AGRICULTURAL INNOVATIONS

2018

Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada
Canada

2018 Agricultural Innovations

Catalogue No. A1-33E-PDF | ISSN 2562-0606 | AAFC No. 12860E
Paru également en français sous le titre, *Innovations en agriculture 2018*
For more information, reach us at www.agr.gc.ca or call us toll-free at 1-855-773-0241.


CASE IH

TABLE OF CONTENTS

Click on name titles to bring you to the story

Introduction	6
Key Figures 2017–2018	7
Intellectual Property and Commercialization	8
Research and Development Centres	9
Growing More with Less	10
More Resilient Alfalfa	10
Using Genomics to Improve Beef Herds	11
Dandelion’s Natural Enemy	11
Cutting Dairy Cow Feed Costs	12
Biotop Containers for Productive Plants	12
Intelligent Nano-Fertilizer	13
Fresher Broccoli	14
Canadienne Cow Cheese	14
Named for Canada's 150th Birthday	15
Understanding Our Soil	15
Setting the Trap for Wireworms	16
Pulse Starches Make Healthy Food Products	17
Precision Agriculture Increases Potato Production	18
Potatoes that Repel Beetles	18
The Science of a Better Pork Chop	19
Protective Viruses in Cheese Production	19
Disease Resistance Discovery in Honey Bees	20
New Biocontrol for Cabbage Loopers	20

For over **130** years Agriculture and Agri-Food Canada (AAFC) scientists have helped build a

strong, healthy, and innovative agricultural sector

INDUSTRY → UNIVERSITIES → PROVINCIAL & FEDERAL GOVERNMENT

to build a robust agricultural environment. AAFC has an integrated national network of 20 research and development centres and 30 satellite research locations across the country, with a strong regional focus.

The work is guided by Sector Strategies in the areas of:

- **Agri-food**
- **Agro-Ecosystem Resilience**
- **Cereals and Pulses**
- **Dairy, Pork, Poultry and other Livestock**
- **Forages and Beef**
- **Horticulture**
- **Oilseeds**
- **Biodiversity and Bioresources**
- **Clean Technologies**

The goal of all activities is to address the major scientific challenges facing 21st century agricultural production systems:

- Increasing agricultural productivity,
- Enhancing environmental performance,
- Improving attributes for food and non-food uses,
- Addressing threats to the agriculture and agri-food value chain.

This publication highlights some of our current scientific accomplishments and shows how they benefit the agriculture and agri-food sector and Canadian economy.

Back to table of contents

Key Figures 2017–2018

2197
Science and Technology staff

814
Science and Technology Projects

20
Research and Development Centres

30
Satellite Research locations

$247 M
2017–18 Science and Technology Branch Budget

$259 M
2018–19 Science and Technology Branch Budget

Back to table of contents

INTELLECTUAL PROPERTY AND COMMERCIALIZATION

COLLABORATIVE RESEARCH AGREEMENTS 2017–18

152 Collaborative Research Agreements executed

212 Material Transfer Agreements executed

270 Total of external collaborators who executed Research Agreements

PLANT VARIETIES

28 Registered in 2017–18

445 Developed by AAFC are currently being grown in Canada

PATENTS

14 Applications filed in 2017–18

211 Active patents in **37** countries for **57** technologies

COMMERCIALIZATION 2017–18

7 Business Opportunities developed

8 Invention Disclosures assessed for their commercial potential

27 Commercialization License Agreements executed

650 Total of active licenses as of July 2018

Back to table of contents

RESEARCH AND DEVELOPMENT CENTRES

Back to table of contents

Growing More with Less

Low levels of sunlight during winters in Canada have many growers using artificial lighting in their greenhouses. Thanks to research conducted at Agriculture and Agri-Food Canada, greenhouse growers can now further increase their yields and cut operating costs by using fewer fixtures to deliver low intensity lighting for longer each day.

Plants, like humans, have a daily rhythm including the need to sleep, which determines how long plants should be exposed to light. Results of recent research showed that by temporarily dropping the greenhouse temperature and turning off the lights 0.5 to 1 hour before sunset and turning them back on around 10 p.m., or earlier in winter, can partially overcome the plant's daily rhythm and extend the light exposure to 19 to 21 hours per day without injuring the plant. Using this new dynamic temperature system minimized the leaf injury on tomato and sweet peppers, and increased yield on all three main greenhouse fruiting vegetables—tomatoes, sweet peppers, and cucumbers.

In addition, the new system requires fewer light fixtures and helps save energy and money during the cold winter months by avoiding heating and lighting during "peak" energy times when pricing is at a premium.

The Greenhouse vegetable industry is an important and fast growing segment of Canadian agriculture with sales of **$1.4 billion** in 2017.

More Resilient Alfalfa

In 2019, farmers will be able to grow a recently commercialized new alfalfa cultivar, developed at Agriculture and Agri-Food Canada. The new cultivar will help farmers grow stronger, higher quality, and more resilient alfalfa that can withstand extended periods of dryness, wetness, or flooding.

In addition to having deep roots that help it tolerate droughts, this new cultivar (CRS-1001), has the ability to develop extensive roots from the main plant that will develop into new plants. If the main plant dies, the ones that spread from it will grow and fill the space, which helps the crop survive in wet conditions. Under flooding trials, the new cultivar also had a 50 percent survival rate compared to an 8 percent survival rate by AC Caribou, a commonly grown cultivar.

This hardiness benefits farmers economically in the long run while also providing better quality hay, silage, and forage for animal grazing.

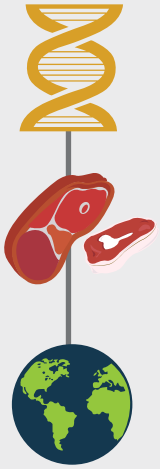
Back to table of contents

Using Genomics to Improve Beef Herds

Cattle producers continually improve their herds by selecting bulls and heifers with desired traits to breed the next generation. This is traditionally done by accessing pedigree records and/or by measuring the desired traits (such as feed efficiency and meat quality), which can be costly and time consuming. That is why Agriculture and Agri-Food Canada scientists and their colleagues at the Livestock Gentec, University of Alberta, and Alberta Agriculture and Forestry have developed a method that uses the cattle's DNA to predict an animal's genetic merit.

Because DNA analysis can be done right after birth, cattle producers are now able to select animals with the best genetic traits much earlier than by using traditional methods. This will be invaluable for producers without access to information from a breed association or the capacity to measure various traits. For example, providing producers with early information on feed efficiency traits of the animals could help reduce feeding costs, improve beef quality, and help mitigate the environmental footprint of beef production by reducing methane and greenhouse gas emissions (i.e., cows with good feed efficiency that require less food also produce less methane gas).

Canadian beef and veal exports valued at **$2.41 billion** in 2017.



Beef producers can already try the genomic prediction method at: **www.beefgenomicprediction.ca**, while scientists are further refining it and preparing it for wide adoption by the industry.

Dandelion's Natural Enemy

Besides being an annoyance when infesting our lawns and greenspaces, dandelions are a significant problem to the turfgrass and horticulture industries, and their spread can reduce grain and forage yields, impacting the profitability of our farmers. The herbicides available on the market today are often considered as environmental pollutants, and their use in public spaces is increasingly restricted.

That is why a team of scientists from Agriculture and Agri-Food Canada developed a bioherbicide based on a naturally occurring soil fungus which destroys dandelions. The fungus enters the roots and grows towards the plant's vascular system causing the plant to die. The scientists isolated and purified the fungus from plants so it will not harm susceptible crops if grown one year after application as the fungus is not persistent in the soil. A multinational company has recently obtained a licence to bring this new bioherbicide to market.

Back to table of contents

Cutting Dairy Cow Feed Costs

Thanks to the work of scientists at Agriculture and Agri-Food Canada, dairy farmers could now save about $0.15 per cow per day, which amounts to almost $4,000 per year for an average farm, by reducing protein—the most expensive component—in their cow rations.

The scientists have established the right quantity of essential amino acids needed in cows' feed that enables the cows to more effectively use the protein they consume. When fed these balanced rations, the cows consume less crude protein but produce the same amount of milk and milk protein as before.

In addition, reducing the crude protein in rations noticeably reduces the amount of nitrogen emitted by cows in their manure and especially in their urine, the most volatile source. Because nitrogen contributes to the production of nitrous oxide, to the formation of fine atmospheric particles, and to groundwater pollution, this new approach offers a means of reducing this pollutant in the environment.

This improved feed formula would enable Canadian dairy producers to cut nitrogen emissions by **17,000 tons** a year and save **$77.5 million annually** in feed costs.

Biotop Containers for Productive Plants

© Lise Lapointe for Biotop Canada inc. [2018]

A unique gardening system, developed by Agriculture and Agri-Food Canada and industry partners, is enabling hotels and restaurants across Canada to grow their own fresh herbs and vegetables.

This system, called Biotop, includes a specially designed container and a highly productive soil mix. The design of the container maximizes implantation efficiency and supports best plant growth by allowing for watering or adding nutrients at the bottom of the container. The highly productive soil mix contains beneficial nitrogen-fixing bacteria, plant growth-promoting rhizobacteria, and beneficial fungus–all of which are known to encourage root growth. Using the Biotop system to grow herbs and vegetables is two to three times more water efficient and two times more productive than growing them in a field.

Biotop might also be providing a solution to the increasing demand to grow fresh vegetables and herbs in areas that may not have ideal growing conditions, such as northern locations, urban gardens, and rooftops. The company that has obtained the commercial licence for this system is building specialty greenhouses complete with specialized lighting, a kitchen, and a boutique to showcase the containers and promote food-growing self-sufficiency, for example in Northern communities where fresh food is more expensive.

Back to table of contents

Intelligent Nano-Fertilizer

It is estimated that every year Canadian farmers apply $1 billion worth of nitrogen fertilizer that is not absorbed by crops. Instead, much of this fertilizer gets washed away or escapes into the atmosphere. Results of recent research by Agriculture and Agri-Food Canada scientists, in collaboration with academic and industry partners, could help solve this problem by developing a fertilizer that only releases nitrogen when plants signal that they need it.

The researchers identified that crop roots, such as wheat and canola, release chemical signals when they need nitrogen, and so the researchers programmed the coating of special biodegradable fertilizer capsules with biosensors. The capsules prevent the loss of fertilizer while the biosensors ensure that the nutrients are released for uptake according to crop demand during growth.

Testing is currently underway in the laboratory and greenhouse settings to see how well the fertilizer performs with real soil and plants. If everything goes well, farmers could be buying smart fertilizer before the end of this decade.

A more efficient and cost-effective fertilizer can play a leading role in increasing crop productivity, addressing malnutrition issues, as well as reducing the amount of fertilizer needed and preventing adverse environmental impacts.

Commercial fertilizers were applied to **70.4 million** acres across Canada in 2016. These products could boost fertilizer nitrogen use efficiency rates to 85% from current 30 to 50%.

That translates into **significant savings for farmers.**

Back to table of contents

Fresher Broccoli

Farm gate value of **$59.89 million in 2017**.

Fresh broccoli is highly perishable so maintaining its freshness and nutritional value while transporting it from the field to grocery stores is challenging. This is why scientists at Agriculture and Agri-Food Canada have developed a new technology to preserve health-promoting values of fresh broccoli.

Scientists noted that treating broccoli with moist hot air slowed deterioration and yellowing and extended its shelf life. Heat treatment of 41 degrees Celsius for three hours delayed yellowing for a full week by slowing down the loss of the green pigment chlorophyll. The treatment increased expression of genes that regulate concentrations of hydroxy-cinnamic acids, some glucosinolates, as well as total antioxidant capacity of florets therefore boosting these health-promoting ingredients.

This treatment has the potential to enhance the healthful properties of fresh broccoli while extending its market life, which will benefit both producers and consumers.

Canadienne Cow Cheese

Canadian dairy producers and processors now have one more new and unique product—"Canadienne Cow Cheese"—to set them apart from their global competition, and it is in large part due to the work of scientists at Agriculture and Agri-Food Canada (AAFC).

This cheese is made from the milk of the Canadienne cow, the oldest breed of dairy cow in North America. The breed descended directly from cattle imported from France that proved hardy enough to survive the harsh Canadian conditions.

Research by AAFC scientists, in collaboration with their colleagues from Laval University, showed that milk from Canadienne cows contains higher levels of protein, fat, and minerals (calcium), and that it takes longer to coagulate (the first step in cheesemaking) than the milk of any other breed. These properties have a profound impact on the appearance and texture of cheese. Today, there are several kinds of Canadienne Cow Cheese on the market, including the award-winning Pied-de-Vent.

This research helped obtain the trademark for Canadienne Cow Cheese, which is helping producers guarantee the authenticity of their unique food products, better distinguish them in the global marketplace, and further support the expansion of Canadian cheese exports.

Canadian cheese exports brought in over **$67 million in 2017**.

© Mario Duchesne for Association de mise en valeur des bovins de race Canadienne dans Charlevoix. [2018]

Back to table of contents

Named for Canada's 150th Birthday

Healthy soil, essential for producing good yields and protecting plants against pests, is home to beneficial organisms which help plants thrive. Agriculture and Agri-Food Canada scientists have recently isolated one such beneficial organism, a bacterium that can fight fungal pathogens. To celebrate the discovery, and in honour of the 150th anniversary of Confederation in 2017, this novel species has been named *Pseudomonas canadensis*.

Members of the bacterial group known as the fluorescent pseudomonads are uniquely capable of producing many substances that help maintain soil health by protecting crops against fungal diseases. Various species of *Pseudomonas* can be found in all agricultural soils and are well adapted to grow in the rhizosphere, the immediate region of soil closest to plant roots. The species are of significant agricultural and environmental importance because they promote plant growth, degrade polluting foreign chemical substances, and prevent pests and disease.

This new bacterium could be used, in the future, as an alternative to chemical fungicides, thus improving soil health and crop yields in a sustainable manner.

Understanding Our Soil

Analyzing and better understanding agricultural soil's properties is key to preserving its long-term sustainability and productivity. Agriculture and Agri-Food Canada (AAFC) scientists have developed a rapid, cost efficient new method for measuring key soil properties, such as soil texture and mineral content.

The visible near infrared reflectance spectroscopy (VNIRS) is a tool that uses a light source to detect information about organic materials—typically in plant and grain samples. When the light is directed toward the sample, the resulting reflectance spectrum produces a characteristic shape that can be analyzed.

The scientists also collected diverse soil samples from across Canada and created VNIRS models to predict short- and long-term changes in multiple soil properties such as total nitrogen and organic matter quality. AAFC scientists developed models for predicting soil nitrogen supply and were the first worldwide to propose a VNIRS model for predicting light fraction organic matter nitrogen.

Armed with this new tool, scientists are better equipped to measure various soil properties to assess and maintain this vital natural resource.

Back to table of contents

Setting the Trap for Wireworms

To help protect potato crops, Agriculture and Agri-Food Canada scientists have designed a new environmentally friendly trap for wireworms—destructive beetle larvae that dig holes in potato roots and make them unfit for sale and consumption.

Wireworms inflict their damage on potato crops during the growing season, and then retreat underground for the winter where they mature. The trap that scientists have designed, called the Noronha Elaterid Light Trap (NELT), uses a small solar powered spotlight, a white plastic cup, and a piece of mesh screen sized to only capture adult beetles emerging from the soil in the spring, as they are attracted to the light on the trap, and unable to escape once they fall into the cup. By using these traps, captured beetles are prevented from laying up to 100 to 200 new wireworm eggs on the new growing season's crop.

In a six-week test with 10 traps, more than 3,000 females were captured in the plastic cups, preventing reproduction of up to 600,000 wireworms. This means that, farmers need about three traps per acre to catch enough beetles to suppression the pest population. This trap provides producers with a cost-efficient way of reducing pesticide use and crop losses.

The trap was trademarked in 2016 and is now being manufactured by a private company, which plans to eventually make it available to producers worldwide.

The potato is one of the most important horticulture crops in Canada, with farm gate receipts rising **12.3% since 2015 to $1.2 billion in 2017**.

Back to table of contents

Pulse Starches Make Healthy Food Products

One of the big challenges for the food industry is producing low glycemic foods that have resistant or slowly digestible starch, which acts like fibre and has a positive effect on blood sugar, but that are also consumer friendly. Now, Agriculture and Agri-Food Canada scientists are looking to Canadian grown pulses (beans, peas, and lentils), with low Glycemic Index (GI), to develop flour that can be used in a variety of food products.

The team developed a technology to modify the properties of pulse starch for food and non-food applications. They created a new pulse flour, with higher resistant starch and slowly digestible starch, that can be used in a variety of foods such as in gluten-free breads. The scientists have also identified starches from two field pea varieties that would be ideal for use in foods that require high temperature processing.

This research is useful for food manufacturers and processors interested in developing healthy, low glycemic food products, and for Canadian consumers who will benefit from having more healthy food alternatives.

The food and beverage processing industry is the second largest manufacturing industry in Canada in terms of production. It accounts for **2% of the national Gross Domestic Product (GDP)** and is the largest buyer of the food Canadian farmers grow.

The Glycemic Index (GI) is a scale that ranks starch-containing food by how much it raises blood sugar levels. Foods with higher GI, which increase blood sugar higher and faster than those with lower GI, can be linked to many chronic illnesses, including diabetes and cardiovascular disease.

Back to table of contents

Precision Agriculture Increases Potato Production

While Canada's overall potato production has increased, this is not the case in Atlantic Canada where potato farmers are looking for tools to improve their yields with more consistent crops. To help achieve this, Agriculture and Agri-Food Canada scientists are using an innovative tool as their eye in the sky: unmanned aerial vehicles, or drone technology.

This collaborative effort between government, universities, producers, and industry uses unmanned aerial vehicles with a specialized camera and advanced software to identify zones within the field that are not performing well. The scientists examine all factors, such as soil health, plant stress, and nutrient management that limit a healthy potato crop, then apply precision agriculture solutions, such as altering the nutrients and adding soil amendments in parts of the field that need it, to improve potato productivity in the targeted zone.

This research has expanded across the country and is providing an alternative way to identify issues accurately and quickly. This specialized camera will help producers discover production problems, find solutions, and get a consistent crop year to year to remain competitive in a market where the sky is the limit.

Canadian potato farmers produced **4.77 million tonnes** of potato in 2016.

Potatoes that Repel Beetles

The Colorado potato beetle feeds on leaves at both the larval and adult stages, and sometimes a single season can see two generations of beetle. Beetles can also overwinter below the frost line and come back a year later, which makes them even harder to control.

Scientists have been working for decades to cross breed commercial potato plants with their wild potato cousins from South and Central America and Mexico in hopes of producing plants with leaves that repel the Colorado potato beetle.

Colorado potato beetle could cause 30 to 50% yield loss, **resulting in a huge economic impact on the potato sector**.

Recently, a team of scientists from Agriculture and Agri-Food Canada succeeded in developing two new potato varieties that the beetle finds disgusting, by studying the potato's leaf chemistry and finding a way to identify cross-bred plants that the beetle avoids.

Two new beetle-resistant varieties are now ready for commercial testing by potato growers and more will be offered in 2019 and following years. The goal is for producers to incorporate some of these beetle-resistant potatoes into their crops to reduce pesticide use and prevent yield losses.

Back to table of contents

The Science of a Better Pork Chop

In a recent study on pork meat quality and its effects on nutritional health, researchers from Agriculture and Agri-Food Canada found a strong link between the presence of carnosine, a molecule found in pork and other meat and fish, and meat quality.

The results showed that pigs with higher carnosine levels in their muscles produced a higher quality meat that retained more moisture and had a more attractive colour—both qualities that appeal to consumers.

In addition, researchers identified a specific gene sequence in pigs that appears to be associated with controlling the carnosine levels in their muscles. This new genetic information could be used by breeders to develop pigs with improved muscle carnosine level.

While this part of the research did not focus on the health effects of consuming carnosine in humans, other studies have documented many possible roles of carnosine in health, in particular, its role with respect to age-related conditions, such as diabetes and its cardiovascular complications, and neurological disorders for which promising preclinical and clinical results have been obtained.

This growing body of knowledge will not only help pig farmers produce higher quality pork but also provide consumers with more knowledge about the potential health benefits of carnosine that meat contains.

Pork production represents almost **30%** of agricultural animal production in Canada, with exports worth more than **$4 billion in 2016**.

Protective Viruses in Cheese Production

Agriculture and Agri-Food Canada scientists, and their colleagues from Université Laval, developed a promising new way to improve the safety of Canadian cheese. The scientists were able to use bacteriophages, viruses that selectively destroy harmful bacteria but pose no risk to human health, to almost completely remove some harmful bacteria from cheese.

The experiments targeted a specific bacterium which can cause significant losses for Canadian manufacturers of milk and dairy products, and also result in food poisoning.

The team was able to determine which combination, and how much of the bacteriophages should be added to cheese as well as at what stage of the manufacturing process, to achieve optimal effect.

This is a promising new tool that could help the dairy industry ensure the production of safe, quality cheese.

Canada produced **$14.3 billion** worth of cheese, yogurt, ice cream, butter, milk powders, and concentrated milk in 2017.

Back to table of contents

Disease Resistance Discovery in Honey Bees

Scientists from Agriculture and Agri-Food Canada and the University of British Columbia found a new way to selectively breed bees that can detect and reduce disease within a colony.

These researchers previously discovered proteins in the antennae of nurse bees—those responsible for feeding young bees—that are associated with their ability to sense the presence of infection in immature bees. After detecting the infection, nurse bees take action to remove the affected bee and stop the spread of disease. Using these proteins as markers for breeding, researchers found they could guide selective breeding to produce more disease-resistant colonies.

In a subsequent agro-economic study, researchers estimated that using this marker-assisted selection method for breeding could increase profits for beekeepers by as much as 90 percent through improved colony health, increased production, and a reduced need for chemical treatments in infected colonies.

Honey bees **contribute up to $5.5 billion annually** to the Canadian economy through pollination and honey production. An estimated one-third of our diet is dependent on pollination by bees and other insects including canola, tree fruits, berries, melons, and cucumbers.

New Biocontrol for Cabbage Loopers

Agriculture and Agri-Food Canada scientists, along with their colleagues at the University of British Columbia, isolated an insect-specific virus that can be used to help protect the productivity and sustainability of the Canadian greenhouse vegetable industry.

The virus attacks and destroys the cabbage looper—a pest that can cause significant crop losses on a wide variety of greenhouse vegetables.

The virus species obtained registration from the Pest Management Regulatory Agency for use in controlling cabbage looper larvae in greenhouse vegetable production, and it has been licenced to a private company and registered under the trademark Loopex.

As a safe and effective biological pest control agent, the virus is a potential alternative to chemical pest control products, which can help the Canadian greenhouse industry respond to consumer demand for high quality produce using little or no pesticides.

Greenhouse vegetables exports were worth over **$863 million in 2016**.

Back to table of contents

NOTES


WESTEEL