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Innovation Express

Science and Technology News from Agriculture and Agri-Food Canada

New Strategic Direction Guides AAFC Science

As an integral part of the global economy, agriculture is increasingly dependent on new knowledge, timely information and cutting-edge technology. Canadian farmers and agri-based companies participate in complex multinational supply chains and play an important role in meeting world food needs.

Agriculture and Agri-Food Canada's (AAFC's) *Growing Forward 2* policy framework underscores the importance of research and innovation in improving productivity, profitability and sustainability of the agriculture and agri-food sector. Increased investments in innovation programming continue to build and support partnerships and leverage industry leadership and investments.

The public-private partnerships enable everyone to focus their efforts in areas where they can have the greatest impact for the sector and complement the contributions of others.

With the creation of the new Science and Technology Branch in July 2012, AAFC has redefined its approach to research, development and knowledge transfer in a manner that best supports government and industry priorities.

The new Branch focuses on applying its science activities to agri-based production systems; fulfilling our role as a federal science provider to inform regulatory and policy decisions; producing far-from-adoption applied science with broad stakeholder application; and supporting innovation to improve economic prosperity.

To help achieve this, we have established three fundamental pillars to guide our science activities:

1. **Providing science that enhances the sector's resiliency**
2. **Fostering new areas of opportunity for the agriculture and agri-food sector**
3. **Supporting sector competitiveness**

This issue of *Innovation Express* illustrates some of our research efforts under these three pillars, showing how our efforts result in crops with improved production traits and production practices that improve productivity, sustainability and profitability. We hope you enjoy reading about these and other innovative projects currently underway at AAFC.

Dr. Siddika Mithani, Assistant Deputy Minister and
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Science and Technology Branch
Agriculture and Agri-Food Canada

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Bacteria Breaks Down Antibiotics in Soils

It's a known fact that a bacteria population that has been exposed to antibiotics for long periods of time can evolve to protect itself by either modifying the antibiotic compound or expelling residues as fast as they come in. A team of Agriculture and Agri-Food Canada (AAFC) scientists at the Southern Crop Protection and Food Research Centre in London, Ontario, in collaboration with colleagues from France, recently discovered a soil bacterium that found a new way of protecting itself—and the environment—from a commonly used veterinary antibiotic, sulfamethazine (SMZ). Commonly fed to pigs and other livestock to keep them healthy, SMZ is also excreted in manure, which is then spread as fertilizer in North American farm fields. The newly discovered bacterium breaks down SMZ and uses it as food, which helps limit the drug's impact on the environment.

Motivated by growing concerns about antibiotic-resistant bacteria, AAFC scientists started their experiments on federal research plots in London more than 14 years ago. The team repeatedly treated plots with a mixture of three common veterinary antibiotics used to promote livestock growth and health—SMZ, tylosin, and chlortetracycline—and monitored how long-term exposure affected soil bacteria populations.

Previous research indicating that pesticides often break down more quickly in soils with a long history of exposure prompted the researchers to compare antibiotic persistence in untreated soil and soil from their treated plots.

The team was surprised to discover that antibiotics were disappearing much faster from soil that was treated with antibiotics over long periods than from the untreated soil. In particular, SMZ was removed from the soil as much as five times faster in the historically treated soil. The cause was identified as a new strain of *Microbacterium*, an actinomycete that has adjusted to long-term exposure by learning to break down SMZ and using it as a food source.

Actinomycetes are extremely common in soils and known to degrade a wide range of organic compounds, but this is the first strain known to break down an antibiotic to feed itself.

This research could significantly change the current understanding of our environment and antibiotic resistance. These findings suggest that under conditions of long-term exposure to antibiotics, bacteria can evolve to break them down, use them as a food source, and help reduce the amount of time that the environment is exposed to these drugs. However, more research is needed to determine if long-term exposure to antibiotics may still put pressure on the soil bacteria to evolve and become resistant to these antibiotics.

Growing Forward 2 Has Arrived!

Federal, provincial and territorial (FPT) governments marked the official launch of the *Growing Forward 2* (GF2) agricultural policy framework in Canada on April 1, 2013. GF2 is a five-year, $3 billion framework that aligns FPT policies and programming to support the agriculture and agri-food sector. The framework features a greater emphasis on innovation, competitiveness and market development.

Three federal programs—AgriInnovation, AgriMarketing and AgriCompetitiveness—were previously launched in December and January. Together, these programs aim to accelerate the pace of innovation, improve competitiveness in domestic and international markets, and help the sector adapt to emerging global and domestic opportunities, as well as enhance business and entrepreneurial capacity. Details on these programs can be found on the *Growing Forward 2* website: www.agr.gc.ca/growingforward2.

Growing Forward 2

A federal-provincial-territorial initiative

The AgriInnovation Program consists of a combination of government initiatives and funding for industry-led projects. The Program is designed to accelerate the pace of innovation by supporting research and development activities and facilitating the demonstration, commercialization and/or adoption of innovative products, technologies, processes, practices and services. For more information on the AgriInnovation Program and how to apply, please contact us at our toll-free number, 1-877-246-4682, or by email at AIP-PAI@agr.gc.ca.

Discovery Helps Protect Global Wheat Supply

Agriculture and Agri-Food Canada (AAFC) researchers have made a breakthrough in the global effort to protect world wheat crops from Ug99, a potentially devastating wheat stem rust that has affected crops from Africa to western Asia, and is threatening global wheat supplies.

While not yet present in North America, AAFC scientists have identified two genes with high resistance to Ug99. The isolation of these genes will allow for cross-breeding into other current wheat varieties to help protect Canadian wheat crops while maintaining production of the most popular varieties. At present, most of the commercial wheat varieties grown in Canada—and about 90 per cent of those grown worldwide—are susceptible to Ug99.

Molecular markers linked to these resistant genes have been developed and are now available for use in wheat breeding efforts. In 2012, AAFC sent seed of the resistant Canadian varieties to wheat breeders in the United States and the International Maize and Wheat Improvement Center (CIMMYT) to develop improved local varieties in affected areas and in developing countries that are most at risk.

The discovery of these genes marks a huge step in controlling Ug99 and is a significant return on investment.

In 2009, the federal government committed $13 million to its three-fold approach in the fight against Ug99. This funding is being used to identify resistance in Canadian wheat lines and ensure that new cultivars have at least two effective resistance genes. It is also used to support AAFC's participation in the Durable Rust Resistance in Wheat (DRRW) project, an international effort based at Cornell University in New York that is studying all aspects of wheat rust—from pathology to variety development and distribution. The project is linked to the Borlaug Global Rust Initiative which is funded by the Bill and Melinda Gates Foundation.

AAFC is one of 23 organizations involved in the DRRW, including many universities and research institutions. The AAFC team includes 18 geneticists, pathologists, and plant breeders from research centres across the country.

This research goes beyond enhancing the security and protection of Canada's food supply; international collaboration like this will help meet the global challenge of doubling food production over the next 40 years to meet the demands of a growing population.

DID YOU KNOW?

AAFC is a world leader in the discovery and exploitation of genetic resistance to various cereal rusts. About half of all known rust-resistance genes to date have been discovered by scientists at the Cereal Research Centre in Winnipeg. This work is continuing at AAFC's PPC3 lab in Morden, Manitoba.

This ongoing investment in cereal disease research has helped keep Canada free of a major outbreak of stem rust since 1955.

New Lab Bolsters Defence Against Plant Diseases

A major upgrade to a laboratory at the Agriculture and Agri-Food Canada (AAFC) Research Station in Morden, Manitoba, has resulted in its certification as a Plant Pest Containment Level 3 (PPC3) facility. The original lab was established in 1989 as a containment lab primarily for research on flax rust. In the fall of 2011, it became the first PPC3 facility to be certified by the Canadian Food Inspection Agency under the new *Containment Standards for Facilities Handling Plant Pests* in Canada.

- PPC3 is the highest containment level for plant pests. Containment is achieved through the use of specialized facilities, stringent operational procedures and state-of-the-art equipment and provides the highest level of safety available for both staff and the public.
- The Morden Research Station was one of eight AAFC laboratories upgraded through an investment from the Modernizing Federal Laboratories Initiative under Canada's Economic Action Plan.

Dr. Khalid Rashid uses the PPC3 lab at Morden for ongoing research to maintain multigenic disease resistance to flax rust.

Hulless Oats Create New Markets

We usually associate oats with cookies, oatmeal and livestock feed. But how about as a replacement for rice, a food choice for people with gluten sensitivity, a nutrition bar for horses or an ingredient in face cream? While traditional oats still have their place, hulless oats developed by Agriculture and Agri-Food Canada (AAFC) scientists at the Eastern Cereal and Oilseed Research Centre in Ottawa are being used to develop new products and open up new markets for this made-in-Canada variety.

The world's first truly bald-seeded (hulless) and hairless oat variety, AC Gehl, is licensed to Semican International Inc. of Quebec and Wedge Farms Nutrition Inc. of Manitoba.

Wedge Farms Nutrition Inc. has re-named AC Gehl "Cavena Nuda" (the naked oat) or "Rice of the Prairies," and is marketing it as a premium food product. Cavena Nuda cooks like rice, but with a much higher nutritional profile. It has twice the protein of rice and very high levels of lysine, an amino acid key to good muscle growth. It also has high beta glucan levels and anti-oxidants for lowering cholesterol and a low glycemic index, making it an excellent option for diabetics and health conscious consumers. It is also proving to be suitable for gluten-free diets.

Semican, a livestock feed company for high-performance racehorses with key export markets in the US, Dubai, Ireland and the UK, uses the oat in their nutrition bar for horses.

This oat was featured at an AAFC Savour Canada event at the 2010 Winter Olympics in Vancouver, and was served to world leaders at the G-20 Summit in Toronto in 2010.

As a cold season crop, AC Gehl has the potential to replace corn, soybeans and rice in some processed foods. AAFC scientists have also worked closely with the Canadian Celiac Association to develop and perfect a method to keep oats pure at every step—from planting to retail—to prevent any gluten contamination. Also, collaboration with China has resulted in these and other Canadian oat varieties being cultivated in that country as a protein-rich supplement to rice and feed for livestock.

In 2012, a new line of hulless oat was assigned to Ceapro Inc., which agreed to complete the breeding process and to cover all associated costs of production, registration and protection with a view to negotiating a sole variety licence before March 31, 2015. Ceapro Inc. plans to grow and use the oat for skin care products and other nutraceuticals.

Specialty crop varieties, like hulless oats, will help increase farmers' revenue and offer exciting new choices for consumers. With all the interest from farmers and industry, this nutritious, highly-adaptable yet underutilized cereal grain is well on its way to new markets.

China Bestows Rare Honour on Canadian Agricultural Scientist

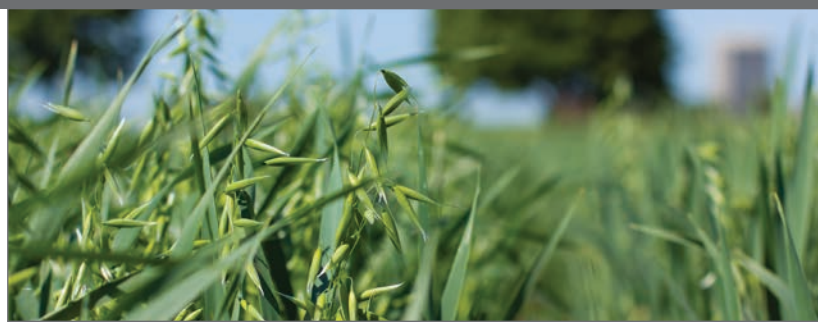
Dr. Vernon Burrows, the AAFC scientist who developed AC Gehl, the first hulless oat variety, was honoured by China with a bronze bust likeness unveiled at the China-Canada Agricultural Science and Technology Forum in Baicheng, Jilin Province, China in July 2012. The bust celebrates his innovations in oat breeding science and outstanding contribution to the friendship between Canada and China. In 2003, he received the friendship medal, the highest honour bestowed upon a foreigner, from the Chinese premier, Wen Jiabao.

Dr. Burrows began volunteer consulting for the Baicheng Academy of Agricultural Sciences more than 14 years ago to help develop oat production in areas of northern China where growing conditions were poor due to saline and arid soil. The results of his work have strengthened international scientific collaborations and have led to increased food security and economic opportunities in this part of China.

Dr. and Mrs. Burrows with Jody Aylard, former ADM, Research Branch in China, July 2012.

DID YOU KNOW?

The majority of oats grown in Canada are not hulless varieties. Approximately 90 per cent of Canada's milling oats (which contain hulls) are produced in Western Canada, mainly in the eastern Prairies. Canada is the world's largest oat exporter with about 95 per cent of the exports going to the United States.



Canadian Oats Help Soothe Sensitive Skin

A new oat, coupled with a technology developed and patented by Agriculture and Agri-Food Canada (AAFC) scientists at the Eastern Cereal and Oilseed Research Centre in Ottawa, is helping to rapidly increase the extraction and commercialization of a beneficial molecule found in oats.

Avenanthramides are naturally occurring plant molecules—incidentally discovered and named by AAFC scientist Dr. F. William Collins 25 years ago—that exhibit antihistamine and anti-inflammatory properties and are the reason oatmeal baths are so soothing to itchy skin. Avenanthramides are found only in oats and in very small quantities, which has so far limited their commercial application.

While traditional malting increases the levels of avenanthramides in oats, it also causes oat grains to germinate, interfering with milling processes. The new technology uses a proprietary malting process that prevents sprouting so that they can be abrasion-milled to efficiently remove the outer oat bran layer, which contains most of the valuable avenanthramides. The combination of the new malting process with abrasion-milling to produce a bran fraction results in a highly concentrated source of avenanthramides.

In 2012 Ceapro Inc., an Edmonton-based biotechnology company, signed two agreements with AAFC—one for use of the technology, the other to complete the breeding process, test and register a specialty oat that was tailor-bred by AAFC for use with the malting technology. Ceapro Inc. plans to process and market avenanthramides in skin, hair, baby, sun care and cosmetic products.

The new hulless oat has a unique shape that is more conducive to milling and processing, which helps extract the beneficial compounds.

By drastically reducing the quantity of oats needed as input material, this new technology, coupled with the new oat, reduces transport, storage, extraction and processing costs and greatly increases production efficiency.

High production and cost efficiency leads to broader commercial applications, development of new food, cosmetic and health products and opening of new markets for our oat farmers and producers.

DID YOU KNOW?

Agriculture and Agri-Food Canada (AAFC) currently holds about 500 active licences with over 200 industry partners. For example, we grant sole rights to seed companies to market crop varieties developed by our plant breeders. Other intellectual property developed by AAFC researchers, such as patents and copyrights, can also be licensed to interested parties. Further information on partnering with AAFC on commercialization opportunities can be found on our website (www.agr.gc.ca/scienceandinnovation) under the "Technology Transfer and Licensing" sidebar.

‘Hairy’ Canola Brushes Off Flea Beetles

Each spring, millions of hectares of canola are sown in Canada with insecticide-treated seed as a strategy for controlling potential flea beetle damage. Once an outbreak occurs, the flea beetles can completely destroy seedlings, delay maturity and cause yield losses in unprotected crops. Even with chemical applications, flea beetles still account for more than $250 million in crop damage annually. Research being conducted at Agriculture and Agri-Food Canada’s Saskatoon Research Centre in Saskatchewan may help producers grow canola without the need for these pesticides.

Scientists have developed ‘hairy’ canola plants that appear to be resistant to flea beetles. The hairs on leaf and stem surfaces, called trichomes, provide a natural physical barrier that seem to prevent flea beetles from feeding on newly emerged seedlings.

Scientists are focused on finding and testing new genes that stimulate canola to produce a dense coverage of plant hairs. Canola (*Brassica napus*) seedlings have very few trichomes, but related species like the mustards have a lot more. This research has received additional financial support from the Canola Council of Canada, the Alberta Canola Producers Commission, the Saskatchewan Canola Development Commission, the Saskatchewan and Alberta governments, and the Western Grains Research Foundation.

Initially, the team developed new enhanced germplasm by modifying one gene, but found even greater improvements when two genes were modified. The new germplasm with two modified genes has trichomes that cover the first nine true leaves and stems. The new germplasm still has hairless cotyledons, the first fleshy storage leaves that attract flea beetles when seedlings emerge in the spring.

Nevertheless, the modified hairless cotyledons and the hairy leaves are equally or more resistant to flea beetle feeding than those on canola plants treated with a standard insecticide for flea beetle control.

The new germplasm also shows a small reduction in feeding damage by the diamondback moth.

In addition, the team has corrected the problems of poor plant vigour associated with the earlier modified germplasm. The plants with two modified genes grow as well as unmodified canola and are more robust than the earlier germplasm with only one modified gene. The new germplasm has slightly cupped, smaller, darker green leaves and more variability in branching, but seed weight and yield per plant is similar to that of insecticide-protected canola.

The researchers are now modifying other trichome initiation or branching genes in *B. napus*. An examination of genetic sequence diversity is also under way in more than 70 trichome genes in selected hairy and non-hairy lines of *B. oleracea* (wild cabbage), *B. rapa* (Polish canola), *B. nigra* (black mustard), *B. napus* (Argentine canola), and the wild related species *B. villosa,* which is extremely hairy and immune to flea beetles. The information gleaned will help scientists determine the optimum genetic composition for hairy canola. It will also help them gain a better understanding of how to develop non-Genetically Modified Organism (GMO), flea beetle-resistant varieties through simple genetics.

Scientists have already field-tested GMO germplasm available for plant breeders to use in developing commercial varieties of hairy canola, and non-GMO germplasm will follow in the future.

For more information on this project please view the science video on AAFC’s website: Hairy Canola Meets the Crucifer Flea Beetle

DID YOU KNOW?

- Generating a quarter of all farm cash receipts and contributing $15.4 billion per year to the Canadian economy, canola challenges wheat as Canada’s top field crop.
- About 85% of canola is exported.

A Potato with Diabetics in Mind

Scientists at the Potato Research Centre in Fredericton, New Brunswick have developed a low glycemic potato. Further trials will tell whether it could open up new menu possibilities for diabetics and others with low glycemic diets—and new markets for farmers.

Recent research shows that healthy, low glycemic index (GI) diets have a range of benefits, including more sustainable weight loss and improvement in the management of diabetes. Low GI foods digest slowly, without creating a big spike of insulin in the body.

Each spring new selections developed by Agriculture and Agri-Food Canada potato breeders are ready for release to industry for further trials.

DID YOU KNOW?

Every year, more than 120,000 potato hybrid seedlings are grown, tested and measured at the Potato Research Centre. These are narrowed down over six years to about a dozen varieties released to industry every year for further development.

New for 2013: The use of a video link allowed potato industry participants attending open houses in Fredericton, New Brunswick, and Lethbridge, Alberta, to view presentations and new potato selections developed by both locations.

The 2012 selections included this low glycemic potato as well as the more traditional fresh market potatoes and potatoes developed for the chip and French fry business.

Other specialty potatoes being developed in Fredericton include germplasm with pigmented flesh and enhanced antioxidant content, as well as potatoes with high starch for industrial use.

The new varieties are developed using traditional breeding methods and exploiting natural genetic diversity existing in local or exotic potato germplasm from South America. Some new technologies help to speed up the development process. For instance, a near-infrared spectrometer and a rheometer at the Potato Research Centre allow scientists to measure starch content and composition of potatoes with a simple test. This technology eliminates years of trial and error to identify desirable characteristics.

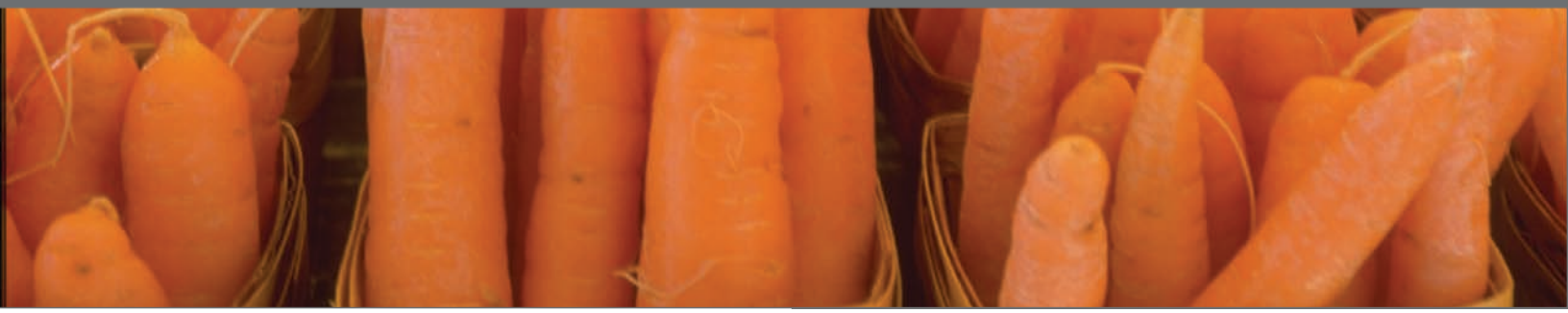
This mix of traditional techniques and new technologies is helping scientists develop potatoes that are adapted to local growing conditions and that have improved nutritional qualities to meet consumer needs and enhance human health. Introducing new varieties to the market creates new opportunities for farmers and helps keep them competitive. The next step is for the potato industry to test the varieties for their commercial potential.

Yukon Gold: Growing Potatoes North of 60

Agriculture and Agri-Food Canada scientists at the Crops and Livestock Research Centre in Charlottetown, Prince Edward Island, have been working with the Yukon territorial government by helping local growers diagnose diseases in order to protect their potato crops. Growers can send photos and potato samples to Charlottetown scientists for advice.

Farmers in the Yukon grow about 40 hectares of potatoes. They plant in late May and harvest in August, but there are advantages to being that far north. The midnight sun provides longer days during the growing season, so the yields are good. There is potential to develop the Yukon as a seed potato growing area because they have few of the potato disease pressures that affect other parts of the country, such as late blight and the Colorado potato beetle.

All of the harvest goes to local markets and supermarkets.



Milestone for Pest Forecasting Software

Thanks to an Agriculture and Agri-Food Canada-developed software called CIPRA (Centre informatique de prévisions des ravageurs en agriculture [Computer Centre for Agricultural Pest Forecasting]), agricultural producers and crop advisors can decide, with just a few clicks of the mouse from the comfort of their office, whether crops need to be treated for pests!

Developed at the Horticulture Research and Development Centre (HRDC) in Saint-Jean-sur-Richelieu, CIPRA is designed to help producers to more effectively control insects and diseases that affect their crops. Offered free of charge, it provides a user-friendly interface for predicting crop growth and pest development (insects or diseases) based on weather conditions using sophisticated mathematical models. It has provided growers in Quebec, Ontario, Atlantic Canada and British Columbia with key forecasting tools for almost two decades.

The software uses weather observations and forecasts to assess, in real and predictive time, the best time to apply pesticides to crops. For 23 different crops, such as crucifers, potatoes, carrots, strawberries, apples, tomatoes and grapes, there are forecasting models for 35 insect pests, 15 diseases, 24 crop phenologies (developmental stages of a plant), 2 post-harvest physiological disorders, and several other agrometeorological indices.

CIPRA's prediction models benefit growers, the environment and, ultimately, consumers.

- **Producers can improve their bottom lines by waiting for the best possible time to apply pesticides, thus reducing the quantity they have to buy.**
- **The environment is healthier because growers use only what is required to protect their crops, significantly reducing the quantity of pesticides needed for crop productivity.**
- **Consumers find high-quality, Canadian-grown fruits, vegetables and grains on the market.**

Roughly 150 agricultural experts and extension specialists regularly use this software to advise hundreds of Canadian producers. Coinciding with the 100th anniversary of the Horticulture Research and Development Centre, the bioclimatology and modeling research team recently added its 100th bioclimatic model to CIPRA, reinforcing the fact that, over the years CIPRA has become the tool of choice for increased productivity, sustainable development and high quality yields. And all signs are that it will only continue to grow in popularity!

The CIPRA users guide is available on-line :
http://publications.gc.ca/site/eng/442576/publication.html

Partnership Documents Changing Horticultural Pest Situation

A unique partnership between Agriculture and Agri-Food Canada's (AAFC) Pest Management Centre (PMC) and the Canadian Horticultural Council (CHC) is ensuring that AAFC's horticultural crop profiles are regularly updated and that they contain a relevant source of information for users.

Since its inception in 2003, the PMC's Pesticide Risk Reduction Program (PRRP) has produced 30 national crop profiles to provide pesticide regulators, pest management specialists, and stakeholders with timely and high-quality information on crop production and integrated pest management practices, as well as resources available provincially for growers.

The profiles, found on PMC's web pages, document key pest management issues or gaps that should be considered when developing national pesticide risk-reduction strategies. They also provide valuable information for registration of new pesticide products or expansion of existing labels. Other government departments, stakeholders, and commodity organizations also use the profiles.

While the crop profiles bring together information from a number of sources—production data from Statistics Canada, pesticide registration information from the Homologa international pesticide information database, resources from provincial crop specialists—at their heart is first-hand information from growers about the occurrence and treatment of pests affecting their crops.

This information, which provides a snapshot of pests and what growers are doing to treat them in a given growing season, is the most difficult to obtain and can quickly become out-of-date. Ultimately, the success and relevance of these profiles depends on the participation of proactive growers and grower organizations.

The CHC, an umbrella organization of over 150 horticultural organizations in Canada, is closely connected to the representatives of the grower community.

With about two-thirds of the profiles focused on horticultural crops such as vegetables and fruits, the CHC can provide input on 21 horticultural crop profiles and has committed to help update 7 profiles each year.

CHC canvasses its members and provincial crop specialists to collect information about the occurrence of diseases, weeds and insects affecting their crops and the measures being taken to treat them. The PRRP automatically compiles data on a provincial or national basis and generates the final, colour-coded information tables seen in the profiles.

The crop profiles are an important tool for both AAFC and growers. It helps AAFC understand key pest management issues or gaps and focus its research efforts to address these threats to the production systems, manage risks, and maintain a healthy equilibrium between pests and beneficial organisms. Growers use them as tools to decide on integrated pest management strategies and to improve their overall competitiveness.

Tell Us What You Think

Innovation Express is Agriculture and Agri-Food Canada's quarterly newsletter to promote research partnerships and technology transfer to organizations interested in agri-food research and development.

We welcome your comments and suggestions.

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