AGRICULTURAL INNOVATIONS

Agriculture and Agri-Food Canada
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Canada

Agricultural Innovations

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For more information, reach us at www.agr.gc.ca or call us toll-free at 1-855-773-0241.

For over 130 years, Agriculture and Agri-Food Canada (AAFC) scientists have helped build a strong, healthy and innovative agricultural sector. AAFC staff work closely with industry, universities, provincial and federal governments to build a robust agricultural environment. AAFC combines an integrated national network, 20 research and development centres across the country, with a strong regional focus.

Our research is guided by the unique issues and opportunities presented by each segment of the agricultural sector. Work is performed in collaboration with various commodity groups, including: agri-food, beef, cereals, dairy, forages, horticulture, oilseeds, pork, and pulses. AAFC research focuses on protecting biodiversity and bioresources, ensuring that practices maintain the productivity and health of our agro-ecosystems.

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.

RESEARCH AND DEVELOPMENT CENTRES

TOOL CALCULATES OPTIMAL NITROGEN

Agriculture and Agri-Food Canada (AAFC) scientists have developed an online tool, SCAN (Soil, Crop and Atmosphere for Nitrogen), to help farmers determine the precise nitrogen needs of their corn crops.

Nitrogen is critical for crop development, but the rate needed for corn is often difficult to determine because a crop's requirements are influenced by a number of factors, including soil properties, rainfall, and corn heat units (CHU). Nitrogen is often applied in excess to offset seasonal uncertainty in rainfall. This can lead to negative economic and environmental impacts.

The new tool calculates the optimal nitrogen application using soil properties, rainfall, previous crop, soil organic matter content, economic ratio and the nitrogen nutrition status of the corn, without compromising yield. Widespread adoption of SCAN will have significant positive impacts on the profitability and sustainability of Quebec and Ontario farms for which it has been calibrated.

SCAN reduced nitrogen rates in grain corn for half of the commercial field trials by an average of 25%, without affecting yield. These reductions translated into equivalent fertilizer cost savings. During commercial field trials, SCAN resulted in average benefits ranging from $25 to $49 per hectare depending on the year. Nitrogen losses to the environment are also reduced, leading to lower risks of aquifer contamination. Moreover, the use of SCAN resulted in increased yields for the other half of the commercial field trials when a higher nitrogen rate was justified by climatic and soil conditions.

The AAFC team is now testing a user-friendly website tool to transfer the information to the farming community. A license for SCAN commercialization is being negotiated and commercial release is scheduled for the 2017 season.

SUSTAINABLE CROP POLLINATION

Like so many agricultural crops, lowbush blueberry production depends on bee pollination. However, a local shortage of managed pollinators (honeybees) has farmers in Atlantic Canada looking for ways to diversify their pollination strategies in order to improve current production levels.

Habitat loss and alteration has been a key factor in declining native bee populations. With this in mind, Agriculture and Agri-Food Canada (AAFC) scientists are examining the relationship between habitat diversity in the agricultural landscape and the pollination services provided by native bees. They have discovered that landscapes which support diverse and abundant flowering plant populations throughout the year had a positive influence on the number of native bees pollinating blueberries. They also learned that as little as 5% of the landscape within 500 metres of blueberry fields could support higher native bee numbers when covered with high quality foraging habitat. The relatively small scale of the landscape effect (500 metres) also shows how effective native bee conservation initiatives on individual land holdings can be.

The team developed assessment guidelines that are now being used by blueberry growers to help them properly plan the management of adjacent land. These important foraging areas for native bees are providing a sustainable component vital to blueberry production. Further research will explore how these landscape patterns contribute to greater diversity in beneficial insects as natural pest control, which in turn can reduce the use of pesticides.

USING SATELLITES TO TRACK SOIL MOISTURE

Weather is a key factor in agricultural production. Farmers need the right amount of soil moisture at the right time. Too little or too much resulting from extreme events (flooding and drought), can reduce farm income.

Agriculture and Agri-Food Canada (AAFC) scientists are providing accurate information on soil moisture to help farmers take action to minimize the damage caused by extreme events.

At the field scale, the team used the Canadian Space Agency's RADARSAT-2 satellite to develop a method to map soil moisture. The capacity of soils to absorb spring snowmelt is a critical factor in flood risk. Given the impact flooding has on agriculture, the team evaluated the satellite soil moisture maps to assist with flood forecasting. These maps improved the accuracy of stream flow forecasts and provided improved information for the operation of flood infrastructure and flood response in rural areas. Knowing the capacity of soils to absorb moisture (i.e., are they already saturated) will also help farmers take action when weather events are predicted. The team is now exploring use of these moisture maps to assess the risk of specific crop diseases.

At the regional scale, the team is assisting the National Aeronautics and Space Administration (NASA) to calibrate and validate their Soil Moisture Active Passive satellite – a system that provides global maps of soil moisture. AAFC led an extensive experiment in Manitoba, in 2012 and 2016, to help improve NASA's models and continues to provide data to NASA. This collaboration ensures that NASA's soil moisture products are as accurate as possible.

(Photo courtesy of NASA/JPL-Caltech)

NEW AGRICULTURE WEATHER TOOLS

Farmers depend on weather forecasts to inform all their agricultural decisions. Now two websites are available to help them:

AgWeather Quebec **www.agrometeo.org**
AgWeather Atlantic **atl.agrometeo.org**

Two online tools have been developed to provide farmers with current, accessible climate information that will help them manage crop pests, inputs, and production. The two websites distill observations gathered by over 400 weather stations in Quebec and Atlantic Canada using a data validation, processing and visualization system from the University of Oklahoma.

AgWeather Quebec and AgWeather Atlantic provide a pipeline through which scientists' knowledge is directly and almost immediately applied in the field. These data feed into Agriculture and Agri-Food Canada's (AAFC) Computer Centre for Agricultural Pest Forecasting (CIPRA)* software and an irrigation planning tool developed in British Columbia. These tools will help producers quickly see weather patterns, manage pests with the latest research and improve their bottom line.

*See page 17 for more information about CIPRA.

BACTERIA ENHANCES CROP GROWTH

Agriculture and Agri-Food Canada (AAFC) scientists have discovered bacteria that could promote crop growth and reduce dependence on commercial fertilizers.

It is estimated that one gram of soil contains more than 100 million bacteria and 6,000 to 8,000 different types of bacteria. The bacterium that AAFC scientists have isolated from crop residues works by enhancing the root size of crops, thereby increasing uptake and fixation of important soil nutrients, like nitrogen. Larger roots enhance growth through better nutrient uptake to the plant's shoots.

One bacterium, isolated from corn roots, fixes nitrogen and produces naturally occurring growth hormones which enhance plant growth as well as antimicrobial chemicals that help protect the crop against pathogens that cause diseases. This disease-fighting property could be useful in developing a natural product for disease prevention or treatment.

Ultimately, this discovery could help farmers save money through reduced use of commercial fertilizers. This will also have an environmental benefit through reduced nutrient run-off from fields, while reduced need for nitrogen fertilizers would also cut down on carbon dioxide emissions.

REDUCING BEEF'S ENVIRONMENTAL FOOTPRINT

Canadian scientists have demonstrated how beef producers have cut greenhouse gas emissions from cattle production by 15% for a kilogram of beef over the past 30 years.

A team from Agriculture and Agri-Food Canada (AAFC), Environment and Climate Change Canada, and the University of Manitoba, collaborated on a comprehensive study that used greenhouse gas emissions, breeding herd and land requirements to measure this reduction in beef cattle's environmental footprint.

In comparing cattle populations and meat production rates in 1981 to rates in 2011, they discovered it took 29% fewer breeding cattle and 24% less land to produce the same quantity of beef. Using Holos, a Canadian whole-farm emissions model developed by AAFC researchers, they also found a 15% decrease in methane, 16% less nitrous dioxide and 13% less carbon dioxide from beef production when comparing numbers. Overall, this translates into an average of 15% fewer greenhouse gas emissions.

The decline in greenhouse gases resulted mainly from improved efficiencies in cattle production and the industry's ability to adopt new technologies. This long-term study highlights the cumulative benefits that have arisen as a result of 30 years of research in support of the Canadian beef industry. AAFC research in genetics, nutrition, reproductive physiology and herd management will continue to help farmers further improve their efficiency. The remaining phases of the environmental footprint study, including water use, air quality, biodiversity and provision of ecosystems services, are expected in 2018.

ECO-EFFICIENT DAIRY FARM MANAGEMENT

Field management is an integral part of dairy farming. While crop and forage management are aimed at maximizing milk production, manure management presents challenges.

Field-based activities, such as producing forage and managing manure, have an impact on the environmental and economic sustainability of dairy farms. They can potentially offset efforts made at the barn to reduce the environmental footprint.

New field management practices have a strong potential to reduce the environmental footprint of dairy farming and increase economic returns for producers. Agriculture and Agri-Food Canada (AAFC) scientists are conducting a comprehensive assessment of these management practices, including improving forage production and quality, increasing beneficial cropping procedures, and reducing carbon outputs with improved manure management practices. Scientists are evaluating the benefits of these practices using a combination of field-based trials and whole-farm computer models at locations across Canada.

Preliminary results are positive. The researchers found changes to cropping alfalfa improves the ability of cows to digest the crop and produces more milk per ton of forage consumed. They also discovered that cropping alfalfa in a mixture with grasses creates more milk from cows per cropped hectare. Sweet sorghum and sweet pearl millet show promise as high-yield crops with low environmental implications on dairy farms in most areas where they have been tested. Results also indicate that applying dairy cattle manure to perennial crops on the dairy farm maximizes the efficient use of nitrogen from the manure and increases carbon sequestration in the soil.

Along with the field results, the computer model (Integrated Farm System Model) is being improved to simulate the economic and environmental footprint of Canadian dairy farms. This work will help Canadian dairy farmers use forages and manure resources in a more eco-friendly way and increase their profitability.

LAKE WINNIPEG BASIN: REDUCING AGRICULTURAL RUNOFF

The flow of nutrients such as nitrogen and phosphorus into lakes and rivers can increase algal blooms and reduce water quality. This is a problem on Lake Winnipeg, Canada's sixth largest freshwater lake, and the many waterbodies throughout its drainage basin.

Most of the land in the Lake Winnipeg basin is agricultural land, so Agriculture and Agri-Food Canada (AAFC) scientists are collaborating with universities, government agencies, conservation groups, and farmers to provide sustainable and economically viable solutions to improve the lake's water quality. The team has established a network of 25 field monitoring sites throughout the Lake Winnipeg watershed area to evaluate nutrient losses and land management impacts. The goal is to increase phosphorus and nitrogen efficiency, reduce runoff, and retain these valuable nutrients on farmland.

For example, the team established that phosphorous tends to accumulate in low lying areas, but the amount varies with the type of tillage, the surrounding landscape, and how the phosphorous is applied. This knowledge will influence the development of variable phosphorous application rates to minimize accumulation in low lying areas.

The researchers are also exploring the impacts of different cattle overwintering systems on nitrogen and phosphorous losses. They compared confined feeding, in which cattle are kept at higher density and fed in the same location, to bale grazing or feeding cattle hay bales on cropland during the winter. While bale grazing improves soil fertility and reduces manure transportation costs, it presents water quality challenges. Runoff losses of nitrogen and phosphorus with snowmelt per animal per day of feeding are similar when confined feeding and bale grazing are compared. However, more research is needed to reduce nutrient runoff and negative water quality issues.

By identifying new technologies and best management practices, the AAFC team will help increase nutrient use efficiency and crop yield, develop conservation practices, and ultimately, increase profitability for producers.

TOOLS TO PREVENT GROUNDWATER CONTAMINATION

Agriculture and Agri-Food Canada (AAFC) scientists have been working with university partners to study the complex linkages between agricultural water management and groundwater nitrate contamination.

The research team has been examining the sources of potential nitrogen leaching from crops located over a sand and gravel aquifer in British Columbia, and a fractured till and bedrock aquifer in Prince Edward Island. The research is improving knowledge about the flow and transport of nitrogen in these aquifers, both of which are the primary sources of potable water for their regions.

The team found that in British Columbia they could significantly reduce nitrate leaching in raspberry production by using a combination of several best management practices. They applied organic fertilizers with a stabilized nitrogen content, scheduled crop irrigation for efficient water use, and used fertigation which applies nitrogen mixed with water directly and efficiently to the raspberry plants. Planting grasses between the rows that didn't compete with the raspberry crop also helped to soak up excess nitrogen.

In Prince Edward Island, where the system is more complicated and less studied, the focus has been on understanding nitrogen cycling and transport. Research is underway to discover how different rotation crops influence the availability of nitrogen to the plant in the root zone and the potential for nitrogen losses. The research will also establish how long water and nitrogen takes to travel to the water table through this fractured flow system.

The results of this research will ultimately help scientists create tools to predict the risk of groundwater nitrogen contamination as well as develop best management practices to assist farmers in reducing groundwater contamination from agricultural outputs.

REDUCING AGRICULTURE'S ENVIRONMENTAL IMPACT NEAR URBAN REGIONS

Growing populations and expensive land are contributing to intensive agriculture production near urban centres around the world. If not properly managed, this can lead to nutrient leaching and environmental issues.

In the densely populated and intensively farmed Lower Fraser Valley region of British Columbia, Agriculture and Agri-Food Canada (AAFC) scientists are developing multi-pronged strategies to use nutrients at the field, farm, and regional scales more efficiently. At the farm level, researchers are finding ways to optimize land use to reduce feed and fertilizer imports. At the regional scale, they have identified manure systems to reduce nitrate leaching, and they are integrating nutrient management over the entire peri-urban region.

The scientists developed a system to help producers with precision nutrient management using a website tool while in the field. The website uses soil and crop information entered by the user in combination with daily weather data from over 100 weather stations across Canada to provide farmers with strategies to manage their soils.

The researchers have also developed a novel precision application technology for dairy manure that allows a more balanced and effective uptake of nutrients. The separated liquid from the manure, which is high in nitrogen, is transferred from storage tanks and applied to forage crops. The settled sludge, which is high in phosphorus, is precision injected into silage corn. The system reduces the need for purchased fertilizers while improving yields. It also reduces ammonia emissions, a significant atmospheric pollutant. On-farm demonstrations are now being conducted. Precision injection of slurry has been validated in the Netherlands and more recently in Denmark, and has been widely adopted by commercial farms in northern Germany.

This multi-layered approach has been effective for tackling complex nutrient issues at various points in farm production. This will help reduce environmental impact and improve economic performance of farms in the urban-rural context.

Precision nutrient management website: **www.nlos.ca**

NEW PLATFORM FOR FERMENTATION OF FRESH PRODUCE

Fermented vegetables are a growing industry worldwide, particularly with high value conventional or organic produce.

Food preservation technologies have continuously evolved throughout history. In recent decades, research has improved preservation methods. Agriculture and Agri-Food Canada (AAFC) scientists developed a way to preserve fresh vegetables for over a year at room temperature without chemical preservatives, pasteurization or freezing, while maintaining the vegetables' nutritional value.

The new fermentation process uses starters, i.e. microorganisms that are found in plants and that are then freeze-dried on plant-based matter and used to process the vegetables. The new technology has been successfully applied to kimchi, a spicy sauerkraut-like dish eaten daily in Korea. While it can be used with almost all vegetables, it is most useful for producers of fermented short shelf life crops such as cabbage, garlic and fiddleheads. It may even have applications beyond the food sector.

The technology offers Canadian companies a competitive advantage by guaranteed product stability, a longer preservation period, and ensured food safety while preserving the anti-microbial and nutritional qualities of fermented food, so valued by consumers.

With interest from the industry, AAFC scientists are now documenting the basic science of fermented vegetables in terms of processes, functional properties and safety assurances.

BLUEBERRIES: CULTIVATED PRODUCTION SUPPLEMENTS WILD BLUEBERRY HARVEST

Cultivated blueberry production in Canada supplements the 'wild' production. Research is underway to develop new varieties with higher quality and yield.

Lowbush blueberry is a native wild small fruit crop that has become a commercially important crop in North America. Agriculture and Agri-Food Canada (AAFC) scientists are working with universities, provincial, and industry partners to develop health promoting, high yielding, cool climate blueberry varieties. This research also involves developing an environmentally sustainable system for the blueberries.

Half-high blueberries are hybrids of highbush (or cultivated) and lowbush blueberries with tremendous potential for commercial cultivation. They are more winter hardy and are expected to produce 50% more than wild lowbush blueberries. AAFC's collection of wild and cultivated berries includes plants that are suitable for cool regions. This collection is being used by researchers to evaluate and select plants that have high antioxidant content, are well adapted to adverse environmental conditions, and that are resistant to insect pests. Identifying varieties that are pest resistant reduces growers' reliance on insecticides, lowers costs, and provides a marketing advantage to sell the berries as "insecticide free."

This blueberry research is vital to the economic development of the agricultural sector in cool climate areas in Canada where blueberries can readily adapt to the environments. This will provide a high value, higher-yielding crop in regions where agricultural land is limited and relatively few other crops exist.

PREDICTING PEST DEVELOPMENT WITH A CLICK OF THE MOUSE

Agriculture and Agri-Food Canada (AAFC) scientists have developed a pest forecasting software called CIPRA (Computer Centre for Agricultural Pest Forecasting) that allows producers to effectively control insects and diseases that affect their crops.

Free of charge, CIPRA predicts crop and pest development (insects or diseases) based on weather conditions using sophisticated mathematical models. Currently over 100 crops/pests are modelled in CIPRA; more than 200 agricultural experts and extension specialists regularly use this software to advise producers in Quebec, Ontario, Atlantic Canada and British Columbia.

As Canada's largest bank of bioclimatic models in real and predictive time, CIPRA-2016 is also used by scientists as a "virtual laboratory" and a platform on which to integrate knowledge from various fields of expertise. It has been used to study historical climate trends in the past and can be used to predict the potential impacts of climate variability and change in the future.

This tool is helping specialists determine proper phytosanitary measures (i.e., right amount at the right time), which allows producers to reduce pesticide applications by 25% to 75%, depending on the weather conditions and the crops involved. This helps ensure that Canadian-grown fruits, vegetables, and grains are of the highest quality for consumers while enhancing food safety and reducing production costs for producers. The crop development forecast also helps producers strategically plan seeding and harvesting along with the preservation, distribution and sale of the commodities they produce.

UNDERSTANDING AND CONTROLLING AN INVASIVE FLY

Native to Asia, the spotted wing drosophila, a fruit infesting fly, is now causing serious damage to soft fruit crops across North America. First detected in British Columbia in 2009, this pest has become a challenge for berry and cherry growers because it has a wide range of hosts and is difficult to control.

Unlike other fruit-infesting flies, which typically lay eggs in damaged fruit, this fly is equipped with a saw-like ovipositor, an appendage that allows it to deposit eggs in undamaged fruit, causing the fruit to decompose and to be unmarketable. Agriculture and Agri-Food Canada (AAFC) scientists have made significant progress in understanding this invasive pest and are examining new control options as its range expands across Canada.

New insight into the pest's reproduction has enabled researchers to develop strategies to help growers decide when it is necessary to apply insecticides. Reducing insecticide applications saves money and decreases insecticide residues on fruit.

The team also identified plant hosts that serve as seasonal refuge for the pest and two possible biological control agents: a small wasp that lays its eggs in the pupal stage of the pest, and a fungus that infects and kills the adult pest, reducing the pest populations. The scientists will continue to evaluate both the insect pest and the effectiveness of introducing the two biological control agents in order to develop a more sustainable suppression strategy.

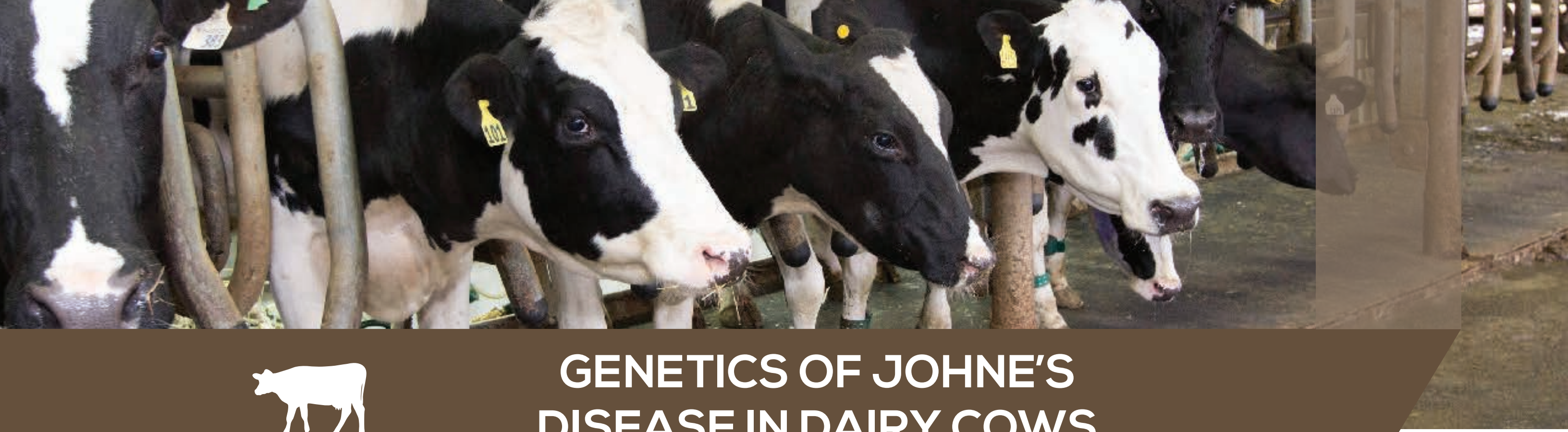
HEALTHY BEE POLLINATORS

The health of bee populations is central to a long-term, sustainable pollination strategy for Canadian agriculture. Honey bee populations have been growing, but require active management to reduce the burden of pests and diseases. Wild bees have suffered substantial losses in abundance and diversity for many years. Agriculture and Agri-Food Canada (AAFC) scientists are studying the issues affecting the health and survival of these pollinators.

The western honey bee, *Apis mellifera,* is the principal managed pollinator in agricultural crop systems. Previous studies have examined individual factors that influence the success of honey bees, including newly-introduced parasites and diseases, poor nutrition and the effects of agricultural pesticides. In the current study, AAFC is using a large-scale experiment to determine the interactive effects of these factors on colonies under different management practices, including honey production, canola seed pollination or blueberry pollination. This research is generating insights as to the key risks affecting colony productivity and survival and will lead to improved practices for Canadian beekeepers.

Declines in wild bees have been linked to the loss, degradation and fragmentation of habitat, land use intensification (particularly the use of pesticides) and diseases. AAFC has systematically identified the types and densities of bees found in different agricultural ecozones across the country. Bee samples have also been analyzed for their exposure to pesticides, and whether they harbour known or new pathogens.

The outcomes of AAFC's research on bee pollinators will provide specific recommendations to reduce bee losses and improve the sustainability of bees as pollinators in agricultural ecosystems.



GENETICS OF JOHNE'S DISEASE IN DAIRY COWS

Johne's disease is present throughout Canada and can cost the Canadian dairy industry up to $90 million annually due to premature culling, reduced milk production, and loss of body weight in infected cows.

Johne's disease is a slow, progressive, contagious and untreatable bacterial disease that usually infects calves and does not show signs until animals are three or more years of age. Agriculture and Agri-Food Canada (AAFC) scientists are studying the infection in order to understand the immune response and develop genetic tools that will eventually help producers select resistant animals. There are provincial programs in place to control Johne's disease with diagnosis, but this is costly and repetitive. Genetic improvement of disease resistance is a slow, long-term process, but results are permanent.

The scientists are studying the host-pathogen interaction in Johne's disease resistant cows and examining the genetic variability and its link with the biological factors that impact disease susceptibility and resistance. This will help them to identify genetic markers to map this disease and in turn develop a successful breeding strategy.

This project will offer the dairy industry information and genetic tools to select resistant animals. Improving the genetics of livestock by enhancing natural disease resistance is part of long-term solutions to reduce threats along Canada's agriculture and agri-food value chain.

USING GENOMICS TO TRACK *E. COLI*

Scientific experts from six federal departments have joined forces to study the dangerous forms of *E.coli* – bacteria that can cause serious, even fatal illness – in our environment.

The team which includes experts from Agriculture and Agri-Food Canada (AAFC), Fisheries and Oceans Canada, Environment and Climate Change Canada, Health Canada, National Research Council Canada, and Natural Resources Canada, is exploring ways that genomics (the study of genes and their functions) can contribute to enhancing the safety of Canada's food and water supply. They have been collecting and testing water samples from hundreds of watersheds and marine areas in six provinces to determine how pathogenic (disease causing) strains of *E. coli* are distributed in the environment. By understanding how the strains enter the water, they can find ways to manage the risk.

The differences between a pathogenic strain and a non-pathogenic strain of *E. coli* can be very subtle. The use of genomics-based technologies provides a precise way to differentiate these bacteria. Genome sequencing is the best method available as it allows scientists to do a side-by-side DNA comparison of those strains.

With a greater understanding of the sources of a pathogen like *E. coli*, researchers can inform more effective land use management practices to reduce downstream contamination, as well as more effective public health interventions at the local, provincial and federal levels.

BIOLOGICAL DIVERSITY: QUARANTINE AND INVASIVE SPECIES PROJECT

Increases in international trade combined with the effects of global warming have led to significant changes in insect, plant and disease species found in Canada. Possible new threats to biosecurity and re-emerging ones continue to be identified by the Canadian Food Inspection Agency and Canada's trade partners.

Led by Agriculture and Agri-Food Canada (AAFC), scientists from several federal departments developed a new tool to detect and address both quarantine classified organisms and invasive pests, based on DNA evidence.

With more than 20 million specimens of insects, pathogenic fungi, and plants in AAFC's National Biological Collections, the team focused on developing a DNA data set for high-risk organisms. The resulting "DNA bar code system" now shortens the time it takes to accurately identify both organisms for quarantine as well as invasive species from all life stages that threaten Canada's agriculture, forestry and natural resources. In the 2016 federal budget, $30 million was allocated to accelerate DNA analysis and digital recording of AAFC's collections.

The DNA bar code system has already been used to address trade challenges received by Canada (e.g. downy mildew of soybean) and to avoid false positives (incorrect detection of an unwanted pest instead of a close relative already established in Canada). This improved system not only protects Canada's domestic natural and managed plant resource base, it also leads to increased access to international markets.

When potato wart was discovered in Prince Edward Island in 2000, AAFC had to look through Canada's national collections to find all pathogens related to the disease before they could work on generating the DNA sequence data. Working extended hours (24 hours/ 7 days a week) it took the team six weeks to generate the DNA sequence, analyze it and send a sample to the Canadian Food Inspection Agency (CFIA) for use in identifying farms and potato crops where the disease was present. Today, with a DNA sequence of a pathogen already available, AAFC can help the CFIA respond to trade issues such as this one within hours.

GENOMICS TO FIGHT FUSARIUM HEAD BLIGHT

Fusarium Head Blight (FHB) is a fungal disease that makes wheat unfit for human or animal consumption. It is considered the biggest problem facing Canadian wheat producers. Beyond its impact on the food supply, it is estimated that Fusarium Head Blight has cost Canadian wheat producers more than $1.5 billion in lost income since the mid-1990s.

As part of the Canadian Wheat Alliance, Agriculture and Agri-Food Canada (AAFC) and the National Research Council are working with the University of Manitoba to develop genomic tools to fight Fusarium Head Blight.

The researchers are investigating resistance genes from AAFC varieties, including AC® Emerson (Canada's first Fusarium Head Blight resistant winter wheat variety) to develop new wheat lines. The new Fusarium Head Blight resistance germplasm was provided to AAFC partners for evaluation and incorporation into their breeding programs. Two breeder-friendly molecular markers also developed by the team will be available in 2017. This introduction of novel sources of resistance into Western Canadian wheat will diversify the genetic base of Fusarium Head Blight resistance and help to protect Canada's wheat supply, maintain export markets, and provide safe and nutritious food to consumers.

The Canadian Wheat Alliance is an unprecedented 11-year commitment among Agriculture and Agri-Food Canada, the University of Saskatchewan, the province of Saskatchewan and the National Research Council Canada to support and advance research that will improve the profitability of Canadian wheat producers.

PROTECTING CROPS AGAINST WHEAT MIDGE

Wheat midge is a chronic pest of spring wheat in western Canada. The larvae feed on wheat kernels, reducing crop yields and lowering the grade of harvested grain. A recent strategy for introducing midge-tolerant varieties is not only helping farmers protect their crops, it is also significantly reducing insecticide use.

Agriculture and Agri-Food Canada (AAFC) scientists first discovered a novel gene (Sm1) that prevents wheat midge larvae from establishing on developing seeds. They then shared this information with wheat breeders in North America who in turn used it to develop new midge tolerant varieties. However, insects have been known to quickly adapt when only a single gene is used to develop resistant lines. To combat this and conserve the effectiveness of the gene, the new lines have been released as a blend – 90% midge tolerant seed and 10% of a midge susceptible seed.

This blending helps prevent the build-up of virulent midge (naturally occurring insects that are resistant to the SM1 gene) by allowing sufficient numbers of avirulent (non-resistant) midge to survive and mate with virulent midge. Theoretically, the new generation of insects would not be resistant to the Sm1 gene, which prevents a build up of the harmful virulent insects. The susceptible component of the variety blend also helps conserve populations of *Macroglenes penetrans* – a parasitic wasp that is the main natural enemy of the wheat midge. Based on computer models, scientists believe that this strategy should extend the life of midge tolerant cultivars from 10 years to more than 90 years.

After the first major Canadian outbreak of wheat midge in 1983, AAFC scientists immediately began working with research partners and industry. They developed a comprehensive pest management program and now provide farmers with forecast and risk warning maps, monitoring tools, improved farming practices, as well as cultural and biological controls to help them manage wheat midge populations while conserving its natural enemies. With the midge tolerant wheat varieties, Canadian wheat growers now have one of the most comprehensive Integrated Crop Management packages of any pest of field crops. See: www.midgetolerantwheat.ca

Research is an investment that pays:
$37 in benefits for every $1 invested in wheat midge research

IMPROVING SWATH GRAZING OPTIONS

Winter feeding is one of the most expensive activities in producing a beef calf in the Northern Great Plains of North America. Thanks to research by Agriculture and Agri-Food Canada (AAFC) scientists, many farmers are now using swath grazing to extend the grazing season and reduce the use of conserved feed and winter feeding costs.

Swath grazing occurs after cereal crops are planted late, and then swathed or cut in September and left in the field for animals to graze on during the winter months, even under snow. To date, there is a 30 to 50% adoption rate of this technique in Alberta. Based on average performance, a beef producer swath-grazing 100 cows for 100 days could save approximately $12,000 (swath-grazing triticale - a hydrid of wheat and rye), $9,300 (swath-grazing corn) or $7,400 (swath-grazing barley) compared to traditional feed systems.

The science team has already found several varieties of spring triticale that could be planted earlier than barley and yield more for the same production cost. They are also finding ways to increase the yield of swath-grazed barley to match that of triticale by improving which varieties are grown and how they are managed.

Swath grazing saves money, makes beef production more economically viable for farmers, and improves the environmental sustainability of beef production.

- Time and labour savings (66% savings on time to feed cattle) allows one farmer to maintain a larger cow herd.
- By increasing the yield of the swath grazed crop the amount of land required to winter the cow herd can be reduced by as much as 50%.
- Swath grazing uses 50% of the energy used by traditional feeding systems; diesel fuel use is reduced by 25% and each tonne of feed produced uses 34% of normal energy requirements. This results in a smaller carbon-footprint for the beef cow herd.

Research is an investment that pays:
$170 in benefits for every $1 invested in swath grazing research

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