



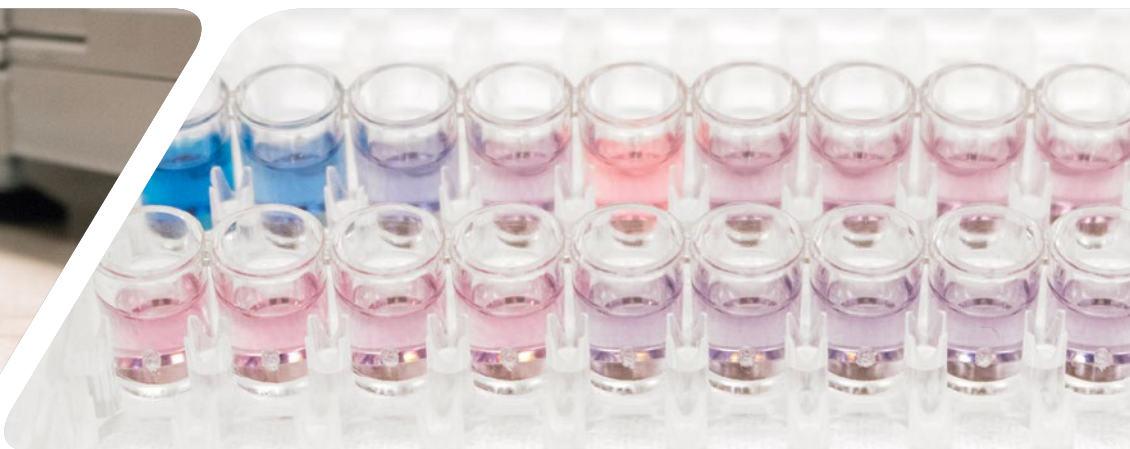
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GRAIN RESEARCH LABORATORY

Annual Program Report

2017



Canadian Grain
Commission

Commission canadienne
des grains

Canada 

Canadian Grain Commission 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.

Grain Research Laboratory vision

Advancing science for better nutrition and lives through high value, quality grain.

Grain Research Laboratory mission

- Be the preeminent provider of science to support Canada's grain quality assurance system
- Enhance the marketability of Canadian grains through scientific research, monitoring and analytical services
- Anticipate and respond to the needs of the grain value chain, through interaction with the grain sector

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Director's Welcome



Dr. Stefan Wagener
Director, Grain Research Laboratory

“These programs are strategically aligned with the needs of the grain sector and provide key information on the quality and safety of Canadian grain to the whole value chain.”
— Stefan Wagener

It is a pleasure to present the 2017 Grain Research Laboratory Annual Program Report. 2017 was another successful and productive year. This year, we welcomed new leadership with Patti Miller as Chief Commissioner, Doug Chorney as Assistant Chief Commissioner, Lonnie McKague as Commissioner, and Jocelyn Beaudette as Chief Operating Officer. We're looking forward to their ideas, and contributions. These are exciting times.

This year's report highlights how our programs support the Harvest Sample Program and cargo quality monitoring, 2 of our 4 key activities. These programs are strategically aligned with the needs of the grain sector and provide key information on the quality and safety of Canadian grain to the whole value chain.

Our Harvest Sample Program relies on the support and participation of the farming community and grain handlers. Because we receive freshly harvested grain annually, we are uniquely positioned to immediately assess each year's crop quality. This year, we provided material to the Canadian International Grain Institute (Cigi) so we could analyze and assess its end-use functionality. This important information was shared during the 2017 New Crop Missions led by Cereals Canada. Our collaboration with Cigi was very successful and it will continue.

The Harvest Sample Program celebrated its 90th anniversary in 2017. Thank you! Without your support and grain samples, we couldn't do the research and quality assurance work that is so important to ensuring you receive full value for your crop, and its successful marketing in Canada and abroad.

In 2016, we asked for your feedback on the Harvest Sample Program. Based on what you told us, we implemented automated emails for harvest sample results, began evaluating 2 additional tests for the 2018 crop year and developed new industry partnerships and collaborations.

I encourage you to read the report and learn more about our abilities, research areas and the quality of service our dedicated scientists and staff at the Grain Research Laboratory provide on a daily basis. Please share with us your comments and thoughts. We greatly appreciate your feedback.

Canadian Grain Commission Grain Research Laboratory

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 allows us to assess 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
- Oilseeds
- Pulse Research
- Wheat Enzymes, Asian Products and Analytical Services

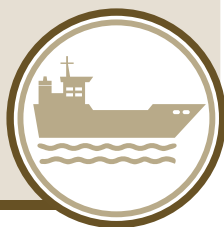
Technology research programs include:

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

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.



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.



Plant breeder line evaluation

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



Grain Research Laboratory Statistics and facts

Harvest Sample Program

We publish annual harvest and crop reports. We also publish an annual Fusarium survey report from samples we collect through the Harvest Sample Program.

The Harvest Sample Program received

14,229 samples
for the 2017–18 crop year



We tested **1551**
cargo shipment samples

Currently, we use **117**
different **test methods**



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

- Peas
- Lentils
- Wheat
- Durum
- Barley
- Oats
- Buckwheat
- Chickpeas
- Beans
- Mustard
- Flaxseed
- Rye
- Soybeans
- Canola/rapeseed



In total, we conducted **118,491**
individual tests this year

We conducted **281**
tests for
service requests
by external clients,
which included
milling of **60**
samples



The most popular requests
were for

Fatty Acid Profile
followed by **Free Fatty Acids**

22 scientific
publications
were published
by our scientists



32 scientific
presentations
were delivered by our scientists

Analyzing Canada's grain quality

The Grain Research Laboratory supports the Canadian Grain Commission's Quality Assurance Program in two key ways: the Harvest Sample Program and cargo quality monitoring.

Harvest Sample Program

The Harvest Sample Program generates quality data about each year's crop. Canadian grain producers submit samples of their crop to the Canadian Grain Commission for analysis. In exchange, producers get free quality results and an unofficial grade.

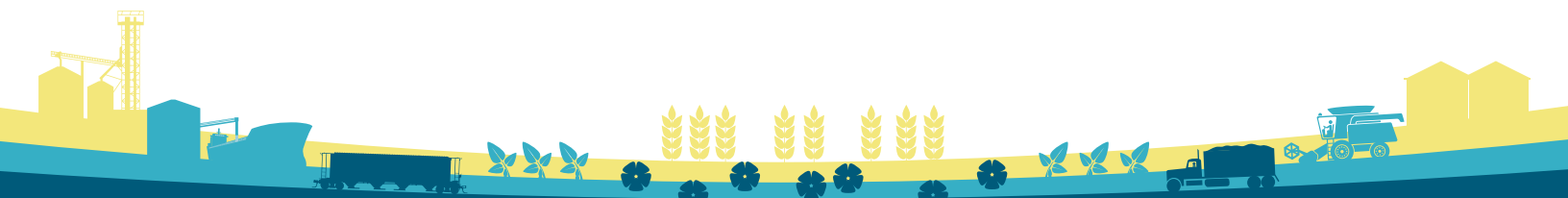
Working with Canadian grain Commission grain inspectors, the Grain Research Laboratory's researchers analyze the quality of the crop. We evaluate the effectiveness of grain grading factors and determine if changes are needed. As well, we use the samples in our research on new uses for grain, grading factors and other issues that may affect end-use quality of Canadian grain.

In addition, marketers of Canadian grain use quality data from the Harvest Sample Program to explain to customers of Canadian grain what they can expect from each year's harvest and to demonstrate Canada's ability to deliver consistent, high-quality grain from year to year.

Cargo quality monitoring

Grain Research Laboratory programs analyze export cargo shipments of grain to ensure these shipments meet Canada's grading and quality parameters. Canadian Grain Commission grain inspectors take samples from each export shipment of grain as it is loaded on a vessel. The size of the sample varies from 2 kilograms to 10 kilograms depending on the commodity.

The articles in this program update will detail how each program is involved in cargo quality monitoring.





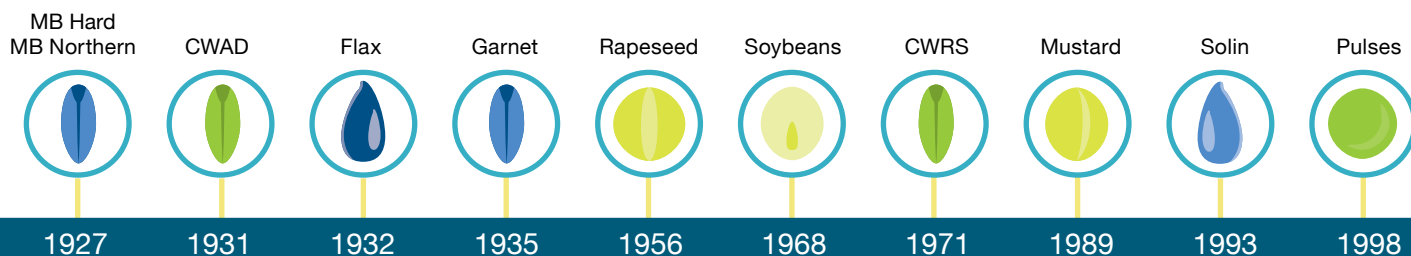
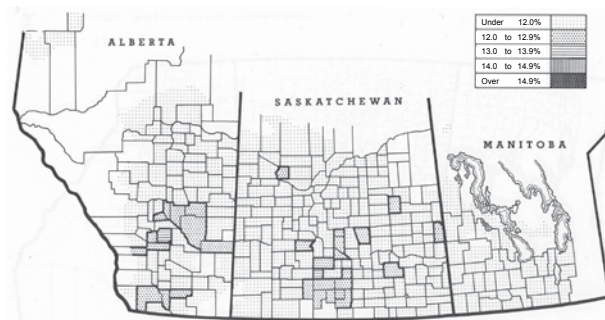
90 years of harvest samples



IN 2017, WE MARKED THE 90TH ANNIVERSARY OF OUR ANNUAL HARVEST SAMPLE PROGRAM. WHILE THE PROGRAM HAS CHANGED IN SOME WAYS SINCE THE FIRST SURVEY IN 1927, IT HAS ALWAYS BEEN AN IMPORTANT SOURCE OF QUALITY DATA FOR CUSTOMERS OF CANADIAN GRAIN.

We conducted the first annual harvest survey by assessing the protein content of the 1927 wheat crop in western Canada. At first, we evaluated only the protein content of milling grades of wheat because protein was an indicator of wheat's strength and baking quality. Each year, we published maps showing protein content across the Prairies.

Since then, we've expanded the survey to include other classes of wheat, oilseeds and pulses.



Sourcing samples

At first, we used harvest samples from country elevators. Then, we added samples from grain company head offices. In the late 1980s, we collaborated with the Canadian Wheat Board in the bulk sample program, asking producers to send wheat from smaller classes and barley.

Beginning in 1995, we sent out postage-paid grain bags to producers selected using Statistics Canada production data and tracked them using Canadian Wheat Board permit books. However, privacy legislation changes in the early 2000s meant we couldn't use contact information gathered by other organizations in order to select producers. Instead, we would have to invite producers to participate.



In 2004, we began the Harvest Sample Program as it operates today. We ask producers to register for the program and then, each year, we send out kits for them to use to submit their samples to us. As well, we ask primary elevators and grain processors for samples.



What happens to your sample

EACH HARVEST SAMPLE ENVELOPE HAS A BARCODE AND THE NAME OF THE PRODUCER SUBMITTING THE SAMPLE. THESE ENVELOPES ARE COLOUR-CODED BY GRAIN AND CLASS.

Here's what happens to a sample once it has arrived in our Winnipeg headquarters.



Changing technology

In 1927, we tested samples using the reference Kjeldahl method of nitrogen determination. In the mid-1970s, we began using an automated digital analyzer thanks to the introduction of near-infrared reflectance technology. This method meant we needed fewer chemicals for protein testing. In 1992, we replaced automated digital analyzers with whole grain analyzers. These analyzers are much faster and don't need ground grain samples for analysis. In 1996, the Kjeldahl method was replaced by combustion nitrogen analysis. We continue to use these today.

Benefits of the Harvest Sample Program

The Harvest Sample Program benefits producers and Canada's grain industry.

For each sample, producers receive free, unbiased quality results and grading information. Producers can use this information to make decisions about sales and delivery.

We publish interim and final quality results on our website for each crop we assess. Marketers of Canadian grain use these results to promote international and domestic sales of Canadian grain. As well, customers of Canadian grain use our quality data to make purchasing decisions based on how they expect Canadian grain to perform in their products.

We use harvest samples as a source of material for grain standards. As well, we use samples to monitor the effectiveness of grading factors and to assess seed-borne fungi and toxins as part of grain safety monitoring.

Finally, our researchers use producer samples for a variety of research projects, some of which you'll read about in this annual report.

6



We send producers their quality results. As of 2017's harvest, we send these results by email as soon as testing is completed.



7



Using wheat samples, we create composite samples for further analysis of the protein content for the year. We usually make one protein segregate near 13.5% and another segregate either at 14.5% or at 12.5%, depending on the availability of samples.



8



We send the composite samples of wheat for full wheat, milling, baking and noodle analysis.



9



We share quality information through quality bulletins posted on our website and through information shared on new crop missions. In 2017, we collaborated with the Canadian International Grains Institute (Cigi) on milling and quality assessment of our wheat composites.





Bread and Durum Wheat Research

Dr. Bin Xiao Fu

Wheat quality monitoring

At harvest, we provide detailed information on quality characteristics of various protein segregations and grades of major Canadian wheat classes. To do this, we analyze composites created from harvest samples.

Buyers use the data we generate to understand how Canadian wheat may perform in their facilities. Exporters use our quality data when they're marketing Canadian wheat to potential buyers.

Throughout the year, we monitor the quality of export cargoes of Canadian wheat by analyzing samples taken as wheat is being loaded onto vessels.

We provide comprehensive evaluation of the quality of new wheat lines before they're registered. Our work identifies breeder lines that merit registration and that are eligible for the Canadian Grain Commission's variety designation list.

New crop quality assessment

Each year after harvest, the Canadian Grain Commission joins the Canadian International Grains Institute (Cigi) and Cereals Canada in new crop missions to major markets for Canadian wheat.

Our harvest quality data is presented at seminars conducted as part of the new crop missions. The audience of these seminars is made up of traders, millers, quality control and quality assurance staff, end-users such as bakers and representatives of industry associations and government agencies.

While the audience is diverse, they are all looking for information in three key areas: availability, functionality and consistency. In turn, we learn if our quality analysis is in line with what the audience needs to know and we can explain to the audience how they can use our quality data in their buying decisions.

“Buyers use the data we generate to understand how Canadian wheat may perform in their facilities. Exporters use our quality data when they're marketing Canadian wheat to potential buyers.”



Customers of Canadian wheat want to know:

Availability

What's available from Canada. Our data can tell them:

- production levels of major wheat classes
- protein content and distribution
- grade distribution and major grading factors

Functionality

How varietal composition and weather patterns during the current growing season affect quality. Our data can tell them about:

- soundness and milling performance, a quality trait mostly reflected in the grades and grading factors on which the Canadian Grain Commission has comprehensive information
- dough strength, related to varietal composition and growing conditions
- end product quality, largely depends on protein content and gluten strength

Each harvest sample we receive from a producer or a grain company is graded and measured for protein content. Composites are then made from individual wheat samples based on their grade, protein content, and crop region, followed with comprehensive quality analyses which include milling performance, dough properties, and end-product quality.

Consistency

Particularly millers and bakers want to know how much they need to adjust their processes when switching from last year's crop to this year's crop. Our data can show them:

- even though quality does vary slightly from year-to-year, overall, Canadian wheat quality is consistent, an advantage we have over our competitors
- our year-to-year comparison is valid because we take into consideration grade, protein (segregation) and flour extraction rate (fixed) when making composites for analysis.

Other uses for harvest samples

In addition to generating information on new crop quality, we use harvest samples for research and other quality assurance projects. For example, we make composites based on variety. We perform quality analyses on these composites and are then able to compare quality attributes across varieties. For example, our data can show how gluten strength differs across varieties (as shown in figure 1) to support Canadian Wheat Class Modernization. AC Foremost, a variety in the CPSR class, is transitioning to the Canada Northern Hard Red (CNHR) class due to its lower gluten strength.

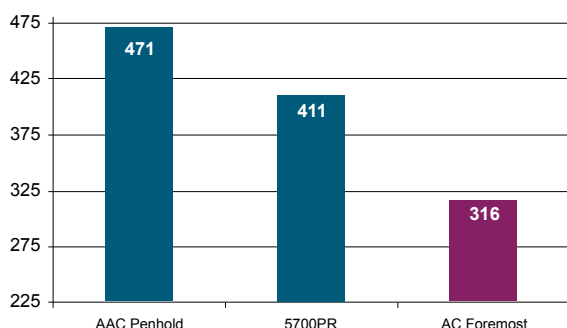


Figure 1 Extensograph Rmax (BU) for CPSR varieties - prairies 2016 harvest

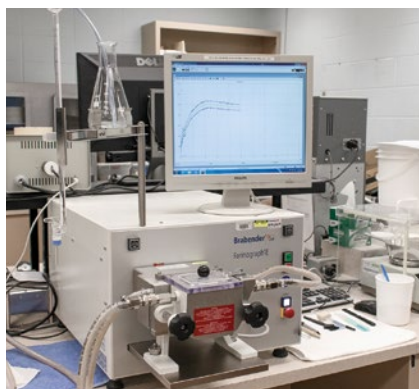


Figure 2 Farinograph



Figure 3 AlveoLAB

Comparing harvest quality to cargo monitoring

We monitor the quality of wheat cargoes and investigate cargo complaints to ensure customers' quality needs are met. Cargo quality monitoring provides a measure of how effective the quality assurance system and grade standards are in ensuring year-to-year consistency in the quality of each grade.

We also use cargo monitoring to determine the extent to which the results from the Harvest Sample Program predict the quality of subsequent cargo shipments. This demonstrates to customers of Canadian wheat that they can rely on the quality results from the Harvest Sample Program when they make purchasing decisions.

In general, the Harvest Sample Program provides a good estimate of the overall quality of the crop in terms of soundness, milling performance, dough properties and end product quality (Table 1). However, the Harvest Sample Program's quality data are not quality specifications for Canadian wheat shipments so we can't precisely compare the data from cargo monitoring to the data from the Harvest Sample Program.

A composite made from harvest samples of a particular grade is made from many individual samples of the same grade. However, a shipment of a grade of wheat can be a blend of different grades that averages out to one grade. We make composites from harvest samples in mid-to-late October. Shipment by specification can make the comparison between Harvest Sample Program and cargo monitoring more complicated.

Quality evaluation of breeder lines

For western Canadian wheat variety registration, we are responsible for quality testing of cooperative trials. We conduct quality testing, review and analyze data, and prepare recommendations or reports on the acceptability of candidate cultivars relative to check varieties.

For each Canadian wheat class, the Canadian Grain Commission maintains a variety designation list that states all the varieties eligible for that class. These lists help producers and grain handlers identify which varieties are eligible for each class. As well, these lists prevent ineligible varieties from undermining the quality of grain shipments, thus avoiding potential issues for end users. The goal is to facilitate trade and the handling of bulk commodities.

We provide a link between marketplace quality requirements and the plant breeder. Because of this, even though market demands change, customers are satisfied that new wheat varieties meet their required end-use quality characteristics.

All new varieties must meet or exceed established quality characteristics of the wheat class. This assures all new varieties designated in a class conform to a narrow quality profile and provide consistent performance from shipment to shipment and from year to year. The Canadian Grain Commission continually updates the designation lists as new varieties are registered in Canada or the registration status of existing varieties is changed.

Scientific publications relating to this research

Fu, B.X., Wang, K., Dupuis, B., Taylor, D., and Nam, S. 2018. Kernel vitreousness and protein content: Relationship, interaction and synergistic effects on durum wheat quality. *J. Cereal Sci.*, 79, 210-217.

Fu, B.X., Chiremba, C., Pozniak, C.J., Wang, K., Nam, S. 2017. Total phenolic and yellow pigment contents and antioxidant activities of durum wheat milling fractions. Antioxidants, in press.

Fu, B.X., Wang, K., Dupuis, B., and Cuthbert, R.D. 2017. A rapid extensograph protocol for measuring dough viscoelasticity and mixing requirement. *J. Cereal Sci.* 76, 99-107

Fu, B.X., Wang, K., and Dupuis, B. 2017. Predicting water absorption of wheat flour using high shear-based GlutoPeak test. *J. Cereal Sci.* 76, 116-121.

Wang, K., Dupuis, B., and Fu, B.X. 2017. Gluten aggregation behavior in high-shear-based GlutoPeak

test: impact of water absorption and strength. *Cereal Chem.* 94, 909-915.

Dupuis, B., and Fu, B.X., 2017. A new lean no time test baking method with improved discriminating power. *J. Cereal Sci.* 74, 112-120.

Suchy, S., Dupuis, B., Sakamoto, J., Fu, B.X., 2017. Alternate dough preparation protocol for extensograph test of dough strength. *Cereal Chem.* 94, 270-276.

Table 1 Wheat, No. 1, and 2 Canada Western Red Spring (CWRS)

Quality parameter ¹	2016 Crop - Harvest - Western Prairies		2016 Crop - Export (2 nd half) - Pacific	
	No. 1, 13.5	No. 2, 13.5	No. 1	No. 2
Wheat				
Test weight, kg/hL	80.3	79.1	81.9	80.5
Protein content, %	13.7	13.8	14.2	13.7
Protein content, % (dry matter basis)	15.9	16.0	16.4	15.8
Ash content, %	1.38	1.58	1.56	1.57
Falling number, sec	410	385	410	370
Particle size index, %	55	55	56	56
Milling flour yield				
Clean wheat basis, %	75.7	75.6	75.8	75.5
0.50% Ash basis, %	79.2	77.4	78.3	78.0
Flour (74% extraction)				
Protein content, %	13.0	13.1	13.3	12.8
Wet gluten content, %	36.5	36.0	37.9	36.1
Gluten index, %	89	89	90	94
Ash content, %	0.43	0.46	0.45	0.45
Starch damage, %	8.0	7.9	8.0	7.8
Amylograph peak viscosity, BU	510	360	510	385
Farinogram				
Absorption, %	65.5	64.9	65.1	64.5
Dough development time, min	5.50	5.25	5.25	6.00
Stability, min	7.5	7.0	6.5	7.0
Mixing tolerance index, BU	25	30	35	35
Extensogram (135 minutes)				
Maximum Resistance, BU	412	406	430	399
Extensibility - Length, cm	23.1	24.0	21.9	21.6
Area, cm ²	121	127	123	112
Alveogram				
P (height x 1.1), mm	115	109	105	99
Length, mm	115	124	125	127
P/L	1.00	0.88	0.84	0.78
W, x 10 ⁻⁴ joules	415	405	392	374
Baking (Canadian Short Process)				
Absorption, %	70	68	69	69
Mixing time, min	4.4	4.1	4.0	4.3
Mixing energy, W-h/kg of dough	10.8	10.5	9.4	10.3
Loaf volume, cm ³ /100 g flour	985	1005	965	985

¹Data are reported on a 13.5% moisture basis for wheat and a 14.0% moisture basis for flour.²Not determined



Milling and Malting / Research on Barley and Other Grains

Dr. Marta Izydorczyk

Quality of western Canadian malting barley

Annual Harvest Report

Barley grown and selected for malting must meet specific characteristics and stringent quality requirements. Every year, we carry out an annual harvest survey and provide detailed information about the quality of malting barley grown in Western Canada for marketers, buyers, and users of Canadian barley. We publish the results in a report “Quality of Western Canadian malting barley” that is available on our website: www.grainscanada.gc.ca.

Working with the Canadian Malting Barley Technical Centre, we collect barley samples selected for malting by grain handlers and malting companies. We assess barley quality according to the official methods of the American Association of Brewing Chemists. We determine protein and moisture content, test weight, kernel plumpness, thousand kernel weight, germination energy, germination index, grain hardness and the degree of pre-germination.

The results for each quality parameter are averaged and compared with mean values obtained in previous years. This allows us to track changes and trends over years as shown in Figures 1 and 2.

We malt harvest samples in our Phoenix Micromalting System (Photo 1) and carry out a complete malt analysis using the American Society of Brewing Chemists’ official methods. We mash malt samples to produce wort and then examine various quality parameters such as wort extract, wort viscosity, beta-glucans, free amino nitrogen and colour. We report quality results for individual malting barley varieties. Table 1 shows the average quality data for CDC Copeland barley from composite samples we received in 2017. Marketers and customers can compare the quality of new barley varieties to CDC Copeland and AC Metcalfe, the dominant varieties in western Canada (Figures 3 and 4).

“Marketers and customers can compare the quality of new barley varieties to CDC Copeland and AC Metcalfe, the dominant varieties in western Canada.”

Seeded area and production statistics

Along with a comprehensive evaluation of both barley and malt quality by variety, our annual report provides a summary of barley seeded area and production statistics (Figure 5 and 6) compiled from Statistics Canada data and provincial crop insurance data. Using information from provincial crop insurance crown corporations, we provide a breakdown of insured seeded area by variety. As varieties with improved yield, agronomic traits, and quality are being registered, we see them entering our survey.



[1] Phoenix Micromalting System **[2]** Barley grain after steeping **[3]** Determining steep-out moisture in barley

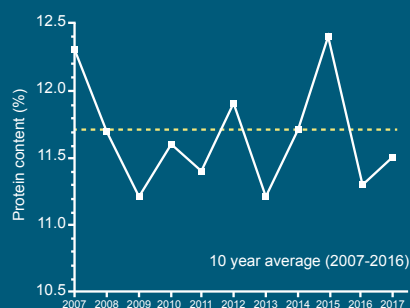
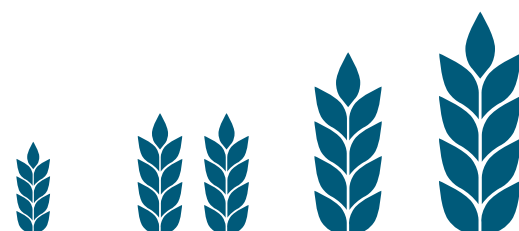


Figure 1 Average protein content in barley selected for malting from 2007 to 2017

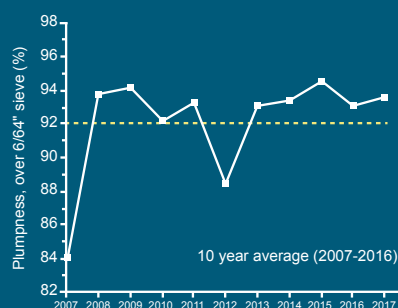


Figure 2 Average plumpness of barley selected for malting from 2007 to 2017

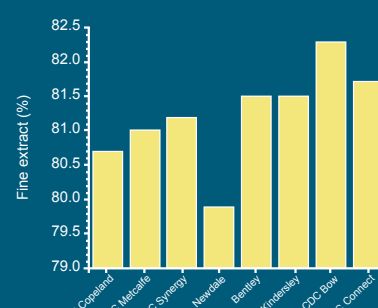


Figure 3 Comparison of average fine extract for varieties collected in annual harvest survey

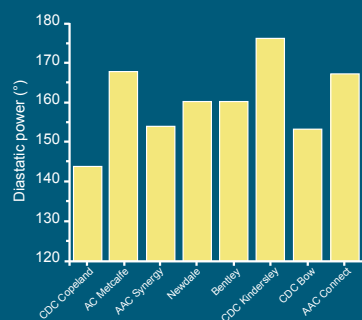


Figure 4 Comparison of average diastatic power for varieties collected in annual harvest survey

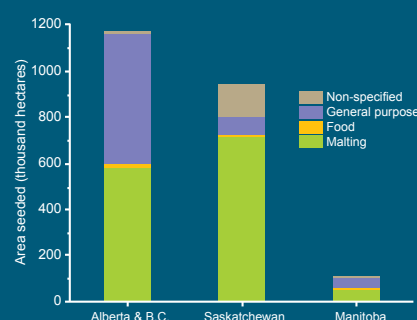


Figure 5 Distribution of barley classes as a percentage of total area seeded with barley in each province

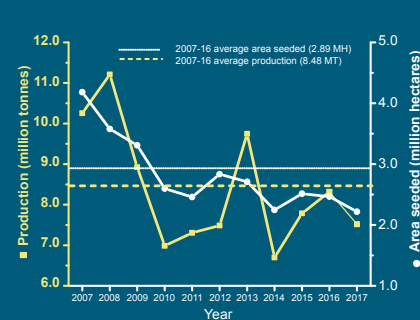


Figure 6 Barley production and barley seeded area in Western Canada from 2007 to 2017



Allis-Chalmers Laboratory mill and purifier for durum wheat milling ►

Table 1 Quality data for 2017 harvest survey composite samples of CDC Copeland malting barley¹

Origin of selected samples	AB	SK	MB	Prairie provinces	
Crop year	2017	2017	2017	2017	2012-2016 average
Tonnage ² , thousand of tonnes	697	655	5.9	1358	440
Barley					
Test weight, kg/hL	67.5	66.6	66.9	67.1	65.9
1000 kernel weight, g	45.9	44.5	45.8	45.2	46.2
Plump, over 6/64" sieve, %	94.2	93.0	93.5	93.6	92.9
Intermediate, over 5/64" sieve, %	4.6	5.6	5.6	5.0	5.2
Moisture ³ , %	11.3	11.4	12.1	11.4	12.2
Protein, %	11.2	11.4	10.3	11.3	11.5
Germination, 4 ml (3 day), %	100	99	96	100	97
Germination, 8 ml (3 day), %	96	98	98	97	90
Malt					
Yield, %	91.1	90.8	91.7	91.0	91.3
Steep-out moisture, %	43.4	43.8	44.3	43.6	44.7
Friability, %	79.1	82.7	85.9	80.9	78.4
Moisture, %	4.8	4.7	5.0	4.7	5.3
Diastatic power, °	145	142	144	144	153
α-Amylase, D.U.	66.3	67.4	70.7	66.8	61.6
Wort					
Fine grind extract, %	80.7	80.7	81.5	80.7	80.6
Coarse grind extract, %	79.9	80.0	81.0	80.0	79.8
F/C difference, %	0.7	0.7	0.5	0.7	0.8
β-Glucan, ppm	90	68	53	79	64
Viscosity, cP	1.44	1.44	1.43	1.44	1.42
Soluble protein, %	4.14	4.25	3.98	4.19	4.83
Ratio S/T, %	36.7	37.0	37.2	36.9	41.8
FAN, mg/L	175	178	177	177	211
Colour, ASBC units	1.73	1.80	1.75	1.76	2.22

¹ Values represent weighted averages based on tonnage of composite samples received.

² Indicates weight of selected barley represented in this survey; does not represent amounts commercially selected.

³ Moisture not representative of new crop moisture levels as samples were not collected or stored in moisture-proof containers.

Harvest Sample Program

We also take part in the Harvest Sample Program, which uses samples from Canadian producers. We analyze barley samples for moisture and protein content, generating some of the quality information producers get for their barley samples.

As well, our grain-milling unit works with other programs in the Grain Research Laboratory and the Canadian International Grains Institute to mill wheat samples submitted by producers as part of the Harvest Sample Program. This year, we milled No. 1 and No. 2 Canada Western Amber Durum wheat samples. We also evaluated the milling performance of 25 individual varieties of Canada Western Red Spring (CWRS), 1 variety of Canada Prairie Spring Red (CPSR), and 7 varieties of Canada Western Amber Durum (CWAD). Milling is performed in a temperature and humidity-controlled room: 21°C and 60% humidity to assure repeatable results, regardless of the ambient conditions. We use a Buhler Laboratory mill for milling common wheat. We mill durum wheat using four Allis Chalmers six-inch roll stands, a purifier, two screen sifters and a box sifter (left).

Cargo monitoring

We also monitor the quality of export shipments of malting barley. Quality data are collected from cargo samples in case there should be concerns about the quality of the cargo after it has been shipped. As well, by assessing the quality of barley exported throughout the year, we can validate the data from our annual harvest survey (Figure 7 and 8).



Figure 7 Comparison of protein content in barley samples analyzed through the annual harvest survey program and cargo monitoring program



Figure 8 Comparison of grain plumpness in samples analyzed through the annual harvest survey program and cargo monitoring program



Oilseeds

Dr. Véronique Barthet

Canola harvest survey and cargo monitoring

Our program takes part in both the Harvest Sample Program and cargo quality monitoring. Like other program areas, we analyze harvest samples in order to provide quality data about the current year's harvest and help us detect quality issues caused by weather conditions during the growing season or during harvest. The cargo quality monitoring program provides information on the quality of the canola, which is exported during the entire shipping season beginning August 1st (before harvest) and ending July 31st of the following year (before the harvest of the new crop).

Valuable tool

Over the years, we've found that the Harvest Sample Program is a valuable tool as harvest quality data can be used to predict the quality of Canadian canola exports for that year. By comparing harvest quality data to quality data from cargo quality monitoring, we can demonstrate to customers of Canadian grain that they can make decisions based on harvest quality data. They can trust the harvest quality data accurately predicts the quality they can expect from their cargo monitoring.

Figure 1 presents the oil content average (with the standard deviation) obtained for canola samples from the Harvest Sample Program and cargo quality monitoring from August 1, 2000 to July 31, 2017.

Figure 1 shows there is constant difference between the oil content averages of samples from the Harvest Sample Program and from cargo quality monitoring. The oil content averages from Harvest Sample Program samples are always about 0.6% higher than the averages from cargo quality monitoring samples. However, there is a linear relationship between the two yearly averages. Samples from exports tend to have lower oil content than harvest samples. This difference is due to dockage. Harvest samples are cleaned to 0.00% dockage before we analyze them; they contain only inconspicuous admixture or seeds that are not readily distinguishable from canola. On the other hand, samples from cargo quality monitoring are only commercially clean. This means these samples may contain up to 2.50% dockage.

Table 1 Summary statistic – Oil content and free fatty acid content of the oil from canola samples harvested before snow (August–October 2016), after snow fall (November–December 2016), during winter 2017 (January 2017) and spring 2017 (April–May/June 2017).

Variable	Oil content (%, 8.5% moisture)				Free fatty acid content of the oil (%, as oleic acid)			
	Aug to Oct 2016	Nov to Dec 2016	Jan 2017	Spring 2017	Aug to Oct 2016	Nov to Dec 2016	Jan 2017	Spring 2017
N	91	53	3	52	91	53	3	52
Mean	44.2	44.4	44.6	44.6	0.17*	0.35*	0.88*	0.43*
Std Dev	2.9	1.8	0.7	2.2	0.12	0.3	0.59	0.2
Min	38.4	40.9	43.8	38.9	0.03	0.07	0.21	0.1
Max	50.4	48.0	45.1	50.9	0.77	1.35	1.35	1.07
Median	44.1	44.2	44.8	44.2	0.15*	0.26*	1.06*	0.42*

*means were statistically significantly different ($p < 0.05$).

Dockage, usually made up of roughage material such as seed pods, knuckles or other seeds, contains less oil than canola seeds, leading to the decrease or dilution of the samples' oil content average when compared to samples from the Harvest Sample Program.

Export samples will always contain dockage because there must be a balance between removing all foreign material (using sieves of various sizes) and losing canola seeds during cleaning. On average, over the year, commercially clean Canadian exports of canola contain 1.88% dockage

Snowed-in harvest

During autumn 2016, an early snowfall delayed canola harvest in Alberta and Saskatchewan. As a result, some canola was not harvested until June of the following year. Customers were concerned about the potential effect of the late harvested canola (or spring canola) on the quality of the canola crop and the canola exports. Since this type of harvest delay has not been observed before, we launched a research project to investigate whether or not this situation would have an impact on end-use functionality.

Producers record their harvest date on their harvest sample envelopes, which allowed us to segregate their samples into groups by date and to assess the effect of snow on canola quality. Of all the quality parameters we assessed, only free fatty acid showed significant differences depending on when a sample was harvested. Canola harvested in November-December 2016, January 2017 and in the spring had a much higher free fatty acid content than seeds harvested from August to October 2016. Some of the canola seeds from the 2017 spring harvest exhibited an orange tint, a sign of seed damage, as shown in Figure 3.

During cargo quality monitoring, we also observed these free fatty acid changes in export shipments. Free fatty acid content increased as spring canola (canola seeded spring 2016 and harvested during spring 2017) moved into the grain handling system and was exported (Figure 2).

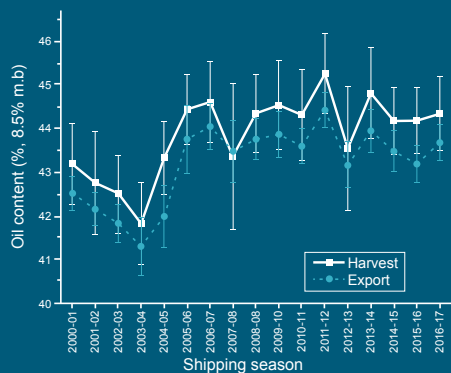


Figure 1 Oil content averages (with the standard deviation) of canola samples from the Harvest Sample Program and from cargo quality monitoring from August 1, 2000 to July 31, 2017.

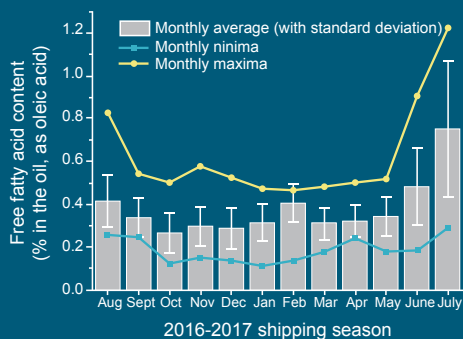
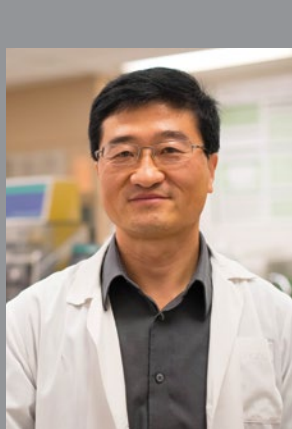


Figure 2 Free fatty acid contents, monthly average with standard deviation, minima and maxima of samples from the cargo quality monitoring from August 1, 2016 to July 31, 2017.



Figure 3 Photo of crushed 2017 spring canola seeds showing normal and damaged seeds, with the damaged seeds exhibiting an orange tint.



Pulse Research

Dr. Ning Wang

Pulse and Food-type Soybean Annual Quality Survey

We support the Harvest Sample Program by providing unbiased information on the intrinsic and end-use quality of Canadian pulse and food-type soybeans. To do this, we conduct annual pulse and food-type soybean quality surveys.

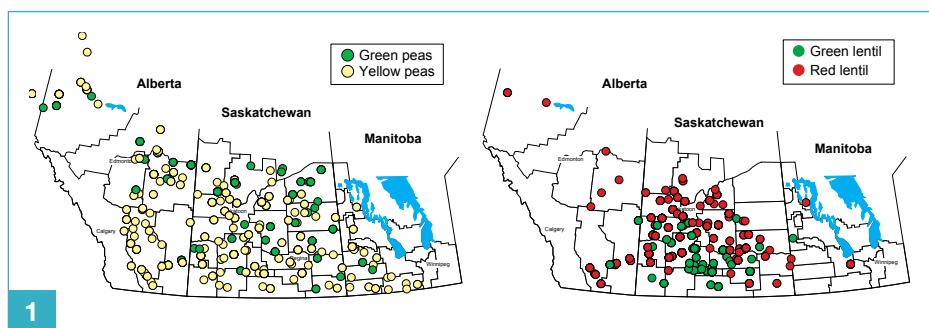
Pulse quality survey

The Harvest Sample Program collected pea and lentil samples from producers across western Canada. (Figure 1 shows the prairie provinces: Alberta, Saskatchewan and Manitoba. Each dot on the map represents a location from where a pea or lentil sample was sent by a producer to the Canadian Grain Commission for analysis. The number of dots does not represent the total number of samples received.)

In 2016, we received:	575 pea samples (471 yellow pea and 104 green pea) 724 lentil samples (258 green lentil and 466 red lentil)
All samples were graded and tested for protein content. Then, composite samples were prepared based on:	- class - green pea, yellow pea, red lentil, green lentil (small, medium and large) - crop region - grade
We tested all composite samples for:	- chemical composition (moisture, protein, starch, total dietary fibre and ash content) - functional properties (water-holding capacity and emulsifying capacity) - mineral content - physical characteristics (100-seed weight and water absorption)

In addition, we evaluated cooking characteristics (cooking time and firmness of cooked seeds) for peas and dehulling quality for red lentils. We carried all tests according to published or standard methods.

Figure 1 Map of western Canada showing origin of 2016 pea and lentil samples from the Harvest Sample Program.



Food-type soybeans

Food-type soybean samples were collected with the cooperation of Soy Canada, and soybean processors and producers from across the Prairies, Ontario, Quebec and Atlantic regions. In 2016, we received 19 natto-type and 456 generic food-type soybean samples, including 6 samples from the Prairies, 313 samples from Ontario and 137 samples from Quebec. Canadian Grain Commission inspectors graded all of these samples as Canada No. 2 or higher. Composite samples were prepared according to region (Prairies, Ontario, Quebec and Atlantic).

We analyzed all composite samples for:

- 100-seed weight
- water absorption capacity/water uptake factor
- protein content
- oil content
- sugar content
- total isoflavone content

We determined protein and oil content using a Tecator Infratec 1241 Grain Analyzer NIRS (near-infrared spectrometer) which we calibrated and verified against the appropriate laboratory reference method. We analyzed sugars and isoflavones using HPLC (high performance liquid chromatography) methods.

How quality data is used

We post annual reports on pulse and food-type soybean quality on the Canadian Grain Commission's website, www.grainscanada.gc.ca.

Internally, quality data is used to monitor and support the quality assurance system. Externally, quality data is used to support the marketability of Canadian pulses and food-type soybeans. Producers can use the quality information to better market their pulses or soybeans.

Results, such as those shown in Figure 2, help us establish long-term databases on quality parameters and environmental influences. Historical data helps producers, marketers and buyers understand the effect of environment on the quality of Canadian pulses. This is an important aspect of marketing Canada's pulses and food-type soybeans in foreign and domestic markets.

Future plans

We will use samples from the Harvest Sample Program to generate analytical reference materials. We will also use samples to study the effect of factors, including grading factors, on the end-use quality of pulses.

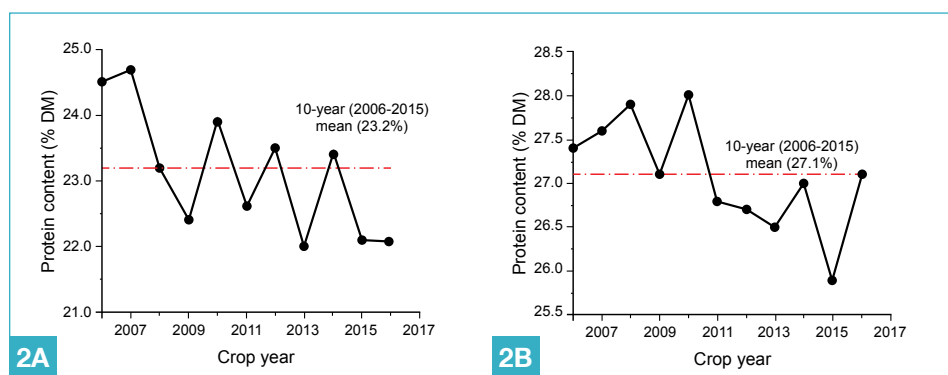


Figure 2A shows the variation of the annual mean protein content in Canadian peas from 2006 through 2016. The mean protein content in 2016 was 22.1%, lower than the 10-year average of 23.2%. There has been a gradual decline of protein content in peas since 2006.

Figure 2B depicts the annual average protein content of Canadian lentils from 2006 through 2016. The mean protein content in 2016 was 27.1%, similar to the 10-year average.

Scientific publications relating to this research

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Wang, N., Hou, A., Santos, J. and Maximiuk, L. 2017. Effects of cultivar, growing location and year on physico-chemical and cooking characteristics of dry beans (*Phaseolus vulgaris*). *Cereal Chem.* 94(1):128-134.

Wang, N., Wood, J. A., Panozzo, J. F., Argansoa, G. C., Hall, C., Chen, L., Singh, M. and Nickerson, M. 2017. Collaborative study on a method for determining the water holding capacity of pulse flours and their protein materials (AACCI Method 56-37.01). *Cereal Food World.* 62(5):227-230.



Wheat Enzymes, Asian Products and Analytical Services

Dr. Dave Hatcher

Testing DON and falling number in harvest samples

In 2015 the Canadian Grain Commission asked producers how we could improve the Harvest Sample Program to make it more relevant to them. Producers identified two high priority items:

The level of DON (deoxynivalenol), a mycotoxin in their samples. DON is caused by the fungi *Fusarium*.

The falling number (FN) value of their sample.

DON is a critical food safety issue and falling number dramatically impacts the quality of end products, such as bread. Currently, DON levels and falling number value are not official grading factors. However, because wheat is increasingly sold based on quality specifications beyond official grading factors, the importance of DON and falling number has escalated substantially and impacts how much producers are paid for their wheat.

We undertook a comprehensive study to see if we could logistically provide this information to producers and if the available tests provide scientifically valid results. As an added benefit, our assessment of these tests could be used to evaluate these tests for suitability in an elevator environment.

Study overview

A Harvest Sample Program envelope holds between 700 to 1000 grams of wheat. In order to report on the quality of the Canadian crop for domestic and international marketing purposes, a sample of this envelope material is removed.

We studied how to best to take a subsample from the remaining harvest sample, in order to ensure the most representative results for both DON levels and FN. We established a detailed sampling protocol, which allows both factors to be determined from the subsamples.

We evaluated how to prepare samples so that the same sample preparation method could be used in both tests. Using a specified grinder (Figure 1) and a rotary divider (Figure 2A and 2B) were found to be appropriate for both tests. We are reporting only on the DON test methods in this article.

“DON is a critical food safety issue and falling number dramatically impacts the quality of end products, such as bread.”





We investigated two ELISA-based (Enzyme Linked ImmunoSorbent Assays) kits and two lateral flow strip tests that are immunologically based (anti-gen-antibody). We designed the project in order to maximize the amount of useful information we could get about potential logistical issues, future Grain Research Laboratory capabilities and the scientific validity of the tests.

We found that the lateral flow test strips were less labour and time intensive. The two strip methods evaluated use the same chemistry for quantifying DON content, but they use different machines. One procedure uses a currently available machine (Figure 3) to determine individual results. The other procedure uses a prototype system machine (Figure 4) designed to remove time sensitive sources of error while running multiple samples, in replicate, simultaneously. Because the prototype uses a cartridge system, it can simultaneously analyze 3 samples in triplicate, it has the potential for increased throughput in a laboratory or terminal elevator environment. This would be invaluable to the Canadian industry.

As well, the prototype is self-timing and automatically takes a reading without operator intervention. The existing machine however requires that an operator remove the test strip from the well when the timer goes off in order for the results to be valid. The self-timing, automatic, multiple simultaneous sample reader offers advantages for higher throughput in both the laboratory and an elevator environment.

Future plans

In 2018, we plan to use material from the Harvest Sample Program in a study evaluating the impact of frost damage on wheat.

Results

This study demonstrated that the representative preparation of the wheat sample for the DON analysis was suitable and achievable for FN testing.

Analysis of hundreds of Harvest Sample Program samples and other wheat samples, as well as Certified Reference Material wheat samples, demonstrated that either of the two lateral flow test strip methods offered significantly quicker sample throughput and were easier to use when compared to the ELISA well-based systems.

The study also highlighted the benefit of the prototype unit for addressing the logistical and human resource issues for potentially undertaking the DON and FN tests as part of the Harvest Sample Program. While both of the lateral flow strip assays offered acceptable scientific reproducibility, because the prototype unit is self-timing and is able to test multiple samples in replicate, we identified it as the most versatile test for laboratory and potential elevator use.

Scientific publications relating to this research

R.-M. Guillermic, F. Koksel, X. Sun, D.W. Hatcher, M.T. Nickerson, G.S. Belev, M.A. Webb, J.H. Page, M.G. Scanlon, Bubbles in Noodle Dough: Characterization by X-ray Microtomography. Food Research International (accepted 2017)

Hatcher, D.W., Bacala, R., Cordova, K., Fu, B.X., Cato, L. (2017) ESI-Mass Spectrometric Characterization of Canadian and Australian Wheat HMW & LMW Glutenin Subunits. First Asian Pacific International Cereals Conference. China

Hatcher, D.W., Bacala, R., Fu, B.X., Cordova, K. (2017) Analysis of Canadian Wheat Varieties Low Molecular Weight Glutenin Subunits Relative to Gluten Strength:

A Genotype x Environment Study. American Association of Mass Spectrometry Conference, USA

Bacala R., Perreault H., Hatcher, D.W. (2017) Evidence for Glycation/Glycosylation of Low Molecular Weight Gluten Polymer Subunits in Wheat Kernels. American Association of Mass Spectrometry Conference, USA

Cordova, K., Bacala, R., Hatcher, D.W. (2017) High Resolution LC-ESI-MS of Intact wheat High Molecular Weight Glutenin Subunits (HMW-GS) Reveals Unexpected Heterogeneity. American Association of Mass Spectrometry Conference, USA



Grain Biotechnology Research

Dr. Tigst Demeke

Simultaneous detection of multiple biotech events

We test grain samples for discontinued or unapproved genetically modified organisms (GMOs) to provide useful information about the presence and distribution of different GM (genetically modified) events. A GMO is an organism in which the genetic material has been changed using genetic engineering. A GM event describes a genetically engineered plant and its progeny. An event is characterized by the insertion of a particular gene into a specific location on a chromosome. For example, cold shock protein B (MON87460 event) was inserted into corn to provide drought tolerance.

ISAAA (International Service for the Acquisition of Agri-Biotech Applications) maintains a list of genetically modified (GM) events and their approval status at www.isaaa.org/gmaprovaldatabase/.

We are ISO 17025 accredited to carry out testing for the presence of GMOs in grain samples. In fact, we've made substantial contributions in dealing with the FP967 GMO flax issue. In 2009, FP967 GMO flaxseed (otherwise known as CDC Triffid) was discovered in Canadian flaxseed shipments to the European Union. CDC Triffid was not approved in EU and many other countries that import Canadian flaxseed. As a result, sampling and testing protocols were developed to handle the issue.

Low level presence of GMOs in non-GMO grain samples is an ongoing concern for the international grain trade. Since 2009, we've tested many flax cargo samples according to the protocols developed between Canada and the European Union and between Canada and Japan.

“We test grain samples for discontinued or unapproved genetically modified organisms (GMOs) to provide useful information about the presence and distribution of different GM (genetically modified) events.”

DNA-based and protein-based methods are used to test for GMOs. We commonly use a DNA-based method, such as real-time polymerase chain reaction (PCR), to detect and determine the amount of GMOs. The number of GMOs has been steadily increasing each year. As a result, it is necessary to be able to detect multiple GMOs at the same time. We've implemented the use of a simple PCR-based platform for the detection of multiple GM events at the same time. In canola and soybeans, we can analyze about a dozen GM events at the same time. In addition, we've established general screening method that can be used for initial detection of various GM events.



Figure 1 Loading pre-spotted plates for testing of GM events

What is the impact?

Grain shipments from Canada are tested for low level presence of unapproved or discontinued GM materials in Europe, Japan and other countries. It is important for Canada to have the capacity to test for the presence of GM events.

We've been testing random canola cargo samples for the presence of discontinued GM canola events. Based on random tests carried out for five years, the OXY235 GM canola event has not been detected in cargo shipments, indicating that commercially grown canola cultivars don't contain the event. Overall, testing of cargo samples provides important information about the kinds and quantities of discontinued GM events in grain shipments.

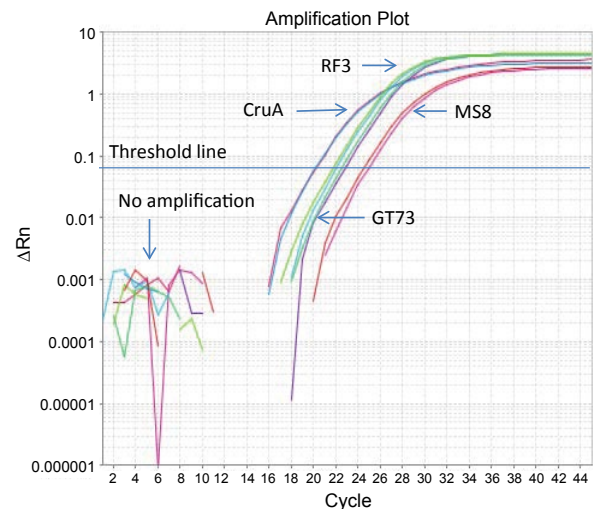
Future plans

We plan to conduct research on the development of suitable methods for the detection of new GM events. As well, we will continue to test cargo samples for the presence of discontinued or unapproved GM events as required.

Table 1 Sensitivity of pre-spotted Plates for the detection of genetically engineered canola events

Event	0.1% Average Ct	0.05% Average Ct	0.01% Average Ct
GT73	33.69 + 0.45	34.99 + 0.27	37.01 + 0.63
MS8	34.64 + 0.17	35.31 + 0.34	37.97 + 0.28
RF1	34.49 + 0.29	35.71 + 0.27	37.90 + 0.66
RF2	29.95 + 0.82	32.62 + 0.45	34.27 + 0.86
RF3	32.68 + 0.16	33.95 + 0.24	35.84 + 0.56
MS1	34.72 + 0.50	35.91 + 0.24	37.88 + 0.50
HCN92	34.65 + 0.19	35.75 + 0.22	37.68 + 0.60
T45	33.93 + 0.22	34.99 + 0.23	37.07 + 0.45
OXY235	33.28 + 0.34	34.51 + 0.27	36.66 + 0.36
MON88302	33.83 + 0.16	34.87 + 0.15	37.19 + 0.36
DP73496	34.54 + 0.13	35.85 + 0.08	38.13 + 0.45
CruA	23.88 + 0.07	23.66 + 0.48	23.75 + 0.05

Notes: Ct = Threshold – detectable increase in fluorescent signal. The average is for 8 independent samples – the 11 events were detected at all three concentration levels. CruA is a reference gene (used as a check).



Amplification shows detection signal

Figure 2 Amplification signal for selected GM canola events using pre-spotted plates

Scientific publications relating to this research

Demeke, T., Malabanan, J., Holigroski, M. and Eng, M. 2017. Effect of source of DNA on quantitative analysis of genetically engineered traits using digital PCR and real-time PCR. J AOAC International. 100(2): 492-498.



Microbiology

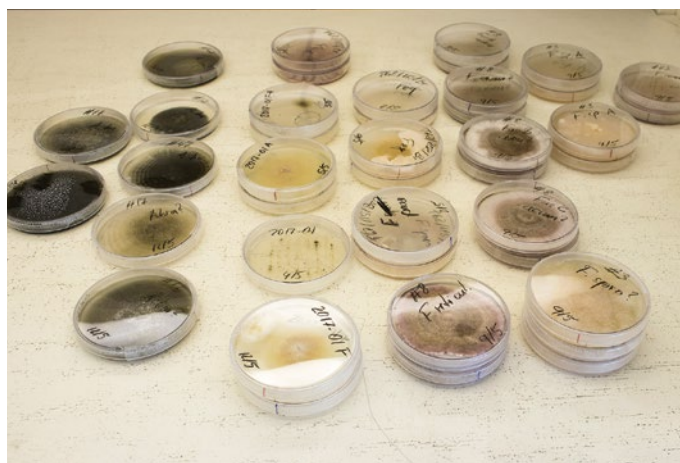
Dr. Tom Gräfenhan

Annual Fusarium survey of cereal grains

Each year, we use samples from Harvest Sample Program to carry out our annual Fusarium survey. After the survey is complete, we statistically analyze hundreds of thousands of data points in order to understand where Fusarium is present in each year's harvest and which species are present. Then we generate distribution maps and graphs that provide an overview of each crop year's survey results. At the end of the survey, we publish our results on the Canadian Grain Commission website, www.grainscanada.gc.ca.

Our data on Fusarium can help provincial governments, grain handlers and agro-chemical companies make strategic decisions because our data and maps show which crop regions are at high risk for Fusarium.

“Our data on Fusarium can help provincial governments, grain handlers and agro-chemical companies make strategic decisions because our data and maps show which crop regions are at high risk for Fusarium.”



The survey also collects baseline data and important information on emerging crop diseases caused by seed-borne pathogens other than Fusarium. Detecting and understanding pathogens is critical for making timely recommendations and providing effective mitigation. Raising awareness early on about foreign or emerging pathogens decreases the risk of further spread while securing profitable returns for Canadian grain producers. Healthy, nutritious crops are key to maintaining a renowned brand and enhanced marketability of Canadian grains.

Figure 1 Petri dish cultures used for identification of Fusarium in FDK samples. Each dish contains a fungal organism grown directly from a single kernel of wheat.



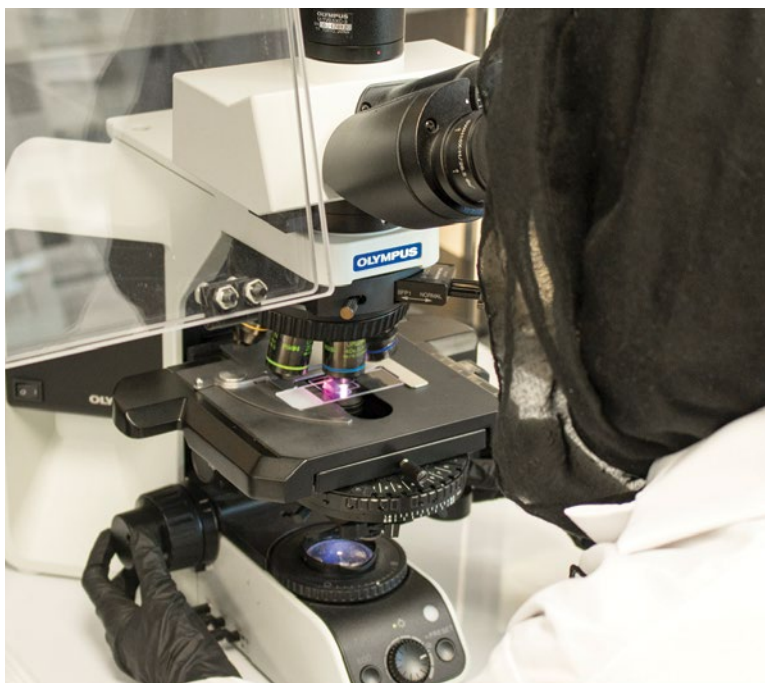
Survey method

The Harvest Sample Program is a valuable source of grain samples for our annual Fusarium survey. The survey uses grain samples that are potentially infected with fungal pathogens, such as the causal agents of Fusarium Head Blight (FHB) on cereal grains. For the survey, Canadian Grain Commission grain inspectors take sub-samples of Fusarium-damaged kernels for us to analyze. We use laboratory tests to monitor for toxigenic Fusarium species associated with Fusarium-damaged kernels and Fusarium Head Blight in both eastern and western Canada.

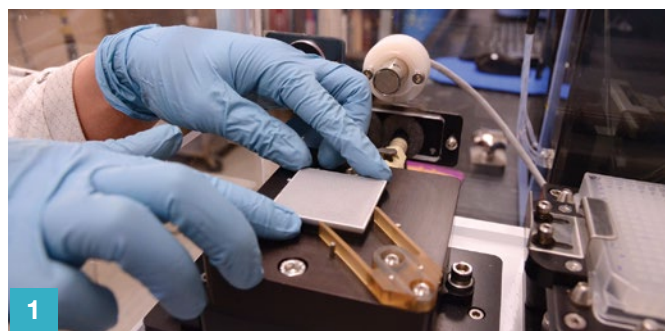
Since 2014, we've used bio-molecular techniques such as high-throughput quantitative PCR in our annual Fusarium survey to process and analyze between 1000 and 3000 wheat samples every crop year. Before 2014, we used agar-plating which meant we could only analyze up to 500 samples every year. Because we are able to analyze more samples now, our data is more comprehensive.

Each PCR assay can detect and quantify a single genetic marker. The PCR technology we use can run several assays simultaneously which allows us to test multiple samples for multiple Fusarium species in a single run. At the end of each instrument run, we've collected almost 5200 data points.

Fusarium-damaged kernels contain the fungal pathogen's DNA, allowing us to identify which species has infected the sample. Bio-molecular methods, such as PCR, target genes or genetic markers that are unique to an organism, such as Fusarium graminearum, which produces the toxin DON (deoxynivalenol). More importantly, genetic markers can encode phenotypic traits of the pathogen that can also reveal their toxicity or virulence. Not all damaged kernels are caused by toxigenic Fusarium species; for example, other fungal pathogens known to cause leaf disease can also affect seeds and their appearance.



[1] The liquid handling robot dispenses over 5000 reactions onto a chip for the detection of Fusarium species in grain samples. **[2]** Fusarium-damaged kernels (FDK) in wheat are shrunk and typically chalky white.



Scientific publications relating to this research

<https://www.grainscanada.gc.ca/str-rst/fusarium/data/frequency-en.htm>
<https://www.grainscanada.gc.ca/str-rst/fusarium/fhbmc-feccg-en.htm>



Trace Organics and Trace Elements Analysis

Dr. Sheryl Tittlemier

Analyzing cargo and harvest samples

We analyze samples taken from cargoes for pesticides, mycotoxins and trace elements, including heavy metals. We analyze approximately 200 samples per year. We run these through different methods that monitor over 300 analytes (or chemical substances), giving us approximately 60,000 results per year.

We analyze samples from the Harvest Sample Program for a more limited number of things. Each year, we look at the cadmium content in composites made from the new Canada Western Amber Durum crop. Cadmium is a toxic heavy metal and there are regulations that limit the amount of cadmium that can be present in wheat and durum. Durum can bioaccumulate cadmium, meaning it can absorb and store cadmium from the environment. However, varieties of durum have been bred that are low accumulators of cadmium.

We also evaluate the relationship between fusarium damage and the presence of deoxynivalenol (DON) in different wheat classes to support grading tolerances.

“We also evaluate the relationship between fusarium damage and the presence of deoxynivalenol (DON) in different wheat classes to support grading tolerances.”

Depending on the year, grain safety issues may pop up. For example, a couple of years ago, there were questions about whether canola treated with quinclorac would contain measureable residues. We developed a new method to measure quinclorac and its metabolite in canola. We used this method to analyze harvest samples to get an idea of the extent of the presence of these two residues.

Sample preparation

We begin all of our analyses by putting a lot of effort into proper sample preparation. Using approved equipment, Canadian Grain Commission inspectors take samples according to defined protocols. Because the Harvest Sample Program samples come directly from producers, we have less control over the methods and equipment used, but the Canadian Grain Commission gives producers instructions to guide sampling. When the samples arrive in our lab, we use special equipment to ensure that, as we grind and subdivide samples, we maintain the connection between our subsamples, test portions and the larger mass of grain from which the sample came.



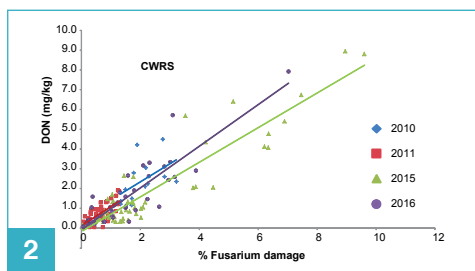
For all of our analyses, we use state of the art instrumentation so that we have the power necessary to generate meaningful data. We want to make sure we're able to measure even low concentrations to confirm Canadian grain meets regulations and specification; and we want to be confident in the identity of what we're measuring.

How our data are used

Data from our cargo monitoring are used for a variety of purposes. First, they're used to prepare statements of assurance. The Canadian Grain Commission issues these to support sales of Canadian grain and to demonstrate how Canadian grain meets customers' regulations and specifications on chemical contaminants and naturally occurring toxicants. Over the last year, 3841 documents based on results from our monitoring of mycotoxins, pesticides and trace elements were issued.

We also use results from cargo monitoring to examine trends. For example, our cargo data shows how successful the breeding of low cadmium accumulating durum has been. The concentrations of cadmium in durum has decreased since the early 2000s, which coincides with the advances made in breeding.

Our Harvest Sample Program work also supports the Canadian Grain Commission, grain producers and other stakeholders to address issues that may come up in a particular harvest year. For example, our analysis of canola harvest samples showed that quinclorac and its metabolite quinclorac-methyl ester are detectable in treated canola. These results helped exporters manage the risk of exporting canola to markets that had not yet approved quinclorac for use.



[1] Samples representing grain exports are analysed for mycotoxins, pesticides, and heavy metals. **[2]** Relationship between fusarium damage and the presence of deoxynivalenol (DON) **[3]** Extracts of grain samples are centrifuged to isolate mycotoxins for analysis.

We often use cargo samples in our method development work. Each year, we update the methods we use – in particular the pesticide methods – to make our methods more efficient and ensure all relevant active ingredients in products registered for use on grain, and their metabolites, are covered by our methods. Lately this work has focused on moving to use QuEChERS (Quick Easy Cheap Effective Rugged Safe) techniques for as many methods as possible. The QuEChERS method is a streamlined approach to testing for pesticide residues that is easier and less expensive.

We are using Harvest Sample Program samples to investigate if the DON/Fusarium damage relationship differs amongst different growing regions within wheat classes. We have also recently used Harvest Sample Program samples to survey the occurrence of mycotoxins in oats grown on the Prairies and the variation of the occurrence over three growing years.

Scientific publications relating to this research

SA Tittlemier, R Trelka, M Roscoe, M Tran, D Gaba, V Barthet, B Siemens (2016). Analysis of quinclorac and quinclorac methyl ester in canola from the 2015 harvest using QuEChERS with liquid chromatography polarity switching tandem mass spectrometry. *Food Additives and Contaminants*. 33:1003-1009.

SA Tittlemier, D Drul, M Roscoe, T McKendry (2015). Occurrence of ergot and ergot alkaloids in western Canadian wheat and other cereals. *Journal of Agricultural and Food Chemistry*. 63:6644-6650.

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Variety Identification Research and Monitoring

Dr. Daniel Perry

Wheat variety monitoring

Our primary activity is monitoring export wheat shipments for wheats of other classes and other ineligible varieties. Originally, we focused specifically on shipments by statutory grade; however, within this past year, our scope has expanded to include shipments by specification.

For each vessel shipment, we receive a portion of the official loading sample and we examine many individual kernels to identify each one by variety. We use efficient DNA-based methods and software that we have developed in-house. We use OpenArray genotyping technology to analyze positions in wheat DNA at which differences are known to occur among Canadian varieties. This gives us a DNA profile for each kernel tested, which we then query against a database of reference profiles to determine variety.

“Confirming that the correct varieties are present in shipments contributes to our confidence that the end-use functionality will be as expected and helps protect the reputation of Canada’s wheat for consistent quality”

We use this same technology to provide variety identification and composition analyses to support other research in the Grain Research Laboratory, including the Harvest Sample Program. Each year, we assess the variety makeup of the Harvest Sample Program’s composite samples that are used to provide information on new crop quality characteristics.

What is the impact?

Monitoring the variety composition of export wheat shipments is a key element of grain quality assurance. Confirming that the correct varieties are present in shipments contributes to our confidence that the end-use functionality will be as expected and helps protect the reputation of Canada’s wheat for consistent quality.

In the infrequent event that wheats of other classes or other ineligible varieties are found in excess of grade tolerances or specifications, our test results provide the data needed to address the issue with the parties involved.

Knowledge of the variety makeup of Harvest Sample Program composite samples and other samples used in research helps to identify potential variety-related influences that may contribute to observed quality characteristics. Recently, gluten strength has received much attention from customers of Canadian grain. Gluten strength is a function of varieties and the environments in which they were grown, so knowing the variety composition of a sample helps researchers understand and explain the gluten strength of that sample.

[1] Placing individual kernels of wheat in 96-well blocks for DNA extraction. **[2]** Transferring DNA of individual kernels to a 384-well sample plate in preparation for loading onto OpenArray plates. **[3]** Placing a sample plate into an instrument that will precisely distribute each DNA sample over specific positions on an OpenArray plate. **[4]** Loading Open Array plates into a specialized PCR instrument for analysis. With a capacity of four plates, a single run generates data for up to 384 kernels of wheat. **[5]** From kernels to results: our custom software develops a profile for each kernel based on two-dimensional plots of fluorescence data and compares each profile against our reference database to identify varieties.



Future

In 2018, western Canadian wheat class modernization will see significant changes to the variety structure of western Canadian wheat classes.

On August 1, 2018, 25 varieties of Canada Western Red Spring and four varieties of Canada Prairie Spring Red wheat will move to the Canada Northern Hard Red class because they don't meet the revised quality parameters for their current classes. Even though kernel visual distinguishability (KVD) was eliminated as a requirement for variety registration in 2008, until now, trained grain inspectors could still differentiate reasonably well between wheat classes based on kernel appearance. However, when varieties that were once in the same class are separated into different classes, any remaining effectiveness of KVD will be lost. This means that Canada's wheat quality assurance system will rely more than ever on class declaration and variety monitoring will take on a more critical role.

