in America. The larvae chew holes into above-ground portions of corn plants, which weaken the plant's stalks and reduce corn yield per hectare. The weakened corn plants are also more prone to falling-over, which further reduces harvested yield per hectare.

Because each of the larvae are only on the surface of the corn plant briefly, prior to burrowing into the plant, they are impossible to control 100% via the application of synthetic chemical insecticides (i.e., the chemical insecticides can't reach larvae that are inside the plant stalk). However, "Bt. toxin" is present throughout the tissues of biotechnology derived "Bt. corn" plants, so such Bt. corn has shown near-100% control of the pest larvae.

*Attacking the below-ground portions of the corn plant*

Caterpillars (larvae) of the pest insect *Diabrotica virgifera virgifera* (corn rootworm) chew into the below-ground portions (roots) of corn plants, which weakens the plants, makes them more prone to falling-over in a wind, and lowers the harvested corn yield per hectare. In order to try to protect corn plants against this pest insect, US farmers spend US $ 150 million per year on synthetic chemical insecticides applied in-soil.

Next year, it is expected that biotechnology-derived corn which is engineered to produce a "Bt. toxin" (in its roots) that kills the larvae of *Diabrotica virgifera virgifera* (corn rootworm) will be commercialized in America. In addition to increasing yields per hectare of corn, it will help to further reduce the amount of persistent chemical insecticides applied to the environment.

## *Antibiotic resistance issues*

Numerous types of bacteria secrete antibiotics to try to kill the bacteria living in the soil beside them. In return, those adjacent bacteria also secrete antibiotics. They all utilize various defense mechanisms (which are collectively known as antibiotic resistance) in order to try to avoid being killed by the various antibiotics being secreted by their "neighbor" bacteria.

Decades ago, mankind learned how to commercially manufacture some of these antibiotics; so they could be administered to people infected with disease-causing (i.e., pathogenic) bacteria. Until those pathogenic bacteria develop antibiotic resistance (just like the soil-dwelling bacteria have always done), such manufactured commercial antibiotics are very valuable to doctors to fight human disease.

Unfortunately, doctors in many developed countries tend to over-prescribe antibiotics to their patients. Research has shown that this sometimes leads to the rapid rise of new strains of pathogenic bacteria, which are resistant to commercial antibiotics. For example, recent research has shown much higher levels of antibiotic-resistant pathogenic bacteria in patients from wealthier neighborhoods in developed countries. That is because patients in the poorer neighborhoods cannot financially afford to over-use antibiotics (e.g., going to a doctor for every minor cold or sniffling nose).

In response to research indicating that some doctors were over-prescribing commercial antibiotics, the US and UK governments have recently issued legal regulations stating that doctors in their countries must halt such over-prescribing of antibiotics. As a result of those new rules, doctors in those countries must now resist the pleas of parents who demand that commercial antibiotics be immediately prescribed each and every time their children become ill.

# Statements on agricultural biotechnology from leading American farm, food, medical, scientific and other independent organizations

**The statements reproduced below are the most recent issued by these organizations on the topic of agricultural biotechnology and biotech food.**

**Links to source websites are included.**

# National Corn Growers Association (NCGA)

NCGA is a national organization founded in 1957 that represents more than 31,000 dues-paying corn growers from 48 states. NCGA also represents the interests of more than 300,000 farmers who contribute to corn checkoff programs in 19 states. NCGA is a federation of state organizations, corn boards, councils and commissions, which develops and implements policies and programs on a state and national level to help protect and advance the corn producer's interests.
NCGA is recognized as the leading corn grower organization on Capitol Hill, by international leaders, by industry and by farm and national media.

**Position on biotechnology**
http://www.ncga.com/biotechnology/main/position.htm
Feb 2001
The development of biotechnology offers great promise for corn growers through improved efficiencies and potential profits when managed wisely and with regulatory oversight based on sound science. However, the proliferation of corn is straining current systems of price discovery, consumer information, health regulation and trade management. Widespread acceptance of biotechnology depends on better methods of informing consumers and better management by biotechnology providers, producers, suppliers, and grain merchandisers.

Resolution/position:
1. Support the positive contributions of biotechnology as it relates to human health, the environment, grain quality, and production benefits.
2. Support trade negotiations including the specific objective of harmonization or mutual acceptance of agricultural products.
3. Support the development of internationally accepted, science based tolerance standards.
4. Support the commercial release of corn hybrids or products that have been fully approved by the relevant US and Japanese regulatory agencies and for which the product registrant is aggressively pursuing approval in every country or bloc that requires approval prior to importation of corn, corn products, or food containing corn ingredients. Recognizing the importance of every customer of US corn and corn products, NCGA will insist that every product registrant conducts due diligence in bringing products to market in a manner that does not disrupt domestic or international trade and will initiate discussions with providers and end users to develop a certified marketing system that assures all events and products will reach appropriate markets.
5. Request the seed industry to employ judicious geographical selection in marketing products that do not have worldwide approval.
6. Support the release of corn that is intended for a specific end use and that has limited regulatory approval only through closed marketing systems or carefully conceived identity preservation systems.

7. Request that biotechnology providers assure the availability of accurate, affordable, timely tests to detect the presence of the regulated trait. Tests should be available prior to the release of new products.
8. Continue efforts to advise growers to insist that 2001 corn seed has been tested for the presence of Cry9C according to the US Department of Agriculture (USDA) recommended testing protocol.
9. Support widespread promulgation by seed retailers of hybrid-specific export approval status to enable growers to immediately determine which hybrids are currently approved and which are not.
10. Request the seed industry to clearly label and identify the approval status of all varieties and to augment this effort with an aggressive communications program targeting grower customers.
11. Support Food and Drug Administration's efforts to provide guidance for voluntary labeling that indicates whether foods have or have not been developed using bioengineering to identify attributes that are important to consumers in a manner that is truthful and not misleading and that provides for reasonable tolerances.
12. Support Grain Inspection, Packers and Stockyards Administration (GIPSA) efforts to develop merchandising standards for goods that do not contain corn.
13. Support establishing a science based tolerance for commingled StarLink corn.
14. Encourage the mediation and resolution of issues in a manner which limits disruption of domestic and international corn marketing.
15. Encourage the Environmental Protection Agency (EPA), registrants and the research community to work closely with producers to develop resistance management strategies that are workable for producers and that maximize the availability of products in areas where both corn and cotton are produced.
16. Require the seed industry to aggressively promote Insect Resistance Management (IRM) in their seed sales strategy.
17. Support a review by the USDA of biotechnology fees and crop protection product prices here and abroad to determine and report differences that may put US producers at a disadvantage.
18. Encourage providers to avoid the use of antibiotic markers that unnecessarily raise consumer concerns.

# Council for Agricultural Science and Tech (CAST)

CAST assembles, interprets, and communicates science-based information regionally, nationally, and internationally on food, fiber, agricultural, natural resource, and related societal and environmental issues to our stakeholders--legislators, regulators, policy makers, the media, the private sector, and the public. CAST is a nonprofit organization composed of scientific societies and many individual, student, company, nonprofit, and associate society members. CAST's Board of Directors is composed of representatives of the scientific societies and individual members, and an Executive Committee. CAST was established in 1972 as a result of a 1970 meeting sponsored by the National Academy of Sciences, National Research Council.

*Comparative Environmental Impacts of biotechnology-derived and Traditional Soybean, Corn, and Cotton Crops*

**http://www.cast-science.org/biotechnology/index.html#cropsbenefit**

A comprehensive review of the scientific literature, supports the conclusion that overall the currently commercialized biotechnology-derived soybean, corn, and cotton crops yield environmental benefits.  Furthermore, a critical analysis of the literature supports the idea that biotechnology-derived soybean, corn, and cotton pose no environmental concerns unique to or different from those historically associated with conventionally developed crop varieties.

**See Appendix for a reproduction of the executive summary of this report**

# National Center for Food and Agricultural Policy

The National Center for Food and Agricultural Policy (NCFAP) is a private non-profit non-advocacy research organization located in Washington, D.C. Originally established in 1984 at Resources for the Future with a grant from the Kellogg Foundation, the Center became an independent organization in 1992. NCFAP was established to analyze and address food and agricultural policy issues. The Center's mandate includes conducting education programs to disseminate research results and recommendations to policy makers, analysts, business leaders, interest groups and others with a business need to understand complex food and agricultural policy issues, the alternative options available to deal with then, and the policy making process.
From its inception, NCFAP has sought to be a catalyst for new ideas that would enable the US food and agricultural system to cope effectively with fundamental changes in its structure and its economic environment and the global economy. The Center's perspective is broad and long-term. NCFAP does not take a stand on specific legislation, nor advocate positions of particular interest groups. Instead, the Center strives to show the consequences of pursing alternative policy options. Its main target audience is public policy officials in the US and in selected regions of the global economy. In addition, NCFAP provides information for the general public, farm organizations, agri-business, commodity groups, and other interested parties.

**Some** 40 case studies of 27 crops compiled by the National Center for Food and Agricultural Policy (NCFAP) document that hardier crops developed through biotechnology can help Americans reap an additional 14 billion pounds of food and improve farm income $2.5 billion, while using 163 million fewer pounds of pesticide.

To view the full NCFAP report, Plant biotechnology: Current and Potential Impact For Improving Pest Management In US Agriculture: An Analysis of 40 Case Studies by Leonard P. Gianessi, Cressida S. Silvers, Sujatha Sankula and Janet Carpenter, National Center for Food and Agricultural Policy, June 2002, go to: http://www.ncfap.org/40CaseStudies.htm

Below are summary reports for 3 studies on the impact of biotech cotton varieties.

***Insect Resistant Cotton (study 32)***

Bt. cotton varieties were introduced in 1996, providing control of three major cotton insect pests: tobacco budworm, cotton bollworm and pink bollworm. These varieties offer an alternative to conventional insect spray programs. Tobacco budworm infestations were particularly heavy in 1995, causing severe yield loss in some areas. The worst damage was sustained by Alabama growers, who experienced, on average, a 29% yield loss due to bollworm/budworm infestation despite seven insecticide applications. These losses were attributed to the ineffectiveness of pyrethroid insecticides against budworm, due to the development of resistant populations in some states.

The adoption of Bt. varieties was extremely rapid in states that experienced resistance problems (Arizona, Alabama, Georgia, and Florida). After the year of very high budworm populations and damage in 1995, growers in Alabama adopted the new tech at an extremely rapid rate, planting over 60% of total acreage to Bt. varieties in 1996. Bt. cotton is credited with saving the cotton industry in Alabama. In 2001, 42% of cotton acreage in the United States was in Bt. varieties. Adoption has been low in California (5%) because the worm pests are not a problem in the San Joaquin Valley and because California's unique cotton cultivars have not been converted to Bt. Adoption was accelerated in certain states (Mississippi, Louisiana, Texas, Oklahoma, Arkansas, and Tennessee) due to implementation of Boll Weevil Eradication Programs (BWEP) and resistance problems experienced in 1995. Growers in BWEP areas are advised to plant Bt. cotton due to the effects of the weevil sprays on predators of bollworms/budworms.

The impacts of the adoption of Bt. cotton varieties include a reduction in yield losses due to Bt. target pests, reductions in insecticide use, and cost savings. Numerous surveys have found that growers are achieving higher yields and attaining higher profits by planting Bt. varieties, due to better pest control and decreased insect control costs. The average increase in net income in 2000, comparing Bt. to conventional varieties, was $20/ acre, taking into account the tech fee. On average, per acre insect control costs were $2 higher. This increased cost was outweighed by a yield increase of 36 lbs/ acre.

In recent years, the bollworm/budworm has become significantly less troublesome in the Southeast (Georgia, Alabama, Florida) narrowing the economic difference between Bt. and non-Bt. acreage.

***Estimated Impacts of Insect Resistant Transgenic Cotton***

Change in Production: 185 million lbs/ yr increase in production
Change in Pesticide Use: 1.9 million lbs/ yr decrease in insecticides
Change in Net Revenue: $ 103 million/ yr increase in net revenue

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***Insect Resistant Cotton (study 33)***

The fall armyworm, soybean looper and the beet armyworm are destructive migratory pests of many crops in the southeastern US. Damage caused by fall armyworms on cotton is from their feeding on the fruit. Once loopers begin feeding on the outer canopy, they can completely defoliate the plant in 36 to 48 hours. Young beet armyworm larvae feed together and gradually disperse as they grow. They "skelotenize" leaves.

Transgenic Bt. cotton has been commercially available in the United States since 1996. Bt. cotton has demonstrated remarkable control of some lepidopteran pests, particularly the tobacco budworm and the pink bollworm. Since its release into commercial markets, Bt. cotton seldom, if ever, has required supplemental insecticide control for these two pests. Control of the bollworm has been less dependable. Common lepidopteran pests such as fall armyworms, beet armyworms and soybean loopers are even more tolerant than bollworms. Supplemental foliar insecticide applications have been used in many Bt. cotton fields to control economically damaging populations of fall armyworms, beet armyworms, soybean loopers and especially bollworms. Approximately 36% of current Bt. cotton acreage is treated for bollworms (1.9 million acres) with 527,700 pounds of chemical active ingredients.

Approximately 65000 bales valued at $19 million were lost to bollworms on Bt. cotton acreage in 2000. For beet armyworm/fall armyworm/soybean looper control, approximately 21% of current Bt. cotton acreage is treated with 458,955 pounds of chemical active ingredients. Approximately 12,000 bales valued at $3.6 million were lost to loopers/armyworms on Bt. cotton acreage in 2000.

Unacceptable control of bollworms and other lepidopteran pests such as beet armyworms, fall armyworms and soybean loopers, prompted the development of a new genetically modified cotton that contains two separate crystalline proteins. The addition of a second Bt. protein provides satisfactory control of beet armyworms, fall armyworms, and soybean loopers. Efficacy is improved against bollworms. The dual-toxin cultivars may not require supplemental insecticide applications for these pests.

Bt. cotton I will likely be phased out and completely replaced with Bt. cotton II; a process that will take several years. It is estimated that Bt. cotton II will be adopted on the same acreage that is currently planted with Bt. cotton I at an increased cost of $2/A. The major impact of Bt. cotton II would be an elimination of current losses and spraying costs due to bollworms/loopers/armyworms on Bt. cotton acreage.

***Estimated Impacts of Insect Resistant Transgenic Cotton***

Change in Production: 37 million lbs/ yr increase in production
Change in Pesticide Use: 1.0 million lbs/ yr decrease in insecticides
Change in Net Revenue: $ 46 million/ yr increase in net revenue

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***Herbicide-tolerant Cotton (study 34)***

Weeds can cause significant losses in cotton and require careful management by the grower. During the initial period of establishment, usually the first 6 to 8 weeks after planting, control of weeds is important in order to prevent undue stress upon the cotton seedlings. Weeds, if allowed to grow unchecked, can dramatically reduce cotton yields.

In 1995, the typical US cotton acre was treated with an average of nearly three active ingredients in nearly three treatments. There were also three cultivations made on the typical acre. Extensive use of hand-weeding crews has been utilized. In the early 1990s, 21% of US cotton acreage was hand weeded annually with the highest use in California where 75% of the acreage was hand weeded.

US cotton growers applied nearly 32 million pounds of active ingredients at an annual cost of $302 million just prior to introduction of transgenic herbicide-tolerant cotton varieties. The total cost of weed control including herbicide, hand weeding, cultivation and application costs was $797 million / yr.

BXN cotton varieties were introduced in 1995, offering cotton growers a cultivar resistant to bromoxynil (Buctril) a post emergence herbicide that kills may broadleaf plants. Roundup Ready cotton varieties were introduced in 1997. These varieties have been developed to tolerate glyphosate, a nonselective herbicide which normally cannot be applied over crops without severe crop injury. Research has not demonstrated better weed control in BXN or Roundup Ready cotton than that which can usually be obtained in non-transgenic cotton with traditional weed control systems. However, both transgenic cottons expand the options for weed management and make the mechanics of weed control much easier, less expensive and more convenient. The highest rates of adoption of BXN cotton have been in the states of Arkansas, Tennessee, and Missouri where morning-glories are a significant problem and where sicklepod is not prevalent. The Roundup Ready system has been widely adopted as Roundup has a broad spectrum of activity, which includes most of the major annual and perennial grass and broadleaf weeds infesting cotton fields.

US cotton acreage planted with Roundup Ready varieties increased steadily following its introduction in 1997 reaching 70% of planted acreage in 2001. Numerous press articles have reported that cotton growers have adopted the transgenic cultivars as a way to significantly reduce their production costs. Growers have reported making fewer trips across fields applying herbicides, making fewer cultivation trips, and making fewer applications of herbicides. USDA surveys of herbicide use by cotton growers show a general decline in overall herbicide active ingredient used per acre for most states since 1996/1997 to 2000. Extension Service cotton weed control specialists were surveyed to estimate the changes in tillage, herbicide application trips and hand weeding that has occurred on the acreage planted to transgenic cotton. All states reported fewer tillage trips and less hand weeding, while herbicide application trips were either reported as unchanged or reduced.

***Impacts of Herbicide-tolerant Transgenic Cotton***
Change in Pesticide Use:  6.2 million lbs/yr. decrease in herbicide active ingredients
Change in Production Costs: $133 million/yr. savings in weed control costs.

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# American College of Nutrition

Established in 1959 to promote scientific endeavor in the field of nutritional sciences.

**Statement on Crop biotechnology**
American College of Nutrition (ACN) - Journal of the ACN, June-2002
The American College of Nutrition is committed to the worldwide availability of a safe, adequate and nutritious food supply. Substantial valid scientific evidence exists establishing the safety of crops developed via biotechnology. Numerous national and international scientific and regulatory organizations have reviewed this evidence and concluded that crops developed via biotechnology pose no unique safety concerns compared to crops developed via traditional breeding. Moreover, since the introduction seven years ago of foods containing ingredients from crops developed via biotechnology, these crops have been widely adopted by farmers worldwide, and have an established history of safe use in practice.

The American College of Nutrition recognizes the potential of biotechnology to improve the size and reliability of crop yields and encourages its use to develop crops that benefit countries of the developing world. Wherever possible, biotechnology should be applied responsibly to improve crops that enhance dietary diversity and thus the nutritional value of the diet for resource poor farmers and consumers who currently have a limited food supply. The College further supports the application of biotechnology to enhance the nutritional quality of foods.

Increasing the levels of desirable components and prolonging food freshness are valuable approaches to ensuring a nutritious and wholesome food supply. In addition, biotechnology offers the possibility of removing some anti-nutrients and allergens present in conventional crops and foods.

Moreover, the College recognizes that crops enhanced via biotechnology may benefit the environment by reducing reliance on agricultural chemicals and by enabling the use of more sustainable agricultural practices. Therefore, the College supports the use of biotechnology to develop food crops that contribute to global food security and enhance the safety and nutritional value of the food supply. At the same time, the College encourages the maintenance of wild-type genetic varieties and the biodiversity they provide. Finally, the College supports the continued application of sound scientific principles to the evaluation of these products and encourages the nutritional science community to participate in scientifically based evaluations of food products. The College is committed to continuing surveillance of the scientific and safety data of individual products developed via crop biotechnology.

The American College of Nutrition is a not-for-profit society composed of over 1,200 professional nutritionists drawn from academia, practice, and industry, and committed to disseminating nutrition knowledge, fostering nutrition education, and encouraging continued research in the broad area of nutrition.

According to Dr. Stanley Wallach, Executive Director of the College, "The College is releasing this statement at this time to coincide with publication of the June 2002 issue of the Journal of the American College of Nutrition (JACN), which is devoted entirely to the subject of crop biotechnology." Wallach continued, "As the papers published in the supplement to JACN on this topic show, the technology is being applied in the US, Europe, Australia, Kenya and SE Asia to make foods more nutritious, more plentiful, and to reduce use of pesticides."

# American Dietetic Association

With nearly 70,000 members, the American Dietetic Association is the nation's largest organization of food and nutrition professionals.

**Statement by Mildred Cody, PhD, RD, The American Dietetic Association before the Food and Drug Administration, November 30, 1999, Washington, DC**

http://www.eatright.org/gov/lg113099.html
I am Mildred Cody, Associate Professor of Nutrition at Georgia State University, and I am representing The American Dietetic Association. ADA's mission is to promote optimal nutrition and well being for all people by advocating for its 70,000 members. This 83-year-old organization provides a sound analytic bridge between scientific research and consumer interests.
We commend the Food and Drug Administration for holding this series of meetings to share information about biotechnology. Few issues have engendered such interest and emotion, with views ranging from highly positive to highly negative.
ADA has actively monitored biotechnology issues since the early 1990's and continues to bring a unique perspective to the complex issues surrounding biotechnology and its potential impact on our lives. ADA members have expertise in science and consumer education, both of which bear on the questions surrounding food and food products derived from biotechnology. We are committed to providing our clients – the American consumer -- with accurate, science-based information on bio-engineered foods in a way that is understandable and balanced.
ADA's position is that biotechnology techniques have the demonstrated potential to be useful in enhancing the quality, nutritional value, and variety of food available for human consumption. biotechnology also can increase the efficiency of food production, food processing, food distribution, and waste management (Position of The American Dietetic Association: biotechnology and the future of food, *J Am Diet Assoc.* 1995, volume 95, pages 1429-1432). As part of the ADA five-year review cycle, we are reassessing this position, and it will be published in the summer of 2000. With all food, nutrition, and health issues related to biotechnology, we see our educational efforts for health professionals and their audiences as a major, on-going task.
For example, ADA has launched an intensive three-year media and public education campaign on food safety. This campaign was developed after an ADA study showed a significant gap between knowledge and practice on a number of key issues related to food borne illness. In less than six months, this campaign has reached more than 40 million consumers across the United States.

As we have heard today, biotechnology is broadly used in medicine, and it is increasingly applied in food production. While ADA believes that the US regulatory system -- based on scientific processes and with public input -- serves the nation's economic and consumer interests well, that does not imply that there isn't work to do. It will take a continuous effort for the regulatory system to keep pace with advancements in biotechnology.

In these meetings, numerous organizations and individuals have offered recommendations on how improvements should be made. We urge federal regulators to look carefully at the merits of new ideas and approaches and refine the US system to:

- Best promote the safety of the US food supply,
- Allow the continued advancement of food production and science techniques to serve overarching economic, environmental and health needs,
- Increase the availability of nutrient-rich, high quality foods so that all may have access to healthful diets, and
- Provide useful, scientifically based information to those who wish to know more – including health professionals and self-informing consumers.

This last point is where I will focus the remainder of my remarks.

A recent national consumer survey found that two out of three consumers support foods produced through biotechnology and have confidence in FDA's current policy for labeling foods (International Food Information Council Background, October 1999: http://ificinfo.health.org/press/positivebio.htm). We cannot afford to undermine this existing consumer confidence surrounding biotechnology.

ADA supports labeling approaches that let consumers make informed decisions in their selections of food. As we know, many complex factors affect food choices. The question is, can we develop labels that provide useful information without being misleading or confusing? Or, is the food label the best place for information on biotechnology? Would other mechanisms of communication better serve the public?

Health care providers, such as qualified dietetics professionals, translate sound science concerning safety and health needs to help individuals make appropriate food choices. In this light, we see the need for a comprehensive approach to biotechnology information dissemination and education. The coordinated oversight of biotechnology by FDA, USDA and EPA needs to be strengthened by the contributions of scientists and industries, health care professionals and educators, consumer organizations and others into a concerted national information initiative. No one group – not government or industry, not scientists or consumer advocates – can successfully address the information and trust gaps developing around biotechnology. But together, each can play to their strengths in support of a safe, nutritious, and consumer-valued food system.

We believe US consumers, accustomed to a system that has served them well, have been patient as the information on biotechnology comes together and is made available to them. It is now time to act. ADA stands ready to work with FDA and others in developing a communication strategy focused on bioengineered foods that help consumers make informed food choices to optimize their health.

Thank you for allowing me the opportunity to share ADA’s views on this important issue.

# American Medical Association

Report 10 of the Council on Scientific Affairs (I-00)
**"Genetically Modified Crops and Foods"**
Published December 2000

http://www.ama-assn.org/ama/pub/article/2036-3604.html
**(Extract)**
More than 40 transgenic crop varieties have been cleared through the federal review process with enhanced agronomic and/or nutritional characteristics or one or more features of pest protection (insect and viruses) and tolerance to herbicides. The most widely used transgenic pest-protected plants express insecticidal proteins derived from the bacterium *Bacillus thuringiensis* (Bt.). Crops and foods produced using recombinant DNA techniques have been available for fewer than 10 years and no long-term effects have been detected to date. These foods are substantially equivalent to their conventional counterparts. Genetic engineering is capable of introducing allergens into recipient plants, but the overall risks of introducing an allergen into the food supply are believed to be similar to or less than that associated with conventional breeding methods. The risk of horizontal gene transfer from plants to environmental bacteria or from plant products consumed as food to gut microorganisms or human cells is generally acknowledged to be negligible, but one that cannot be completely discounted. Pest-resistance due to exposure to Bt.-containing plants has not occurred to date, and harmful effects on non-target organisms, which have been detected in the laboratory, have not been observed in the field. Nevertheless, these and other possible environmental effects remain areas of concern.

**Conclusions.** Federal regulatory oversight of agricultural biotechnology should be science-based. Methods to assure the safety of foods derived from genetically modified crops should continue to be refined and improved. Although no untoward effects have been detected, the use of antibiotic markers that encode resistance to clinically important antibiotics should be avoided if possible. Genetic modification of plants could potentially lead to detrimental consequences to the environment. Therefore, a broad-based plan to study environmental issues should be instituted. There is no scientific justification for special labeling of genetically modified foods, as a class, and voluntary labeling is without value unless it is accompanied by focused consumer education. Government, industry, and the scientific and medical communities have a responsibility to educate the public and improve the availability of unbiased information on genetically modified crops and research activities.

# Center for Science in the Public Interest

CSPI is a non-profit consumer-advocacy organization that focuses on improving the safety and nutritional quality of our food supply and on reducing the damage caused by alcoholic beverages. CSPI seeks to promote health through educating the public about nutrition and alcohol; it represents citizens' interests before legislative, regulatory, and judicial bodies; and it works to ensure that advances in science are used for the public good. CSPI primarily focuses its activities in the United States, although it does have a satellite office in Canada. CSPI is also involved in international activities involving food safety and labeling issues, such as the Codex Alimentarius and the Trans-Atlantic Consumer Dialogue.

CSPI is primarily supported by the 800,000 member-subscribers to its Nutrition Action Healthletter. CSPI receives no funding from industry or the federal government. CSPI does receive some funding from independent philanthropic foundations. In fact, CSPI's biotechnology Project is partially funded by the Rockefeller Foundation.

**Common Sense on biotechnology**
Michael F. Jacobson, Ph.D., is the executive director of the Center for Science in the Public Interest, a nonprofit consumer-advocacy group funded by its members and foundations.
This opinion piece originally appeared in the Wall Street Journal on January 25, 2001.
http://www.cspinet.org/new/biotechnology.html
My organization, the Center for Science in the Public Interest, has waged many campaigns over the last three decades to improve the nutritional quality and safety of our food. From advocating nutrition labeling to attacking olestra and sulfites, we know how to publicize problems. Predictably, we've been vilified more than once on this page.
But the campaign we have not joined is the one aimed at halting agricultural biotechnology and genetically engineered foods. While biotechnology is not a panacea for every nutritional and agricultural problem, it is a powerful tool to increase food production, protect the environment, improve the healthfulness of foods, and produce valuable pharmaceuticals. It should not be rejected cavalierly.
Too many biotechnology critics have resorted to alarming the public about purported environmental and food risks. For example, one environmental group has stated: "If deadly toxins that kill butterflies are being introduced into our food supply, what effect are these toxins having on you and your family? Is it possible that these toxins will build up over time in our systems? If so, what effect will they have? The scary answer is that no one really knows." Actually, we do know: The Environmental Protection Agency and others have concluded that the "toxins" approved for human consumption have no adverse effect on health.

While current biotechnology crops have not been shown to cause any health problem and only minor environmental disturbances, they have begun to yield major benefits.  cotton, for instance, has reduced insecticide use by more than two million pounds a year. That saves a lot of beneficial insects (not just butterflies) and reduces farmers' exposure to dangerous chemicals. Biotechnology cotton also has meant higher profits for farmers.

Likewise, soybeans engineered with immunity to certain herbicides have allowed farmers to replace more-toxic herbicides, which pollute water, with relatively benign ones and to reduce soil erosion. And in Hawaii, biotechnology papayas resistant to a devastating virus are saving that industry.

In developing countries, biotechnology will protect sweet potatoes from viruses, increase yields of rice, and reduce contamination in corn from mold-produced carcinogens. Some critics complain that biotechnology's promise has not yet been widely fulfilled in those nations. That however, does not constitute a compelling indictment of this emerging technology. Who would have predicted the Internet from the meager beginnings of home computers?

Of course, not all the fruits of biotechnology deserve a place on the dinner table. Used injudiciously, biotechnology could wreak havoc: weeds resistant to herbicides, novel toxins or allergens in foods, pesticide-bearing crops that kill beneficial insects, and loss of genetic diversity. And in developing nations it could jeopardize the livelihoods of small farmers.

James D. Watson, co-discoverer of the structure of DNA, makes a telling point: "[N]ever put off doing something useful for fear of evil that may never arrive." Instead of worrying about every remotely imaginable problem — and suffering with today's known problems caused by conventional agriculture — we need a coherent system to reap the benefits and avoid any problems. Regulatory improvements are essential to building public confidence in biotechnology — a goal that industry on its own has been unable to attain.

Last week, the Food and Drug Administration took a useful step forward by proposing a mandatory review system. While mandatory approvals would bolster public confidence more than reviews, the agency says it doesn't have the authority to require that. Ironically, the biotechnology and processed-food industries oppose formal approvals for FDA-regulated foods, even though they manage fine at the EPA, which has just such a system for plants engineered to produce pesticides.

The National Academy of Sciences and others have found that significant gaps abound in EPA's system. Even so, the basic structures are there and need only to be strengthened by the agency or, where necessary, by Congress. But the FDA's statutes were written long before genetic engineering was developed and need to be updated.

The FDA also proposed guidelines for making voluntary label claims like "made without genetic engineering." That won't satisfy critics' demand that labels of engineered foods declare "contains genetically engineered ingredients," a statement that few companies would agree to put on their products. It would, however, help consumers choose non-engineered foods. Later, labels could be required for engineered foods themselves, provided they would not significantly increase costs or convey inferiority.

For both humanitarian and selfish reasons, the industry should join with others to support the sound measures that would help rescue the technology from doubt and controversy.

For starters, Congress should give the FDA a legal mandate to review safety data on biotechnology foods, provide opportunities for public comment, and explain its decisions in the Federal Register. Also, Congress should invest more heavily in biotechnology research and development to bring more beneficial products and methods into the public domain. We need to develop better pre-approval testing methods and to conduct post-approval monitoring of products. And, biotechnology aside, to help farmers survive, we should encourage organic and sustainable methods, which are environmentally and socially sound and, unlike much farming, often highly profitable.

Furthermore, the United States — and the biotechnology industry — must provide generous assistance to the developing world, where the need for food is greatest. We should help scientists develop locally appropriate products that benefit consumers, the environment, and small farmers, as well as help governments strengthen their oversight agencies.

Sensible reform would overcome the extremism of both industry and its critics in a way most beneficial to the public interest.

# Institute of Food Technologists

Founded in 1939, the Institute of Food Technologists is a nonprofit scientific society with 28,000 members working in food science, food technology, and related professions in industry, academia and government.

**Biotech foods are as safe, if not safer, than conventional foods**
Sept. 9, 2000
http://www.ift.org/press/releases/090900.shtml?L+mystore+

WASHINGTON—*If it seems too good to be true, it probably is.* There's a lot of wisdom in this suspicious, cynical cliché. Could a technology really offer the potential for non-allergenic foods and vaccines to prevent deadly diseases for mere pennies per dose, increased yields with environmentally beneficial farming practices, and healthier, more nutritious foods? French fries with less fat? Naturally decaffeinated coffee that tastes just like the "real thing"?

From a young age we're taught to take product claims "with a grain of salt," not to believe "everything you read," and "there's no such thing as a free lunch." Is it any wonder consumers are wary of rDNA biotechnology-derived foods, with their promise to, among other things, feed the world? What's the catch, consumers are asking.

The science behind rDNA biotechnology foods is substantial, complicated and diverse. The ability to transfer DNA from one species to another is mind boggling to some. Consumers have asked, "Can rDNA biotechnology-derived foods really be safe to eat?" Fortunately, scientists have already asked—and answered—this question.

"All of the existing foods produced using rDNA biotechnology have undergone a science-based safety assessment focusing on the characteristics of the product, especially the unique components," said Dr. Dallas Hoover, a professor in the Department of Animal and Food Sciences at the University of Delaware. Hoover chaired the expert panel that produced the safety section of the IFT Expert Report on biotechnology and Foods.

The science-based safety assessment compares the rDNA biotechnology-derived food with its conventional counterpart to identify any potential differences that might present safety or nutritional concerns. Substances that are new to the food supply, potential allergens, changes in the concentrations of major dietary nutrients, and increased concentrations of anti-nutritional factors and toxins inherent to the food all trigger additional scrutiny. In fact, this safety assessment is more stringent than for foods produced using conventional cross-breeding techniques.

The appropriate federal agencies have reviewed all the rDNA biotechnology-derived foods on the market to ensure their safety. The safety and quality of their products are of paramount important to food manufacturers, and FDA ensures that the high standards for food safety are upheld.

Biotechnology processes actually tend to reduce risks because they are more precise and predictable than conventional breeding. Recombinant DNA techniques enable researchers to precisely identify, characterize, enhance, and transfer the appropriate genes. Cross breeding transfers uncontrolled and randomly assorted groups of genes, hoping the desirable ones were included.

“Considering that there are tens of thousands of the host organism’s own genes, the introduction by precise techniques of one or a few additional, well-characterized genes does not create an organism that is more likely to be changed in major physical properties or wholesomeness than an organism derived through traditional breeding. Indeed, because of the greater precision in selecting the desired trait, an adverse event is unlikely,” Hoover said.

The safety of rDNA biotechnology-derived foods has been extensively reviewed by a number of national and international scientific organizations, with a striking congruence in the resulting conclusions and recommendations. The use of rDNA biotechnology in itself has no impact on the safety of foods derived using these techniques. The related risks are not unique and tend to be associated with particular products and their applications, not with the production process or technology per se.

So consumers needn’t “go looking for trouble.” Recombinant DNA biotechnology-derived foods are as safe, if not safer, than conventional foods. Enjoy!

# American Phytopathological Society (APS)

The American Phytopathological Society (APS) is an international scientific organization that promotes the study of plant diseases and their control through publications, meetings, symposia, workshops, and the World Wide Web.

APS advances modern concepts in plant health management in agricultural, urban and forest settings. The Society was founded in 1908 and has grown from 130 charter members to nearly 5,000 plant pathologists and scientists worldwide.

**Plant Health Scientists Issue Statement in Support of Biotechnology**
http://www.apsnet.org/media/press/2.asp

St. Paul, MN (October 12, 2001) ¾ The American Phytopathological Society (APS), the world's largest organization of plant health scientists, has issued a formal statement in support of biotechnology. Citing the enormous potential benefits to humanity possible through biotechnology, while advocating responsible and science-based oversight and regulation, the APS members hope to call attention to the importance of biotechnology in their work.

"Virtually all aspects of plant pathology are affected by biotechnology," states Sue Tolin, a plant pathologist with Virginia Polytechnic Institute and State University and a member of the APS Public Policy Board. "Advances in this area have played a critical role in our ability to identify and control plant pathogens that cause billions of dollars of crop losses each year, particularly in developing countries where diseases routinely destroy important food crops."

Among the benefits outlined in the APS statement are the environmental positives promised through biotechnology. Plant pathologists point out that biotechnology is an important tool for reducing dependence of growers on synthetic pesticides for controlling plant diseases, and minimizing adverse environmental impacts of modern agriculture practices. The statement also calls for placing consideration of risks associated with plant disease management through biotechnology in perspective with other disease management approaches, including social, economic, and environmental issues and concerns.

"biotechnology must be practiced in a responsible way, respectful of human, economic and environmental impacts," states Noel Keen, current APS President. "We believe it would be an enormous setback if we were unable to continue the progress we've already made." APS, he says, created and issued their statement at this time to underscore the substantial contribution biotechnology has made to the understanding and control of plant diseases, and to stress the important role it can play in future advancements.

# American Society for Microbiology

The American Society for Microbiology is the oldest and largest single life science membership organization in the world. Membership has grown from 59 scientists in 1899 to over 42,000 members today located throughout the world. ASM represents 25 disciplines of microbiological specialization plus a division for microbiology educators.

**Statement of the American Society for Microbiology on Genetically Modified Organisms**
17 July 2000

http://www.asmusa.org/pasrc/genmodorg.htm

In recent months public understanding of biotechnology has been challenged by controversy concerning genetically modified organisms. The public has been confronted with charges and counter charges regarding the risks and benefits associated with using biotechnology to produce quality food in quantity. Since biotechnology enables well characterized genes to be transferred from one organism to another with greater precision and predictability than is possible using traditional breeding procedures, the American Society for Microbiology (ASM) is sufficiently convinced to assure the public that plant varieties and products created with biotechnology have the potential of improved nutrition, better taste and longer shelf-life.

Nothing in life is totally free of risk. However, to minimize risk it is important to rely on fact rather than on fear, and the ASM is not aware of any acceptable evidence that food produced with biotechnology and subject to FDA oversight constitutes high risk or is unsafe. Rather, plant varieties created with biotechnology are grown more efficiently and economically than traditional crops. This eventually should result in a more nutritious product at less cost to the consumer as well as to reduced pesticide use and greater environmental protection. Those who resist the advance of biotechnology must address how otherwise to feed and care for the health of a rapidly growing global population forecast to increase at a rate of nearly 90 million people per year. However, a continued expression of public concern at the current level should be understood by federal agencies as reason to support more research, and to improve the quality and public accessibility of information on the regulation of products of biotechnology.

The ASM, which represents over 42,000 microbiologists worldwide, has special interest in issues and policies related to biotechnology research and development. The ASM includes scientists working in academic, governmental and industrial institutions with expertise in medical microbiology and infectious diseases, molecular biology and genetics, environmental microbiology, agricultural and industrial microbiology, including the microbiology of food. ASM members pioneered molecular genetics and were principals in the discovery and application of recombinant DNA procedures which have advanced biotechnology's prominence. Moreover, ASM members have for several decades participated in discussions concerning biotechnology before federal agencies and Congress.

The ASM methodically reviews safety issues associated with biotechnology and its applications to assure that oversight and regulation are consistent with current scientific principles and practices. The ASM has long held the position that oversight and regulation should be based on the risk associated with products of biotechnology, and not on the processes used to create or produce these products. This is necessary not only to protect public health and the environment, but also to encourage continued nological research and development which is in the national interest, and in the interests of the health and welfare of people worldwide. Indeed, the Food and Drug Administration (FDA) is to be commended for constructing a framework for safety evaluation that is product based, and for taking the position "that the critical consideration in evaluating the safety of (bioengineered) foods should be the objective characteristics of the food product or its components rather than the fact that new development methods were used."

Although the public appears to recognize a direct personal benefit from applications of biotechnology in medicine, it remains skeptical that similar benefit will result from applications of biotechnology in agriculture and the environment. It is imperative that an understanding of the rigor of oversight of the science-based regulatory systems used by the FDA, the Department of Agriculture (USDA) and the Environmental Protection Agency (EPA) to manage biotechnology is shared with consumers in this country. A greater public awareness of our regulatory process is needed. Nevertheless, the ASM recognizes that for the public to feel secure, mandatory FDA assessment of the safety of genetically modified foods is warranted. Scientifically based regulatory systems to identify and monitor potential adverse effects on human health and the environment need to be established in every country to ensure and promote public confidence in biotechnological advances.

Fear of the unfamiliar has created a clamor for labeling of genetically modified products. The ASM believes that labeling on the basis of process is not scientifically warranted. Genetic modification has long been used to enhance the production of plants and animals for food. Indeed it is doubtful that there exists any agriculturally important product that can be labeled as not genetically modified by traditional breeding procedures or otherwise. Biotechnology as practiced in agriculture today is part of a continuum of ever more refined attempts to breed better plants and animals for food or show. Plant and animal genomic research are legitimate areas for public funding, and they deserve increased attention and support from federal and state funding agencies. Because of the improved precision and predictability of biotechnology, it can be anticipated that in the future food will be more, rather than less, safe.

Food labeling is justified if it identifies real risk and provides information for the safety of consumers. To label a product only because it is genetically modified would be punitive. Moreover, labeling will probably impose significant costs to farmers and others who would have to separate genetically modified from non-genetically modified products in the field, during processing and in the marketplace. This increased cost ultimately would be borne by the consumer. Since there are no simple, inexpensive procedures to differentiate genetically modified from non-genetically modified products, a requirement to label would invite deception, and be exceedingly difficult and costly to regulate.

The ASM is strongly involved in programs of science education for the public, and encourages its membership to strive collectively and individually to increase public understanding of biotechnology. It is important for the public to comprehend just what biotechnology and genetic modification entail as well as their history and various applications in agriculture, the environment and medicine. Familiarity will diminish fear, and reliable and responsible knowledge will result in informed choice.

# Society for In Vitro Biology (SIVB)

The Society for In Vitro Biology (SIVB) was founded in 1946 as the Tissue Culture Association to foster exchange of knowledge of in vitro biology of cells, tissues and organs from both plant and animals (including humans). The focus is on biological research, development, and applications of significance to science and society.
The mission is accomplished through the Society's publications; national and local conferences, meetings and workshops; and through support of teaching initiatives in cooperation with educational institutions.
Over the years, SIVB has expanded to create an environment of scientific exchange and interdisciplinary synergy with the goal of advancing current and future systems for in vitro biology.

**Statement on GE Crops**
http://www.sivb.org/mem_publicPolicy.asp

The membership of the Society for In Vitro Biology believes that the commercialization of genetically engineered (GE) crops will have a dramatic and positive impact on people the world over. We believe the current oversight of these crops by the federal regulatory agencies (FDA, USDA, EPA) is adequate and that these crops are as safe, if not safer, than traditionally bred crops.

*Background statement*: Several advances in technology during the past half century made it possible to develop transgenic crop plants, also known as biotech or genetically engineered crops. The commercialization of these crops has been met with intense opposition from a few sectors of society. Scientific facts are often lost amidst the ensuing rhetoric and emotional debates. Given that the SIVB is honored to have one the largest groups of crop geneticists and biotechnologists in the world among its membership, the SIVB wishes to acknowledge the following statements:

1. The vast majority of the crops used worldwide are the product of genetic modification and selection, both intentional and unintentional, which has taken place over the centuries. The result of this selection is that most cultivated plants have been altered to such and extent that they are distinctly different from their wild counterparts, to the point that they would not be recognized as even being the same species by the average person. Thus, grains, vegetables, fruits, and flowers that sustain people and enhance the quality of life today have modifications which humans found valuable and therefore selected for, in providing food and pleasure for their families and communities.

2. Genetic engineering extends the plant breeding techniques used during the past century. Genetic engineering differs in two ways from previous techniques which emphasized selection of randomly induced rare genetic variants. First, using methods in molecular biology, more targeted genetic changes are possible, which makes the identification and selection of variants more efficient. Secondly, it is now possible to transfer into crops DNA derived from essentially any organism, incorporate this DNA into the genome of the crop and regulate the synthesis of RNA and proteins from genes encoded on the new DNA sequence.

3. The first generation of genetically engineered crops has provided several environmental benefits, by decreasing the use of insecticides and promoting the shift toward more environmentally friendly herbicides, and by increasing the productivity of land already in agriculture. Though genetically engineered crops have been grown over millions of acres, no claim of an adverse effect on humans or the environment have held up to close scrutiny.

4. Additional research on genetic engineering is leading to the development of transgenic crops that have the potential to result in produce that is more nutritious and better tasting, crops able to resist a variety of biotic and abiotic stresses, and crops able to produce pharmaceuticals, biofuels, biodegradable plastics, and edible vaccines. Overall, these will contribute toward the stability and quality of the world's food supply, as well as a significant improvement in quality of life for people around the world.

5. Every commercial product of genetic engineering needs to be evaluated based on its unique merits and any potential risks to the consumer or to the environment. Historically, there has always been significant public debate concerning the introduction and applications of new technologies. Public policy and decisions concerning new technologies need to be well-grounded on the scientific facts concerning the benefits and risks of any new technology. The United States has an established regulatory system to evaluate risks associated with new agricultural and pharmaceutical products. Safety evaluation is conducted by the United States Food and Drug Administration (FDA), the US Department of Agriculture (USDA-APHIS), and, in some cases, the Environmental Protection Agency (EPA). Under the auspices of these agencies, all crop and animal products that result from biotechnology are demonstrated to be safe as non-engineered versions of that plant or animal product, prior to their use by the public. This is an effective principle for guiding their regulation to safeguard human and environmental health and safety.

6. The SIVB supports the current science-based approach for the evaluation and regulation of genetically engineered crops. The SIVB supports the need for easy public access to available information on the safety of genetically modified crop products. In addition, the SIVB feels that foods from genetically modified crops, which are determined to be substantially equivalent to those made from crops, do not require mandatory labeling. Current FDA food labeling practices require labeling if a food has a known human health issue, and allows for voluntary labeling of ingredients as long as the label is truthful and not misleading.

*The position statement on crop genetic engineering was prepared by the SIVB ad hoc Committee on GMO Policy, and presented for consideration by the SIVB membership. For additional information or comments on the statement, contact: Dr. Wayne Parrott, Chair, GMO Policy Committee, at* wparrott@arches.uga.edu.

# Appendices

## COUNCIL FOR AGRICULTURAL AND SCIENCE TECHNOLOGY REPORT

June 2002

### Comparative Environmental Impacts of Biotechnology-derived and Traditional Soybean, Corn, and Cotton Crops

**- Summary -**

By Janet Carpenter, Allan Felsot, Timothy Goode, Michael Hammig, David Onstad and Sujatha Sankula.

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A comprehensive review of the scientific literature supports the conclusion that overall the currently commercialized biotechnology-derived[1] soybean, corn, and cotton crops yield environmental benefits. Furthermore, a critical analysis of the literature supports the idea that biotechnology-derived soybean, corn, and cotton pose no environmental concerns unique to or different from those historically associated with conventionally developed crop varieties.

Soybean, corn, and cotton farmers in developed and developing nations have rapidly adopted biotechnology-derived commodity crops during the six years of their commercial availability. In 2001, farmers planted biotechnology-derived seed on 46% of global soybean acres, 7% of global corn acres, and 20% of global cotton acres. To date, nearly all of the planted biotechnology-derived crops have introduced tolerance to selected herbicides for weed control or have introduced protection against pest insects. Of the 129.9 million acres (52.6 million hectares) of biotechnology-derived crops planted in 2001, seventy-seven percent were tolerant of specific herbicides (herbicide tolerant), fifteen percent were resistant to selected insect damage (insect resistant) and eight percent were both herbicide tolerant and insect resistant.

The peer-reviewed literature, regulatory assessments, nongovernmental organizations and the popular media have repeatedly raised questions about the environmental safety of biotechnology-derived crops. To answer these questions relative to soybean, corn, and cotton, the scientific literature was reviewed and analyzed to evaluate the environmental impacts of commercially available biotechnology-derived crops in relation to the current agricultural practices for crop and pest management in conventionally bred crops. Nine potential environmental impacts were identified as follows:

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[1] Biotechnology-derived refers to the use of molecular biology and / or recombinant DNA technology, or in vitro gene transfer, to develop products or impart specific capabilities in plants or other living organisms.

1. **Changes in pesticide use patterns -** Does the adoption of biotechnology-derived soybean, corn, and cotton impact the use of pesticides and, if so, do these changes alter farmer practices in ways that affect water quality or soil health?
2. **Soil management and conservation tillage -** Does adoption of biotechnology-derived soybean, corn, and cotton lead to changes in the adoption of no-till and other conservation tillage practices or otherwise impact soil erosion, moisture retention, soil nutrient content, water quality, fossil fuel use, and greenhouse gasses?
3. **Crop weediness -** Have biotechnology-derived soybean, corn, and cotton acquired weediness traits?
4. **Gene flow and outcrossing -** Do biotechnology-derived soybean, corn, and cotton hybridize with local plants or crops and impact the genetic diversity in the areas where the biotechnology-derived soybean, corn, and cotton are planted?
5. **Pest resistance -** Do biotechnology-derived soybean, corn, and cotton posses' plant-protectant traits to which pests will become resistant and, if so, is the development of resistance to these traits different than development of resistance to conventional chemical and microbial pesticides? How is the development of resistance being managed?
6. **Pest population shifts -** Do biotechnology-derived soybean, corn, and cotton cause changes in weed or secondary insect pest populations that impact the agricultural system or ecology of the surrounding environment?
7. **Non-target and beneficial organisms -** Do biotechnology-derived soybean, corn, and cotton with pest protection characteristics have an impact on natural enemies of pests (i.e., predators and parasitoids) or on other organisms in the soil and crop canopy?

8. **Land use efficiency/productivity -** Does the adoption of biotechnology-derived soybean, corn, and cotton impact crop yields or impact the need for cultivating forested or marginal land?

9. **Human exposure -** Do the traits of herbicide tolerance and resistance to pest insects in biotechnology-derived soybean, corn, or cotton pose any new or different safety concerns in comparison to conventionally bred crops with similar traits?

Biotechnology-derived crops provide options and potential solutions for a number of challenges in modern agriculture, but the extent to which they may be viable or the preferred option is dependent on many economic, social, and regional factors. Nevertheless, a number of general conclusions about biotechnology-derived soybean, corn, and cotton are supported by the literature.

- Biotechnology-derived soybean, corn, and cotton provide insect, weed, and disease management options that are consistent with improved environmental stewardship in developed and developing nations.

- Biotechnology-derived crops can provide solutions to environmental and economic problems associated with conventional crops including production security (consistent yields), safety (worker, public, and wildlife), and environmental benefits (soil, water, and ecosystems).

- Although not the only solution for all farming situations, the first commercially available biotechnology-derived crops, planted on over 100 million acres (40.5 million hectares) worldwide, provide benefits through enhanced conservation of soil and water and beneficial insect populations and through improved water and air quality.

- The high adoption rates for commercially available biotechnology-derived crops can be attributed to economic benefits for farmers.

- When biotechnology-derived crops are available to small farmers in developing nations, the farmers can realize environmental benefits and reduce worker exposure to pesticides.

**BIOTECHNOLOGY-DERIVED SOYBEAN**

- Herbicide-tolerant soybean is the most widely adopted biotechnology-derived crop, planted on 68% of United States' soybean acreage and over 98% of Argentina's soybean acreage in 2001. The United States and Argentina together account for 99% of total herbicide-tolerant soybean production in the world, which represents 46% of the total acreage of soybean planted. Farmers in the United States are projected to plant 74% of soybean acreage to herbicide-tolerant soybean in 2002.

- The major reasons farmers have adopted the herbicide-tolerant soybean so widely are lowered production costs, reduced crop injury, and simplicity and flexibility in weed management.

- Biotechnology-derived herbicide-tolerant soybean has facilitated the adoption of conservation tillage. No-till soybean acreage in the United States has increased by 35% since the introduction of herbicide-tolerant soybean. Similar increases are observed in Argentina, which can be attributed in part to reliable and effective weed control provided by herbicide-tolerant soybean. Use of no-till farming in soybean production results in decreased soil erosion, dust, and pesticide run-off and in increased soil moisture retention and improved air and water quality.

- Cost savings in biotechnology-derived herbicide-tolerant soybean programs have allowed adopters to decrease weed control costs, leading to price cuts of conventional herbicide programs. The result has been weed control cost savings for both adopters and non-adopters.

- Farmers using biotechnology-derived herbicide-tolerant soybean are able to use a herbicide that rapidly dissipates to inactive amounts in soil, has little potential for water contamination as a substitute for herbicides used with conventional soybean varieties, and allows greater flexibility in timing of application.

- Biodiversity is maintained in biotechnology-derived herbicide-tolerant soybean fields. Soil microbes, beneficial insects, and bird populations in conservation tillage biotechnology-derived herbicide-tolerant and conventional soybean fields were similar in number and variety.

- Both conventional and biotechnology-derived soybean production systems require effective management strategies for weed population shifts and to prevent the development of weed resistance to herbicides. Emerging reports on glyphosate-resistant weeds may be a concern in herbicide-tolerant soybean; however, herbicide resistance in weeds is not unique to biotechnology-derived crops.

- Conclusions regarding yield decreases attributed to the biotechnology-derived herbicide-tolerant trait may be inaccurate because the study design included improper comparisons between the biotechnology-derived varieties and conventional varieties.

- Soybean with insect protection properties is also in development and will be useful in climatic regions where insect pressures justify insecticide applications.

## BIOTECHNOLOGY-DERIVED CORN

- *Bt* corn can enhance the biodiversity of cornfields because beneficial insects fare better than when conventional cornfields are sprayed with insecticides. Moreover, field studies of biotechnology-derived corn show that populations of beneficial insects are not adversely affected.

- Use of *Bt* corn can decrease farm worker exposure to certified organic *Bt* sprays and chemical insecticides.

- Decrease of naturally occurring mold toxins resulting from use of *Bt* corn can provide direct benefits to people and corn-fed livestock. Insect-protected corn is less vulnerable to mold infestation.

- Yields since the introduction of insect-protected and herbicide-tolerant corn have continued at historically high levels. When European corn borer pressure is high, farmers obtain significant economic benefit from the use of insect-protected corn.

- Herbicide-tolerant corn varieties allow use of herbicides that are less persistent in the environment and reduce the risks of herbicide run-off into surface water. These herbicide-tolerant corn varieties allow for greater flexibility in the timing of application and encourage the application of reduced and no-till soil and soil moisture management practices.

- Insect Resistance Management (IRM) plans have been required, developed, and implemented to prevent or to delay the development of insect resistance to *Bt*.

**BIOTECHNOLOGY-DERIVED COTTON**

- Herbicide-tolerant cotton enhances the use of herbicides that are less persistent in the environment.

- Herbicide-tolerant cotton is a major factor in promoting reduced and no-till farming practices, which result in improved soil and soil moisture management and reduced energy use.

- Herbicide-tolerant cotton provides greater flexibility for the timing of herbicide applications for effective weed control and less damage to the cotton plants.

- Use of biotechnology-derived cotton in developing nations does not require significant capital investment, changes in cultural practices, or significant training for adoption.

- Rapid adoption of *Bt* cotton in China serves as an example of how, in developing nations, plant-incorporated protectants greatly decrease the volume of pesticides applied and the risks of pesticide run-off while increasing safety and health of agricultural workers.

- *Bt* cotton has been documented to have a positive effect on the number and diversity of beneficial insects in cotton fields in the United States and Australia.

- The introduction of *Bt* cotton in Australia, India, and the United States demonstrates the ability of these varieties to alleviate problems with insect resistance to chemical pesticides. The future production of cotton in these regions was in jeopardy prior to the introduction of *Bt* cotton.

- The ability to add several different genes to control the same pest should delay the time it takes for pesticide resistance to develop.

- *Bt* and herbicide-tolerant cotton decreases production costs to farmers and increases the range of options available for whole-farm management systems.

## AUTHORS' RECOMMENDATIONS

1. Given that biotechnology-derived crops can provide positive net environmental benefits, we recommend continued development of agricultural biotechnology to enhance environmental stewardship.

2. Biotechnology provides a tool for management of production risk in agriculture. We recommend evaluating the role of biotechnology-derived crops in the context of whole-farm management.

3. When drawing conclusions regarding the impacts of biotechnology-derived crops on productivity, we recommend that conclusions be based on comparisons involving whole-farm systems.

4. When comparing the consequences of a specific trait, we recommend the following characteristics be held constant: varieties that are genetically identical in all aspects other than the trait(s) being evaluated; the crops be grown during the same time in the same geographic location; and use of identical soil and crop management practices. For example, having observed contradictory and inconsistent data regarding yields in some crops, we recommend better measurement of yield impacts.

5. We recommend evaluating the environmental impacts of biotechnology-derived crops in agricultural regions where the crops may be adopted and in the context of viable, currently available alternatives and practices in agriculture.

6. We recommend large-scale and farm-scale field studies to provide supplemental information to document long-term environmental benefits and safety impacts of adopting biotechnology-derived crops.

7. We recommend continued development of policies for implementation of effective management strategies for insect and weed resistance in both conventional and biotechnology-derived crops. Also, we recommend continued research on management strategies to abate or the slow development of resistance to new and existing pest control tools.

8. Recognizing that gene flow is a natural process that may increase biodiversity, we recommend that research on gene flow between biotechnology-derived and other crops or native plants focus on the environmental and social impacts / consequences of that gene movement.

9. Recognizing the potential for biotechnology-derived corn varieties to help resolve current corn rootworm control problems stemming from the development of insect resistance to both chemical insecticides and crops rotation, we recommend research include consideration of resistance management strategies as well as impacts on soil and other non-target organisms.

10. Recognizing that enhanced land use efficiency is an important environmental benefit, we recommend continued development of biotechnology-derived hybrids that improve crop yields.

**http://www.cast-science.org/pubs/biotechnology cropsbenefit_es.pdf**

# INTERNATIONAL DOCUMENTS AND SCIENTIFIC PUBLICATIONS ON PLANT BIOTECHNOLOGY AND THE SAFETY ASSESSMENT OF FOOD PRODUCTS DERIVED FROM PLANT BIOTECHNOLOGY

ILSI International Food Biotechnology Committee
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*International Documents and Scientific Publications on Plant Biotechnology and the Safety Assessment of Food Products Derived from Plant Biotechnology* is a bibliography of international documents and scientific publications on plant biology and the safety assessment of foods products derived from plant biotechnology.

To download this publication, go to

http://www.ilsi.org/publications/pubslist.cfm?publicationid=348

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