



*From Science*  
.....  
to Seed



## Vice-president's message

Agriculture is one of the most technologically advanced industries in Canada. Innovations in plant breeding go back thousands of years in human history. As long as there has been agriculture humans have been improving plants to make them hardier and improve their taste.

In Canada and around the world plant breeders and scientists are carrying on this tradition by producing crops with new traits through plant breeding innovations such as biotechnology that offer a wide range of benefits for farmers and consumers. These crop improvements are part of the reason farmers are growing more per acre of land than at any other time in history and supplying Canadians with one of the safest food supplies in the world.

Farmers experienced the benefits of the first generation of biotechnology-derived crops, including genetically modified crops, in the 1990s. Herbicide-tolerant canola enabled the adoption of conservation tillage practices, which dramatically improved soil health and made agriculture more sustainable. And while it's not generally well understood, herbicide-tolerant and insect-resistant crops are just parts of the much broader success story of plant breeding innovations.

A big part of the reason Canadian farmers have and continue to enjoy access to the latest crop varieties developed through plant breeding innovations is because of Canada's world-class, science-based regulatory system that ensures that all new varieties brought to market are safe for people, animals and the environment. This gives Canadians confidence in the food they are eating and it gives our trading partners around the world confidence in what we grow and helps drive agricultural trade.

Getting a new crop variety to market is no small feat. For crops that will be grown and traded around the world it's a process that can take more than a decade and cost more than \$150 million. As part of the process of developing a new crop variety plant breeders identify desirable traits and then introduce them into a crop. They can also remove undesirable traits or modify an existing trait.

The new varieties are then tested extensively to ensure that the new plant does not pose any risk to human health, environmental safety and livestock feed safety. Developers conduct thousands of tests in labs, greenhouses and out in the field to demonstrate that the new crop is safe before they decide to submit an application to Health Canada and the Canadian Food Inspection Agency (CFIA) for safety approval.

This document, *From Science to Seed*, explains how plants developed through plant breeding innovations make it from initial research and discovery through to approval by Canada's regulatory system and into the hands of farmers. It is this process that ensures the safety of Canadians and creates an environment for continued innovation in this country.



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**CropLife Canada** is the trade association that represents the manufacturers, distributors and developers of plant science technologies, including plants enhanced through modern breeding. Our members work to provide Canadians with innovative products that protect the environment and contribute to a healthy food supply and a vibrant economy.



## *What is modern plant breeding?*

Since the earliest days of agriculture 10,000-plus years ago, farmers have been working to improve the quality of plants by increasing yields and reducing unfavourable traits like tough skins or hard seeds. These forward-thinking ancestors were the first plant breeders. Today's plant breeders have carried on this tradition by using plant breeding innovations, including biotechnology, to better understand a plant's genetic makeup so that they can introduce beneficial genes, modify existing genes and remove detrimental ones with a range of very precise tools.

Genetic engineering, which produces genetically modified (GM) plants (sometimes referred to as GM organisms or GMOs), is perhaps the most talked-about plant breeding innovation. But there are many other breeding tools used to improve plants.

Certain varieties of corn, soybeans and canola enhanced to be tolerant to herbicides and resistant to insect pests first came on the market in the early 1990s. These crops, which were developed through genetic modification as well as other methods, allowed farmers to better control weeds and deal with insect pests. Since then modern plant breeding has led to additional crop varieties in Canada such as legumes, sugar beets, apples and potatoes with beneficial new traits including healthier oil profiles, drought tolerance and traits that reduce food waste.

Today plant breeders have access to a whole range of plant breeding innovations for creating better crops that are good for farmers, the environment and consumers. The future promises crop varieties tolerant to salt conditions; foods with better texture and flavour; crops with improved health benefits and lower allergenic properties; and reduced food waste in a broader range of crops.



## *Why do we need plant breeding innovations?*

Farmers, like most Canadians, enjoy having access to modern technology. Just as many people use innovations like mobile technology and the Internet to improve their lives, farmers also rely on technology to help improve their business. Crops enhanced through modern plant breeding provide benefits to farmers, the environment and to consumers.

These crops help farmers produce more using the land already in production. When farmers are able to maximize the land they already use, the environment is protected because valuable green spaces and the wildlife that live within these spaces are left intact.

Herbicide-tolerant crops developed through modern plant breeding have allowed farmers to better control weeds without having to till the soil. This has many benefits for the environment including enriching the soil and reducing erosion, reducing fuel use and contributing to fewer greenhouse gas emissions.

While herbicide-tolerant and insect-resistant crops help farmers protect their crops against pests in more sustainable ways, plant breeding innovations are also leading to the development of new crops that meet evolving consumer tastes and demands. And as climate change leads to more extreme weather conditions, it will be critical to use every tool in the toolbox, including modern plant breeding, to develop hardier varieties of crops that can thrive in increasingly challenging climate conditions.

This technology is part of an agricultural system that is constantly evolving and offers farmers new and improved ways to produce the safe, nutritious and affordable food Canadians enjoy.



## *How a new crop gets to the farmer's field*

To bring a crop developed through modern plant breeding to market it can take more than a decade and cost more than \$150 million for crops that will be grown and traded around the world. Companies looking to develop a new crop start by conducting tests in labs, then move to the greenhouse to see if the plant still holds potential. If the crop makes it past this step, testing continues in the field, under strict confinement conditions.

During these phases, researchers examine issues related to human health, environmental safety and livestock feed safety.

## HOW ARE CROPS DEVELOPED THROUGH PLANT BREEDING INNOVATIONS REGULATED IN CANADA?



Canada has one of the safest food supplies in the world, thanks to the regulatory system in place. In Canada, Health Canada and the Canadian Food Inspection Agency (CFIA) are responsible for regulating products of modern plant breeding such as plant biotechnology to protect human, animal and environmental health and to maintain international quality and safety standards that facilitate trade. The government has been assessing tests on biotech crops for two decades and the results demonstrate that these crops are safe for people, animals and our environment.

Health Canada has declared that biotech crops, one of the most widely known forms of modern plant breeding, are just as safe as non-biotech crops and it is not alone in this view. Regulatory agencies around the world, including the World Health Organization, have all endorsed the safety of biotech crops.

The CFIA is responsible for regulating plant breeding innovations such as plant biotechnology to ensure they are safe for the environment and for livestock animal feed. Health Canada is responsible for ensuring that all products developed through these methods are safe for people to eat.



## Innovation and discovery of a new crop

To bring a new crop to market, developers start by working in a lab. Here they use plant breeding innovations such as plant biotechnology to precisely and effectively identify and introduce beneficial traits or reduce negative characteristics in plants to produce a new and improved seed.

Developers often start with thousands of plants that have been modified with a new desirable trait. After they've completed the tests in the lab, only the plants that hold potential move to the greenhouse.

In the greenhouse, real growing conditions are simulated to see how the plant will react. If the plant continues to show promise, it then advances to the field under strictly controlled conditions. The introduction of a new trait and the various phases of testing can take the developer five to seven years to complete and cost millions of dollars.

## Confined field trials for plants with new traits

If a modified plant still shows promise after testing in the greenhouse it moves to a confined field trial to test the plant under outdoor conditions. Very few plants make it to this stage. When a developer is testing a potential new plant in Canada, it grows the plant on small plots to closely monitor how the plants will grow under normal conditions. This is called a confined field trial and it allows developers to evaluate, under safe conditions, the growing capabilities of the new crop and to collect safety information.

The CFIA closely monitors the confined field trial evaluation of all test crops and takes steps to minimize the possibility of the crop having any environmental impact during this phase. This includes implementing measures to prevent pollen from the crop transferring to other plants, land use restrictions and follow-up monitoring. If the plant still shows promise after the confined field trial, developers will submit all the required data for that plant for review. After starting research with thousands of plants, typically only a few plants will be submitted for evaluation.

CropLife Canada offers an online training course on how to apply for and complete a confined field trial. The content of the course is reviewed by the CFIA each year to ensure the information is current and up-to-date. The CFIA and the plant science industry continue to work together to ensure high rates of compliance in field trials.



## Trustworthy testing

In addition to data submitted by developers, Health Canada and CFIA scientists also review independent research available in published scientific journals. In order to be considered, all tests and studies, regardless of who completes them, must be designed and completed according to good laboratory practices to ensure the quality and validity of test data and to improve acceptance of the data generated.

Canada's regulatory guidelines indicate what data has to be submitted to the CFIA and Health Canada. These guidelines were developed, and are regularly updated, by the government through consultations and reflect recommendations from international groups such as the World Health Organization and Food and Agriculture Organization and the Organisation for Economic Co-operation and Development. Canada is not alone in using this approach to examine industry data.





## *Assessment by Health Canada and the Canadian Food Inspection Agency*

Before a new plant variety can be grown in Canada, it must be approved by Health Canada and the CFIA. Data from the discovery phase and confined field trials are submitted to be evaluated under three categories: food safety, environment safety and livestock feed safety. The data must show that there is no change to the safety of the crop, the way the crop will grow or the food that will be harvested.

The comprehensive assessment is completed by a team of molecular biologists, toxicologists, nutritionists, chemists and microbiologists who follow international standards that are recommended by the World Health Organization, the Food and Agriculture Organization of the United Nations and the Organisation for Economic Co-operation and Development, as their guide to ensure the new crops are safe.

CropLife Canada member companies voluntarily allow Health Canada and the CFIA to publicly post information about the new crop varieties submitted for review. This gives Canadians the chance to provide scientific input relevant to the safety assessment of a new product.



### Food safety

Health Canada conducts a thorough review of all new foods, including those developed through modern plant breeding, to determine that they are as safe and nutritious as food already available in Canada, to ensure that Canada's food supply is safe and to protect the health of Canadians.

Companies submitting data to Health Canada on a new crop must provide detailed data such as:

- A description about the safety and composition of the crop before it was modified so their analysis can be based on characteristics of the unmodified crop
- A technical explanation of the process used to modify the food
- A full description of the nutrient makeup of the food to gauge whether it is nutritionally comparable to the unmodified crop
- Evidence that no toxins have been introduced through genetic modification
- Verification that the new food does not contain allergens



## Environmental safety

CFIA does the environmental safety assessment of products of plant breeding innovations. Five criteria are used to determine the product's potential to:

- Become a weed or invade natural habitats
- Transfer the new traits to other plants that may become more weedy or invasive
- Become a plant pest
- Impact non-target species, including humans
- Impact biodiversity

This assessment looks at the effects of the new crop in agricultural and natural environments as well as the effects of the possible transfer of the new characteristics to other plants. To evaluate this, two sets of documents are considered.

The first document contains information about the original crop, before it was altered. This information is used to compare the modified crop to the unmodified crop during the safety review by the CFIA.

The second document contains all the information about the product under review. This document is used by the CFIA to determine if any of the original characteristics of the crop have been changed in the modified crop according to the five criteria identified above. It provides the data and scientific information to show that no environmental risks have been introduced into the modified crop. This data is collected through testing and analysis in the lab and during confined research field trials.

During the CFIA's environmental assessment of a new product, it may consult relevant scientific experts within Canada or internationally as well as peer-reviewed scientific literature.

Applicants may also be required to provide a stewardship plan that addresses how the crop will be responsibly used in the field. These include things like insect resistance management and herbicide tolerance management. For more information on these stewardship activities, visit [www.croplife.ca](http://www.croplife.ca).





## Livestock feed safety

The livestock feed safety assessment is conducted by the CFIA. The assessment considers the safety of a new crop to livestock as a feed, in a similar way as Health Canada assesses the crop for human food safety.

The CFIA requires data to be submitted that compares the unmodified crop as well as data on the new crop to complete their assessment. The data that needs to be supplied includes molecular, compositional, nutritional and toxicological data.

CFIA scientists compare the data between the modified and unmodified crop and the differences are examined. Scientists will look at the new crop for the potential for adverse health effects on livestock.

## Approval

After Health Canada and the CFIA have evaluated all the data for food safety, environmental safety and livestock feed safety, a decision is made about whether to authorize the crop. All three categories must be completed before an overall decision is made to approve the crop for use. Health Canada and the CFIA closely coordinate their respective assessments. If the crop is deemed safe to be grown in Canada by Health Canada and the CFIA, it can then be made available for Canadian farmers to choose to plant in their fields.

## After approval

Health Canada and the CFIA are responsible for appropriate inspection and monitoring so that authorized new varieties continue to meet quality and safety standards. If at any time new information becomes available regarding risk to human health, the environment, or livestock from a new variety, Health Canada and the CFIA will re-evaluate the crop to determine if it continues to meet regulatory standards.

Crops derived from modern plant breeding have been cultivated for close to two decades and eaten by billions of people worldwide. These crops are the most extensively tested food crops available today and they are safe for people, the environment and livestock. They provide farmers with innovative tools to help them produce safe and affordable food for Canadians.

