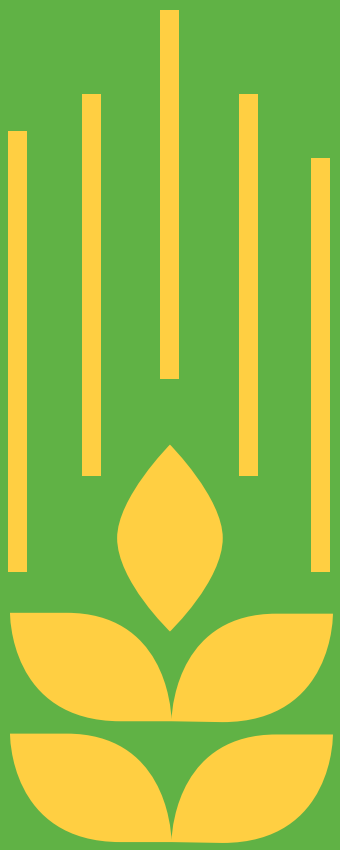
Winter 2023

Spotlight on Alberta Barley-funded

# Research



Alberta Barley



**TOM STEVE | ALBERTA WHEAT AND BARLEY COMMISSIONS**

## A message from Alberta Barley's General Manager

Alberta Barley has had a long-standing history of providing barley producers with advanced management solutions and improved, adapted genetics to increase their profitability. Research is integral to making sure barley remains a competitive, prominent crop in Alberta and a viable option for farmers as they adapt to various outside forces such as government policies, international market demands and changing environmental conditions.

Enclosed in this edition of Alberta Barley's Spotlight on Research is a sampling of research and information on new initiatives and projects in the industry. Learn about new undertakings coming out of the Canadian Malt Barley Technical Centre (CMBTC) including ways to better understand the compounds in malt barley that impact the flavour and aromas of beer. Meanwhile, researchers at Université Laval in Quebec City are looking at how genetic markers can help breeders develop new, cheaper varieties. We'll also look at two projects conducted by Agricultural and Agri-Food Canada (AAFC). One in Charlottetown where researchers are testing a hypothesis that would allow barley growers to decrease their nitrogen inputs, while still maintaining quality and yield, and another closer to home in Lacombe, where researchers are providing valuable insights for barley growers, primarily on fungicide timing. Lastly, a team from the University of Alberta is identifying what could be achieved in Western Canada by including high levels of feed barley in the diet of weaned piglets.

As always, we are committed to funding critical research to improve barley farmers' success. I hope you enjoy reading about the excellent science that is being conducted across the prairies to benefit barley growers.

More information on Alberta Barley's research projects and extension opportunities can be found at **albertawheatbarley.com**

Stories written by Geoff Geddes | **www.thewordwarrior.ca**

DR. FRANCIS BELZILE

# REDUCING COSTS FOR BARLEY BREEDERS? PRICELESS

While most of us strain to find jeans that fit, breeders are seeking genes to fit the needs of producers. Whether it's higher yield, better disease resistance or greater drought tolerance, genetics make it possible. Unfortunately, high-tech often means high-priced, so the challenge with breeding is to lower costs without compromising results. To that end, researchers are exploring more efficient methods of applying genetics to breeding with projects like "CropSNPs: an ultra-low-cost genotyping approach in barley and soybean".

To find the right genes for the job, breeders rely on genetic markers that are similar to signposts on the highway.

"Genetic markers have become essential tools for breeders, helping them to more rapidly develop new varieties with improved traits," says Dr. Francois Belzile, professor, Crop Genetics and Genomics at Université Laval in Quebec City, QC. Belzile is the principal investigator on this project.

"If you break down on the road, you may not know exactly where you are. But if you can say 'I am on Highway X between the signs for 200 km from town and 210 km', the tow truck driver will find you."

Similarly, breeders can narrow down the search for genes of interest by identifying their position as between points A and B, thereby speeding up the quest and reducing costs in the process.

As part of this project, scientists assembled and genotyped 500 soybean and 500 barley cultivars and breeding lines. Genotyping is a way of analyzing DNA to explain how a plant's genetic makeup influences its traits and characteristics.

"Breeders are always looking to develop superior barley lines, so we analyzed the lines they sent us. One might offer greater yield, yet be susceptible to disease, while another yields less but has better disease resistance. By crossing the two, they hope to produce a progeny with the best of both worlds. This is the bread and butter of plant breeding, creating new varieties that will one day be registered for use by growers."

Using the lines they received, researchers created a high-resolution genetic map showing the distance between markers linked to traits of interest. The map is a representation of how frequently genetic markers from the same chromosome are transmitted to the progeny in a similar fashion.

"It is this proximity of markers to one another that becomes critical for breeders. The farther apart two markers for the same trait – such as disease resistance – are positioned, the less likely it is that this trait will be passed along to the next generation."

With traditional plant breeding, scientists must inoculate plants with a certain pathogen and watch for the reaction in order to gauge resistance. Using genetic maps, they can make the same determination faster and for less money.

"Ultimately, our goal is to develop a crop-specific genotyping tool capable of yielding information on these markers for less than $2 per sample," says Belzile. "That represents the key research gap we are trying to address with this project.

Belzile and his colleagues hope that a marked reduction in genotyping costs will speed the uptake of DNA markers by breeders. In turn, this can enhance their ability to select superior lines in response to a changing climate and emerging threats.

"By developing low-cost genotyping tools on the basis of the genetic diversity present in Canadian soybean and barley germplasm, we will maximize the relevance and utility of these for Canadian breeders and geneticists," says Belzile.

While this project and its tools are aimed at breeders, barley growers stand to benefit in the long run.

"For producers, the impact is a bit indirect, in that they are touched by the work breeders can do as a result of new technology. Everything flows through the improvements breeders can funnel to the market in the form of improved varieties."

In the last year, Belzile and his colleagues have published some of their findings, demonstrating how DNA marker information can help breeders separate promising crosses from those with little potential.

"Using a set of soybean crosses breeders had already made, we applied our DNA marker technology. In doing so, we found that none of the crosses we predicted to be poor generated any progeny of interest. Conversely, all of the improved lines which were ultimately commercialized for growers were derived from crosses that our technology characterized as superior."

According to Belzile, these results "lit up the eyes of breeders", and for good reason, as genetic maps may assist with one of the most challenging aspects of plant breeding: "Which two lines should I cross to produce superior progeny?"

"Breeders face an overwhelming number of choices with thousands of potential crosses that could be made, so anything that can speed up and improve that process is invaluable."

As concern for the planet's future continues to grow, so too does the interest in enhancements to plant breeding.

"Breeding represents one of the most cost-effective tools to adapt to the anticipated impacts of climate change, through the incorporation of resistance to both existing and emerging diseases and pests. DNA markers constitute a highly applied technology that has experienced a very rapid uptake by end-users such as breeders and seed companies, thus contributing to enhancing the resiliency and productivity of the agriculture sector."

Projects of this magnitude are demanding, both in time and money, so Belzile is thankful for producer support.

"It is gratifying to be partnering with growers on subjects of interest to them, and knowing that we can make a real difference in the end."

Research made possible through collaborative industry funding:

Alberta Barley · SaskBarley · Grain Farmers of Ontario · Producteurs de grains du Québec

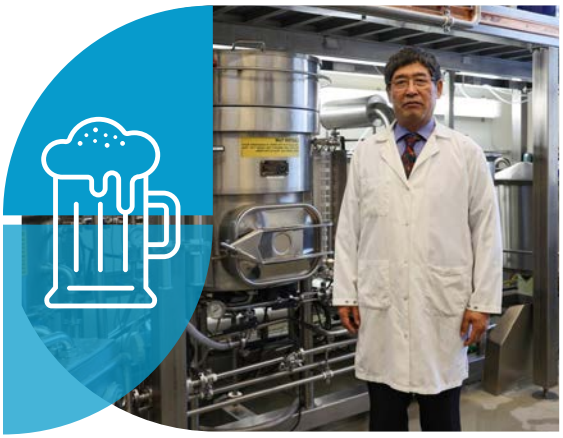
## About Dr. Francis Belzile

Dr. Francis Belzile has been a professor of Crop Genetics and Genomics at the Université Laval since 1992. After earning a B.Sc. Agronomy at the Université Laval, he went on to obtain his M.Sc. Genetics and Ph.D. Genetics at the University of California-Davis. He then served as a Post-doctoral Research Fellow at the John Innes Centre, Norwich, UK.

His research team is interested in exploring how genomics can help us better understand the workings of crop plants and how we can make them more productive for growers. This encompasses basic research trying to answer questions such as "which genes control flowering and maturity?" or "which genes determine the development and growth of plant roots, and how does this impact a plant's resistance to drought?". More applied research aims to provide breeders with better tools to characterize the genetic makeup of their breeding materials and to allow them to make greater use of genetic information to guide their efforts in developing new and improved varieties.

## DID YOU KNOW?

- *The barley genome (its entire genetic makeup) is almost twice that of humans.*
- *Canada is world's fourth-largest producer of barley and the second-largest exporter of malt barley.*
- *We can build genetic maps in plants to indicate where important genes are located.*



Dr. Yueshu Li

# EVEN BETTER BEER? WE'LL DRINK TO THAT

Now that science has put a man on the moon and cured polio, the focus shifts to something really important: brewing better beer. While Canada is renowned for its exceptional malting barley, it is always seeking an edge in the marketplace, and targeting flavour is a good place to start. As part of that effort, researchers embarked on a malt mission with the project "Examination and definition of flavours and aromas and their precursors in malting barley cultivars".

Brewers, including major international companies and small craft enterprises, often cite the importance of specific malting barley varieties for the positive sensory profile of their beer. To date, little research has been done to objectively evaluate these claims. Moreover, the expansion of the craft brewing sector in the U.S., Canada and worldwide has generated renewed interest in the importance of flavour imparted from specific barley varieties. More breweries are seeking opportunities to distinguish their products based on sensory attributes related to raw materials.

"Currently, the Canadian barley, malting and brewing industries have limited knowledge of the flavour profile that specific malting barley varieties can impart on the end product," said Dr. Yueshu Li, director of malting and brewing operations for the Canadian Malting Barley Technical Centre (CMBTC) in Winnipeg, MB.

"In addition, there is limited knowledge of the compounds in malting barley that contribute unique and positive flavour attributes. Gaining an understanding of these compounds, and the ability to screen new barley varieties to maintain the attractive flavour profile of Canadian malting barley over the long term, would benefit the barley and malting industry value chain."

For researchers, one of the main challenges with this study was trying to objectively assess flavour, a quality that many people view as subjective.

"We decided to employ a systematic approach," said Li. "Taking several barley varieties that included both older, established ones and newer offerings, we grew them in three locations: Saskatoon, SK; Brandon, MB and Lacombe, AB."

While they used the same agronomic practices throughout, the three sites differed in soil type and rainfall pattern. Researchers grew barley for two seasons and collected barley samples, separating them by variety, location and crop year. They then brewed beers with the malts generated and took two approaches in assessing the end products.

"Our first step was performing a sensory panel evaluation. We trained several people on how to judge beer and the terminology involved, and then had them evaluate samples produced by this project. The second component was a chemical analysis of each beer."

Finally, scientists analyzed data sets from the two approaches, looking for correlations of flavour profiles and links to barley variety, crop year and growing location. They found that while barley variety does contribute to flavour, the test panel was mostly unable to detect varietal differences. At the same time, the chemical analysis revealed distinctions in flavour profile based on barley variety and growing location.

At first glance, you might ask "if there's no difference that is detectable by consumers, who cares?". As it turns out, the answer is "everyone else".

## About Dr. Yueshu Li

Dr. Yueshu Li obtained his M.Sc. in China and holds a Ph.D. in plant science (physiology & ecology) from the University of Saskatchewan. He has worked in the malting industry in Canada, the U.S. and China, serving in the capacities of research scientist, R & D project manager, director of technical services and general manager.

At present, Li is the director of Malting & Brewing Operations at CMBTC in Winnipeg, MB. He oversees the daily operations of the center's malting plant and pilot brewery, working on quality evaluation of new barley varieties and optimization of process conditions. He also provides technical support to barley end-users and oversees Malt Academy programs, as well as leading all research initiatives.

Li is a member of the American Society of Brewing Chemists, the Master Brewers Association and the Cereals & Grains Association. He currently serves on the Prairie Grain Recommendation Committee and the Technical Committee of the Brewing and Malting Barley Research Institute.

In the past, brewers have been reluctant to move away from older barley varieties, for fear it will change the beer quality profile and alienate drinkers who were happy with the status quo. Based on this study, growers should be able to use newer, higher-yielding varieties for malt and not raise alarms with buyers.

The test results could also be useful to breeders as a reference for focusing on a specific aspect of flavour, just as they target yield and disease resistance.

"I'm excited we were able to prove that most barley varieties in Canada have comparable flavours," says Dr. Li. "That should make it easier for the barley industry to promote new varieties that could be advantageous to growers. The brewing industry in Canada is very conservative, to the point that some brew masters have been using the same variety for many years as the flagship brand of their company. For example, AAC Copeland has served as a go-to malt variety for 20 years now. Unless they want to start paying extra for malt, however, we need to keep the entire beer community happy. If a grower can improve barley yield by 10-20 per cent, they can afford to keep costs stable for maltsters and brewers, so everyone wins."

Going forward, Li feels that characterizing sensory attributes - including flavours and aromas - derived from specific malting varieties, and understanding the underlying chemical compounds will be critical. In his view, these attributes will be an important foundation for ensuring future malting varieties exhibit flavour profiles that end-users have pointed to as contributing in a beneficial way to their product. This may offer advantages to the Canadian malting barley industry, potentially allowing new varieties to target specific market segments that are seeking certain sensory attributes; for example, the mainstream brewing sector versus the craft beer business.

"We are breaking new ground with this study in terms of our focus on flavour profiles. Ultimately, the results could help Canadian malting barley remain competitive in the global market place against competitors who lack the same level of understanding of the sensory attributes that their malting barley varieties impart on the final product."

## DID YOU KNOW?

- *Malt is the soul of beer; you can't make beer without malt, just as you can't make wine without grapes.*
- *Barley is a vital contributor to the brewing industry. Even making wheat beers relies on a big portion of base barley malt. The style of beer is determined mainly by the types of malts included in a brew.*
- *Canada is a key player in the world malting barley market. Our quality barley is the key ingredient in many premium beers worldwide.*

Research made possible through collaborative industry funding:

SaskBarley Development Commission

Brewing and Malting Barley Research Institute

DR. KELLY TURKINGTON

# FUNGICIDE: SOME TIMELY ADVICE ON TIMING

If you ever gave your spouse a late birthday gift and wound up sleeping on the couch, you learned a hard lesson: Timing is everything. Since many factors are beyond producer control, it's important to make the best possible choices in areas you can influence. Recognizing this fact, researchers sought valuable insights for barley growers, primarily on fungicide timing, with the project "In-crop management strategies to reduce the impact of fusarium head blight in barley".

Using test plots, researchers experimented with water volume levels of 20, 40 and 60 litres per acre.

"Typically, head tissues are a vertical target, so reaching them with water can be challenging," said Dr. Kelly Turkington, plant pathologist with Agriculture and Agri-Food Canada (AAFC) at the Lacombe Research and Development Centre in Lacombe, AB.

"Our experiment confirmed findings out of North Dakota State University and from spray expert Tom Wolf showing the usefulness of having angled nozzles set up in both the forward and rear-facing positions."

While the angled nozzle maximizes water coverage, results from the test plots also mean that growers should avoid cutting water rates below the standard recommendation, as doing so could compromise the canopy and limit the coverage of plant tissue.

For seeding rates, scientists found that lower rates were more conducive to uniform head emergence, which improves the effectiveness of fungicide and ties into the main focus of the project: fungicide timing.

"In looking at the timing of fungicide spraying, we tried three different scenarios: shortly after head emergence, which is most typically recommended, a couple of days later, and 8-12 days after emergence."

"We are still waiting on some data and analysis from the trials, but there doesn't appear to be an ideal time to spray barley. That said, infection in barley and wheat can occur anytime from head emergence through to the start of ripening. That is a wide window for infection of 3-4 weeks, but most of the fungicide only remains active for about two weeks. For that reason, late spraying likely provides the best protection against Fusarium head blight [FHB], one of barley's main enemies."

On the other hand, spraying late for diseases like cereal leaf spot, spot blotch and net blotch can compromise the level of disease control and yield response. By the time you reach 8-12 days after emergence, there is already a significant amount of disease established in the upper canopy leaves.

Based on these findings, researchers on the project recommend a dual spraying regime, including soon after head emergence and 7-10 days later. Since FHB risk is also influenced by weather and the fusarium inoculum and spore loads in the air, growers are advised to consult FHB risk maps. These are produced by the Government of Alberta and Alberta Wheat Commission, and are useful for barley growers as the conditions conducive to FHB are similar in wheat and barley.

Adding to the challenge for growers, proper fungicide timing only provides about 50 per cent control against FHB, and only about 30-40 per cent for DON (Deoxynivalenol), the most common mycotoxin associated with FHB in Canada. By contrast, spraying offers 80-90 per cent protection against scald, net blotches and leaf blotch. That difference highlights the need to choose a barley line with a strong disease-resistance package for the specific pathogen affecting your fields. As well, it supports one of the main findings of this

Research made possible through collaborative industry funding:

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## DID YOU KNOW?

- *The window for Fusarium head blight (FHB) infections and potential deoxynivalenol (DON) production is from the emergence of head tissues to the start of senescence (Senescence in plants involves massive nutrient relocation and age-related cell death).*
- *For effective suppression of FHB symptoms and DON development, tissues need to be directly impacted by your fungicide spray. Ensuring good head coverage is critical via correct timing and dual-angled nozzle arrangements.*
- *Improving crop uniformity can help to enhance the effectiveness of fungicides for FHB and DON.*

project: To combat FHB and DON, growers must adopt an integrated approach that includes fungicide timing, FHB maps, disease-resistant varieties and proper crop rotation. Ideally, this would include a 2 -3 year gap for growing barley.

"By limiting the development of FHB and DON, it may be possible to improve the quality of the resulting malt. In that way, enhancing our ability to manage FHB will make barley a more attractive cropping option, which will be critical for Canada to meet burgeoning demands for malt barley from China and the expanding North American craft beer market.

Though the study has some promising recommendations for growers, they come with a caveat.

"I recognize that some producers may not have the luxury of leaving 2-3 years between barley crops," said Turkington. "During some of the talks with growers, my dad will be in the audience and say, 'it's all well and good to recommend a gap like that, but what am I going to grow in the interim?'. When making recommendations, I often come back to that comment and emphasize that I am speaking as a plant pathologist. At the end of the day, producers need to understand the risks of a tighter rotation, yet also factor in the other elements influencing crop rotation."

Speaking of risk, Turkington can only assist with the dangers of pathogens. If you should forget your partner's birthday again, you're on your own.

## About Dr. Kelly Turkington

Dr. Kelly Turkington was born in Humboldt, SK and spent most of his summers on his father's small grain farm near St. Brieux, SK. Since November 1996 he has been a plant pathologist with Agriculture and Agri-Food Canada (AAFC), in Lacombe, AB. He received a Bachelor of Science in Agriculture in Agricultural Biology from the College of Agriculture University of Saskatchewan in 1985, and M.Sc. and Ph.D. degrees in Plant Pathology from the Department of Biology at the University of Saskatchewan in 1988 and 1991, respectively. Turkington's graduate work focused on the epidemiology of sclerotinia stem rot of canola and the potential of using petal testing as an indicator of disease risk and fungicide need.

Turkington's main focus at Lacombe is on diseases of barley, wheat and canola as part of collaborative studies with colleagues across Canada. Turkington has developed a passion for the development of practical solutions for effective disease management. He is currently involved with research related to the development and use of plant resistance for disease control in cereals, improving in-field management tools for FHB and leaf spots in wheat and barley, and plant disease surveillance and risk assessment.

Over the last 26 years, Turkington has been involved in multiple projects related to the use of seed treatments and fungicide timings for barley and winter wheat leaf spot management, the use of intercropping, barley variety mixtures and variety rotation to manage leaf disease risk in silage production systems, and the impact of conventional versus zero tillage on crop productivity and pest management.

Dr. Ruurd Zjilstra

# POWER TO THE PIGLETS: JUST ADD BARLEY

Unlike the Energizer Bunny, the energized piglet can't keep going...and going...and going. Piglets need to refuel, and that comes at a high price for producers. As feed costs continue to rise and take an ever greater chunk of the profits, science is seeking alternatives that will power up pigs without punishing the pocketbook. In that vein, researchers sought out options in a project demonstrating that barley can be used as a main energy source for weaned piglets: "Enhancing competitive value of barley in swine diets".

"In recent years, we have been trying to push the limits when it comes to feed options for the pork sector," said Dr. Ruurd Zjilstra, professor, Faculty of Agricultural, Life and Environmental Science at the University of Alberta.

"That effort led to an exploration of different scenarios and how we could react to them. For example, if the wheat harvest is low one year, can you feed barley to nursery pigs instead? Based on both scientific and anecdotal evidence, and looking at what is done in other jurisdictions, we know that the answer is 'yes', provided you use a modern feed formulation and regulate energy and amino acids."

At present, producers in Western Canada feed high energy diets to nursery pigs in an effort to replicate what producers in the U.S. do with corn, and then add a large amount of oil to raise energy levels even further. By contrast, other parts of the world start with a lower energy regime and include barley as part of the ingredient mix for nursery pigs.

"In this project, our primary goal was to see what could be achieved in western Canada by including high levels of feed barley in the diet of weaned piglets. In reviewing our research trials with a reasonable number of animals, it appears that barley is a viable option that will provide comparable weight gain and performance for your animals. We have published some of those results already, with more to come in the near future."

This study is multi-faceted, with another component looking at slaughter trials and trying to determine how the weight gain from a barley-enhanced diet is distributed between carcass and organs. Also, since barley contains a bit more fiber than other feed alternatives, how does that impact gut health and gut fill?

"More recently, our project also examined the role played by the barley hull, which is very high in fiber and lecithin."

## About Dr. Ruurd Zjilstra

Dr. Ruurd Zijlstra is a professor at the Department of Agricultural, Food and Nutritional Science at the University of Alberta in Edmonton. He was born and raised in The Netherlands, where he completed a M.Sc.-degree at Wageningen University. In 1996, he completed a Ph.D. at the University of Illinois and served as research scientist – nutrition for eight years at the Prairie Swine Centre in Saskatoon, Saskatchewan.

Zjilstra has produced 161 scientific papers and 12 book chapters on nutrition topics. His current research program is focused on unique aspects of starch and fiber nutrition, nutritional quality of co-products in pigs, and feed quality evaluation techniques. He received the 2018 Nonruminant Nutrition Award of the American Society of Animal Science – American Feed Industry Association.

Lecithin is a lipid material that represents a potential source of energy in pig diets. The metabolizable energy content of lecithin is greater than carbohydrate sources (e.g.: corn, wheat, sugar), but less than fats (e.g. soybean oil, pork lard).

Because the yield for hulless barley is low, it is not feasible for producers to grow that crop as feed for pigs. Researchers are studying whether the hull can be rendered more digestible in the pig gut through fermentation. Though they have yet to establish that, Zjilstra and his team see the confirmation of barley's suitability for nursery pigs as a major step forward, as long as the diet is balanced for energy and amino acids. Without such balancing, producers will lose feed efficiency, so it's crucial to consult a nutritionist when formulating the diets.

Though adding barley to the mix is not simple and has a few moving parts, the benefit for producers should outweigh the hurdles.

"At the moment, barley is very expensive, but most years, making the change could offer substantial savings to farmers. The positive impact of barley on the gut could also be significant down the road as we look for other ways to control gut health in pigs without using large amounts of zinc oxide or employing antibiotics."

Barley is already used widely in Europe for nursery pig diets to aid in growth and cut costs at the same time.

"The more restrictions that are imposed around the feed additives you can use with pigs, the more important your choice of grain becomes. Barley has a big advantage over wheat in that regard due to its fiber profile, which can also aid in controlling post-weaning diarrhea."

Though the developments in Europe around barley and pig feed are encouraging, Zjilstra says that solid research is essential before changing your approach.

"Messages from Europe are not always solidly underpinned with scientific data. In Western Canada, we have a strong tradition among universities and research stations of applying sound science and extensive trials before we start making recommendations to industry. Now that we have proven the value of barley for growth and performance, we can more closely scrutinize aspects like gut health. In addition, we can explore other benefits that barley may provide to render it an even more attractive option for nursery pig diets."

Of course, barley is not just advantageous for nursery pigs. When used in pig diets all the way up to slaughter, it generates a product that is often preferred over that of pigs raised in the U.S. on a predominantly corn-fed diet.

"My target with all aspects of this project is to shine a spotlight on barley and how it can be used as a fundamental ingredient in pig production. It's surprising to some extent that barley is not currently used for nursery pig diets in Western Canada, given that it's a primary part of the feeding regiment for growing-finishing pigs in the west. Barley is a key piece of the puzzle in producing high quality pork with nice, white fat that commands the greatest price possible on the export market. In the Pacific Rim, for example, pork from barley-fed animals is highly prized."

If the pros of adding barley don't get you energized, it may be time to change your battery.

Research made possible through collaborative industry funding:

Alberta Barley · SaskBarley · Manitoba Crop Alliance

"At the moment, barley is very expensive, but most years, making the change could offer substantial savings to farmers. The positive impact of barley on the gut could also be significant down the road as we look for other ways to control gut health in pigs without using large amounts of zinc oxide or employing antibiotics."

## DID YOU KNOW?

- *Pigs require a number of essential nutrients to meet their needs for maintenance, growth, reproduction, lactation, and other functions.*
- *Nutrients needed by pigs fall into six general classes: water, carbohydrates, fats, protein (amino acids), minerals, and vitamins.*
- *Energy, although not a specific nutrient, is an important nutritional component and is primarily derived from the oxidation of carbohydrates and fats.*

DR. AARON MILLS

# NITROGEN: FEWER INPUTS, BETTER OUTPUT

Doing more with less is like planning a "quiet" night with the kids: great in theory. For growers, harvesting better malt barley with less added nitrogen is a worthy goal that has only one hitch: How do you do it? Seeing the possible value in the concept, scientists went in search of an answer and found it with a project showing the nitrogen-saving power of integrating legumes into malt barley production.

"Barley growers in Canada sometimes have difficulty achieving malting grade, largely due to protein levels that are too high or too low," says Dr. Aaron Mills, research scientist with Agriculture and Agri-Food Canada (AAFC) at the Charlottetown Research and Development Centre in Prince Edward Island.

"Annually in Western Canada, only about 20 per cent of malt barley grown is deemed acceptable for malting. The rest is sold as feed for livestock, and this can result in reduced revenues for growers. In Eastern Canada, malting barley is a relatively new crop, however, the situation is similar."

As Mills points out, variability in protein concentration and the proportion of plump kernels (>80 per cent) are major acceptance criteria for malting grade. While nitrogen (N) fertilizer application rates drive barley yield, excessive N can impair malting barley yield and quality by increasing lodging and protein concentration, decreasing kernel plumpness and reducing extract. Unfortunately for growers, determining N fertilizer recommendations to optimize yield, quality and economic returns for malting barley is often difficult.

"This project stemmed from some work we had done in previous barley cluster studies in eastern North America, where we examined cultural practices such as seeding rate and fertilizer rates. Following the work of Dr. John O'Donovan [researcher at the Lacombe Research and Development Centre in Lacombe, AB], we found that we were seeing some slightly different responses from the previous crops than what they were seeing out west."

"We wanted to explore how growing different legume crops prior to malt barley would affect the plant's needs for nitrogen, and how malt quality and yield would be affected. The project consisted of a two-year experiment conducted twice at 13 locations across Canada."

The first year of each experiment involved planting a preceding crop consisting of one non-legume and two leguminous crops. For the second year of the study, malt barley was planted into the same replicated plots and subjected to six different nitrogen fertility treatments. The treatments looked at 0 per cent, 50 per cent, 70 per cent and 100 per cent of the recommended applied nitrogen from commercial labs, based on spring soil sampling. They also included two split application treatments of 50% at plant and 50% at stem elongation, as well as a 70 per cent / 30 per cent split.

"The field portion of the study involved three experimental years per site in total. The last year of the study was dedicated to finalizing malt qualitative analysis, data analysis and technology transfer activities. Crops preceding malting barley were seeded in 2018 and 2019; malting barley with nitrogen treatments were seeded on the preceding crop residue in 2019 and 2020."

Overall, researchers noted better plant emergence in Eastern Canada, and higher head counts in western Canada, with western yields being higher than what was observed down east. This likely stemmed from the vastly different growing practices between east and west (row spacing, no-till vs. tillage), which can affect many aspects of malt barley.

"While yields were generally higher in the west, the N response was quite consistent across the country. This confirmed our theory that growers could reduce their N applications through planting a legume crop before malt barley, without harming quality or yield. The study showed that this reduction could be as much as 30 per cent which equates to significant cost savings for producers."

Lowering applied N also has implications for the environment, with the Government of Canada targeting a 30 per cent reduction in emissions.

Given the high standards imposed for barley to be accepted as malt in Canada, researchers looked at how quality was affected by lowering N inputs, whilst relying on fertility from the previous crop.

"We struggle with higher protein in Eastern Canada. In the west, you can generally apply more N and get fewer negative effects than we see out east. N in the east tends to go right to the grain in the form of protein, whereas western growers don't seem to encounter that same issue."

Generally, scientists on the project found that the more they pushed yield, the greater the negative impact on quality. Consequently, growers must find a balance between yield and quality.

"The need for that balance is not new information. What is novel about this study is the finding that you can back off on N application and rely on N fixed by the previous year's crop, and still come out okay."

Those insights are all well and good, but they don't answer the most burning question for consumers: "What is the impact on beer?"

"In terms of beer quality, N provided by the preceding legume crop produced greater malt yields and higher diastatic power [an indicator of the amount of enzymes available to convert grain starches into sugar]."

For Mills, one of the most interesting aspects of the study was the contrast between Eastern and Western Canada for elements such as yield and plant response. He would like more closely examine the geographic variations and the impact of differences in agricultural practices from east to west.

"There is a pressing need to develop N fertilization strategies that balance crop productivity and desired quality characteristics. Most malt barley growers in Canada apply N fertilizer only at seeding time. Research into the effects of enhanced efficiency nitrogen fertilizers on yield and quality of malting barley is needed. In addition, the interactive effects of N rate and timing with legume rotational crops on malting barley yield and quality have not been studied extensively."

This project is the first national evaluation of nitrogen management in malting barley to be conducted in Canada. Agronomic data generated at this scale will provide growers with important information to determine optimal fertility required to maximize malt quality in combination with a diversified cropping system.

So maybe you really can do more with less. That "quiet" night with the kids, however, remains elusive.

Research made possible through collaborative industry funding:

Alberta Barley · SaskBarley · Brewing and Malting Barley Research Institute

## About Dr. Aaron Mills

Dr. Aaron Mills is a research scientist with Agriculture and Agri-Food Canada at the Charlottetown Research and Development Centre in Prince Edward Island. He earned his B.Sc. Agr. Plant Science at the Nova Scotia Agricultural College, and an M.Sc., Postharvest Plant Pathology at the University of Prince Edward Island. He went on to earn his Ph.D., Soil Biology, Plant Ecology at Dalhousie University.

Most of his work is focused around cropping systems, plant stress physiology, novel crop development and aboveground/belowground relationships in agroecosystems. Crops of interest include grains and oilseeds, pulses, carrot and potato, and novel crops such as hops and malting barley.

Mills' areas of specialty encompass crop production systems, biodiversity, intercropping, soil ecology and multivariate data analysis.

## DID YOU KNOW?

- *78 per cent of the atmosphere is Nitrogen that is not usable by plants.*
- *Plants need to have nutrients available as salts in order to absorb and utilize them. In this form, nitrogen is referred to as "fixed".*
- *Soil bacteria are responsible for most of the nitrogen being converted from the atmospheric form into usable forms.*
- *The Alberta Wheat and Barley Commissions recently developed a nitrogen rate of return calculator to help growers understand the possible economic returns of various nitrogen fertilizer and crop prices. Learn more at* ***https://www.albertawheatbarley.com/nitrogen-calculator***

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