Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada
Canada

AGRICULTURAL INNOVATIONS

2019

Agricultural Innovations 2019

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TABLE OF CONTENTS

Key Figures
2018–2019

2195
Science and Technology staff

740
Science and Technology Projects

20
Research and Development Centres

30
Satellite Research Locations

1056 science articles published in **429** journals

INTELLECTUAL PROPERTY AND COMMERCIALIZATION

COLLABORATIVE RESEARCH

218 Collaborative Research Agreements executed

278 Material Transfer Agreements executed

331 Total external collaborators

PLANT VARIETIES

17 Plant varieties registered in 2018–19

458 Plant varieties currently grown

PATENTS

30 New Patent/Trademark Applications filed in 2018–19

215 Active patents in **34** countries for **68** technologies

COMMERCIALIZATION

35 Commercialization License Agreements executed

696 Total of active licenses as of May 2019

AAC Brandon: A Superstar Among Wheat

AAC Brandon, a Canada Western Red Spring Wheat (CWRS) developed by Agriculture and Agri-Food Canada (AAFC) and licensed to SeCan in 2012, is continuing to soar in popularity and was selected as the 2018–2019 Seed of the Year. More than 66 percent of Manitoba's CWRS acreage was planted with AAC Brandon in 2019, with the next closest competitor at 8.1 percent of total acreage. This wheat variety is well adapted across Western Canada, but especially suited for the Prairies where short, strong straw and good resistance to Fusarium head blight is desirable.

Canadian Oat Discovery Reaching New Heights

Discovered by AAFC, avenanthramides are naturally occurring oat compounds that soothe itchy skin and reduce redness and inflammation. AAFC developed a malting technology that increases the concentration of avenanthramides in oats. The patented technology was licensed to the Canadian company Ceapro Inc., the only company in the world commercializing avenanthramides for cosmetic, nutraceutical, and therapeutic applications.

RESEARCH AND DEVELOPMENT CENTRES

Protecting Water from Pesticides

Already popular in Europe for their ability to reduce the amount of pesticides entering lakes and rivers, biobeds have now made their debut in Canada thanks to Agriculture and Agri-Food Canada (AAFC) researchers.

A biobed is typically an open tank or a lined pit in the ground filled with a mixture of straw, soil, and peat. This mixture absorbs large amounts of moisture, captures pesticide molecules from the liquids, and provides perfect habitat for microorganisms that can break down the pesticides. This technology is particularly suitable for disposing water used for rinsing pesticide spraying equipment. After spraying a field with pesticides, farmers rinse the sprayer equipment and this rinse water can be trickled onto a biobed for adsorption and biodegradation.

AAFC researchers across Western Canada tested different prototypes of biobeds and found them effective in removing many types of herbicides, fungicides, and insecticides. To optimize this technology for Canada's climate, they added heat tape inside the biobed and modified its design to "winterize" it.

And they are not stopping there — having recently won an award for their biobed research, the team is now customizing the biobeds for use in orchards and vineyards, encouraging further use of this technology to protect Canada's water resources.

AAFC results: a typical biobed removes more than 90 percent of the pesticides from the equipment rinsing water; using two biobeds in a series can remove more than 98 percent of the pesticides.

Lowering the Carbon Footprint of Milk Production

By separating the liquid and solid manure on an Ontario dairy farm, researchers discovered that the total methane emissions from the composter, storage tank, barn floor, and field after manure fertilization could be reduced by 50 percent.

Most dairy cow manure in Canada is untreated and stored as a liquid in tanks where, as it degrades, it produces methane, a potent greenhouse gas.

Research by Agriculture and Agri-Food Canada scientists shows that using an automated system that separates and composts the solid part of manure can significantly reduce methane emissions and lower the carbon footprint of producing milk. Using only the separated liquid part of the manure as fertilizer improves carbon sequestration in the soil compared with using untreated manure. In addition, farmers can reduce the need for importing sand for dairy cow bedding by using the composted manure solids instead.

Even with the electricity needed to operate it, this automated composter-separator still provides overall environmental benefits. That's good news for the climate, considering that manure alone is responsible for 17 percent of greenhouse gas emissions from the agricultural sector in Canada.

Advances in Pain Mitigation for Beef Cattle

AAFC scientists, in collaboration with colleagues from the University of Calgary, have recently raised the standards of animal welfare with an effective pain mitigation strategy for castrating cattle.

Castration is a common but painful procedure that has historically been done without pain medications. However, the newly revised Canadian Code of Practice for the Care and Handling of Beef Cattle now requires that pain control measures are used when castrating calves older than six months.

By studying pain control strategies in calves of various ages, the scientists identified that injecting meloxicam (a medication in the same class as aspirin and ibuprofen) immediately before castration is an effective pain control measure that is easy for farmers to use. The effect of meloxicam can last for almost two days, making it practical for one-time administration. They also confirmed that while castration associated pain increases with calf age, calves can feel pain at any age, and even week old calves can benefit from meloxicam.

Canada is recognized internationally for its scientific leadership in beef cattle welfare, in large part thanks to AAFC's trailblazing and industry-focused research.

Canada's 60,000 beef farms produce approximately 1.3 million tonnes of beef annually.

New Tests to Fight Weeds

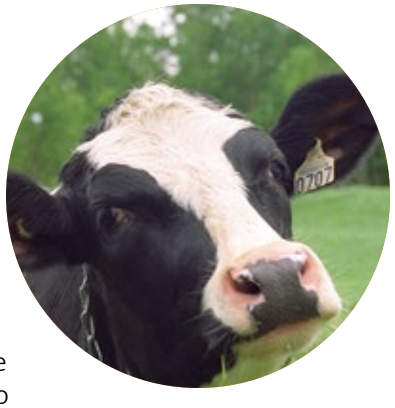
Field vegetable crops generated more than $1.7 billion in farm cash receipts in 2017.

New genetic tests, developed by AAFC scientists, are helping Canadian vegetable growers detect herbicide resistant weeds in their fields much quicker than before. The new tests provide results in only a few days, instead of the traditional six months needed to grow, spray, and evaluate plants in a greenhouse. Thanks to this technological development, growers can use alternative weed control strategies before resistant weeds have a chance to spread within their fields and to adjacent farms.

When the same herbicide is used year after year in the same field, herbicide resistant weeds can emerge. Without a timely strategy for weed control, these weeds can spread quickly causing crop yield losses. Herbicide resistant weeds can also increase the costs of production by forcing growers to implement supplementary weed control strategies, such as additional herbicide applications and hiring workers to manually remove weeds.

The new tests have already been shared with the provincial pest diagnostic lab in Quebec, which regularly processes weed samples from both Quebec and Ontario, enabling experts to recommend alternative strategies to growers for weed control within the same growing season.

Diet Good for Cows and Environment



AAFC scientists have found a new way to further increase productivity while decreasing the environmental footprint of the Canadian dairy sector. For years, AAFC scientists have been studying different ways to increase the energy content of forages fed to dairy cows, finding that improved sugar content in forages can increase milk production by up to eight percent.

What they now found is that when a high concentration of soluble sugars in forages is combined with a low crude protein concentration, it improves nutrient use by dairy cows and might eventually decrease greenhouse gas emissions. It all rests on the type of forage the cows are fed and the harvest timing. Forages harvested at first cut have a greater ratio of soluble sugars to crude protein than those harvested from subsequent cuts. Also, alfalfa-grass mixtures have greater soluble sugar to crude protein ratios than pure alfalfa and the ratio increases with more grasses in the mixture. Alfalfa mixtures with festulolium grass or perennial ryegrass have the highest ratios of soluble sugars to crude protein, but these two grass species do not always survive well in eastern Canada. Alternatives to these two species are meadow fescue and tall fescue.

This information will help milk producers make informed decisions about forage species, mixtures, and how to better use the first cut forages in their cows' ration. And by reducing the use of concentrates and corn silage to supplement forages in a cow's diet, dairy farms will also save money.

Canada's 10,593 dairy farms generated $6.6 billion in farm cash receipts in 2018. Dairy is one of the largest agricultural sectors in Canada, annually contributing roughly $20 billion to our gross domestic product (GDP).

Canada is the seventh largest pork producer in the world, representing approximately two percent of global production.

Measuring Fat Composition in Pork

Canadian pork exporters could soon have a new tool to help them deliver high quality products to markets around the world.

AAFC researchers recently tested a portable (hand-held) device that uses near-infrared spectroscopy to scan the carcass and quickly estimate pig fat composition, meaning the amount of saturated, polyunsaturated, and unsaturated fat. The quality of fat in pork affects the meat's structure, taste, processing, and shelf life, all of which impact pork's export value, estimated at more than $4 billion in 2017.

The new device provides a quick analysis by scanning the inner layer of fat on a split carcass without further processing of the fat. This would help sort and market carcasses based on fat composition faster than with current methods which are expensive, time consuming, and require a high level of technical expertise. The research also showed that portable near-infrared spectroscopy can classify pork bellies based on softness, which negatively affects bacon quality.

AGRICULTURE AND A

AAFC Supports agricultural science through department-led research an

AAFC scientists work with industry, provinces, territories, and academia to:

- Increase agricultural **productivity**.
- Enhance **environmental performance**.
- Improve **attributes** for food and non-food uses.
- Address the **threats** to the value chain.

IN THE AREAS OF:


Agri-Food


Agro-Ecosystem Resilience


Cereals & Pulses


Dairy, Pork, Poultry & other Livestock


Forages & Beef


Clean Technologies


Horticulture


Oilseeds


Biodiversity & Bioresources

AGRI-FOOD CANADA

d investments in industry-led research

$557 million in 2018–2019 Supports innovation, competitiveness, trade and sustainability of agriculture and agri-food sector in Canada through:

Research by AAFC scientists such as:

- **Genomics Research and Development Initiative** which aims to improve crop quality, disease resistance, and nutrient use efficiency; and protect animal and plant health, and food safety.
- **Living Laboratories Initiative** which brings farmers, scientists, and other partners together to co-develop, test, and monitor solutions to agri-environmental challenges in a real-life context.

Industry-led research and innovation projects and initiatives such as:

- **AgriScience Clusters** which accelerate the pace of innovation by funding and supporting pre-commercial science activities and cutting-edge research that benefits the agriculture and agri-food sector and Canadians.
- **AgriScience Projects** which support specific shorter-term research activities to help industry overcome challenges and address fiscal barriers experienced by small and emerging sectors.

Canada's Agriculture and Agri-Food Sector:

- Core driver of Canadian economy.
- Generates over $116 billion of Canada’s gross domestic product.
- Employs approximately 2.3 million Canadians.

Agriculture and Agri-Food Canada (AAFC)

Studying Antimicrobial Resistance

Antibiotics are crucial for treating a wide range of infections in both humans and animals, but their overuse can lead to bacteria becoming resistant which can severely hinder the effectiveness of these drugs. Through the Genomics Research and Development Initiative on Antimicrobial Resistance (GRDI-AMR), AAFC scientists are working with their federal colleagues from the Public Health Agency of Canada, Health Canada, the Canadian Food Inspection Agency, and the National Research Council to better understand how livestock and food production systems contribute to antimicrobial resistance.

The team is using recently developed genomics tools including machine learning to analyze a large amount of DNA from resistant bacteria. So far, they have identified a specific plasmid—a small, mobile DNA molecule within bacteria—that confers antimicrobial resistance to the *Salmonella* Heidelberg found in chicken, retail poultry, and human clinical cases in Quebec. This finding illuminates how resistance genes could jump from bacteria in poultry to bacteria in humans. As a result, the team analyzed *Salmonella* isolates from commercial chicken farms and prioritized certain antimicrobial resistance genes for monitoring.

The team also looked at *Enterococcus* bacteria and found that, when certain antimicrobials are added to feed, resistant strains can potentially contaminate the soil when poultry litter is applied to farm land. On a more positive note, the team discovered that *Enterococcus* bacteria clearly differ between humans and cattle, suggesting that cattle are an unlikely source of *Enterococcus* transmission to people.

As the GRDI-AMR work continues into future years, using new and evolving genomics tools will enhance Canada's ability to detect and monitor resistant bacteria throughout the food chain and help scientists understand where interventions can best mitigate antimicrobial resistance development.

In 2018, lengthier hospital stays, longer courses of treatment, and other expenses attributable to antimicrobial resistance cost the Canadian health care system about $1.4 billion.

Sweeter Market for Canadian Apples

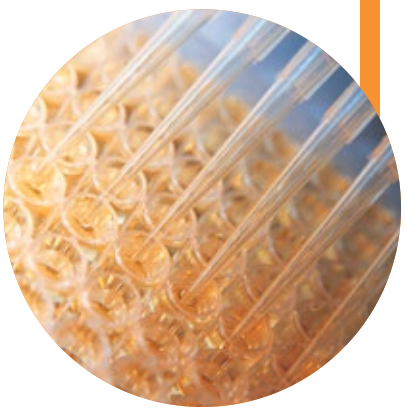
Broken Ladder cider is a great example of AAFC scientists and industry working together to find solutions for challenges facing the agricultural sector in Canada. During the last decade, Canadian apple growers have struggled with increasing production costs and environmental pressures, leading to a decline in their market share. Dessert apples in particular were providing low returns and were sometimes being discarded.

In response, AAFC scientists teamed up with BC Tree Fruits, to find out if dessert apples, rather than traditional cider apples, could produce high quality hard cider. Without adding sugar, water, or artificial flavours and colourings, the AAFC team evaluated several apple cultivars in various combinations and under different fermentation conditions, blending and balancing the apples and conditions to develop the now highly successful product: Broken Ladder cider. This research prompted BC Tree Fruits to invest in an apple cider processing facility in Kelowna, British Columbia, and to commercialize Broken Ladder, bringing it to market in the summer of 2015 (just one year after completing a six-month project with AAFC).

BC Tree Fruits has expanded the cider's flavour options and sells about $1.5 million worth of Broken Ladder cider a year. This research collaboration has helped increase the resiliency of Canada's apple industry by accessing a new market for dessert apples and by creating jobs in the processing sector.

Apples represent 20 percent of the total farm gate value for fruit in Canada, reported at $232 million in 2018.

Canada is an international leader in oat research and is one of the largest exporters of oats in the world. Oats had an annual farm gate value of $497 million in 2018.



Finding the Resistance Within

Collaborating with scientists from across the US, researchers from AAFC mapped key genes in oat plants — research that will help farmers protect their yields by planting varieties that are genetically resistant to crown rust, the most serious fungal disease of oats in North America.

The research team's comprehensive genetic study of resistance to crown rust disease in oats involved examining nearly 3000 genetic markers in more than 600 diverse varieties of oat. Oat plants were infected with specific fungal strains of crown rust, and the scientists observed how well they could resist developing disease both in field and greenhouse conditions.

The team found 29 markers (on 12 of the 42 oat chromosomes) that predicted how the plant would react to crown rust infections. While some of these predictions confirmed previous work, approximately one third were newly discovered genetic sources of crown rust resistance, and all can be used to select disease-resistant varieties for oat breeding. Providing farmers with varieties that are genetically resistant to crown rust is currently the best line of defence against this disease.

Agriculture and Agri-Food Canada (AAFC)

Not Your Grandmother's Frozen Peas

AAFC scientists, in collaboration with industry partners, successfully developed a new process that better preserves the texture and flavour of frozen vegetables. They adapted a technology using a vacuum-microwave process to partially dry vegetables before freezing them. The new process removes some of the water (15–30 percent) from the vegetables just before freezing. This prevents them from turning mushy when they are thawed and even improves flavour by concentrating the natural sugars of the vegetables.

The AAFC team worked with Bonduelle Amérique to validate the new process on red peppers, onions, and zucchini—vegetables that typically suffer damage when frozen. In terms of food safety, it is comparable with the conventional method of blanching (quick heating) vegetables before freezing. But while blanching works well to reduce freezer burn and to prevent unpleasant flavours, it can also destroy some of the vitamins or nutrients. Also, freezing blanched vegetables causes some of the tissue to break down, mainly due to the water content, and the thawing results in a mushy texture for certain vegetables.

While this new process could initially be more expensive than conventional blanching, it can produce a tastier product with an overall better quality. This may increase consumer demand and lead to more opportunities for new frozen food products, reduced food waste, and expanded markets, which is good news for producers and consumers alike.

Revenue from Canada's frozen food manufacturing industry was more than $4 billion in 2016.

© Bonduelle 2019

Shining a Light on Clubroot in Canola

Canola plays an important role in the Canadian economy, with approximately 20 million tonnes produced and farm cash receipts worth over $9 billion in 2018.

AAFC scientists recently made great strides in detecting clubroot disease in canola. This disease can kill the crop, inflicting up to 100 percent yield losses in heavily infested fields, and there is currently no way to remove the disease once it enters a field. That is why AAFC scientists are working with industry and academic partners to understand the disease, prevent its spread, and develop ways to manage it.

Clubroot disease is spread by spores, which can survive in the soil for many years before developing into parasites. Not all of the spores in soil are able to cause infections, but the standard clubroot test does not distinguish between infectious and inactive spores. The AAFC team discovered that by shining a bright light on spores pre-treated with a chemical, they could distinguish between infectious and inactive spores.

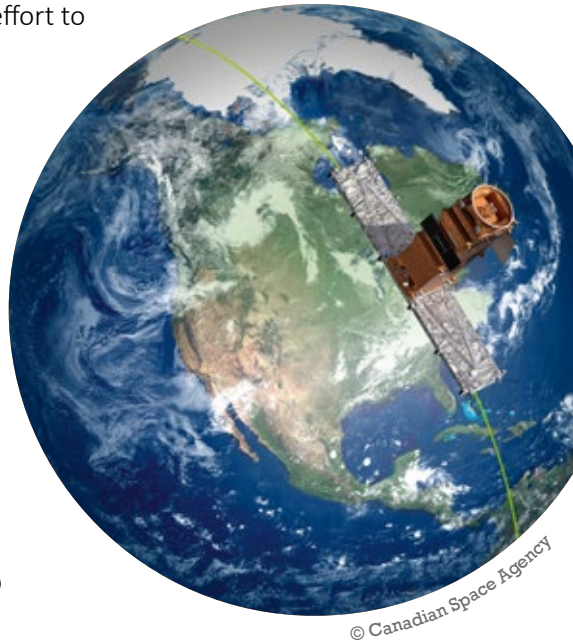
This improved detection method is being used to further examine spores in soil to help farmers make informed decisions about what to grow on lightly infested fields. This test will also help scientists measure how effective new methods are in managing clubroot disease.

Satellites and Teamwork Combat Food Insecurity

International cooperation is key to addressing major challenges, such as global food insecurity. That is why AAFC scientists are leading an ambitious international effort to use satellites for mapping crops and estimating crop productivity.

The project is called the Synthetic Aperture Radar (SAR) Inter-Comparison Experiment. Funded in part by AAFC and the Canadian Space Agency, and conducted under the umbrella of the G20 Joint Experiment for Crop Assessment and Monitoring (JECAM) network, this project brings together scientists from around the world to develop methods and best practices to monitor crops from space. Satellites equipped with the latest radar and optical technologies orbit the earth and collect data. These data are then used in models to determine the location, type, and productivity of crops. Meanwhile, ground teams throughout the world are taking field measurements and sending that information to AAFC researchers who process it alongside satellite measurements.

The scientists involved in this experiment share their data to build new and robust methods that will provide better monitoring and earlier forecasting of problems such as crop diseases and low harvests. This information will help policy-makers and producers improve agricultural planning around the world. This experiment will also build the foundation for future collaborations and technology transfer.



Using Satellites to Assess the Risk of Canola Diseases

Sclerotinia is one of the most important diseases affecting Canadian canola. In 2010, Western Canada canola growers lost $600 million to this disease.

AAFC scientists have turned to satellite images to help battle a devastating fungal disease that can cause up to 50 percent yield loss in canola. Sclerotinia stem rot can develop if soils are wet for long periods when canola is flowering. In partnership with A.U.G Signals Ltd. and Environment and Climate Change Canada, the science team developed a new method to estimate crop growth stages and soil wetness—information valuable in designing strategies to reduce the impact of this disease.

The new method uses satellite data to accurately predict the date of flowering for canola plants, which is the ideal time for fungicide application. The method also identifies persistently wet soils and determines whether canola had been previously planted in the field (spores from the disease can survive over the winter). Maps of these risk factors are then integrated into a geospatial tool (developed by Lim Geomatics) which classifies the risk of sclerotinia disease, at field scales.

The AAFC team is considering expanding this tool for use on other crops and will adapt this method for use with Canada's new RADARSAT Constellation Mission satellites, which launched into space in June 2019.

The Diversity of Arthropods in Canada

AAFC's Canadian National Collection of Insects, Arachnids and Nematodes in Ottawa played a key role in the validation of species records and prediction of unrecorded species. The collection is one of the five largest of its kind in the world and contains over 17 million specimens.

Arthropods, which include insects, mites, spiders, centipedes, and marine relatives such as lobsters, are the most numerous and diverse group of animals on Earth. Documenting their biodiversity enables us to detect and respond to new invasive pests and species that spread disease, and to utilize beneficial species for the biological control of pests and for ecosystem services (e.g., pollination and regulation of soil and water quality).

That is why scientists from AAFC, other federal government departments, and the Biodiversity Institute of Ontario, recently published the first component of the *Biota of Canada: The Terrestrial Arthropods*—the culmination of a massive undertaking to document the arthropods in Canada, summarize knowledge about them, and identify gaps for future research. Published in a special issue of the journal *ZooKeys*, seven of the 29 articles were written by AAFC scientists, including all the most agriculturally important groups except spiders. Each article provides an overview of the state of taxonomic knowledge on a group of arthropods (beetles, flies, true bugs, thrips, bees and wasps, butterflies and moths, mites) in Canada.

Key facts:

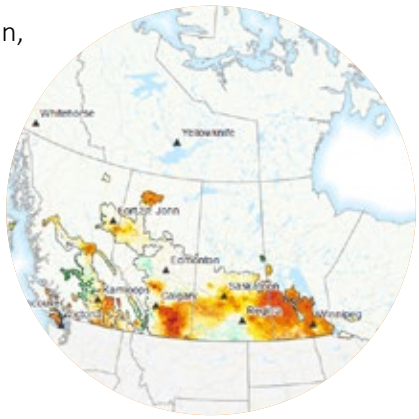
- More than 44,000 named species of terrestrial and freshwater arthropods are recorded in Canada.
- The number of recorded species corresponds to 50–60 percent of the total number of species estimated to be present in Canada based on compiled expert estimates, which means that 27,000 to 43,000 species remain unrecorded.
- As many as 11,250 species are newly recorded in Canada since the last assessment in 1979.
- At least five percent of the known species in Canada are non-native; among these are important pests of agriculture, forestry, and natural ecosystems.
- Populations of many species have declined (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services [IPBES], 2019) and 50 species in Canada are now designated as "at risk" (*Species at Risk Act*, Committee on the Status of Endangered Wildlife in Canada).

Link to special issue: https://zookeys.pensoft.net/issue/1251

Monitoring Agricultural Drought in Canada

Increased drought is one of the biggest challenges that climate change will bring to agriculture, but AAFC science teams are making use of new technological advancements to improve drought monitoring.

Over the past several years, AAFC has worked with American scientists at the National Drought Mitigation Center (NDMC), the University of Nebraska–Lincoln, and the United States (U.S.) Geological Survey Earth Resources Observation and Science Center to determine if the Vegetation Drought Response Index, or VegDRI, could be adapted for Canada. VegDRI is a hybrid drought monitoring and mapping tool which has been operational in the U.S. since 2009. VegDRI integrates satellite observations of vegetation status, climate data, information on land cover, soil, and other environmental factors, to better understand the specific effects of drought on vegetation and plant growth.



Working together over the past two years, the joint team created a Canadian version of this tool, and using 15 years of historical climate and satellite data, they have demonstrated that VegDRI-Canada can successfully identify agricultural drought in Canada. VegDRI is a high resolution data set and it will help identify drought severity and the impact on vegetation growth and agricultural productivity on a seasonal basis. The tool is currently in final testing to ensure it is ready to use in Canada for the 2020 agricultural season.

Predicting Extreme Weather

The new VegDRI tool and Extreme Weather Indices are found on the Drought Watch website www.agr.gc.ca/drought

Producers now have a new set of forecast tools to help them assess the risks of extreme weather. The Extreme Weather Indices are a suite of interactive maps showing short-term forecasts conditions throughout the agricultural season. Developed by Agriculture and Agri-Food Canada (AAFC) and Environment and Climate Change Canada (ECCC), they are a result of nearly a decade of scientific collaboration.

What makes these indices different from other weather prediction tools is that the information is specifically tailored to agriculture. The website's interactive nature enables users to zero in on particular parameters and a geographic region. The maps not only show where the extreme weather is forecast, but also the magnitude and the probability of its occurrence. Users can choose to view and explore maps from categories such as temperature, heat, wind, and precipitation prediction up to a month ahead.

The AAFC and ECCC science teams developed the indices by sharing climate data and working with high performance computers, complex models, and large datasets. It was a big undertaking and serves as an example of the positive results that can come about when scientists from different government departments collaborate.

Virus-resistant Potatoes: Now Available in Days, not Weeks

AAFC researchers are helping protect the Canadian potato industry from viruses PVX and PVY, that can reduce yields by as much as 90 percent. The best and most cost effective way to outsmart these two viruses is to grow potato varieties that are resistant to them.

Traditionally, screening for virus resistance in plants is a labour-intensive and expensive process. It can take up to three months to grow plants in a greenhouse, infect them with the virus, wait for symptoms to develop, and then examine them in a laboratory to detect the virus. Today, many breeding programs are relying on more efficient processes of extracting and analyzing plant DNA in a laboratory, but this method can still take weeks.

To speed things up, AAFC researchers looked to a method used by some other breeding programs, called high-resolution melting DNA analysis, where a machine analyzes the multiplied DNA fragment within minutes, cutting the entire screening process down to two to three days. They succeeded in customizing and perfecting this much more efficient process so it can be used to select genetic material to grow new potato varieties that will be extremely resistant to PVY and PVX.

Canadian potato production has an average annual farm gate value of $1.1 billion. Prince Edward Island leads production followed by Manitoba and Alberta.

3D Technology Uncovers Parasite Behaviour

An AAFC scientist, in conjunction with others from around the world, made a breakthrough discovery in studying a parasite that attacks ants but that also, when ingested by cattle and sheep, causes liver diseases that are difficult to diagnose and treat. The parasite, *Dicrocoelium dendriticum* causes ants to become attached to vegetation which are then ingested by farm animals. Until recently, it was unknown how the parasite influenced the ants' behaviour, partly because there were no effective visual tools to inspect the ant.

Now, for the first time, AAFC scientists are able to see that *D. dendriticum* is manipulating the ant's behaviour through a visual scan of the ant's brain. Using modern micro-computed tomography (micro-CT) scanning, the scientists created virtual 3D models of the infected ants. This enabled them to see the precise location of the parasite in the ant's brain—a portion that controls the ant's jaw muscles, forcing the ant's mouth to close and attach to the plant.

This crucial discovery will guide scientists in understanding how the parasite works and how they can alter its destructive behaviour, which is good news for Canadian cattle and sheep producers who pay the price of treating infected animals.

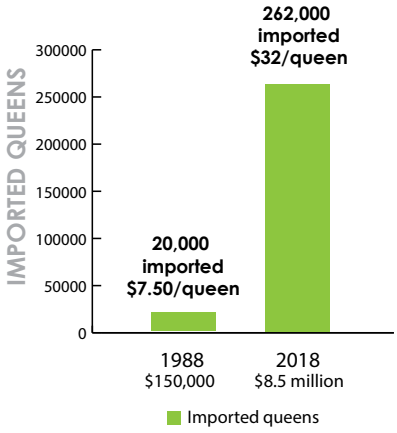
Canadian Honey Queen Bees

In recent surveys, Canadian beekeepers reported poor queen health as a leading cause of colony mortality during the 2014 to 2018 seasons. To better understand the situation, scientists from AAFC, provincial governments, and academia involved in the Bee'Omics research project, along with stakeholders, recently consolidated bee breeding and beekeeping information in the *Canadian Honey Bee Queen Breeders Reference Guide.*

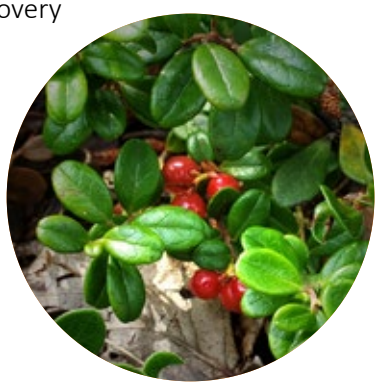
The guide provides an overview of Canada's current queen bee industry, as well as challenges and potential solutions. For example, each spring Canadian beekeepers purchase queens to replace lost colonies—but in the last 20 years have increasingly relied on imported stock. This practice has become more expensive and comes with the risk of introducing new diseases, undesirable genetics and introducing bees poorly adapted to Canada's northern climate.

Given these challenges, Canadian scientists believe that our domestic queen sector needs to be strengthened, and in this guide provide twelve recommendations and next steps to help Canada achieve a more self-sustainable queen industry.

In 1988, Canadian beekeepers imported about 20,000 queens worth $150,000 (averaging $7.50/queen). In 2018, this number increased to 262,000 queens per year, at a cost of $8.5 million (averaging $32/queen).



Lingonberry Juice May Help Kidneys Heal



Researchers from AAFC recently found that lingonberry juice could help kidney recovery after surgery. Lingonberries are tart, red berries that grow wild in northern Canada and have many compounds that function as antioxidants. These antioxidants are showing promising health benefits, especially for their role in preventing inflammation.

During kidney transplant and some other major surgeries, the oxygen and nutrient supply to the kidneys is cut off for a length of time and then suddenly restored at the completion of surgery. The rush of oxygen and nutrients into the kidney after surgery is traumatic and triggers an inflammatory response which can cause cell injury. However, scientists found that drinking lingonberry juice can protect against this inflammatory response.

AAFC research on experimental mice showed that drinking lingonberry juice for three weeks prior to kidney surgery significantly decreased kidney inflammation following the surgery. Although more testing is needed to include human clinical trials, these results are promising for patients scheduled to have surgery, because drinking juice is an easy way to potentially improve kidney recovery. Kidney damage is one of the most common complications following surgery, compromising survival rates for many patients worldwide.

The health benefits of consuming this berry may increase the value of this crop and open up new opportunities for Canadian growers.

New Way to Fight an Old Foe — Wheat Leaf Rust

Combining AAFC's long-term annual monitoring of major cereal diseases, such as leaf rust, across Canada with advanced genetic tools is crucial to help Canada's wheat producers avoid catastrophic losses.

Wheat, Canada's largest crop with a gross farm-gate value of approximately $7 billion annually, can suffer yield losses of up to 40 percent when infected with wheat leaf rust. Developing new wheat varieties that are more resistant to this fungal disease effectively prevents yield losses. Over the years, significant progress has been made in developing new wheat varieties containing different genes resistant to leaf rust. However, leaf rust can quickly adapt, overcoming the plant's resistance and infecting the new variety.

To solve this problem, AAFC scientists are using a multidisciplinary approach, including advanced genetic research tools to determine common strains of leaf rust and to test if the strains are adapting and overcoming the resistant genes used in common wheat varieties today.

AAFC scientists, who in fact have discovered the majority of all known rust resistant genes in the world and have used them to develop new resistant wheat varieties, recently found that some strains of the disease are adapting to *Lr21*, a resistant gene that is currently used in many Canadian wheat varieties.

Although the adapted strains are found in low levels, this discovery gives wheat breeders an early warning about which specific resistant genes are becoming ineffective. This allows them to adapt their breeding strategy and develop new varieties that include different, more effective resistant genes.