

Plant Products of Biotechnology

Plant products of biotechnology have been available in the market for some time now. These modified crops look like their traditional counterparts, but they possess special characteristics that make them better. These crops benefit both farmers and consumers. Farmers gain higher crop yields and have increased flexibility in management practices while consumers have “healthier crops” (i.e., crops grown with fewer pesticides and/or with healthier nutritional characteristics).

Plant products of biotechnology approved for food use have been modified to contain traits such as:

- Insect resistance
- Disease resistance
- Herbicide tolerance
- Altered nutritional profile
- Enhanced storage life

Examples of plant products of biotechnology

Product	Trait
Alfalfa	Herbicide tolerance, altered lignin production
Apple	Non-browning
Bean	Virus disease resistance
Canola	Herbicide tolerance, modified oil/fatty acid, pollination control system, phytase production
Cotton	Herbicide tolerance, insect resistance
Maize	Abiotic stress tolerance, altered growth/yield, herbicide tolerance, insect resistance, modified product quality (modified alpha amylase, lysine boost, phytase production), pollination control system
Melon	Delayed ripening
Papaya	Disease resistance
Plum	Disease resistance
Potato	Disease resistance, herbicide tolerance, insect resistance, modified product quality (modified starch, reduced acrylamide potential, non-bruising), fungal disease resistance
Rice	Herbicide tolerance, insect resistance, anti-allergy
Soybean	Herbicide tolerance, insect resistance, modified product quality, altered growth/yield, abiotic stress tolerance, modified oil/fatty acid
Squash	Disease resistance
Sugar beet	Herbicide tolerance
Tomato	Disease resistance, insect resistance, delayed ripening, delayed fruit softening
Wheat	Herbicide tolerance

BIOTECH SOYBEAN



Soybean is the oil crop of greatest economic relevance in the world. Its beans contain proportionally more essential amino acids than meat, thus making it one of the most important food crops today. Processed soybeans are important ingredients in many food products.

Herbicide tolerant soybean

Herbicide tolerant soybean varieties contain a gene that provides resistance to one of two broad spectrum herbicides.

This modified soybean provides better weed control and reduces crop injury. It also improves farm efficiency by optimizing yield, using arable land more efficiently, saving time for the farmer, and increasing the flexibility of crop rotation. It also encourages adoption of no-till farming-an important part of soil conservation practice. These varieties are the same as other soybeans in nutrition, composition, and in the way they are processed into food and feed.

**Argentina, Bolivia, Brazil, Canada, Chile, Colombia, Costa Rica, Mexico, Paraguay, South Africa, United States of America (USA), and Uruguay are planting countries. China, European Union (EU), Indonesia, Japan, Malaysia, New Zealand, Philippines, Russian Federation, Singapore, South Korea, Switzerland, Taiwan, Thailand, Turkey, and Vietnam are importing countries.*

Insect resistant soybean

This biotech soybean exhibits resistance to lepidopteran pests through the production of Cry1Ac protein. Insect resistant soybean was developed to reduce or replace high insecticide applications and at the same time maintain soybean yield potential. **Argentina, Brazil, Canada, Colombia, Paraguay, USA, and Uruguay are planting countries. Australia, China, EU, India, Indonesia, Japan, Mexico, New Zealand, Paraguay, Philippines, Russian Federation, Singapore, South Korea, South Africa, Taiwan, Thailand, Turkey, and Vietnam are importing countries.*

Oleic acid soybean

This modified soybean contains high levels of oleic acid, a monounsaturated fat. According to health nutritionists, monounsaturated fats are considered “good” fats compared with saturated fats found in beef, pork, cheese, and other dairy products.

Oil processed from these varieties is similar to that of peanut and olive oils. Conventional soybeans have an oleic acid content of 24%. These new varieties have an oleic acid content that exceeds 80%. **Canada, China, Colombia, South Africa, and USA are planting countries while Australia, EU, Japan, Mexico, New Zealand, Philippines, Singapore, South Korea, South Africa, Taiwan, and Vietnam are importing countries.*

BIOTECH MAIZE

Maize is one of the three most important grains of the world. It is used as livestock feeds, processed as cooking oil and food additives, and currently as feedstocks for biofuels.



Herbicide-tolerant maize

These maize varieties work in a similar manner to herbicide-tolerant soybean. They allow growers better flexibility in using certain herbicides to control weeds that can damage crops. **Argentina, Brazil, Canada, China, Colombia, EU, Honduras, Mexico, Panama, Paraguay, Philippines, South Africa, USA, and Uruguay are planting countries. Australia, Indonesia, Japan, Malaysia, New Zealand, Russian Federation, Singapore, South Korea, Switzerland, Taiwan, Thailand, Turkey, and Vietnam are importing countries.*

Insect resistant maize

This modified maize contains a built-in insecticidal protein from a naturally occurring soil microorganism (*Bacillus thuringiensis*) that gives maize plants season-long protection from corn borers. This means most farmers do not have to spray insecticide to protect maize from harmful pests, which can cause significant damage and yield loss in many areas. Bt maize also reduces toxin contamination arising from fungal attack on the damaged grain. The Bt protein has been used safely as an organic insect control agent for over 50 years. **Argentina, Brazil, Canada, Chile, China, Colombia, Egypt, EU, Honduras, Panama, Paraguay, Philippines, South Africa, USA, and Uruguay are planting countries. Australia, Indonesia, Japan, Malaysia, Mexico, New Zealand, Russian Federation, Singapore, South Korea, Switzerland, Taiwan, Thailand, Turkey, and Vietnam are importing countries.*

BIOTECH RICE



Rice is life for more than half of humanity. It is the staple food for over 3 billion people, more than 90% of whom are Asians.

Herbicide-tolerant rice

These rice varieties work in a similar manner to herbicide-tolerant soybean. They contain a gene that provides resistance to one of two broad spectrums, and environmentally benign herbicides. **The USA is currently the only planting country, while Australia, Canada, Colombia, Honduras, Mexico, New Zealand, Philippines, the Russian Federation, and South Africa are importing countries*

Insect tolerant rice

This modified rice works in a manner similar to insect-resistant corn. It reduces yield losses caused by caterpillar pests, the most important of which are the yellow stem borer in tropical Asia and the striped stem borer in temperate areas. **China and Iran are planting countries.*

BIOTECH TOMATO



Delayed-ripening tomato

The delayed-ripening tomato became the first genetically modified food crop to be produced in a developed country. These tomatoes spend more days on the vine than other tomatoes, thus resulting in better flavor. Furthermore, the longer shelf life has commercial advantages in harvesting and shipping that can reduce the costs of production. **China and the USA are planting countries while*

Canada and Mexico are importing countries.

BIOTECH COTTON



Herbicide-tolerant cotton

This cotton works in a manner similar to other biotech tolerant crops. For benefits, see herbicide tolerant soybean. **Argentina, Australia, Brazil, Colombia, Costa Rica, Mexico, Paraguay, South Africa, and USA are planting countries. Canada, China, Japan, EU, New Zealand, Philippines, Singapore, and South Korea are importing countries.*

Insect resistant cotton

This modified cotton works in a manner similar to insect resistant corn. It contains a protein that provides the plant with season-long protection from budworms and bollworms. The need for additional insecticide applications for these pests is reduced or eliminated. **Argentina, Australia, Brazil, Burkina Faso, China, Colombia, Costa Rica, India, Mexico, Myanmar, Pakistan, Paraguay, South Africa, Sudan and USA are planting countries. EU, Japan, New Zealand, Philippines, Singapore, South Korea, and Taiwan are importing countries.*

BIOTECH POTATO

Insect resistant potato

This biotech potato works like insect resistant corn. It contains a protein that provides the plant with built-in protection from the Colorado potato beetle. Thus, this potato needs no additional protection for this pest, benefiting farmers, consumers, and the environment. **Canada, and USA are planting countries. Australia, Japan, Mexico, New Zealand, Philippines, Russian Federation, and South Korea are importing countries.*



Virus resistant potato

Several potato varieties have been modified to resist potato leafroll virus (PLRV) and potato virus Y (PVY). In the same way that people get inoculations to prevent disease, these potato varieties are protected through biotechnology from certain viruses. Furthermore, virus resistance often results in reduced insecticide use, which is needed to control insect vectors that transmit

viruses. **Canada, and USA are planting countries. Australia, Japan, Mexico, New Zealand, Philippines, and South Korea are importing countries.*

Low acrylamide potato

Innate™ potato, developed by Simplot, was approved for commercialization in the U.S. in November 2014. This biotech potato has 50-75% lower levels of acrylamide, a potential carcinogen in humans, produced when potatoes are exposed to high temperatures, and also less susceptible to bruising. *Canada and USA are the only planting countries.*

BIOTECH CANOLA



Canola is a genetic variation of rapeseed and was developed by Canadian plant breeders specifically for its nutritional qualities, particularly its low level of saturated fat.

Herbicide tolerant canola

Herbicide tolerant canola contains transgenes conferring tolerance to herbicides. This is similar to the trait exhibited by herbicide tolerant soybean. **Australia, Canada, Chile, and USA are planting countries. China, EU, Japan, Mexico, New Zealand, Philippines, Singapore, South Africa, South Korea, and Taiwan are importing countries*

High laurate canola

These canola varieties contain high levels of laurate. Oil processed from these novel varieties is similar to coconut and palm oils. This new canola oil is being sold to the food industry for use in chocolate candy coatings, coffee whiteners, icings, frostings, and whipped toppings. Benefits extend even to the cosmetics industry. ** Canada and USA are the only planting countries.*

BIOTECH ALFALFA



Alfalfa is one of the most important legumes used in agriculture.

Herbicide-tolerant alfalfa

This alfalfa works in a manner similar to other HT crops. **Canada, Mexico, and USA are planting countries. Australia, Japan, New Zealand, Philippines, Singapore, and South Korea are importing countries.*

BIOTECH PAPAYA



Virus-resistant papaya

This Hawaiian-developed papaya contains a viral gene that encodes for the coat protein of papaya ringspot virus (PRSV). This protein provides the papaya plant with built-in protection against PRSV. This biotech

papaya works in a manner similar to virus resistant potato. **China, and USA are planting countries. Japan and Canada are importing countries.*

BIOTECH SQUASH

Virus resistant squash

A biotech yellow crookneck squash is now able to resist watermelon mosaic virus (WMV) and zucchini yellow mosaic virus (ZYMV). These new varieties contain the coat protein genes of both viruses. This biotech approach bypasses aphid control, which may reduce or eliminate the use of insecticides. **USA is s planting country. Canada is an importing country.*



BIOTECH SUGAR BEET

Herbicide tolerant sugar beet

In 2008, an herbicide tolerant sugar beet variety was planted in Canada and USA for the first time. The herbicide-tolerant sugar beet allows farmers to cut the number of required cultivations by half. **Canada and USA are planting countries. Australia, China, Colombia, EU, Japan, Mexico, New Zealand, Philippines, Russian Federation, Singapore, and South Korea are importing countries.*

** Approved for food, feed, and/or cultivation.*

CONCLUSION

In the developed world, it is evident that the use of GM crops has resulted in significant benefits. These “first generation” crops have proven their ability to increase crop yields, reduce farm costs, increase farm profit, and help protect the environment. Current research is focused on “second generation” GM crops that will feature increased nutritional, pharmaceutical and/or industrial traits. These varieties should prove valuable in countries where millions of people suffer from dietary deficiencies and have difficulties in accessing vaccines and medicines.

REFERENCES

ISAAA GM Approval Database. <http://www.isaaa.org/gmapprovaldatabase/>.

James, C. 2015. 20th Anniversary (1996 to 2015) of the Global Commercialization of Biotech Crops and Biotech Crop Highlights in 2015. ISAAA Brief No. 51. ISAAA: Ithaca, NY.

GLOSSARY

Bt: *Bacillus thuringiensis*, a common soil bacterium that produces a protein toxic to certain insects

Coat protein (CP): a major component of viruses. CPs protect viral genetic information.

Enzyme: a protein that regulates chemical reactions inside every living cell and organism

Gene: a biological unit that determines an organism's inherited characteristics

Herbicides: chemicals frequently used in agriculture to control weeds that compete with crops for soil nutrients, water and sunlight

Laurate: an important fatty acid used in the food industry, mainly sourced from coconut and palm oil

Oleic acid: a monounsaturated fatty acid found in animal and vegetable oils. Monounsaturated fats are the most benign of the fat sources and are generally considered safe as they do not cause disease or other health problems.

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