Biotech basics – a guide to plant biotechnology in Canada

Biotechnology

is a term covering a broad range of scientific activities used in many sectors, such as food, health and agriculture. It involves the use of living organisms or parts of living organisms to provide new methods of production and the making of new products.

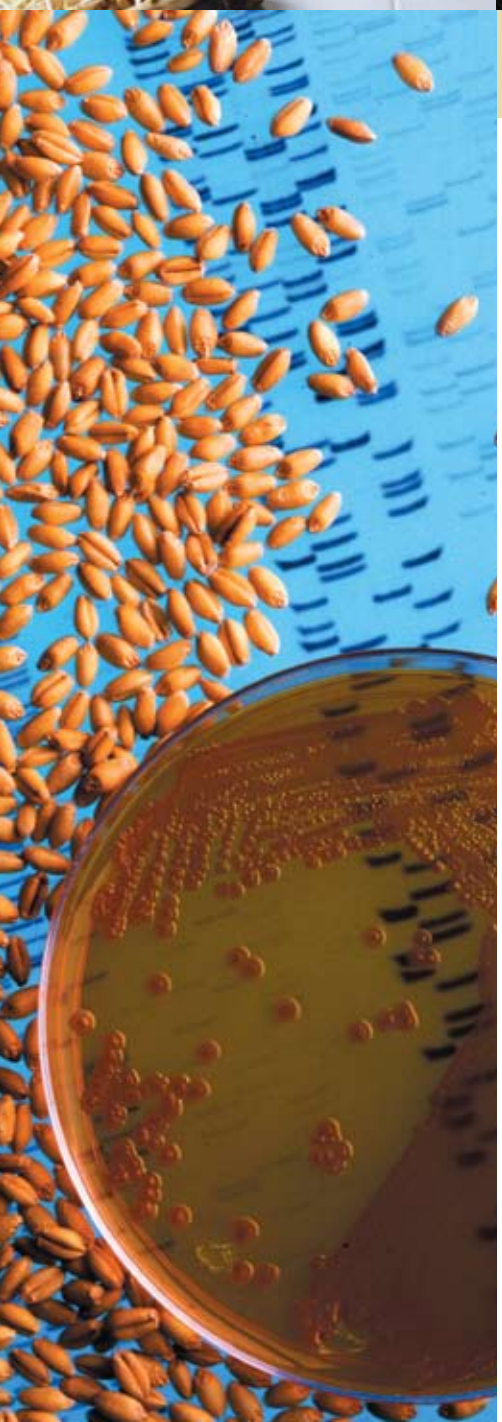
Health Canada











Biotechnology has a 2000-year history

Beer, wine, bread and cheese were the original biotech foods. By using naturally occurring bacteria, yeasts and moulds, farmers developed foods that had better tastes and textures. Fermentation was at the heart of the process.

In its simplest definition, biotechnology is the use of living organisms to make a new product or improve a process.

For centuries, plants have been given new traits through selective breeding. In their original forms, the tomato, potato and corn plants would not be recognized today. Only through patient plant breeding were negative traits such as bitterness and low yields removed and replaced with more desirable traits such as sweetness and robust harvests. The same painstaking work resulted in seedless varieties of grapes and watermelons.

Modern plant biotechnology, an extension of these same processes, uses the principles of heredity discovered by Gregor Mendel and the DNA double helix discovered by Watson and Crick. It involves the extraction, addition or alteration of specific genes to achieve beneficial traits.

Producing a rainbow of products

Today, the products of biotechnology vary. Consider specialty canola oil that can be used to produce commercial baking that doesn't include trans fats. Crops are being developed to maintain high seed yields even when stressed by drought. Biodegradable plastics can be made from corn. High-quality, soft, white hemp fibre has been derived through the use of enzymes for the textile industry. All of these applications are better for our health and environment.

Providing environmental solutions in a seed

After a decade of rigorous laboratory and field testing, under strict safety conditions set by Canadian regulators, the first genetically engineered corn, soybeans and canola were introduced in Canada in 1996. These biotech-improved seeds were bred for either herbicide tolerance or insect resistance. Herbicide-tolerant sugar beets were introduced in 2008.

Canadian farmers rapidly adopted biotech seed and its related management practices. They often use minimum-till or zero-till equipment to plant seed into the previous year's stubble without disturbing the soil. In tandem, they use one-pass herbicide sprays which kill the weeds but do not damage the crop. As stewards of the land, farmers embrace the environmental benefits of no-till farming in improved soil structure, less soil erosion and fewer trips across the field. In practical terms, this means less use of fossil fuels and lower greenhouse gas emissions.

The next milestone will be drought-tolerant crops, likely to be commercialized by 2011 or 2012. Researchers have found a number of genes that enhance the ability of the plant to withstand drought without adversely affecting yield in crops such as canola, corn and soybeans. More crop per drop is the goal in an era of variable climate.

Improving consumer health

In addition to improving agronomic traits, biotechnology also improves nutrition. Canada is a global leader in growing canola, an oilseed that's been bred to have characteristics that are supportive of heart/cardio health. Canola oil is the best vegetable source of omega-3 fatty acids of all popular oils.

In other developments, peanut researchers are identifying and sorting the genes that govern proteins which cause allergies. Once these proteins are removed, peanuts will gain a much higher standard of acceptability as a protein source and this process can become a model for removing allergens in other foods. The challenge is that the protein that produces the allergen is also responsible for flavour. These are typical practical considerations which face crop breeders every day as they look to enhance positive traits and remove negative ones.

Greening industrial processes

Besides applying biotechnology to food improvements, Canadian scientists are also looking at other applications. For example at the National Research Council of Canada, scientists have identified an enzyme that breaks down fibrous hemp in hours rather than days. This biological process provides a faster, more environmentally sound method to transform hemp into commercial fibres for use in aprons, T-shirts and sportswear. The same science is at the root of other industrial applications for plants such as wheat straw and flax.

Canadian biofuel plants are already benefiting from new corn hybrids which contain higher levels of fermentable starch that convert more efficiently into ethanol. Researchers are also developing biocatalysts – enzymes, yeasts and bacteria – to convert organic matter such as agricultural byproducts, wood chips and grasses into cellulosic ethanol.

A specialty canola oil high in mono-saturated fat has been bred to reduce the need for hydrogenation in the processing phase, thus eliminating trans fats. These specialty oils are in high demand by food processors anxious to meet consumer demand for reduced trans fatty acids.

Tissue culture produces fresh materials under sterile laboratory conditions breaking the cycle of pest infestation. These banana plantlets will lead to earlier maturity and higher yields.

Feeding a hungry world

As a major exporter of food crops, Canada remains one of the bread baskets of the world, partly due to genetically engineered crops. Biotech-improved corn and cotton were originally targeted to farmers in the developed world, however the positive impact is most pronounced for farmers in developing countries. In fact, of 12 million farmers planting this seed, 11 million are resource-poor farmers. South African farmers now use insect-resistant seed for 57 percent of their white corn food crop. A similar story is told in India, where farmers using insect-resistant Bt cotton seeds have increased cotton sales to $250 per hectare. India used to post one of the lowest yields for cotton, but since 2002, has doubled production and is now an exporter.

Producing more from the same area of arable land will be crucial in years to come.

Many crops do not trade on world commodity exchanges but nevertheless are critical for survival. Of late, much focus has been on Africa where biotechnology research is being applied to food staples. Genetically engineered sorghum varieties, for example, are being developed to improve digestibility and boost the uptake of vitamins, essential amino acids, iron and zinc. Cassava, a carbohydrate-rich tuber that provides basic nutrition for millions, shows improved yields with resistance to mosaic virus. Thanks to donations of genetic know-how by private and public companies and institutions, this research is advancing in the hands of African scientists.

Tracking the safety record of biotechnology

More than 100 foods from plants with novel traits (PNT) have been approved in Canada. These traits can be introduced using biotechnology, mutagenesis or conventional breeding practices. The process of testing, evaluating and commercializing these products usually takes up to 10 years and is evaluated by the Canadian Food Inspection Agency and Health Canada.

Canadian farmers have been using biotech seed since 1996. Twenty-five years of research supports the commercial record. No safety or health issues have ever arisen in Canada as a result of genetically engineered crops.

Scientific and regulatory agencies around the world have also investigated the safety of biotechnology foods and endorse the technology including: World Health Organization (WHO), the Food and Agriculture Organization (FAO) of the United Nations, the US National Academy of Sciences and the Royal Society of London.

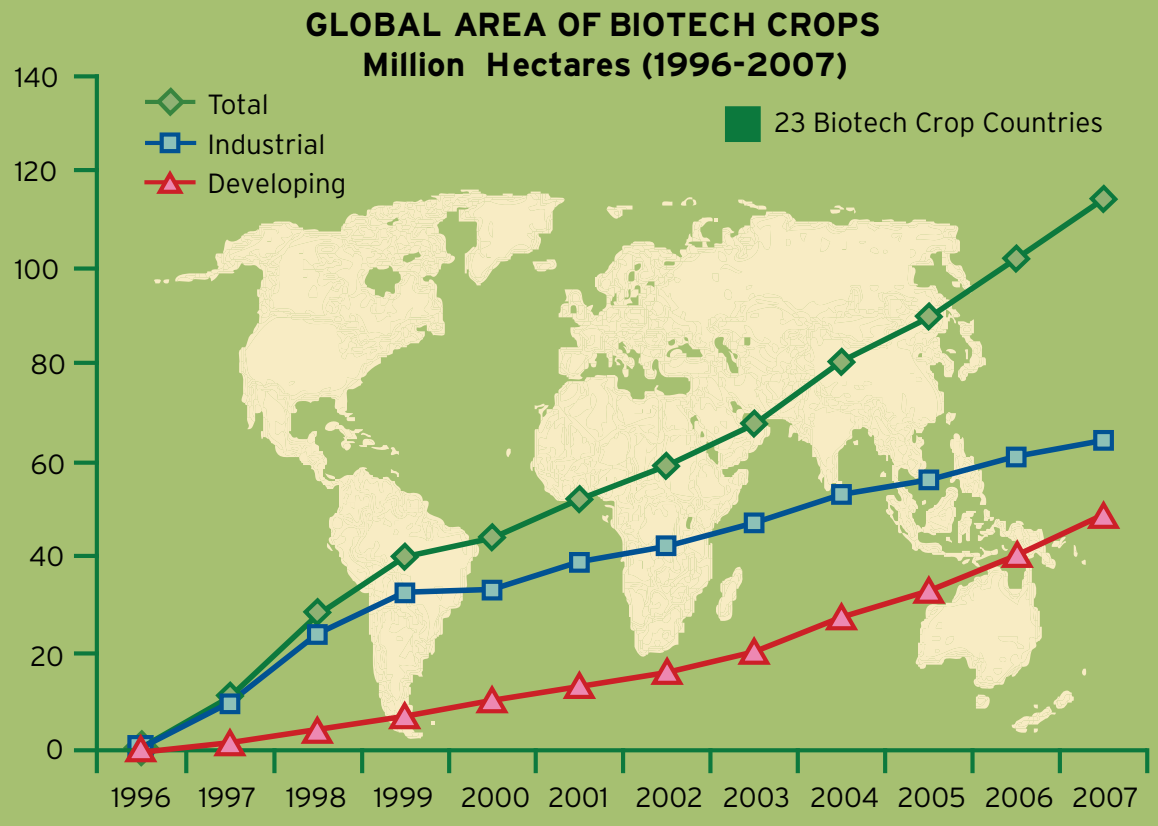
Doubling food production for the planet by 2030

Food security is acknowledged as one of the keys to a peaceful world. No one knows that better than Norman Borlaug. Originally a University of Minnesota crop scientist, Borlaug made his mark when he moved to the International Maize and Wheat Improvement Center in Mexico. There he bred semi-dwarf, high-yielding, disease-resistant wheat. These varieties were then transferred to India and Pakistan where they lifted millions out of food poverty in the 1970s. For this, Borlaug was known as the father of the Green Revolution and awarded the Nobel Peace Prize.

Today's challenge is to feed billions, many of whom are in tropical climates which have more intense weed, disease and insect pressures. Increasing food security must be accomplished from a shrinking arable land mass.

Like Borlaug, Indian geneticist MS Swaminathan, is a strong advocate for scientific technology to meet the challenge of doubling food output by 2030. He encourages an Evergreen Revolution -- conservation farming and biotechnology as the way forward to sustain the planet.

From plant developers to regulators to farmers, the Canadian food chain has a strong system to respond to this food production challenge.



Increase of 12%, 12.3 million hectares (30 million acres), between 2006 and 2007.

Source: Clive James, 2007

Glossary of terms

"Biotechnology" means the application of science and engineering in the direct or indirect use of living organisms, or parts or products of living organisms, in their natural or modified forms. This term is very broad and includes the use of traditional or conventional breeding, as well as more modern techniques such as genetic engineering.

"Modern biotechnology" is used to distinguish newer applications of biotechnology, such as genetic engineering and cell fusion from more conventional methods such as breeding, or fermentation. Most often the term "biotechnology" is used interchangeably with "modern biotechnology".

"Conventional breeding" or *"selective breeding"* means propagating plants or animals sexually, selecting for certain traits. Using selective cross-breeding, people can produce different varieties of plants and breeds of animals.

GM stands for *"genetically modified"*. An organism, such as a plant, animal or bacterium, is considered genetically modified if its genetic material has been altered through any method, including conventional breeding. A "GMO" is a genetically modified organism.

GE stands for *"genetically engineered"*. An organism is considered genetically engineered if it was modified using techniques that permit the direct transfer or removal of genes in that organism. Such techniques are also called recombinant DNA or rDNA techniques.

Some international agreements like the Cartagena Protocol on Biosafety use terms like *"living modified organism"* (LMO). The Protocol defines a LMO as a microorganism, plant, or animal that has been derived through modern biotechnology—using techniques such as recombinant DNA—that is capable of transferring or replicating its genetic material (DNA, or "deoxyribonucleic acid", is the genetic material found in all living organisms).

"Transgenic" organisms have a gene from another organism moved into them. For example, the plant product known as "Bt. corn" is a transgenic plant because it has a gene from the bacterium Bacillus thuringiensis, or Bt. That gene produces a protein with pesticidal properties that, when incorporated into a plant, allows the plant to produce this protein, thus transferring the bacteria's natural defence to the plant.

"Mutagenesis" is the use of methods to physically change or "mutate" the genetic sequence, without adding DNA from another organism. Various chemicals and ionizing radiation can be used to invoke these changes. "Site-directed mutagenesis" can also be used to invoke changes in specific genes. In plants, such agents are used to change a plant's genetic sequence, and the plant can pass on these new characteristics to its offspring.

Source: Canadian Food Inspection Agency

For more information:

Health Canada: Genetically Modified Foods and Other Novel Foods
http://www.hc-sc.gc.ca/fn-an/gmf-agm/index-eng.php

Canadian Food Inspection Agency: Biotechnology? Modern Biotechnology? What do these terms mean?
http://www.inspection.gc.ca/english/sci/biotech/gen/terexpe.shtml

Dietitians of Canada
http://www.dieteticsatwork.com/biotech_order.asp

NRC-Plant Biotechnology Institute
http://www.pbi.nrc.ca/en/pbi.htm

CropLife Canada
http://www.croplife.ca/english/resourcecentre/resourcecentrebio.html

Council for Biotechnology Information
http://www.whybiotech.ca

GMO Compass
http://www.gmo-compass.org/eng/home/

International Service for Acquisition of Agri-Biotech Applications
http://www.isaaa.org/resources/publications/briefs/37/executivesummary/default.html

The Council for Biotechnology Information is a NAFTA-aligned, non-profit association whose mandate is to communicate science-based information about the benefits and safety of agricultural and food biotechnology. CBI members are the leading agricultural biotechnology companies.

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CBI Canada
102-116 Research Drive
Saskatoon, SK S7N 3R3
Toll-Free: 1-866-922-1944
www.whybiotech.ca

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