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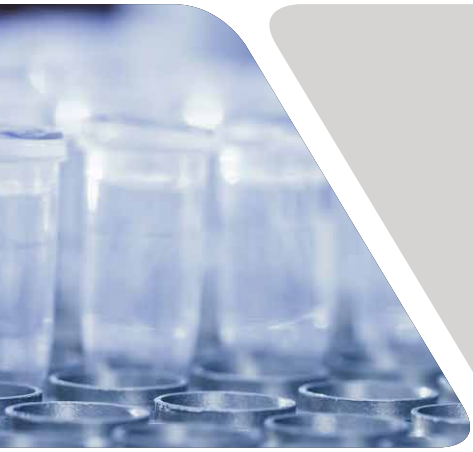


Grain Research Laboratory
Annual Program Report
2015

Canadian Grain Commission
Commission canadienne des grains

Canada

Our Mandate:

The Canadian Grain Commission works in the interests of grain producers. Guided by the *Canada Grain Act*, the Canadian Grain Commission works to establish and maintain standards of quality for Canadian grain, regulate grain handling in Canada, and to ensure that grain is a dependable commodity for domestic and export markets.

Our Vision:

To be a world class, science-based quality assurance provider.

Contents

Director's Welcome

Dr. Stefan Wagener
Director, Grain Research Laboratory

"Today's scientific analyses, research and technology projects by the Grain Research Laboratory are tomorrow's grain quality and safety assurance for Canada." – Stefan Wagener

In continuing with the tradition of previous years, I am pleased to present to you an annual report on the key activities and responsibilities of the Grain Research Laboratory and its nine programs. As the new director of the Grain Research Laboratory, I would also like to thank and acknowledge Dr. Peter Burnett for his dedication and commitment to Canada's federal public service and the Grain Research Laboratory. He retired in January of 2014.

2015 was a year of reflection and planning after coming out of a period of significant workforce adjustments within the Government of Canada, including the Canadian Grain Commission. Within the Grain Research Laboratory we saw the consolidation of programs and the reduction of staff. In the end, we emerged with a smaller workforce and a more focused approach to grain quality and safety research and services. The nine programs, their managers and staff within the Grain Research Laboratory will be introducing themselves as part of this report.

Some of the services in which we are involved include analyzing the annual harvest material; providing plant breeder variety quality assessments; monitoring for variety composition and contaminants like mycotoxins, GMOs and many other quality and safety factors. In addition, our specialized research and technology programs at the Grain Research Laboratory are highly focused programs providing significant benefits now and in the future for the Canadian Grain value chain.

To further strengthen the Grain Research Laboratory, we undertook a science and technology project review with external experts. An executive summary of this review is included in this report and copies of the full report are available upon request.

I have the pleasure and privilege to work with a group of highly dedicated, experienced and well-recognized scientists and staff. Their productivity and motivation are key to our success in providing the scientific evidence and justification for our Grain Quality Assurance and Grain Safety Assurance programs here at the Canadian Grain Commission.

I encourage you to read this report and discover for yourself the diversity of topics and focus areas within the Grain Research Laboratory and share with us your comments and thoughts. We greatly appreciate your feedback.

Overview

The research conducted by the Canadian Grain Commission's Grain Research Laboratory falls under two categories: **crop research** and **technology research**.

Research related to crops assesses Canadian grain harvest quality and studies how grading factors affect end-use properties. Crop research also develops new uses for Canadian grain and evaluates new varieties as part of the variety registration process.

Research related to technology evaluates and develops methods used to assess the quality and safety of Canadian grain.

Crop research programs include:

- Bread and Durum Wheat Research
- Milling and Malting/Research on Barley and Other Grains
- Wheat Enzymes, Asian Products and Analytical Services
- Pulse Research
- Oilseeds

Technology research programs include:

- Variety Identification Research and Monitoring
- Trace Organics and Trace Elements Analysis
- Microbiology
- Grain Biotechnology Research

Beyond each program's own testing and research, all of the programs support four key activities:

Cargo quality monitoring

Provides analytical testing of export grain shipments (e.g. mycotoxins, pesticides, variety composition) to ensure they meet Canada's grading and quality parameters.

Plant breeder line evaluation

Provides testing and recommendations for the advancement of breeder line seed.

Harvest Sample Program

A yearly survey of the crop quality for that year's harvest. Producers send in a voluntary sample of their harvest, and in return receive a free, unofficial Canadian Grain Commission grade. Data from this survey is used to generate a harvest quality report of Canadian grain.

Requests for service analysis

Provides analytical services of samples submitted by the industry for testing, at times for a fee.

GRL Statistics and Facts

In 2015

50 tours visited the Grain Research Laboratory

We met **327 visitors** from **around the world**

THE HARVEST SAMPLE PROGRAM received over **11,850 samples** for the 2015-2016 season

Our research scientists and staff gave over **25 presentations nationally and internationally**

Out of **20 grains** regulated by the Canadian Grain Commission, we analyze **15 different types of grains:**

- peas
- lentils
- wheat
- durum
- barley
- oats
- buckwheat
- chickpeas
- beans
- mustard
- flaxseed
- rye
- soybeans
- canola/ rapeseed

12 scientific publications were published by our scientists

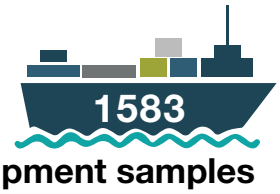
We employ **65 full time** employees.

In total, we conduct approximately **55,000 individual tests a year**

As well, we hire **additional staff** for the **Harvest Sample Program** and we hire co-op students and temporary employees to work on specific projects throughout the year

Our **staff members participate in farm shows** to **meet attendees and answer questions**

We tested **1583 export cargo shipment samples**



We conducted **1416 tests** for service requests by external clients, which included milling of **311 samples**

The most popular requests were for wet gluten followed by alveograph testing

Currently, we use over **90 different test methods**

Bread and Durum Wheat Research

Dr. Bin Xiao Fu


1

Our overall goal is to support the Canadian wheat quality assurance system.

We conduct quality analyses of composite samples created from samples submitted via the Harvest Sample Program. These analyses provide information on the new crop quality characteristics of the major Canadian wheat classes.

We monitor the quality of wheat cargoes at export and investigate cargo complaints.

Our program also evaluates the quality of new wheat lines before they are registered, and identifies which new varieties are eligible for the Canadian Grain Commission's variety designation lists.

Our research determines the effects of grading factors (e.g. mildew) on wheat quality. As well, we identify and characterize biochemical components that are responsible for wheat quality. The other research priority is to develop new methods or modify existing ones to measure end-use quality more effectively and efficiently.


2

Our relevance to the industry

Many participants in the grain industry, from breeders developing new lines to customers of Canadian grain, use information we generate through our quality assurance and research activities. For example, wheat exporters use quality data generated by the Harvest Sample Program to market Canadian wheat. Buyers use quality data to determine how Canadian wheat will perform in their facilities.


3

Our quality evaluation of new varieties of wheat provides a link between marketplace quality requirements and the plant breeder. Changing market demands are satisfied by new wheat varieties that have the required end-use quality characteristics.

Cargo quality monitoring allows us to verify that the exporter delivers based on customer requirements, and the quality assurance system and grade standards meet industry expectations.

For each type of visual damage assessed by grading, we determine the degree and intensity of harmful effects on end-processing quality, providing a scientific basis for tolerances for each grading factor.

We develop new and improved analytical and technical tools that are faster, more accurate, less costly, or more specific and that will quantify the functionality of wheat based on its physicochemical properties. Research on the biochemical basis of quality often leads to the development of new methods to measure quality more specifically and provides new screening tools for wheat breeders in developing new varieties with improved quality.

What we're working on

We're developing a high throughput screening method for gluten strength. Gluten, or dough strength, is a key intrinsic quality trait considered when a Canada Western Red Spring wheat variety is being evaluated for quality, part of the registration and classification process. The method is based on the extensograph, an instrument that measures dough's resistance to being stretched or extended before tearing. Higher gluten strength dough is more resistant. The new method will reduce the required wheat sample size from two to three kilograms to 250 grams or less. It will also increase the output from five to six samples a day to 15 to 20 samples a day.

In durum, a specific minimum content of hard vitreous (HVK) kernels is a primary factor in grading and marketing. We're conducting a study to investigate the effect of HVK on durum wheat quality. We're using a few unique sample sets as part of this study.

Other ongoing research projects include:

- Developing a test bake method with improved discrimination power
- Studying fractionation and quantification of key gluten protein fraction in relation to dough strength
- Studying the effect of mildew on wheat quality

Staff

One research scientist

Two chemists

Six scientific support staff

Short bibliography

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Fu, B.X., Schlichting, L., Pozniak, C.J., and Singh A.K. (2013). Pigment degradation power in durum wheat semolina: measurement and relationship with pasta colour. J. Cereal Sci. 57: 560-566.

Fu, B.X., Schlichting, L., Pozniak, C.J., and Singh A.K. (2011). A Fast, Simple and Reliable Method to Predict Pasta Yellowness. Cereal Chem. 88(3):264–270.

Photo captions:

1. Dough is placed in the Brabender extensograph before evaluation.
2. Dough is stretched during the evaluation of dough visco-elastic properties by Brabender extensograph.
3. Resting of wheat dough pieces during the evaluation of dough visco-elastic properties by Brabender extensograph.
4. Two loaves of bread with diverse quality baked with the newly developed Lean No Time Dough Method.

Milling and Malting/Research on Barley and Other Grains

Dr. Marta S. Izydorczyk

We identify, characterize, and quantify components and molecular mechanisms responsible for the quality, functionality and performance of Canadian barley and other grains, such as oats and buckwheat. Our research activities involve assessing genetic, agronomic, and environmental factors that affect the quality and performance of barley during malting and brewing processes. We also quantify and characterize bioactive components in barley and other grains such as beta-glucans, dietary fibre, vitamins, and minerals. As well, we develop technological processes that will allow manufacturers to use barley and other grains in new and different ways.


1

We evaluate instrumental techniques and develop methods and protocols for measuring and predicting the quality and value of barley. We support the Grain Quality Assurance program by monitoring the quality of barley destined for export, evaluating the quality of advanced breeders' lines and assessing the quality of malting barley produced in western Canada.

Our relevance to the industry

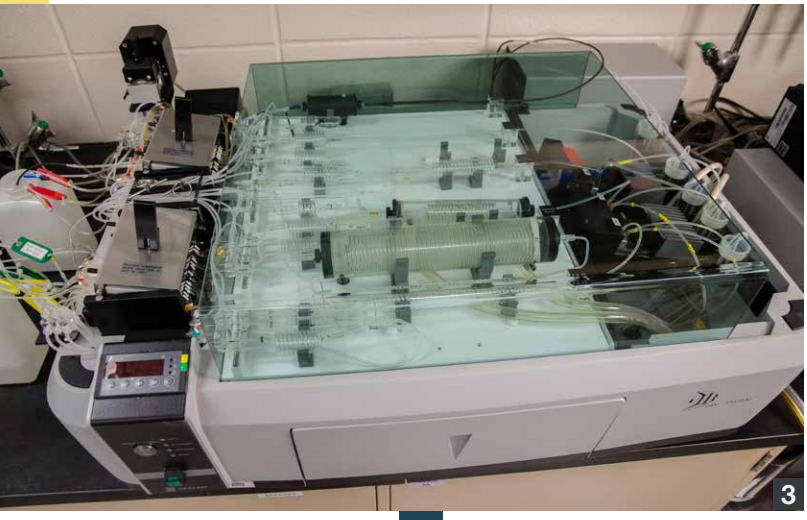
The knowledge and data generated by our activities helps us provide the expected scientific evidence and information to the agri-food sector. Our research helps develop effective and innovative strategies for improving the properties of Canadian barley and other grains that affect products made out of them. Our research also helps develop effective and innovative strategies for improving the processing performance of barley and other grains.

Every year we provide detailed information about the quality of malting barley to marketers, end users, and customers of Canadian barley. Our annual harvest survey report provides detailed information on the quality of malting barley associated with each variety and growing region for the newly selected barley crop.


2

Our assessment of the quality and processing properties of advanced barley breeding lines support the development of improved malting and food barley varieties.

We provide quality information to marketers and customers of Canadian wheat and to Canadian wheat breeders. This is based on our evaluation of the milling performance of wheat samples from cargo shipments and the current harvest. As well, we appraise the milling performance of advanced wheat breeding lines.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What we're working on

We're studying:

- Quality and yield response of malting barley varieties to increasing nitrogen rates
- Effects of rate and timing of a pre-harvest glyphosate application on seed germination and quality of malting barley
- Effect of plant growth regulator application on yield and quality of malting barley
- Improving malting barley production in eastern Canada through the development of improved cultural practices
- Effects of digestibility of barley cell wall polysaccharides on viscosity and filterability of wort
- Effects of seeding rate and nitrogen fertilization rate on beta-glucan levels in hull-less barley across various soil and climatic zones in western Canada
- Steam processing of barley grain for retention of high molecular weight of beta-glucans in whole grain and in barley milling fractions
- Effects of genetic and environmental factors affecting the content and composition of vitamin E in hull-less and covered barley
- Occurrence of and fate of toxigenic fungi and their associated mycotoxins in Saskatchewan-grown oats and oat milling products

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Staff

One research scientist

Two chemists

Five scientific support staff

Our program also employs one additional scientific support staff during the Harvest Sample Program

Photo captions:

1. A display of various products prepared from food barley at the GRL: pearled barley, steel-cut barley groats, instant flakes, old-fashion whole flakes, and fibre-rich/ β-glucan-rich fractions (grits).
2. Pilot-scale germination chamber for evaluation of the malting performance of barley.
3. Skalar segmented flow analyzer for determination of enzymes, β-glucans, and Free Amino Nitrogen (FAN) in malt and wort.
4. GRL uses Buhler MLU 202 Laboratory Mills, located in a temperature and humidity-controlled room, for evaluation of the milling performance of wheat samples.

Wheat Enzymes, Asian Products and Analytical Services

Dr. Dave Hatcher

1

Our program pursues three different functions:

1 The Analytical Services group is responsible for collecting and receiving samples, performing a variety of different analytical techniques on the samples, and collating their data. Our group plays a major role in our annual Harvest Sample Program, plant breeder trial evaluations, cargo monitoring and submitted samples to meet the needs of the industry.

2 The Asian Products group investigates and optimizes wheat use in Asia, where over 50% of Canadian wheat is exported. We focus primarily on yellow alkaline and white salted noodles. We are the only laboratory in the world using ultrasonics to explore noodle texture attributes. We have received two Natural Science and Engineering Research Council grants to fund graduate students and aid in this research.

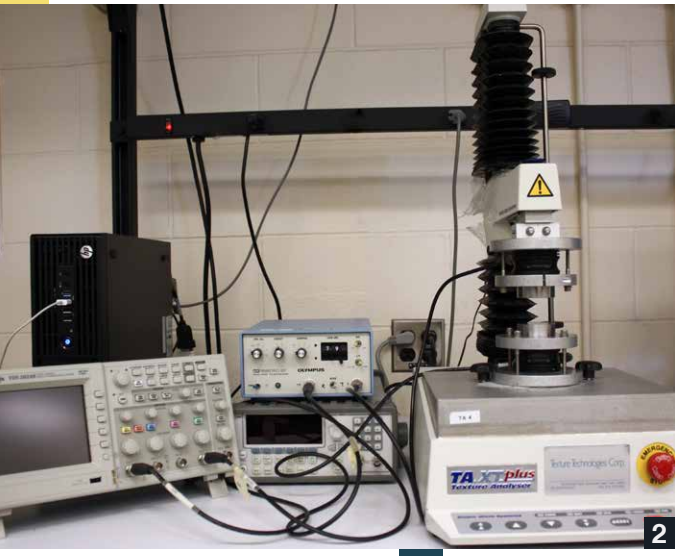
3 The Protein Quality Research group uses state-of-the-art mass spectrometry to study the key quality proteins in Canadian wheat which sets them apart from other wheat in the world. Our studies show unique and different aspects of these proteins which were not known before. For example, we have demonstrated that a key gluten protein, critical to bread making, high molecular glutentin subunit 8, has three slightly different forms reflecting differences in their amino acid composition and their end-use functionality. We're applying further research to improve Canada's wheat quality profile for a diverse range of products.

Our relevance to the industry

Our analysis of wheat samples helps the grain industry fulfill contract specifications for the Canadian Grain Commission's Certificate Final. As well, we provide timely and relevant grain quality data.

We generate key quality information for the domestic grain industry. As well, we showcase the use of Canadian wheat in a wide variety of products.

Our work supplies new crop quality data to enhance the marketing of Canadian wheat. As well, our quality data is part of the wheat variety registration process and ensures that new varieties maintain Canada's reputation for wheat quality. Our research focuses on improving the quality of Canadian wheat to enhance its marketability in Canada and overseas.



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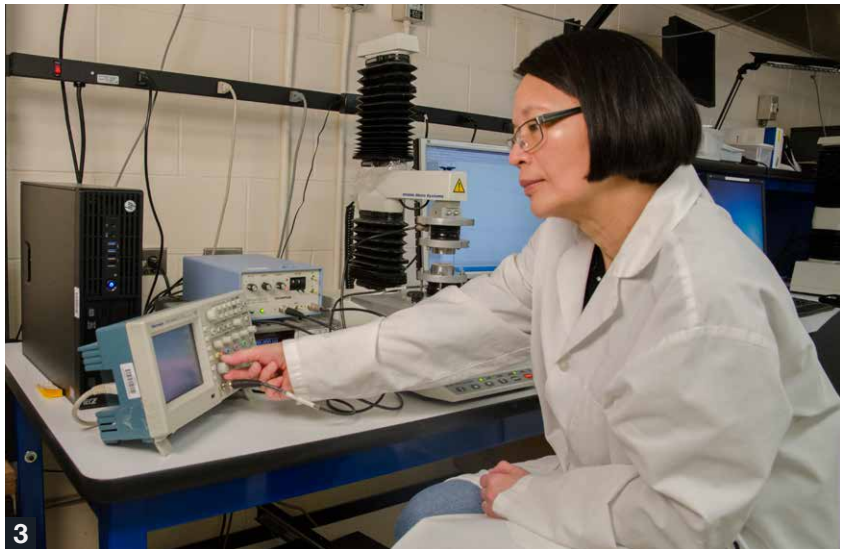

3

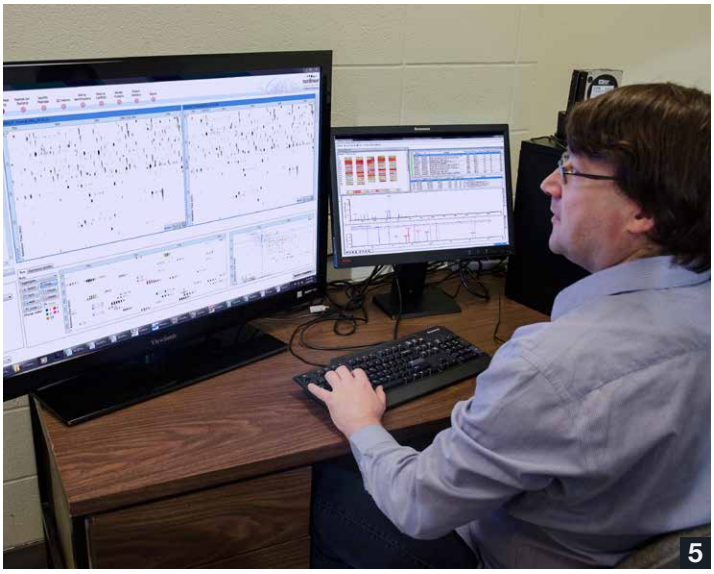
What we're working on

Our research using the mass spectrometer continues to focus on exploring low molecular glutenins, a group of proteins. These form wheat's unique gluten polymer, essential for bread making. Our research will identify which of these key proteins are needed for optimum wheat flour performance in products such as noodles and bread.

Our ultrasonic research continues to focus on discerning the key qualities for producing noodle texture properties that customers desire and prefer.

We continue to develop fast and efficient tests to enhance the grading of specific quality parameters such as gluten quality as well as mildew and frost damage.

4


5

Staff

One research scientist

Three chemists

Eight scientific support staff

Our program also employs two additional scientific support staff during the Harvest Sample Program

Short bibliography

D. Daugelaite, a. Strybulevych, M.G. Scanlon, J.H. Page and D.W. Hatcher. (2016) The Use of Ultrasound to Investigate Glucose Oxidase and Storage Effects on the Rheological Properties of Cooked Asian Noodles. Cereal Chemistry http://dx.doi.org/10.1094/CCHem-01-15-0006R

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Photo captions:

1. An example of the wide diversity of noodle products made from Canadian wheat.
2. The use of special ultrasonic transducers attached through custom made fittings allows both ultrasonic measurements and traditional rheological testing to be carried out simultaneously on the exact same sample experiencing the identical conditions. This has never been done before.
3. The Grain Research Laboratory is the only laboratory in the world exploring the use of non-destructive ultrasonic measurements to understand how the key biochemical components, protein and starch, interact to convey different textures in our mouths.
4. The GRL is using state of the art mass spectrometry to investigate both intact proteins and peptides in different wheat classes and varieties to understand how minor differences in protein composition can have a tremendous impact on the quality of the end products such as bread and noodles.
5. State of the art equipment generates vast quantities of data which must be carefully evaluated using highly specialized programs. This allows the researchers to glean, using these advanced computer programs, as much meaningful and relevant information as possible out this mountain of data.

Pulse Research

Dr. Ning Wang

1

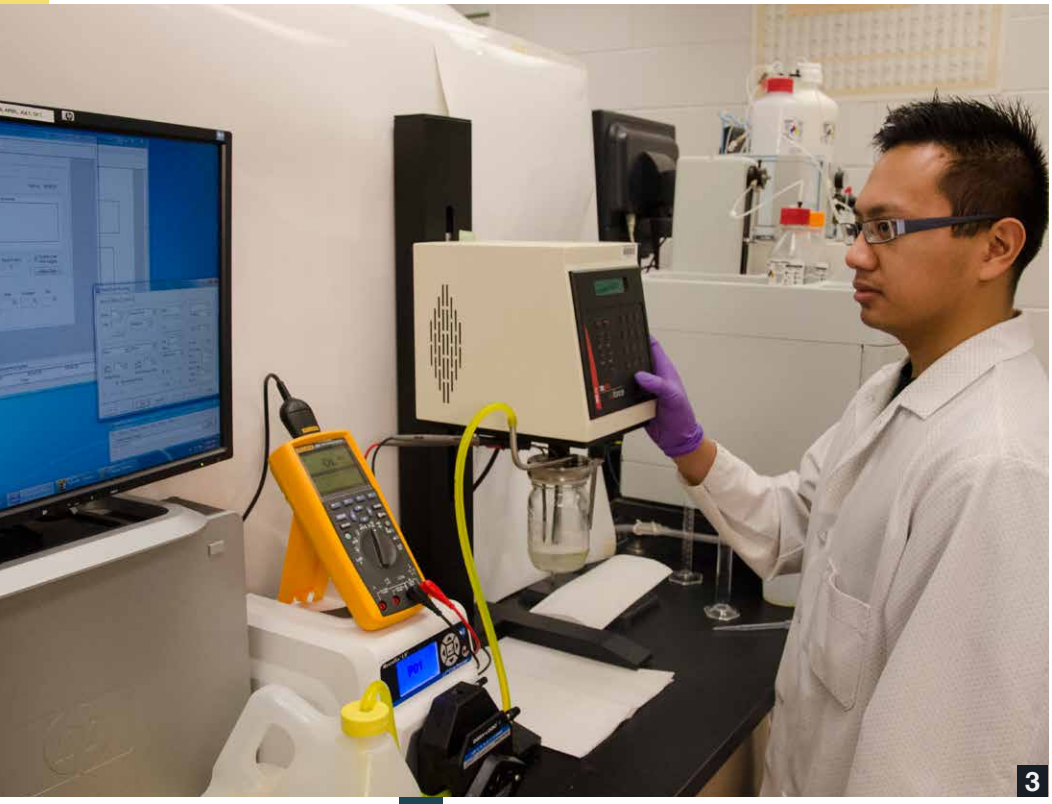
We investigate factors that contribute to the overall quality of pulses and study the end-use functionality of pulses, that is, how the physical and chemical components of pulses affect the final product made from pulses. We also study the role of grading, environmental and genetic factors in determining pulse quality and end-use functionality.

We research methods for measuring and assessing pulse end-use quality and functionality. As well, our program conducts the annual pulse and food-type soybean quality survey in support of the annual Harvest Sample Program. Additionally, we take part in the Canadian Grain Commission's monitoring of export cargo shipments.

2

Our relevance to the industry

We provide scientific support to the Canadian Grain Commission's development of grading standards for pulses.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Our research provides the pulse industry with information on pulse quality and end-use functionality. Furthermore, research on methods for new grading factors provides the pulse industry with consistent, objective measurements for pulse quality.

Each year, we conduct an annual quality survey which provides data on the intrinsic and end-use quality of Canadian pulses and food-type soybeans. We use the data to monitor and support the quality assurance system. As well, the data is used by marketers to promote Canadian pulses and by customers of Canadian pulses to understand end-use quality.

We also participate in cargo quality monitoring to ensure that the export shipments meet the quality requirements.

Short bibliography

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What we're working on

We are working in partnership with international researchers to establish the precision of a method for determining the water-holding capacity in pulse flours. Water-holding capacity is an important factor for pulses because it influences functionality of ingredients in various food systems, for example, in the case of baked goods, where water takes part in the phenomena associated to starch gelatinization and protein-water interaction during mixing and baking.

We will, in collaboration with the bean breeding program at the AAFC Morden Research and Development Center, investigate the effects of cultivar, growing location and year on dietary fiber contents and anti-nutrients in Manitoba grown dry beans. This two-year project is supported partly by Manitoba Pulse and Soybean Growers.

We will investigate the effects of processing parameters on composition and functionality of pulse fractions by air-classification. Protein and starch are the main constituents in pulses, and can be liberated through fine grinding. Air-classification uses a stream of air to separate finely-ground pulses into protein-enriched and starch-enriched fractions. These fractions have potential for use as food ingredients.

Staff

One research scientist

Two scientific support staff

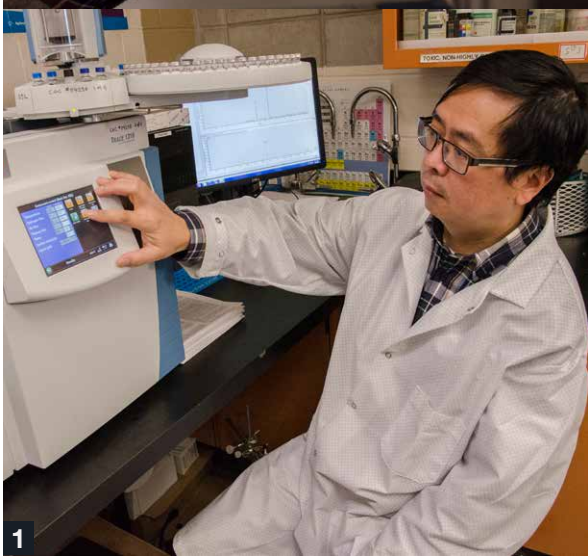
Our program also employs one additional scientific support staff for the Harvest Sample Program

Photo captions:

1. Yellow peas (raw, cooked and soaked).
2. Determining dietary fiber contents in pulses with a fiber analyzer.
3. Determining oil emulsifying capacity of pulse flours or protein materials by an improved electrical resistance method.
4. Producing protein-enriched and starch-enriched fractions from pulses using an air-classifier.
5. A lab twin-screw extruder for making gluten-free pasta from pea or lentil flour.

Oilseeds

Dr. Véronique J. Barthet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We conduct research on factors that contribute to the quality of products made from Canadian oilseeds (canola, rapeseed, flax, soybean and mustard) and into seed factors – such as free fatty acids and chlorophyll derivatives - that could affect quality of these products. Our research includes understanding the effects of variety and environment on the composition and quality of oilseed crops. As well, we develop new and improved methods to analyze minor and major components (e.g. phenolic, chlorophyll, vitamins and cyanogenic glycosides) in oilseeds.

Our relevance to the industry

We conduct quality monitoring programs using samples from the Harvest Sample Program and samples taken at export. We analyze factors such as oil, protein, glucosinolate, fatty acid composition, free fatty acid and chlorophyll to give domestic and export customers of Canadian oilseeds an indication of each year's crop quality.

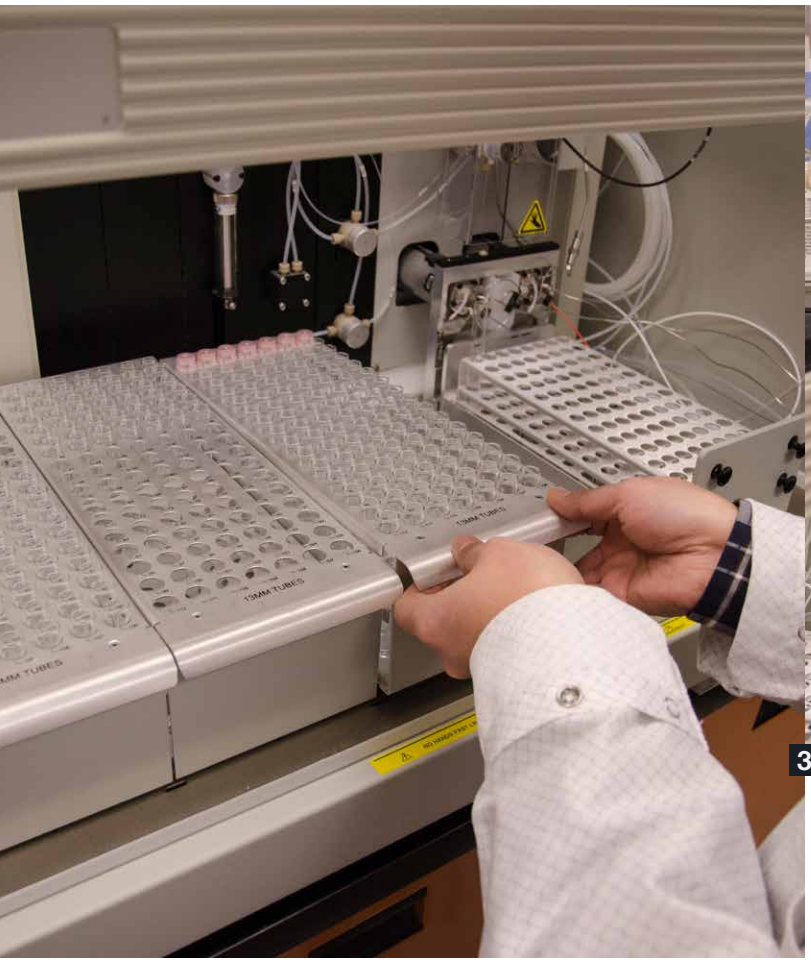
As part of Canada's quality assurance system, cargo monitoring assesses the quality of exported Canadian oilseeds. Cargo monitoring allows export customers to determine if export shipments meet their specific requirements for their end-products.

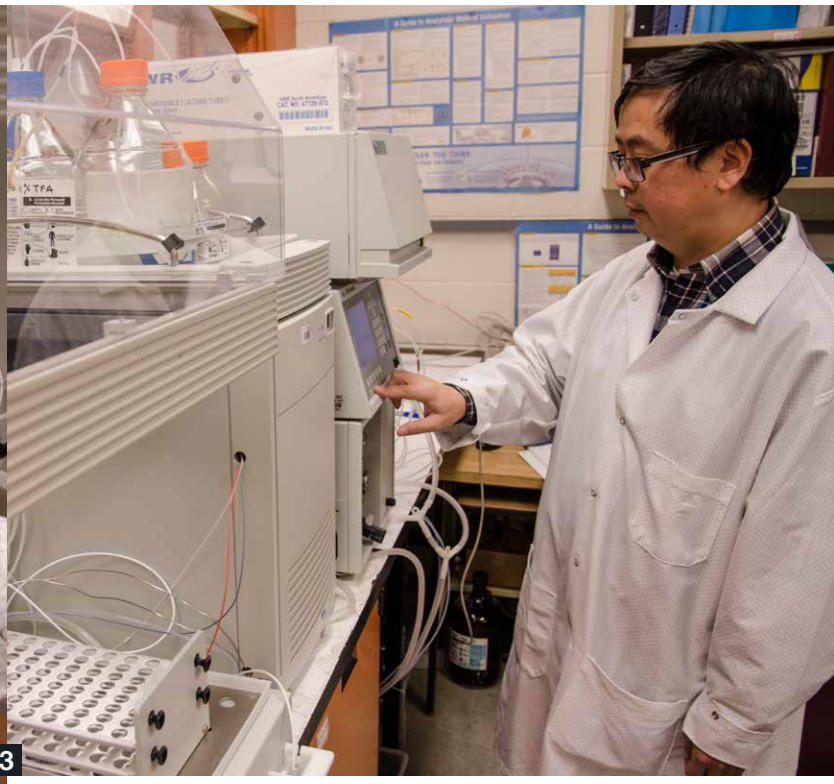
Because Canadian crops are segregated and sold by grade, it is important to determine grading factors using an unbiased, scientific approach. The Canadian Grain Commission does this by developing methods and projects to understand the inherent quality of grains and the products made from grain. We have been involved in the development of internationally-recognized methods (e.g. methods recognized by ISO, American Association for Clinical Chemistry, American Oil Chemists Society) for assessing oilseed quality. These methods provide unbiased oilseed analyses for use by the industry.


2

What we're working on

We're developing rapid methods to analyze oilseeds. We're committed to continuing to develop rapid, accurate, repeatable and reproducible analytical methods that will help in segregating and marketing oilseeds. At the same time, we're developing reference methods to analyze minor components, such as phenolic, vitamin E and cyanogenic glycosides, of oilseeds. These methods will help assess nutritional or antinutritional components that may be regulated in export countries. We are also working to understand how oilseed components affect quality.





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Staff

One research scientist

Three chemists

Three scientific support staff

Our program also employs one additional scientific support staff during the Harvest Sample Program

Photo captions:

1. Analysis of cyanogenic glycosides using Gas Chromatography Mass Spectrometry (GC-MS).
2. Analysis of oil content of whole oilseeds by pulse Nuclear Magnetic Resonance (NMR).
3. Preparation of standards using a preparative High Performance Liquid Chromatography (HPLC).

Variety Identification Research and Monitoring

Dr. Daniel Perry

We monitor export wheat shipments for wheats of other classes and ineligible varieties as these could undermine quality and create problems for customers.

We also provide varietal purity certification of malting barley cargoes.

Our variety identification and composition analyses support other research, including the annual Harvest Sample Program and support the Canadian Grain Commission's grain inspection services.

In addition to comparing patterns generated by electrophoresis of seed proteins, we use more advanced technologies to look at differences in DNA sequences that are characteristic among varieties. Our reference database currently contains DNA profiles of over 800 wheat and barley varieties.

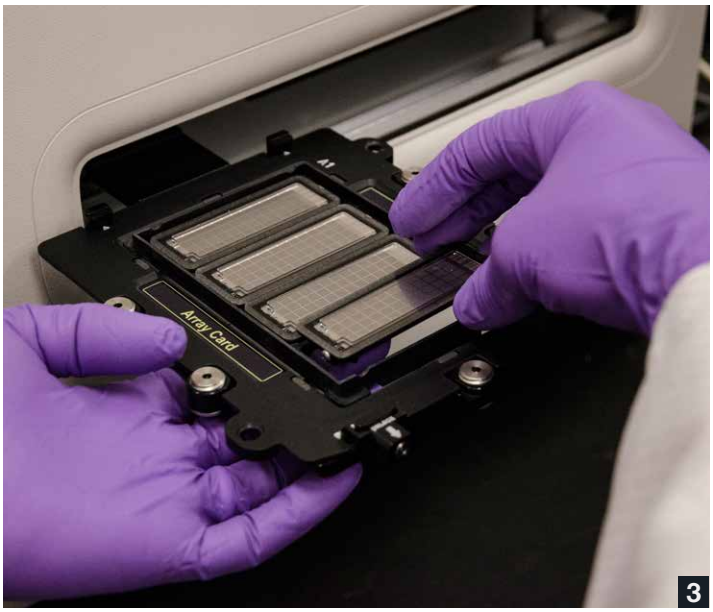

2

Our relevance to the industry

Monitoring the variety composition of export cargoes is a key element of grain quality assurance. When kernel visual distinguishability was eliminated as a requirement for variety registration in 2008, the industry implemented a declaration system for western Canadian wheat and the Canadian Grain Commission increased variety monitoring to protect the reputation of Canada's wheat for consistent quality.

We continuously develop new methods and explore new technologies for grain variety identification. We use the methods we develop for our own work and we also make them available to other seed and grain testing laboratories.

1



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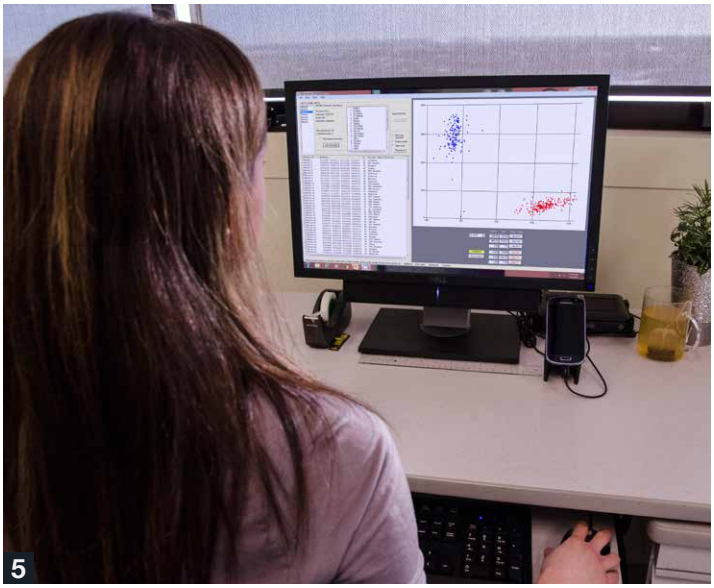
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What we're working on

The Canadian Grain Commission is modernizing Canada's wheat class system. On August 1, 2016, two new wheat classes, Canada Northern Hard Red and Canada Western Special Purpose take effect. On August 1, 2018, 25 varieties of Canada Western Red Spring wheat and four varieties of Canada Prairie Spring Red wheat will move to the Canada Northern Hard Red class. These changes will impact variety monitoring; high resolution methods will be required to precisely differentiate among similar varieties that will no longer be eligible for delivery into the same class.

Until recently, we primarily used protein electrophoresis to monitor shipments of Canada Western Red Spring wheat for the presence of correct varieties. However, in preparation for wheat class modernization, we are eliminating protein electrophoresis and moving to using a more precise DNA analysis exclusively. We will use efficient individual-kernel methods that we developed based on OpenArray genotyping technology. We're also developing a similar system for durum wheat.

For barley, we are exploring droplet digital PCR. Our aim is to develop a new method to analyze the variety composition of bulk-ground samples rather than having to analyze many kernels individually.

Staff

One research scientist

One biologist

Four scientific support staff

Short bibliography

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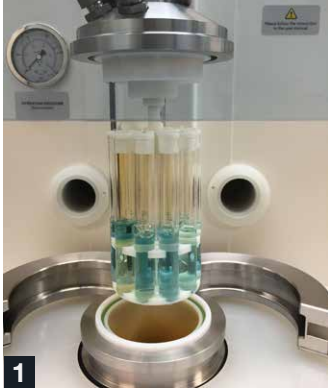
Photo captions:

1. DNA extracted from individual wheat kernels is transferred to a 384-well sample plate in preparation for analysis.
2. A technician prepares to begin the automated loading of DNA samples onto OpenArray plates for variety identification analysis.
3. OpenArray plates are placed in an instrument for analysis. Up to four plates containing the DNA samples of 384 wheat kernels may be analyzed at one time.
4. A technician operates the instrument that runs the OpenArray analysis and collects the raw data that we use to make variety calls.
5. Analysis of OpenArray genotyping data and automated calling of wheat varieties is performed using our custom software, VID Inspector.

Trace Organics and Trace Elements Analysis

Dr. Sheryl Tittlemier


1

Our research and monitoring relates to pesticides, mycotoxins, fungal biomarkers, and elemental analysis, including heavy metals, in grain. We develop, evaluate and validate analytical methods. We also monitor samples from the Harvest Sample Program and from grain export shipments. Our research focuses on how factors such as sampling, processing, agronomic practices, or environmental conditions affect the presence of pesticides, mycotoxins, heavy metals and other elements, and fungal biomarkers, such as ergosterol, in grain.


2

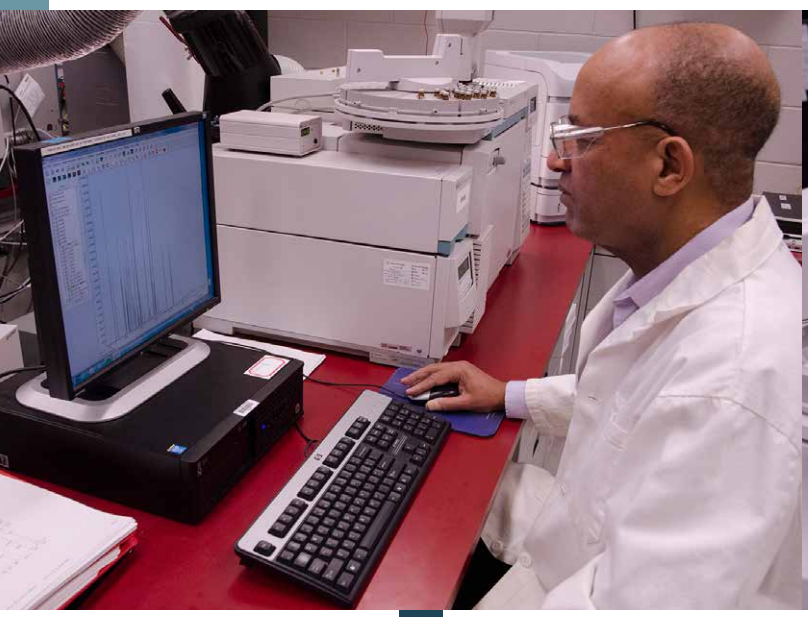
Our relevance to the industry

Our work directly supports a number of Canadian Grain Commission activities and helps the Canadian grain industry on topics related to grain safety.

Through cargo monitoring, we generate data for Statements of Assurance. These statements give exporters and importers science-based assurance that Canadian grain meets safety requirements.

Through the Harvest Sample Program, our research provides a scientific basis for a number of grading factors, including Fusarium-damaged kernels and ergot. Our program also monitors how tolerance levels for grading factors manage the presence of mycotoxins in Canadian grain.

Through our monitoring and research, we can assess trends in the occurrence of pesticides, mycotoxins, trace elements, and heavy metals in grain over time or across geographic regions. By analyzing grain that is suspected to be contaminated the Canadian Grain Commission and private grain companies can identify contaminated grain and prevent it from entering the grain handling system.

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What we're working on

We continuously update our methods to include new analytes and incorporate new techniques and technologies that increase sensitivity and throughput of analyses. We recently added a high resolution mass spectrometer to our instrument laboratory to help rapidly identify mycotoxins and pesticides, as well as their degradation products, in grain.

Other ongoing research projects include:

- Examining the fate of pesticides (such as glyphosate) during the processing of cereals and pulses
- Determining the best practices for sampling oats for mycotoxin analysis
- Surveying the geographic distribution of cadmium in wheat in eastern Canada
- Correlating ergosterol levels to total fungal biomass in cereals

Staff

One research scientist

Three chemists

Seven scientific support staff

Photo captions:

1. Grain samples digested using an UltraWAVE microwave digestion system for trace element analysis.
2. Instruments used for detecting pesticides and mycotoxins.
3. Preparing instrument to analyze samples.
4. Adding whole grain sample to a grinder.
5. Pipetting a solution in the fumehood.

Microbiology

Dr. Tom Gräfenhan


1

We research and monitor pathogenic, quarantine and toxigenic micoorganisms, such as moulds and bacteria, associated with Canadian grain and products made from Canadian grain. Our program develops new tools and employs new technologies for the detection, identification and characterization of these microorganisms.

We use newly developed and validated methods to investigate how agronomics, environment and processing affect microbial communities naturally associated with crops and grain products.


2

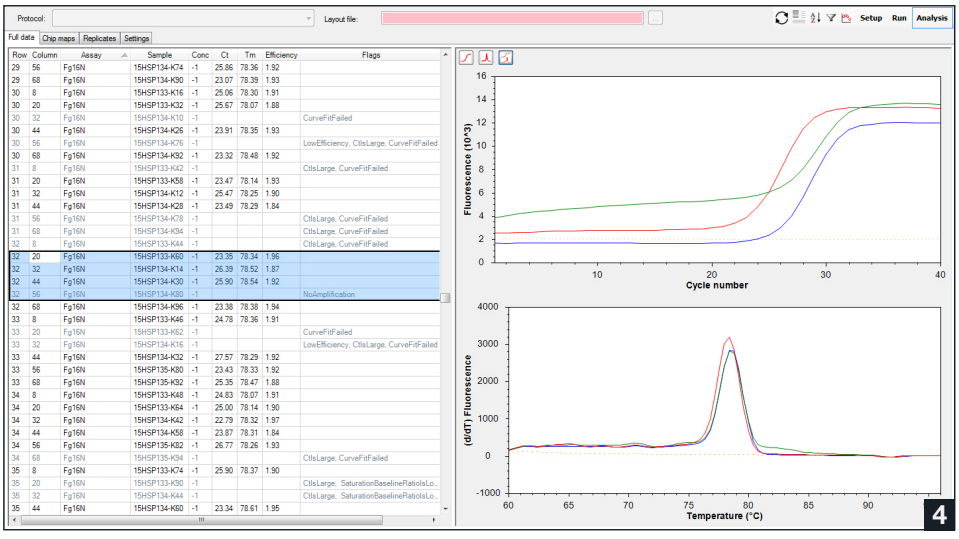

3

Our relevance to the industry

The Official Grain Grading Guide identifies a number of factors which can directly or indirectly affect the quality and safety of Canadian grain. Our program supports the maintenance and updating of grading factors and tolerances linked to microorganisms, for example, ergot, Fusarium damage, mildew, smudge and Sclerotinia.

We also conduct an annual Fusarium survey on samples submitted by producers as part of the Harvest Sample Program. This survey monitors the occurrence and frequency of *Fusarium* species and populations associated with Fusarium Head Blight in eastern and western Canada. The survey's statistics give producers, grain handlers and others valuable information for managing the risk of Fusarium Head Blight on the farm and throughout the grain supply chain.

Our program monitors and carries out surveillance of high-risk pathogenic, quarantine and toxigenic microorganisms in exported grain. Our work provides baseline and surveillance data to support official documents for grain exports and also ensures market access and grain safety.



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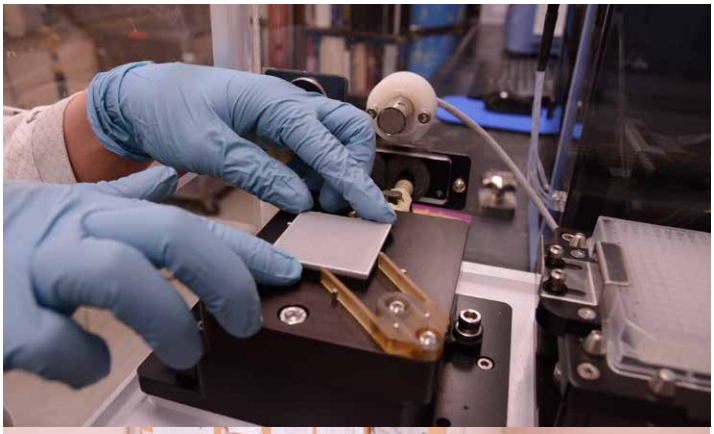

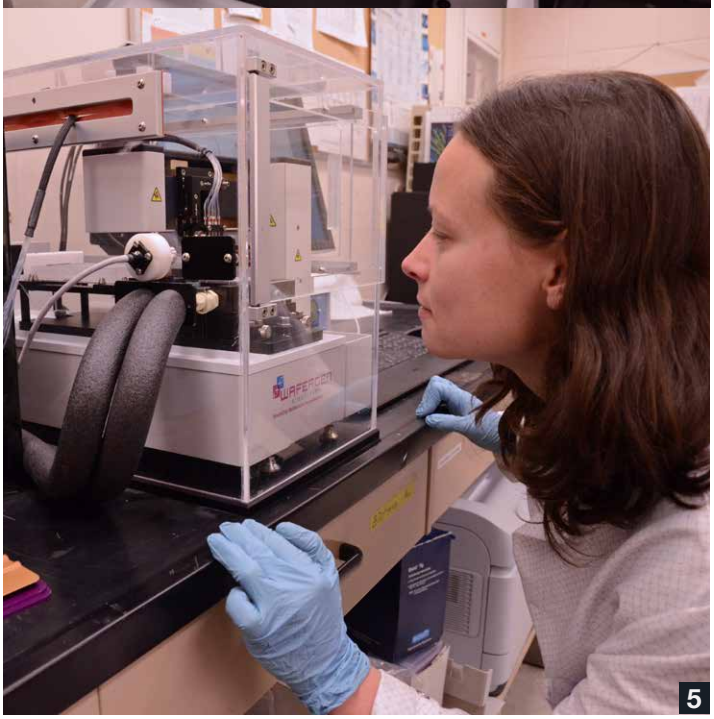

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What we're working on

We collaborate with other Grain Research Laboratories and/or government programs, academia and the grain industry to analyze biological factors that cause plant diseases in the field and that spoil stored or processed grain.

Our future direction is threefold:

1. Develop faster methods and evaluate new technologies for diagnostics of microorganisms associated with grain.
2. Characterize the metabolic profile, that is, toxins and enzymes, of microorganisms that affect grain safety and how these affect the final product made from that grain.
3. Study the ecology and population dynamics of indigenous microbial communities that may affect quality assurance and on-farm risk management. Example: High-throughput diagnostic tools, such as next-generation sequencing and metagenomics analysis, are used to pinpoint the origin of a disease outbreak or to compare invasive species with indigenous populations. New studies into fungal genomes generate new information that can be used to identify the genes responsible for the production of mycotoxins or genetic markers for plant pathogenicity.

Staff

One research scientist

Three scientific support staff

Photo captions:

1. Examining the growth of microorganisms infecting selected wheat kernels on an agar plate.
2. Selecting kernels of interest from a wheat sample for further microbiological and bio-molecular analyses.
3. Placing *Fusarium* damaged kernels (FDK) from FHB infected wheat samples into a 96 well plate for DNA extraction.
4. Screenshot of quantitative PCR data and results for kernels, which tested positive for *Fusarium graminearum*. The graphs on the right show 3 positive (solid lines) and 1 negative (dashed line) samples highlighted in the table to the left.
5. Setting up a liquid handling robot, which dispenses DNA onto a chip with 5,200 nano-reactions in preparation for an automated, high-throughput detection of *Fusarium* and other grain pathogens.

Grain Biotechnology Research

Dr. Tigst Demeke

Our program develops and evaluates DNA-based methods for identifying and quantifying genetically modified organisms (GMOs) in grains and oilseeds. We also verify protein-based methods to determine if they are suitable for detecting GMOs.

We are ISO 17025-accredited to carry out GMO testing using real-time polymerase chain reaction (PCR). PCR is used to amplify, that is to reproduce, the DNA sequence of the gene of interest so that GMO analysis can be performed with high sensitivity.

Our relevance to the industry

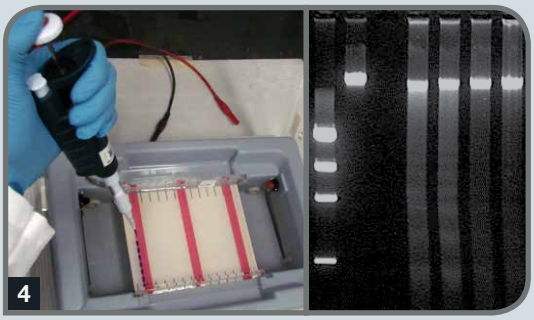
Many countries require that grain and food products containing genetically modified materials are labelled. As well, many importing countries have tolerances for the amount of genetically modified materials that can be present in non-genetically modified shipments. Several importers of Canadian grain routinely test for the presence of unapproved GMOs, including the European Union.

In 2009, we successfully implemented a testing method for CDC Triffid, a genetically modified variety of flaxseed. Our method followed sampling and testing protocols developed by the Government of Canada, the European Union and Japan.

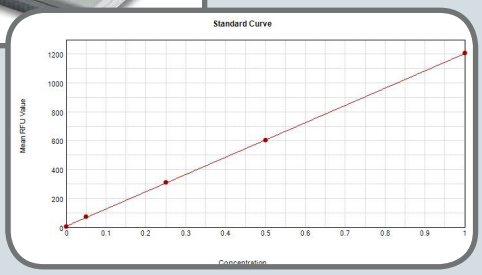
FP967 GMO Flax (CDC Triffid) Testing Steps

- Grind 4 x 60 g sub-samples from 2.5 kg sample per cargo hold

- Extract DNA
- DNA



- Check DNA quality by gel-electrophoresis



- Determine quantity of DNA

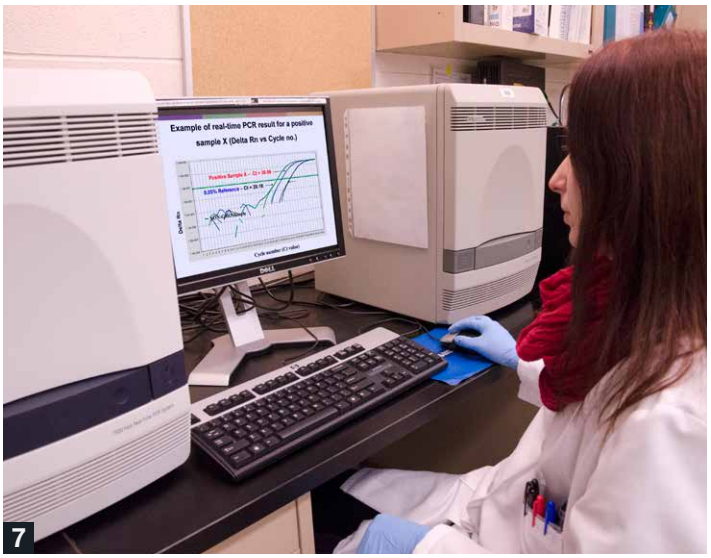
- Real-time PCR Instrument
- Placing samples on real-time PCR instrument

What we're working on

Our group is collaborating with other Grain Research Laboratory programs on using DNA markers to assess grain quality and safety traits. We'll also collaborate with other institutions (such as the United States Department of Agriculture's Grain Inspection, Packers and Stockyards Administration) to develop and verify GMO testing methods.

As they become available, we will evaluate new DNA-and-protein based methods for assessing GMOs. We are exploring the use of digital PCR for measuring the quantity of genetically modified material in a given sample. After more verification of this method, we plan to use it to monitor cargo samples.

New and fast technologies related to DNA extraction and assessment of GMOs will be evaluated for their convenience, cost-effectiveness, sensitivity and accuracy.



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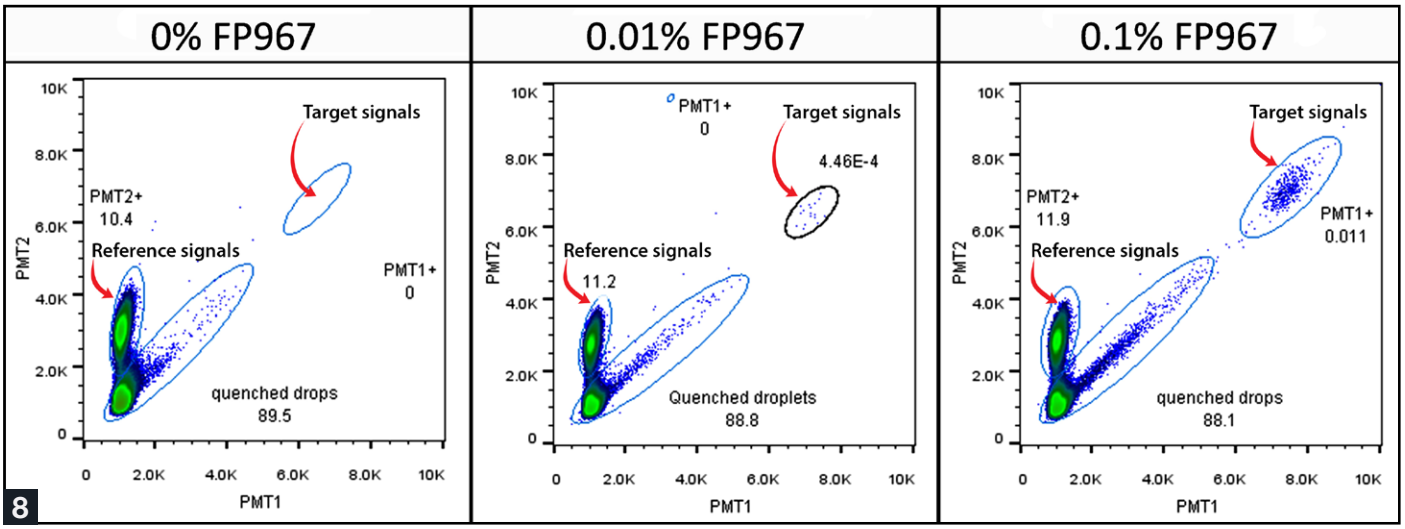

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Short bibliography

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Demeke, T., I. Ratnayaka, M. Holigroski and A. Phan. (2012). Assessment of DNA extraction methods for PCR testing of discontinued or unapproved biotech events in single seeds of canola, flax and soybean. Food Control. 24:44-49.

Staff

One research scientist

One biologist

One scientific support staff

Photo captions:

1. Nucleic acid double helix.
2-6. FP967 GMO Flax (CDC Triffid) Testing Steps.
7. A biologist analyzing real-time polymerase chain reaction (PCR) results for the presence of a GMO event.
8. Example of analysis of GMO flax (FP967 flax event) with digital PCR.

Strategic Planning Session 2015

Future Directions for Scientific Research and Technology Programs within the Grain Research Laboratory

The Grain Research Laboratory Director and program managers agreed to engage in a strategic planning exercise during the first quarter of 2015-16 in order to assess the direction and priorities for the Grain Research Laboratory going forward. The session was facilitated by Scott Wolfe Management Inc. and involved nine external reviewers from Canada and the United States.

The overall objective was:

Through a two-day strategic planning session with Canadian Grain Commission Industry Services staff and external reviewers set future direction in science and research carried out by the Grain Research Laboratory.

A key aspect of the session was to provide guidance, direction and scope of the program managers' research priorities and plans.

As stated by the reviewers, the Grain Research Laboratory is recognized nationally and internationally for the leading edge scientific research and technology programs it provides to the Canadian grain industry.

The Grain Research Laboratory was founded over 100 years ago. There is strong research project history that it continues to deliver on.

The organization's mandate focuses on grain safety and quality assurance; this guides all operations and research programming. With the current global environment and the changing Canadian grain industry, it is critical that the Grain Research Laboratory is able to adapt and continue to deliver relevant and leading edge grain quality and safety research and programs. The Grain Research Laboratory recognizes it will be essential to consult with Canadian value chain partners to ensure research priorities remain relevant to Canadian grain industry needs.

This strategic planning session provided significant input to the future direction in science and research carried out by the Grain Research Laboratory. After reviewing the current research and technology projects, the reviewers felt that most of the research was highly relevant, particularly those projects that are funded by the Growing Forward 2 Agri-Innovation Programs and industry co-sponsored projects. They also commented there may be broader application for some research projects if the technology developed and available for certain testing could be used and provide value in research efforts for other grain crops (for example, DNA testing).

For future research and technology projects, the reviewers recommended that the Grain Research Laboratory use broader stakeholder consultation to ensure that its research is relevant to the industry and that it addresses priority needs. In addition, the reviewers felt that exploring, assessing and pursuing contract research arrangements with value chain stakeholders in the Canadian grain industry could be of benefit. Other potential areas for future research are developing methods using developing or emerging analytical technologies and focusing on pre-commercial research on quality and testing methods.

To help the Grain Research Laboratory assess and prioritize future research and technology projects, the reviewers suggested using criteria such as stakeholder support, relevance, capacity and capability, as well as economic impact in the decision-making process.

A copy of the complete report is available upon request from the Canadian Grain Commission.

In accomplishing this, the project:

- Assessed the current Grain Research Laboratory scientific research and technology programs in light of the changing Canadian Grain Industry and current and future relevance.
- Provided suggestions on medium (2 to 4 year) and long-term (4 to 8 year) areas for scientific research and technology programs for the Grain Research Laboratory; and,
- Developed a set of criteria to be used by the Grain Research Laboratory to assess new and upcoming scientific research and technology projects for their suitability, stakeholder relevance and potential benefits, and proposed a prioritization tool based on these criteria.

Grain Research Laboratory · Canadian Grain Commission · 1404-303 Main Street · Winnipeg MB R3C 3G8

www.grainscanada.gc.ca