A global view of biotechnology crops

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Question: First, what is biotechnology?

Answer: As stated in another article in this series, biotechnology, or biotech, involves methods of using plants, animals, microbes, or enzymes, either wholly or in part, to make or modify a product or change an existing organism (http://www.nysaes.cornell.edu/comm/gmo/). Some types of biotechnology have been used routinely in agriculture worldwide. For example, marker-assisted breeding has produced many plant varieties in use today (see article on genetic modification of crop plants).

Genetic engineering is one form of biotechnology. It involves copying a gene from one living organism (bacteria, plant, or animal) and adding it to another living organism. Scientists define a genetically engineered organism as an organism that has been modified using genetic engineering techniques in which a small piece of one organism's genetic material (DNA) is inserted into another organism. Products of genetic engineering are often commonly referred to as "genetically engineered organisms" or "GE products" or "genetically modified organisms," "transgenics," or "GMOs." Since plants and animals have been selectively bred for more than 10,000 years, they have all been "modified," so scientists tend not to use the term "genetically modified." Products developed through genetic engineering are more properly referred to as "GE products" (http://www.nysaes.cornell.edu/comm/gmo/).

Many tools of biotechnology are used routinely worldwide in agriculture, medicine, household products, and for industrial uses . . . all without substantial controversy. However, genetic engineering is the exception in some cases.

Question: What kinds of genetically engineered products are produced for the global market?

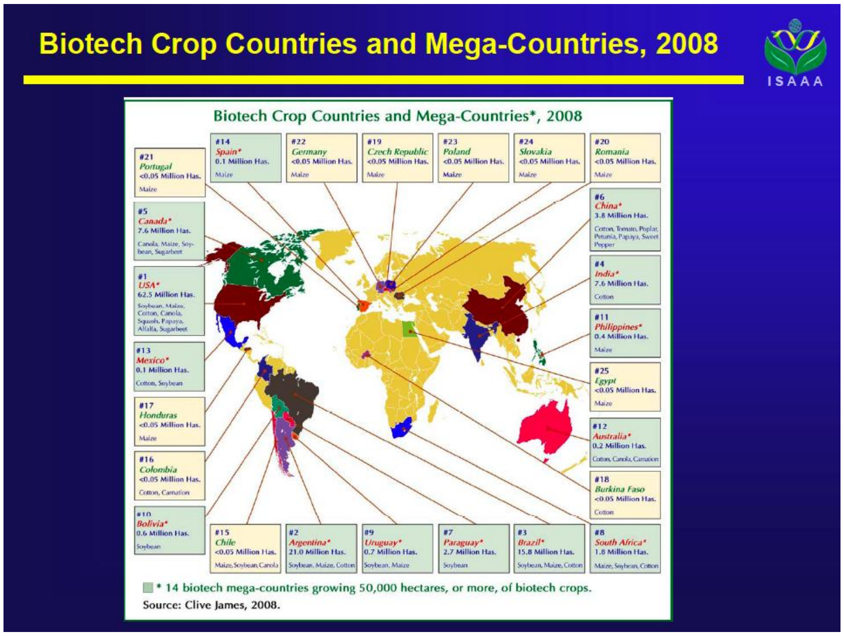
Answer: The first GE product was insulin, and medicines remain one of the largest markets. A little description about GE insulin may be helpful. Insulin is a hormonal protein that stimulates cells to absorb glucose (sugar) from the blood stream. Without a proper level of insulin, blood sugar levels can increase to dangerous levels and result in medical problems. Prior to the advent of genetic engineering, those who suffered from low levels of insulin were given insulin from cows and pigs. However, some suffered allergenic reactions to these animal proteins.

Beginning in the 1970s, the human gene that codes for the insulin protein was cloned (copied) and then put inside bacteria so the bacteria would make insulin. The bacteria are grown in sterile conditions and human insulin is then extracted from them. Today, nearly all the insulin used to treat diabetes is genetically engineered insulin (http://www.endocrineweb.com/diabetes/2insulin.html). Genetic engineering is also used to make antibiotics, vitamins, and proteins to fight infections.

In our food system, most cheeses are produced using genetically engineered enzymes (chymosins) that are made in bacteria or yeasts rather than obtained from the stomachs of animals. Additionally, yeasts used in bread are often genetically engineered. In both of these examples, genetic engineering was done to avoid potential contamination or allergenicity problems and to ensure consistency of the product. These examples of genetic engineering in our food system are generally regarded as noncontroversial. Use of GE crop plants has been more controversial. There are no GE animals on the market, but regulatory processes for their use are being developed (see related articles on animal biotechnology).

Question: What are genetically engineered crop plants?

Answer: This is described more fully in another article in this series, "Genetic modification of crop plants: Comparing conventional modification with genetic engineering." Currently, the vast majority of crops that have been genetically engineered allow for improved pest management (weeds, insects, and viruses) and are described in other articles in this series. In 2008, the area cultivated with GE crops was 308 million acres spread over 25 countries (15 developing countries and 10 industrialized countries) by an estimated 13.3 million farmers (James 2008). The countries that grow the largest amount of genetically engineered crops (by rank) are: United States, Argentina, Brazil, India, Canada, China, Paraguay, South Africa, Uruguay, Bolivia, Philippines, Australia, Mexico, and Spain.



Question: According to most sources, there are 195 countries in the world. Why don't more countries grow genetically engineered crop plants?

Answer: In some cases, the types of GE crops (alfalfa, canola, corn, cotton, papaya, sugar beet, and squash) that have been developed are simply not suitable or needed in a country. For example, Sweden does not grow cotton so there is no need for them to grow GE cotton. In other cases, the countries do not have the biosafety regulations that are required to grow the crops or they simply choose not to grow them for various reasons.

Question: What international regulations govern planting genetically engineered crops?

Answer: The Cartagena Protocol on Biosafety (www.cbd.int/biosafety) is an international agreement on biosafety, and a supplement to the Convention on Biological Diversity. The Biosafety Protocol seeks to protect biological diversity from any potential risks posed by living modified organisms resulting from modern biotechnology. Countries that have signed on to this document are required to develop biosafety laws and regulations that govern the production or import of genetically engineered plants.

If one looks at the map above, there are only 3 of the 54 countries in Africa that currently allow the production or import of such crops. This situation reflects the lack of appropriate resources (government agencies, scientists, etc.) in countries to develop appropriate biosafety laws and regulations. Countries that have such laws and regulations are serving as a source for information that can be used by countries that wish to produce or import genetically engineered crops. In the U.S., the United States Agency for International Development has programs specifically to help countries develop biosafety laws and regulations (www.ifpri.org/pbs/pbs.asp). In the U.S., the planting of biotech crops is regulated by three agencies (see article "How are biotech crop varieties regulated?")

Question: Besides inadequate resources to develop biosafety laws and regulations, what other factors influence countries to not grow or produce GE plants?

Answer: Political, cultural, or other social factors may influence their non-adoption. European scientific societies (e.g., The Royal Academy UK, German Medical Association, and French Medical Association) have concluded that GE corn for insect control is as safe as non-GE corn. Nonetheless, in 2008 France banned growing GE corn despite protests by many of its farmers and in striking contrast to its neighbor Spain that continues to increase its production area. France's decision was due to pressure from anti-globalization movements and trade protection of its markets, rather than from any scientific studies about potential risks to the environment or human health.

In a recent decision, the European commissioner for the environment decided to defer market approvals of some new GE corn varieties, against the opinion of his scientific advisors (Devos et al. 2008). Such decisions continue to restrict the planting of GE crops throughout Europe. This is in stark contrast to India, the largest cotton-producing country in the world. When GE insect-resistant cotton was legalized in 2002, 54,000 farmers grew it on 123,500 acres. In 2008 there were 5.0 million farmers growing GE cotton on 18.8 million acres. Similar adoption rates have occurred in China, Brazil, and Argentina (James 2008).

Question: What happens when growers in one country legally grow a GE crop and growers in another country wish to also grow it but their government has not developed biosafety laws and regulations?

Answer: This situation happened in India. Indian farmers became aware of insect-resistant GE cotton and planted it illegally. When this was discovered, pressure was put on the government to destroy the plantings but farmers rallied and threatened a national boycott. The Indian government quickly approved three varieties of GE cotton, based largely on biosafety information from countries that had been growing GE cotton for years. This demonstrates the political power of Indian growers (Herring 2007).

In stark contrast, growers in African countries have comparatively little political power. In a recent book, *Starved for Science: How Biotechnology is Being Kept Out of Africa,* the author explains why poor African farmers are denied access to productive technologies, particularly genetically engineered seeds with improved resistance to pests. He traces this situation to the current opposition to agricultural sciences in prosperous European countries that results in their inappropriate influence on financial aid and marketing policies on African countries. Such influence even resulted in the initial refusal of American food-aide corn by the governments of Zimbabwe and Zambia during the famine of 2002.

Question: What other policies might restrict the wider use of GE crops?

Answer: Besides the 25 countries that have chosen to legally grow GE crops, an additional 29 countries allow the import of GE crops for food and feed use. However, there is a lack of harmonization among national regulatory agencies regarding trade and use of GE crops. This is especially true in the regulations about tolerance levels of GE material in non-GE food and the labeling and traceability of GE products (Ramessar et al. 2008). Such lack of harmonization causes confusion in the marketplace and leads to disputes and the impounding of food and feed. Such problems will increase since it is estimated that the number of countries growing GE crops will double over the next 10 years (Ramessar et al. 2008).

Question: What is the bottom line?

Answer: From the trends seen in the yearly double-digit growth rates for the adoption of GE crops worldwide, it is apparent that farmers see benefits to this technology. Studies (Brookes and Barfoot 2008) have shown that GE crops have provided substantial net economic benefits at the farm level amounting to $6.94 billion in 2006 and $33.8 billion for the eleven-year period from when GE crops were first introduced (1996). The technology has reduced pesticide spraying by 286 million kg and, as a result, decreased the environmental impact associated with herbicide and insecticide use on these crops by 15.4 percent. In addition, GE technology has also significantly reduced the release of greenhouse gas emissions from this cropping area, which, in 2006, was equivalent to removing 6.56 million cars from the roads.

However, while growers in many countries have adopted GE plants and the public has benefited from their use, it is also apparent that their adoption has become a challenge to regulatory agencies in some countries. Finding the proper balance of regulations for biotech products will ensure proper protection of the public and allow the use of newer, safer technologies. However, because of cultural and political differences between countries, harmonization of regulations has proven difficult. Until this is resolved, trade restrictions will continue to inhibit the flow of GE products across national borders, even in neighboring countries.

References and Further Reading

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