Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada



Innovation EXPRESS

Science News from Agriculture and Agri-Food Canada

Volume 3, Number 1

Carrot Trimmer Goes International

Sometimes home grown technology is just too good to keep down on the farm. A piece of farm equipment developed for Canadian carrot growers at the Crops and Livestock Research Centre in Charlottetown is now a standard piece of machinery for carrot production in the United Kingdom. This Canadian carrot trimmer technology is also starting to be used by organic carrot producers in the Netherlands and Germany.

Each year carrot producers across Canada can lose a substantial amount of their harvest due to Sclerotinia rot caused by the fungus *Sclerotinia sclerotiorum*. This devastating disease can destroy crop quality and make carrots unsuitable for human consumption.

There are no known effective controls for this serious disease. During the growing season, the canopy of one row of carrots will grow to the point where it meets that of the adjacent rows. As a result, air flow is restricted, sunlight cannot reach the soil, and moisture levels increase, creating conditions that favour disease development. Carrot growers in Prince Edward Island can suffer losses between $250,000 to $500,000 in any given season due to Sclerotinia rot.

The carrot trimmer cuts a portion of the canopy of carrot tops in-between the growing rows. The cut carrot foliage trimmings fall between the rows and dry out which causes any fungi on the leaves to die. The carrot foliage trimmer reduces Sclerotinia rot of carrots (SRC) by up to 80 per cent and provides a simple way to reduce pesticide use in carrot production. There are both environmental and cost-of-production benefits. An added advantage of trimming is the reduction of foliage which makes harvesting more efficient.

Trimming carrot canopies is now standard practice for carrot growers in Nova Scotia where 1,000 hectares of carrots are benefiting from this technology. The trimmer has also been adopted by growers in Ontario, Manitoba and Wisconsin and is being considered in many other carrot growing regions of Canada, the United States and Europe.

There is even more good news. Researchers in Charlottetown assessed 10 different carrot varieties in 2009 to see what the impact of trimming would be. The results clearly demonstrate that growers can grow a wide variety of cultivars and still obtain excellent control of SRC with carrot canopy trimming. In addition, there is no loss of carrot yield when a portion of the canopy is removed.

The device was developed in collaboration with the Prince Edward Island Vegetable Growers Cooperative, Brookfield Gardens Ltd. Brookfield, PEI and Oxford Frozen Foods, Oxford, Nova Scotia, with funding through the Pesticide Risk Reduction Strategies Initiative of Agriculture and Agri-Food Canada's Pest Management Centre. •

Inside:

Canada

Technology Goes into Action

Generating new ideas and transforming them into products and processes that yield real benefits for farmers, industry and Canadians is a priority of Agriculture and Agri-Food Canada's (AAFC) Research Branch. Quite often this involves partnering with government, industry and farmers at various stages along the innovation process to develop, refine and promote the uptake of AAFC technologies into the marketplace.

This issue of Innovation Express provides examples of several technologies and intellectual properties developed, evaluated or supported by AAFC scientists. Many of these examples illustrate all the important elements that we are trying to achieve in agriculture – creating products with added value, reducing waste, seizing opportunities, developing new markets, creating jobs in rural areas, and creating programs that allow producers to take the lead and get a share of the benefits.

From new plant varieties, techniques to detect or prevent diseases, novel ways to create energy from agricultural waste, and technologies to enhanced production in the agri-food sector AAFC has a vast array of technologies and intellectual property developed specifically for growers or available for commercialization.

Who would have thought that trimming carrot tops in the field could save growers thousands each year by reducing the occurrence of a devastating disease or that this concept would become standard practice in many countries? Or that we could use off-grade or waste canola to create a high value product and kick-start a new biodiesel industry?

There are many steps on the path from knowledge to commercialization of a product and many key partners along the journey. The examples in this issue highlight our partnerships and demonstrate how science and innovation have a strong role to play in helping the agricultural sector achieve greater competitiveness, improve environmental performance, increase the security of the agricultural sector and contribute to the health and well-being of Canadians. •

Marc Fortin, Assistant Deputy Minister,
Research Branch, Agriculture and Agri-Food Canada

Quick Test Spots Weak Seeds

Canola and barley seeds that look just fine to the eye may in fact be complete duds, leading to costly losses. But with new seed and grain quality tests developed by scientists at the Brandon Research Centre in Manitoba, growers, seed labs and industry now have several options for testing canola seed and malting barley for loss of vigour.

Canola seed deterioration can mean lower seedling emergence and crop establishment, and ultimately poorer yields. Poor-vigour barley, although initially suitable for malting, can undergo unacceptable loss of germination during storage. Catching these costly problems is tricky because there's no visible tip-off and the effects don't show until it's too late—that is, the canola has been planted or the barley has become useless for malting.

The new tests work by detecting the relatively high levels of gaseous ethanol given off by deteriorated seed or grain. Three versions of the test have been developed for canola–two instrumental tests and a colour test. In all versions, seed and water (or a solution) are added to bottles which contain chemicals on the interior surface. The bottles are then shaken and set aside or incubated for 24 hours. A user friendly colour assay, specifically designed for use on the farm, gives canola growers the option of testing their seeds before planting. A colour develops in the cap that indicates seed quality. This winter, SaskCanola will be distributing the colour assay kits to many of its members.

The two other canola assays measure the test results electronically using a modified breathalyzer that costs less than $800. Although seed labs are expected to be the major users, the instrument is simple to use and could be used by seed companies or even right on the farm.

Depending on the assay conditions, one of the instrumental tests measures the current vigour of the seed (like the colour test) while the other predicts the loss of vigour in storage. The former of the two is presently undergoing an international, inter-laboratory evaluation. The latter of the two tests identifies seed with poor storage capacity and should help reduce waste, the need to blend seed, and most importantly, the amount of deteriorated seed sown in the field. Scientists hope that these tests will become important risk reduction tools to help ensure that farmers plant only good quality seeds. After all, healthy crops from good quality seeds can mean the difference between success and failure.

The tests were originally developed for canola seed but were modified to predict germination loss of barley. This modification was supported by the Brewing and Malting Barley Research Institute to help alleviate problems that the malting barley industry experiences. In some years wet conditions during harvest causes barley to begin the metabolic steps involved in germination, a process which can sometimes proceed to sprouting. Although the non-sprouted grain may appear acceptable, it quickly looses its ability to germinate during storage. The barley test, which identifies the barley lots susceptible to germination loss, also uses the modified breathalyzer and, except for a larger test bottle, is run much like the canola test.

The new tests, whether for barley or canola, are particularly useful when making decisions about seed and grain selection at various stages of harvest, storage, processing, marketing and planting. •

Test Puts Sudden Halt to Sudden Oak Death Disease

A diagnostic test developed by researchers at Agriculture and Agri-Food Canada (AAFC), Natural Resources Canada (NRCan) and the Canadian Food Inspection Agency (CFIA) is helping specialists identify an invasive pathogen responsible for Sudden Oak Death. This test has already saved British Columbia's nurseries from a potential disaster, helped to reduce the prevalence of the disease in the United States, and helped prevent it from spreading elsewhere.

Sudden Oak Death, caused by a pathogen that produces cankers, leaf spots and disfigurement of oak trees and many other plants, had been brewing in Europe and California for some time before it reared its head in Canada for the first time in 2003. By then, AAFC scientists had already been working on *Phytophthora ramorum*, the fungus that causes Sudden Oak Death, for a few years, having sequenced some of its DNA for a range of strains from both Europe and California.

The process of obtaining a DNA sequence from the pathogen and its close relatives is necessary for creating diagnostic tests and is no longer a difficult process. If AAFC scientists hadn't already started on building up a reliable collection, and had a robust test in the making by the time the disease first appeared in Canada, the losses could have been tremendous.

The National Canadian Collection of Fungal Cultures (CCFC), developed by AAFC and considered one of the largest of its kind in the world, has collected and maintained upward of 16,000 live species of fungi for examination. This collection became an indispensable resource in the Sudden Oak Death test creation, providing researchers with the *Phytophthora ramorum* pathogen and its close relatives for investigation.

AAFC provided the reference material from the CCFC, obtained more strains from affiliate international collections, and performed the initial work on sequencing a wide range of strains of the pathogen and closely related species, which was then passed on to NRCan for further test development and to CFIA for test validation and plant surveys. The collaborative effort ensured that the best resources were used at all stages of test development, to achieve the highest quality result.

A test had previously existed for Sudden Oak Death in the United States; however it became clear that without a large database such as the CCFC behind it, it was not reliable. The existing test proved to provide far too many false positives – meaning original US test results were evaluating many healthy plants as infected.

Ongoing pathogenicity tests are showing Sudden Oak Death susceptibility in an increasing number of species, making this test even more important. Rhododendron, the Douglas fir, blueberries and cranberries are just a few other species that are at risk for contracting the disease.

Although Canada is now considered clear of the pathogen and meticulous screening is unnecessary before export, the test will remain an irreplaceable resource for inspecting suspicious plants, and preventing the disease from being re-introduced.

Thanks to collaborative research efforts, Canadians can now be confident that Sudden Oak Death is less likely to happen because there is a test that can quickly detect the pathogen, and prevent the spread of the disease at the very first stages of its existence. •

Saving Water from a Rainy Day

Farms operating on heavy clay soils often install tile drainage systems to remove excess water from fields. They often wish they could have kept some of this excess water for the dry season. Now they can, thanks to innovative research from scientists at the Greenhouse and Processing Crops Research Centre in Harrow, Ontario.

Getting crops the right amount of water at the right time has always been a challenge for farmers. Too much or too little water can jeopardize crops. Scientists at Agriculture and Agri-Food Canada are helping farmers achieve this balance and, at the same time, reduce their impact on local water quality and quantity. And as an added bonus, farmers can save money on fertilizers and dramatically improve yields.

Scientists there have developed an innovative closed loop water management technology that combines tile drainage, reservoir and controlled drainage with irrigation system. The riser pipes can be installed on existing tile drainage systems which allow farmers to control the in/out flow of water. The system is attached to a reservoir to store any excess water drained from the field and return it to the crops during dry periods. This new water management system can achieve both economic and environmental benefits. Water and nutrients captured in the drainage/reservoir system are kept put.

In collaboration with local producers and conservation groups, researchers have tested the system on field and vegetable crops in southwestern Ontario. The field tests have demonstrated an increase in soybean yields by 50 per cent, tomato yields by 40 per cent and corn yields by nearly 90 per cent. This is not only good for crops - it is also good for the environment. Nutrients captured in the reservoir are returned to the crops which reduces the farmer's need for extra fertilizers. It is estimated that this may result in a 25-50 per cent reduction in nitrate loss.

This water management system has become a farming practice guideline and is included in Best Irrigation Management Practices booklets. The technology is being used by several producers in North America including farmers in Ontario, Quebec, Manitoba, Michigan, Ohio and North Carolina.

In 2008, the water quality research facility originally constructed in 1991 was upgraded with the addition of four storage reservoirs to capture and recycle all surface runoff and sub-surface tile drainage waters from the 16 adjacent field plots. These upgrades will allow scientists to explore and develop new best-management practices that combine the water management system with other soil and crop management practices.

For example, liquid and solid manure applications are currently being examined using the controlled drainage/sub-irrigation and closed loop water recycling system to study their effect on water quality and crop production. The results will benefit producers using livestock manure applications and intense field crop production in regions that experience dry periods and times of excess water. •

Treatment Turns Manure into Gold

It's a given that livestock producers need to address waste management issues to avoid contamination of surface and ground waters, emission of odours, ammonia and greenhouse gases. A pork slurry treatment system developed at the Dairy and Swine Research and Development Center in Sherbrooke, Quebec not only stops odours, but it generates energy and a natural fertilizer better balanced for agricultural soils. This new, patented transformation process has been applied, tested at a large scale and marketed for farmers by the Canadian company Bio-Terre Systems Inc. This low-temperature, anaerobic treatment system offers many benefits for agricultural producers, their communities and the environment.

If this were applied throughout Quebec, the robust, simple-to-operate technology, which is easily integrated in farming operations, could generate up to 150 MW of electricity (and light 150,000 houses) while reducing greenhouse gas emissions by more than three million tons of CO_2 each year, according to the company's estimates. In Beauce, Quebec, the methanization unit on a farm producing 5,000 pigs a year is producing electricity which is delivered to the Hydro Québec network. In Manitoba, two bioreactors were installed in 2005-2006 and a co-generation unit that has the capacity to handle the biogas produced by the 18,000 pig operation was installed in 2010 and will begin producing electricity in May 2011. Bio-Terre Systems consortium, anticipates $5-10 M in revenue from the sale of slurry biomethanization units in the next year. Some of this money will be used to continue research on new applications, including some using chicken slurry, for example.

Although the system is primarily intended for agricultural farms, the feasibility of having these methanization units handle the organic residue of agri-food businesses and municipal organic wastes is currently being studied. And it is already known that bioreactor microorganisms can easily break down the carcasses and residue generated by slaughterhouses.

Bio-Terre Systems is currently in talks with the United States for the construction of sixty facilities. Agriculture and Agri-Food Canada and Bio-Terre Systems are awaiting other patents needed to meet requests from Mexico, Spain, Poland and China, among other countries. At the global scale, this new technology would make it possible to achieve significant reductions in greenhouse gas emissions without hindering the growth of livestock production. Farmers could aim for energy self-sufficiency, or even gain a source of revenue by selling their surplus electricity or organic residue treatment service to municipalities. •

The transformation process extracts three valuable components from the slurry:

- Biogas – In the absence of oxygen, microorganisms produce a methane-rich gas (70% methane) which is transformed into electricity. In the climatic conditions of Canada, bioreactors produce from 20 to 37 cubic metres of biogas per cubic metre of slurry.
- Biofluid – Bioreactors produce a liquid slurry, free of pathogens and odours. For farmers, this odourless fertilizer is more bioavailable to crops than untreated slurry.
- Biosolid – Deposited sludge, rich in phosphorous and free of pathogens, may be delivered to composting and transformation centres or exported to other land to enrich it.

New Dairy Research Complex Up and Running

New leading edge technology is helping the Dairy and Swine Research and Development Centre in Sherbrooke, Quebec bolster its worldwide reputation as a leader in dairy production research and better address the industry's needs. The new technology is part of a new research complex opened in October 2010 to support blue-chip research, attract collaborators and attract a critical mass of scientific expertise. This infrastructure will help enhance the centre's reputation for research excellence in nutrition, physiology, immunology and molecular biology as well as lessening the environmental impact of dairy production and improving the quality of the foodstuffs produced.

Funding for the project was a result of a $12 million investment under the Modernizing Federal Laboratories Initiative of the Government of Canada's Economic Action Plan. •

AAFC Writes New Chapter for Canada's Canola Crop

Canola oil has found an important place in the world's kitchens, food processing companies and restaurants. Now, technology developed by Agriculture and Agri-Food Canada (AAFC) scientists at the Saskatoon Research Centre in Saskatchewan has created a new market for off-grade canola as a feedstock for biodiesel. And in the process, kicked off a whole new canola-based biodiesel industry in Canada.

Collaboration between scientists, industry and canola growers culminated in the grand opening of a crushing and biodiesel facility in Foam Lake, Saskatchewan in July 2009. Using technology licensed from AAFC in 2007, Milligan Bio-Tech Inc. produces high quality biodiesel from non-food grade canola (heated, green, and spring threshed) that is normally considered unusable by the industry.

AAFC has played a key role in the canola story where scientists from the Saskatoon Research Centre, the National Research Council and the University of Manitoba released the Cinderella crop to the world in 1974. A once declining crop, known as rapeseed, quickly became a valuable commodity and created an entire industry in Canada - from growers, input suppliers, researchers, crushers and processors to exporters and marketers.

By 1993, canola was well established in Canada and had healthy export markets. At this time scientists at the Saskatoon Research Centre began working with the Saskatchewan Canola Development Commission to find an economical method of producing biodiesel in Canada. The team was soon joined by a group of forward thinking and passionate canola producers from Foam Lake, now known as Milligan Bio-Tech Inc., and researchers from the University of Saskatchewan who continued to work with AAFC to develop canola based products.

This research began long before biodiesel was a household word, but the collaborators worked to overcome this and market their new products. Once the technology was developed at the bench scale, the end product was made on a large enough scale to test the market and create product awareness. The expertise of various players in Saskatchewan, such as the POS Pilot Plant, Saskatchewan Research Council and the BioProcessing Centre in Saskatoon not only gathered the data necessary to scale up the technology, they also helped increase the visibility of the project.

As part of the field testing in 2002, the team joined forces with Saskatoon Transit and introduced the "Bio Bus", still in operation, to examine how biodiesel would affect the fuel consumption, engine wear, and longevity of these heavy duty engines. Additional field testing during the 2007-08 Alberta Renewable Diesel Demonstration confirmed the suitability and operability of low level renewable biodiesel blends in cold weather. Managed by Climate Change Central and sponsored by AAFC, Shell Canada Ltd., the Canola Council of Canada, Milligan Bio-Tech and others, the field tests became Canada's largest study into the cold weather performance of renewable diesel with over 60 trucks of various sizes taking part in the demonstration.

Throughout the years and with the input from various field tests and end users, canola biodiesel has continuously improved to the point of passing both North American and European standards. Milligan now also supplies other canola based products including diesel fuel conditioner, penetrating oil, road dust suppressant, and oil and meal feed supplements to the agriculture, aviation, forestry, trucking and mining industries as well as to some provincial and municipal government departments for use in their fleet vehicles. Sales of these products have increased every year since Milligan began production in 2001 to supply growing markets across Canada, the United States and overseas.

Biodiesel can replace a significant percentage of petroleum diesels worldwide with a positive environmental effect. While other forms of biofuel have been said to compete for food production, the Canadian technology increases total food production by recovering the low quality stream and converting 70 per cent of the seed to animal feed.

In addition, the biodiesel technology developed in Saskatchewan will help the Canadian industry meet federal targets requiring five per cent renewable fuel content in gasoline by December 15, 2010, and a further two per cent in heating oil and biodiesel this year.

The technology also enables the use of oilseed crops in high value applications, constitutes a more cost effective process for refining waste from the oilseed industry, reduces the cost of producing biodiesel, allows manufacturers to diversify their product offerings and increases the performance of biodiesel for the consumer.

At the local and provincial level, through job creation and economic benefits, the impact of Milligan Biotech's development has been significant to Foam Lake and to Saskatchewan. The company now has a total investment of over $15 million and employs 28 people in Foam Lake, a town of only 1200. The future looks bright for Milligan as they continue to introduce new products and have plans to expand to a MegaPlant capable of producing 150 million litres of biodiesel per year by 2012. •

Flax Dehulling Technology Makes the Impossible Possible

Thanks to an innovative technological discovery by Agriculture and Agri-Food Canada (AAFC) researchers at the Guelph Food Research Centre, one of the world's oldest and most sought after crops is now more readily available for consumption and industrial use. The researchers have developed a novel, comprehensive shelling process, known as flax dehulling technology, which effectively separates the hull from the kernel.

This separation of hull and kernel is necessary since the human digestive system cannot break down the flaxseed's tough outer shell, known as the hull. Once digested, the seed merely passes through the digestive tract and the nutritional benefits remain inaccessible to the body. And, while it may seem logical to simply remove the hull before ingestion, the physical characteristics of the seed – tiny, flat, smooth – have made removal of the hull anything but simple.

The patented dehulling process involves treating or drying the seed to remove any existing moisture, using mechanical friction or abrasion to break the hull from the kernel, and blowing air through the mixture to separate the various components by density. Throughout this process, both the hull and kernel remain intact and the cells where the oil resides within the kernel are undisrupted. When consumed, the flaxseed, *sans hull*, can easily be broken down and absorbed by the body.

AAFC researchers at Guelph confirmed that the dehulled flaxseeds offered the same nutritional benefits as other flax products and were much easier to store. While flaxseed oil and ground flax require refrigeration to avoid oxidation, which results in a loss of nutritional value and produces a rancid odour, the flax dehulling technology eliminates the threat of oxidation. Since the oil remains safely contained within the kernel, the dehulled seeds can be stored at room temperature for up to one year.

AAFC researchers took their success to a commercial scale and collaborated with Natunola Health Inc., a Canadian company and leading supplier of botanical ingredients in the functional food and cosmetic industry. As a result, Natunola built the world's first manufacturing plant for dehulling flaxseed products in 2002.

Located in Winchester, Ontario, the Natunola plant currently provides shelled flax and flax extracts for a variety of industry partners. As a key ingredient in a variety of products, including baked goods and dairy products as well as creams, lotions, shampoos, body washes and cosmetics, Natunola's flax products are used by clients for a wide range of retail products.

This technology has also had an impact on other food and nutraceutical industries. For example, the dehulling process is being tested on other crops, such as hemp. It also created new functional ingredients using omega-3 fatty acids, lignans and fibre extracted from the kernel, hull and the processing by-products (powder). These ingredients have in turn helped develop new food products and processing technologies as well as new raw materials for the nutraceutical industry including omega-3 flax kernel, flax hull, flax fibre, as well as milled flax and flax meal. •

Roses Take Flight

In 2010, the Canadian Nursery Landscape Association (CNLA) acquired much of the Agriculture and Agri-Food Canada (AAFC)-developed genetic material for roses and ornamental trees and bushes and is making the long-term investment in developing new genetic material for the national industry.

This investment of time and energy follows the tradition set forward by AAFC scientists at the Central Experimental Farm in Ottawa and then in Morden, Manitoba, and Saint-Jean-sur-Richelieu, Quebec, who undertook to develop rose bushes that would thrive under Canadian conditions. They began by finding cultivars able to resist the harsh conditions of the northern latitudes. They then developed valuable genetic material for the desired disease resistance and flower scent. For example, *Simon Fraser,* from the Explorer series, can produce lovely roses under snow in November! It is highly disease resistant, has very few thorns and grows into a magnificent bush. Other varieties show different desirable traits, such as the delightfully fragrant *David Thompson.*

The combination of desirable traits which led to the success of AAFC roses in Canada and abroad, is the result of close collaboration between nurseries and AAFC research scientists. For example, Explorer and Parkland Series roses are easily propagated using soft wood cuttings and have excellent growth and development potential on their own roots, which eliminates the need for grafting. Since 1994, AAFC has received approximately $2 million in royalties for its genetic material alone.

Following this model of close collaboration, competing businesses in the ornamental plant industry have united and will work together on the long-term development of new crop material. The CNLA has over 3,600 members and represents the interests of nine provincial non-profit associations for landscapers, garden centres and nurseries. Under the terms of the transfer, the CNLA has engaged the Vineland Research and Innovation Centre in Ontario to use the material for breeding purposes. •

Centre Honoured by Nova Scotia Fruit Growers

In recognition of 100 years of cooperation and support, the Nova Scotia Fruit Growers Association (NSFGA) has bestowed an honourary membership on the Atlantic Food & Horticulture Research Centre (AFHRC) for their efforts to help develop a viable and sustainable tree fruit industry in Atlantic Canada. The award was accepted in January 2011 on behalf of AFHRC by Dr. Mark Hodges at the NSFGA's 147th Annual Convention.

Located in western Nova Scotia's Annapolis Valley, the centre's programs are unique in addressing problems throughout the Canadian horticultural and food system while emphasizing the regional needs of Atlantic Canada. Current research at the centre focuses on primary production, crop protection, soil and water evaluation, post-harvest storage, food quality assessment, pilot plant processing of food and consumer safety using a multi-disciplinary approach at all levels from the field to the consumer. •

Cluster Strengthens the Science behind Organic Agriculture

While the Canadian organic sector is reporting strong growth of 15 to 20 per cent annually, four out of five organic products consumed in Canada are currently being imported. A newly formed Organic Science Cluster hopes to correct this by uniting scientists and coordinating their research efforts to increase the quality and quantity of Canadian organic products and support ecologically sound farming practices. Their research will help Canadian organic farmers capture more of the $2 billion domestic market and improve their ability to compete in world markets.

The Organic Science Cluster includes research activities in nine provinces and involves more than 80 researchers and scientists from all major Canadian agricultural universities and AAFC. The participants include leading scientists in organic agriculture, who will work alongside other scientists who are leaders in their respective disciplines.

Both the Organic Federation of Canada and the Organic Agriculture Centre of Canada (OACC) played an instrumental role in securing industry funding for the project. The Director of the OACC believes that in this challenging period of declining oil supplies, increasing climate change and economic shifts, research findings in organic agriculture offer options for all farmers and consumers. As Canadian consumers turn increasingly to organic products, the research will help Canadian farmers take advantage of the resulting opportunities.

The Organic Science Cluster will be supported through 2013 with $6.5 million in funding through AAFC's Growing Forward Program, complemented by $2.2 million in funding from 20 industry partners. The announcement of the official launch of Canada's Organic Science Cluster and the associated funding was made in Truro, Nova Scotia in September 2010.

To learn more about Canada's Organic Science Cluster, visit www.agbio.ca and click on the Organic Science Cluster link. •

The information produced by the Organic Science Cluster will be disseminated to the industry and add to the credibility of organic farming practices and scientific advances in this sector. The 30 research activities have specific research goals aimed at:

- Significantly improving phosphorus use efficiency in organic crop production by increasing knowledge in various areas, such as the role played by mycorrhizae;
- Enhancing organic cereal crop breeding;
- Improving the energy efficiency of organic greenhouse production, by optimizing fertilizer and irrigation management and harnessing geothermal energy to achieve zero emissions;
- Developing low-till production practices without herbicides;
- Evaluating growing media for vegetable transplants in greenhouse and field production;
- Developing effective systems for the management of organic horticultural crops and studying the effect of stocked or unstocked rotations on nitrogen;
- Characterizing the contribution of organic production to reducing greenhouse gas emissions, with the aim of modifying management approaches and protecting the global environment;
- Overcoming impediments to high value fruit production, with a focus on day-neutral strawberries which have the ability to flower and fruit continuously, everbearing raspberries and apples.

AAFC Captures Seed of the Year Awards

Hats off to AC Metcalfe barley and Estival lettuce! These two varieties developed by Agriculture and Agri-Food Canada (AAFC) scientists captured top honours in the annual Seed of the Year competition in 2010. The competition, hosted by SeCan and the University of Guelph, recognizes publicly-developed varieties that have made a significant contribution to the economy, agriculture, and the Canadian public in general. And these two AAFC varieties are no exception.

The western winner, AC Metcalfe, is a two-row malting barley variety developed by AAFC scientists in Manitoba at the Brandon Research Centre and the Cereal Research Centre in Winnipeg. AC Metcalfe received full registration in 1997 and was an advance in agronomic, disease resistance and quality traits. This barley is used in multiple markets and is known for its consistency, high enzyme levels, rapid throughput in the malthouse, and high levels of fermentable extract. Maltsters and brewers throughout the world demand the quality of AC Metcalfe for their products.

Estival lettuce, the eastern winner, was developed by scientists at the Horticultural Research and Development Centre in Saint-Jean-sur-Richelieu, Quebec. This promising new cultivar has outstanding performance, sustainability, marketability and industry acceptance – currently holding 18 per cent of the total crisphead or iceberg lettuce sold in Canada. This high-quality lettuce variety is better adapted to extreme weather conditions and was developed specifically for both the fresh and processing markets. It also has a high tolerance to bolting and rib discolouration and has a greater capacity over other popular varieties to produce a high head weight on a short stem.

These two varieties add to the long list of exceptional new crops developed by AAFC scientists during the past 125 years to enhance the Canadian agricultural industry. •

Scientist Wins Science Writing Award

Agriculture and Agri-Food Canada (AAFC) research scientist Dr. Ernest Small has been named winner of the Lane Anderson Award for Canadian Science Writing in the adult category for his book *Top 100 Food Plants: the World's Most Important Culinary Crops*. The $10,000 award was given out at a ceremony in Toronto on September 21st, 2010.

Top 100 Food Plants reviews scientific and technological information about the major food plants and their culinary uses. All categories of food plants are covered and information is provided on scientific and common names, appearance, history, economic and social importance and food uses, including practical information on storage and preparation.

The book is intended to be a reference guide for specialists in agricultural areas, but gardeners, cooks, and those interested in human health as it relates to diet will also find this volume appealing because of the user-friendly presentation and the hundreds of attractive illustrations included.

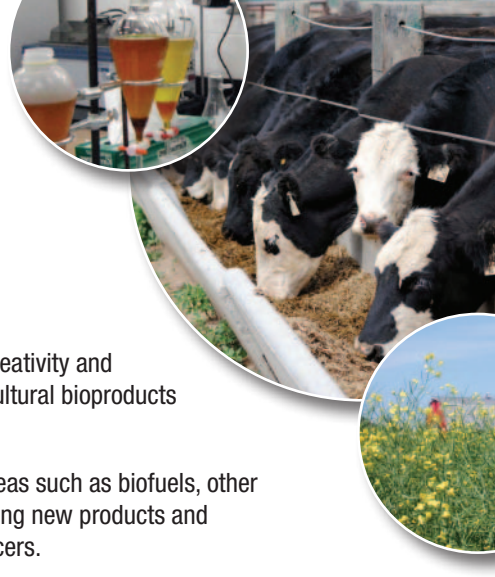
Dr. Small, a scientist at AAFC's Eastern Cereal and Oilseed Research Centre in Ottawa, is the author of thirteen books and over 300 scientific publications on plants.

Top 100 Food Plants is published by the National Research Council of Canada (NRC):

http://pubs.nrc-cnrc.gc.ca/eng/books/books/9780660198583.html •

> "*A massively-detailed and highly informative compilation of what we eat and its origins. Every Canadian should see this encyclopedic book.*"
> – Lane Anderson Award Jury.

Note: The previous issue of Innovation Express Vol2 No2 did not contain a complete list of Order of Canada recipients from AAFC. A full list of recipients can be found on the AAFC website under the Scientific Staff and Expertise page at www.agr.gc.ca/scienceandinnovation



Innovations from the Agricultural Bioproducts Innovation Program

The multi-year Agricultural Bioproducts Innovation Program (ABIP) created networks of talent, creativity and resources from academia, industry and governments to build greater research capacity in agricultural bioproducts and bioprocesses in Canada.

The program promoted research, development, technology transfer and commercialization in areas such as biofuels, other forms of bioenergy, industrial chemicals, biomaterials, and health products. This work helped bring new products and processes to the marketplace, and opened the door to greater opportunities for Canadian producers.

ABIP's nine networks, listed below, involved 36 universities, 52 industry groups, and 19 government organizations.

- Industrial Oil Seed Network (IOSN)
- Cellulosic Biofuel Network (CBioN)
- Canadian Triticale Biorefinery Initiative (CTBI)
- Sustainable Cropping System Platforms for Biodiesel Feedstock Quantity and Quality (SBQQ)
- Agricultural Biorefinery Innovation Network for Green Energy, Fuels and Chemicals (ABIN)
- Feed Opportunities from the Biofuels Industries (FOBI)
- Natural Fibres for the Green Economy Network (NAFGEN)
- Pulse Research Network (PURENet)
- BioPotato Network

Each ABIP network exemplified Agriculture and Agri-Food Canada's (AAFC's) commitment to encourage and facilitate collaboration and partnerships across sectors and disciplines to progress from basic research to application. Many of the networks were groundbreaking in the extent of the collaboration they achieved, harnessing strengths from diverse partners to work toward a common goal. Here are some examples of the progress made by the network partners.

The Sustainable Cropping System Platforms for Biodiesel Feedstock Quantity and Quality (SBQQ) network has developed a strong field-based program for key crop species (e.g., canola, mustard, camelina, flax, soybean) and has worked together to achieve their goal of ensuring an adequate supply of Canadian-grown, oil crop feedstock for use by the biodiesel industry in Canada and abroad to produce high-quality biodiesel. The network has made progress in determining how biodiesel quantity and quality are influenced by agronomic and environmental factors and was involved in extensive work in profiling oils, determining biodiesel sample adherence to biodiesel standards, and identifying compounds that influence biodiesel quality. They also conducted research to determine the pest management and sustainability implications of growing canola in rotations that do not have recommended levels of diversity.

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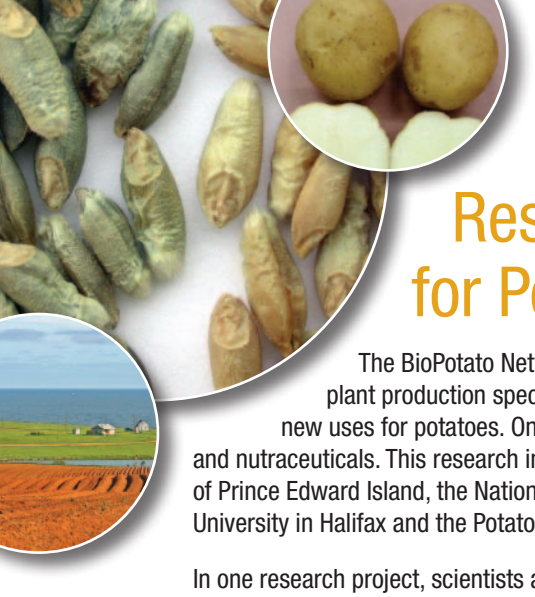


Research Paints a Colourful Future for Potato Products

The BioPotato Network combined the expertise of plant breeders, food scientists, molecular biologists, and plant production specialists to commercialize potato extracts, develop healthier potato varieties, and discover new uses for potatoes. One of the four areas of focus for the network was the development of potato functional foods and nutraceuticals. This research involved the investigation of potato bioactives and their health interactions at the University of Prince Edward Island, the National Research Council's Institute of Nutrisciences and Health in Charlottetown, Dalhousie University in Halifax and the Potato Research Centre in Fredericton.

In one research project, scientists at the Food Technology Centre adapted the potato granulation process used to make dehydrated instant mashed potatoes to include anthocyanin-rich colourful potatoes bred at AAFC's Potato Research Centre.

Anthocyanins, the natural colourants found in fruits and vegetables, have recently been studied for their nutritional aspects and anti-oxidant activities. The research chefs at Holland College, Canada's Smartest Kitchen, used the anthocyanin-rich potato granules to develop new functional food product concepts for commercialization such as colourful mashed potatoes.

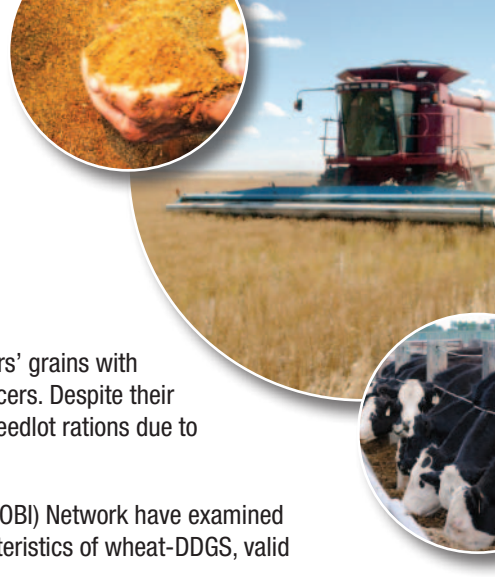
Triticale Poised to Become Canada's Bio-Industrial Cereal

Triticale may never displace wheat as Canada's number one cereal but research through the Canadian Triticale Biorefinery Initiative (CTBI) has brought the crop closer to being recognized as Canada's bio-industrial cereal.

Triticale, a hybrid of wheat and rye, is a source of carbohydrates including starch, cellulose and hemicellulose that can be used to produce chemicals and fuels derived from simple sugar chemistry, and a competitive source of fibre and raw biomass. The development of new specialty lines of triticale and advanced processing technologies will enable triticale to become a valuable renewable resource for chemicals, fuels and biomaterials such as natural fibre reinforced composites, and thermoplastic starch based polymers and composites.

To track the genetic purity of new lines, scientists at Agriculture and Agri-Food Canada's (AAFC's) Lethbridge Research Centre in Alberta have introduced a blue-coloured seed which will be incorporated into future bio-industrial varieties of triticale. The blue seed colour is used as a marker by scientists at the University of Alberta to indicate gene transfer to help determine if genes from triticale are transferred to wheat or other triticale crops via pollen. This research helps ensure that new triticale varieties can be grown without adverse effects on existing markets.

Initial results suggest that triticale has a low frequency of crossing with common and durum wheat. Best management practices, however, such as careful seed handling and certified seed production should maintain variety purity while the blue triticale seed for bioproducts will help ensure that mixing of seed is minimized. As genes to improve the bio-industrial properties of triticale are introduced, the blue seed and completion of biosafety work has provided CTBI with the necessary information to deliver new varieties to producers as quickly as possible.



Wheat Distillers' Grains May Benefit Bottom Line for Livestock Producers

With the recent expansion of the wheat-ethanol industry in western Canada, wheat dried distillers' grains with solubles (wheat-DDGS) have become a readily available, low-cost ingredient for livestock producers. Despite their availability, wheat-DDGS are currently used infrequently and at relatively low inclusion rates in feedlot rations due to the limited information on nutrient/feed quality, composition and impact on animal performance.

To address these concerns, researchers with the Feeds Opportunities from Biofuels Industries (FOBI) Network have examined various nutritional aspects and produced a comprehensive set of information on nutrient characteristics of wheat-DDGS, valid for a wide array of livestock operations including beef, dairy, swine, poultry and fish.

The results from animal trials have shown that wheat-DDGS can be used as sources of both energy and protein depending on the type of livestock and, at a significantly higher inclusion rates than previously recommended. For instance, wheat-DDGS can replace 50 per cent of the barley normally used in diets given to back-grounding cattle, while in feedlot animals it can be included as high as 40 per cent of the diet without affecting health, meat quality or performance. Similarly, wheat DDGS can be successfully included in the diets of grower-finisher pigs by up to 25 per cent and 10 per cent in broiler chicken diets.

Inclusion of DDGS means a significant cost savings to livestock farmers while creating a ready market for the wheat-DDGS, a win-win situation leading to a synergetic integration of the wheat-ethanol and livestock industries.

NAFGEN Member Expands both Capacity and Capability

The key focus of the Natural Fibres for the Green Economy Network (NAFGEN) was on developing the full potential of currently underutilized natural fibre crops, such as flax and hemp, and facilitating their entrance into new and expanding fibre markets. This research examined feedstock production, crop management (with emphasis on straw harvesting techniques) and product development.

Schweitzer-Mauduit Canada (SMC), a key member of NAFGEN, processes approximately 100,000 tons of flax straw annually from Manitoba, Saskatchewan and North Dakota to create bast fibre for paper and flax shives for horse bedding, soil erosion control and biofuels. The flax fibre can also be substituted for fibreglass and other petroleum based products to produce superior products and help manufacturers lower their carbon footprint.

Schweitzer-Mauduit worked closely with other NAFGEN scientists at the Composites Innovation Centre in Winnipeg, Manitoba, Tekle Technical Services in Edmonton, Alberta and Agriculture and Agri-Food Canada in Morden, Manitoba, to assess fibre quality and its suitability for processing and have produced test scale batches for marketplace assessment. This research has helped generate the technical knowledge and the business case to proceed with a $1,120,000 expansion of SMC's plants in Carman and Winkler, Manitoba.

With the new equipment, SMC will develop and produce a line of renewable and sustainable biomaterials to serve the growing bio-economy throughout North America. Completion of the expansion will allow the company to access new markets, which in turn will provide additional revenue, value chain businesses and jobs on the prairies.

Funding for the expansion came from the Canada/Manitoba Growing Forward initiative, Manitoba's Entrepreneurship, Training and Trade's Technology Commercialization Program, matching funds from SMC and the National Research Council.

‘Eco-pactor’ Helps Make Toronto Green

Canada’s largest landlord has begun using technologically “smart” Eco-pactors containing specially formulated, environmentally-friendly bio-oil as a substitute for petroleum-based hydraulic fluid in trash compactors across Metro Toronto.

The Eco-pactor pilot project was initiated by Linnaeus Plant Sciences Inc., the network lead of the Industrial Oilseed Network (IOSN), in partnership with the Toronto Community Housing Corp. and equipment-maker Metro Compactor Service Inc. Linnaeus has been working with the housing corporation and the compactor-maker to begin roll out of this next generation of garbage compactors.

The Toronto Community Housing Corp., with almost 60,000 units and 160,000 tenants, predicts it could save between $1-million and $2-million a year in waste removal costs by using this next-generation of compactors that feature renewable plant-based fluids and electronic sensors to reduce garbage truck fuel consumption.

The old petroleum-based hydraulic fluid in the garbage compactors has been replaced with a high-performing bio-based lubricant formulated from canola oil grown on farms in western Canada. This new oilseed-based fluid is totally renewable, bio-degradable, and is far less toxic than traditional petroleum-based oil. It reduces greenhouse gas emissions while offering better lubricating qualities and higher viscosity than traditional petroleum-based oil.

Linnaeus Plant Sciences Inc. expects to see wider public use of its innovative, homegrown, 100 per cent renewable bio-friendly vegetable oils – products that can be used as a petro-chemical substitute – to make industrial and household lubricants, motor oils, plastics, nylon and greases. With interest from major end-users such as the Toronto Community Housing Corp., Linnaeus hopes to leverage its flexibility and take this to the next step, making a variety of bio-based oils that will benefit consumers, farmers, and all Canadians while helping protect the environment for future generations.

Agri-Therm Inc. Posts Gains in Technology Transfer and Commercialization

New legislation in Europe and the United States now requires that a sizeable and increasing percentage of domestic energy be derived from renewable sources, yet neither market has the resources or technology to meet this demand. With funding from the Agricultural Biorefinery Innovation Network (ABIN), a Canadian company has created a mobile unit that turns waste from agriculture, forestry and food processing into renewable fuel products.

Agri-Therm Inc., a spin-off company from the University of Western Ontario, has developed the first mobile pyrolysis process to rapidly convert low value bio-residue into higher-value bio-oil and bio-char and decrease the costs of transporting the raw material to conventional fixed pyrolysis plants. For example, the mobile unit can be brought directly to a logging operation where it converts low value wood chips into higher value, low volume bio-oil and bio-char with a much greater energy density than the original feedstock. Pyrolysis breaks down organic matter by using high heat in the absence of oxygen.

The Agri-Therm technology is being tested with a variety of feedstocks including agricultural residues (such as tomato and grape residues from juicing) and co-products of other energy industries (dry distiller’s grains and sugar cane residues). The versatile unit has a capacity of 10 tons of dry feedstock per day, and also produces a co-product gas which is recycled as an energy source back into the process. The operating conditions of the unit can also be adjusted, depending on the feedstock, to maximize either the bio-oil or the bio-char products to achieve liquid bio-oil yields of up to 70 per cent of the original feedstock mass.

Agri-Therm is presently designing and manufacturing the second generation mobile pyrolysis pre-commercial demonstration unit and is collaborating with ABIN researchers on bio-oil upgrading, utilization and technology transfer. This allows Agri-Therm to anticipate technological advances and future market needs and improve their mobile technology as they develop new generations of the unit. Agri-Therm will soon launch a pilot study to test their unit in the field and transfer the technology to a commercial industrial scale.

Research Spurs Biofuel Production from Agricultural Cellulosic Biomass

The most abundant biomass feedstock available for renewable bio-energy production is fibre readily found in agricultural food-crop residues such as stalks, straws and chaff, and forestry residues including wood chips and unusable damaged trees, renewable land cover like grasses and trees, plant-based garbage, and waste paper products.

The starch in wheat and corn grains is currently used as a source of fermentable sugar to make bio-ethanol in Canada. But starch is an energy-producing food product, and as a biomass feedstock, it can produce only a small fraction of the ethanol needed on a national and global scale. Cellulosic biofuels are primarily derived from the cellulose, which comes from the fibre in stalks and straws, leaving grains for human and animal consumption. The huge amount of potential energy available from plant fibre is attracting attention and investment worldwide.

In Canada, the Cellulosic Biofuels Network has helped overcome current technological and economic barriers that limit the formation of a Canadian fibre-based biofuel by investigating sustainable low-cost agricultural biomass production and working to decrease reliance on expensive physical and chemical pre-treatments. Researchers are also studying and modifying plant cell-wall composition and developing better enzymatic and fermentation tools to transform fibre efficiently into the fermentable sugars needed to produce bio-ethanol.

The breadth of the Canadian land mass with its vast agricultural and forestry base offers a tremendous advantage for the production of biomass and biofuels. The creation of a cellulosic bio-ethanol industry will also help sustain two viable domains by providing a new source of revenue for farmers, while maintaining food production capacity.

Pulse-based Diets Show Potential Health Benefits

Over the past 20 years, Canada's production of eight major pulses and specialty crops -- pea, lentil, bean, chickpea, mustard, sunflower, canary seed, and buckwheat -- has increased fivefold from 1 million to 5.6 million tonnes per year (http://www.pulsecanada.com/pulse-industry). Canadian pulse exports generated $2.2 billion and accounted for about 35 per cent of the global pulse trade in 2009. Globally, pulse consumption has continued to decline on a per capita basis but this is being offset by an ever-growing population.

With an eye toward protecting a valuable Canadian industry, pulse producers and processors are focused on firmly establishing the health and wellness benefits of pulses, creating high-value novel foods and ingredients for a larger number of food formulations, and nutraceuticals, and proving the environmental benefits of growing pulse crops. Research through the Pulse Research Network (PURENET) has significantly advanced scientists' understanding of how pulse-based diets of peas, lentils, beans, and chickpeas impact human health and has successfully developed new pulse-based food concepts and pilot products.

For example, scientists at the University of Saskatchewan have studied the effects of a pulse-based diet on cholesterol and blood glucose levels in people 50-years and older, a demographic at increased risk of diabetes and heart disease. Eighty people participated in the study and consumed a pulse-based diet twice per day for two months. A comparison of blood chemistry before and after the study period showed that the participants' fasting glucose and cholesterol levels were significantly reduced.

Tell Us What You Think

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

We welcome your comments and suggestions.

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AAFC No. 11417B
ISSN 1920-0471 (Print/Imprimé)
ISSN 1920-048X (Online)
ISSN 1920-0498 (En ligne)