CBRC
Canadian Barley Research Coalition

Conseil de l'orge du Canada
Barley Council of Canada

BUILDING BETTER BARLEY

National Barley Research Cluster 2018-2023:
Progress Report to March, 2021

THE CLUSTER

The cluster is a component of Agriculture and Agri-Food Canada's AgriScience program under the Canadian Agricultural Partnership. The National Barley Research Cluster brings together twelve research activities from across Canada. The overall goals of the research are to ensure that barley production remains competitive with other major crops in Canada and to improve the quality traits of Canadian barley to satisfy the diverse and evolving needs of our customers. Research areas within the cluster include variety development, agronomic productivity, disease resistance, quality and performance, and sustainability.

INDUSTRY FUNDERS

Alberta Barley

Brewing and Malting Barley Research Institute

CBRC Canadian Barley Research Coalition

CFCRA Canadian Field Crop Research Alliance | ARCCC Alliance de recherche sur les cultures commerciales du Canada

CFCRA members supporting barley research include: Grain Farmers of Ontario, Producteurs de grains du Québec, Atlantic Grains Council and SeCan

Manitoba Crop Alliance

SaskBarley Development Commission

WGRF Advancing Agriculture through Research

Canadian Agricultural Partnership

Canada

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PROJECTS

VARIETY DEVELOPMENT

BREEDING BARLEY FOR HIGH YIELD AND RESISTANCE TO FUSARIUM HEAD BLIGHT FOR EASTERN CANADA

Project lead: Dr. Raja Khanal, Agriculture and Agri-Food Canada, Ottawa Research and Development Centre	**Timeline:** 2018-2023
Status: Ongoing	

Project goals:

- Evaluate new barley varieties that are high quality, high yielding, fusarium-resistant and also have good standability over current varieties
- Increase profitability for producers, increased competitiveness for barley in crop rotations and decreased input costs

Key achievements to date:

- **AAC Bell:** two-row feed barley variety registered in 2018. Characterized by great lodging resistance for a taller variety with great straw strength, excellent yield potential in Quebec and the Maritimes, and good test weight. Marketed by SeCan with good uptake through 2020.
- **AAC Ling:** two-row feed barley variety registered in 2018. Characterized by good lodging resistance, high seed weight, and excellent yields in Quebec and the Maritimes. Marketed by SeCan with good uptake through 2020. Has been evaluated by a Quebec maltster for their craft malting industry.
- **AAC Madawaska:** two-row feed barley variety registered in 2019. Characterized by high yield and good lodging resistance for eastern Canada. Marketed by Eastern Grains Inc.
- Submitted two barley lines to the Office of Intellectual Property & Commercialization (OIPC) in February 2020 for germplasm disclosure.
    - Advanced line CH2909-162-95, a two-row hulless barley variety with higher beta-glucan content and protein than check cultivars received support for registration from the Atlantic Registration Committee for Cereal Crops (ARCCC).
    - Elite line CH2730-60, a six-row feed barley with good yield and improved fusarium head blight resistance, received support for registration from the Quebec Recommending Committee for Cereal (QRCC).
- Submitted two barley lines to the Office of Intellectual Property & Commercialization (OIPC) in February 2021 for germplasm disclosure.
    - OB2705n-11, a shorter hulless six-row feed barley with good yield, that received support from the Ontario variety and recommending committee.
    - OB2930-35, a six-row hulled feed barley with high yield potential and improved foliar disease resistance, that received support for registration from the Ontario variety and recommending committee.
    - CH1009-1, a two-row hulled feed barley with high yield potential and moderate susceptibility to fusarium head blight. Support for registration was received from the Quebec variety registration and recommending committee.

NOTES FROM OUR RESEARCHERS

"ONE OF THE FAVORITE THINGS ABOUT PLANT BREEDING IS SEEING PRODUCERS ADOPT THESE NEW AND IMPROVED VARIETIES."

DR. RAJA KHANAL

"THIS ACTIVITY WAS, IS AND WILL ALWAYS BE IMPORTANT, SINCE A NEW STREAM OF BARLEY CULTIVARS IS CONTINUOUSLY REQUIRED."

DR. ANA BADEA

"THIS PROJECT IS ESSENTIAL TO PRODUCE THE NEXT GENERATION OF VARIETIES THAT WILL ... REPLACE THE CURRENT SET OF NEW VARIETIES."

DR. AARON BEATTIE

PROJECTS

VARIETY DEVELOPMENT (CONTINUED)

BREEDING MALTING AND FOOD BARLEY VARIETIES FOR WESTERN CANADA

Project lead: Dr. Ana Badea, Agriculture and Agri-Food Canada, Brandon Research and Development Centre

Timeline: 2018-2023

Status: Ongoing

Project goals:

- Create new barley varieties for western Canada with better protection from biotic and abiotic stresses, higher yields and greater marketability
- Increase profitability for producers and end users

Key achievements to date:

- Previously released variety, AAC Connect, seeing commercial success with placement on CMBTC's 2018-19 Recommended Malting Barley Variety List, receiving US Plant Variety Protection in February 2020, and appearing on the American Malting Barley Association (AMBA) Recommended Malting Barley Variety List in 2020.
- TR17255, a two-row hulled malt variety with an attractive high-enzyme malting profile for adjunct brewing, received full support for registration at the 2019 Prairie Recommending Committee for Oat and Barley (PRCOB), and has been licensed to Canterra Seeds. It is seen as a replacement for AC Metcalf.
- TR18262, a two-row feed variety with an above average disease package including lower deoxynivalenol (DON) levels, received full support for registration at the 2019 PRCOB. Licensing bids were open again in 2020-21.
- Advanced malt barley lines TR18257 and TR18258, and feed line TR19268 received full support for registration at the 2020 PRCOB. Support for interim registration was also received for TR13255 due to interest from the Canadian distilling industry in its desirable non-glycosidic nitrile (non-GN) trait.
- Sequenced and assembled the reference genome for the first Canadian barley cultivar, AAC Synergy, and published associated data.

BREEDING TWO-ROW MALT, FEED AND FOOD VARIETIES

Project lead: Dr. Aaron Beattie, University of Saskatchewan Crop Development Centre

Timeline: 2018-2023

Status: Ongoing

Project goals:

- Improve current two-row barley varieties for established markets and develop new varieties to capitalize on opportunities in new and emerging markets.
- Ensure barley remains a viable crop within producers' rotations while providing value to maltsters, brewers, and the feed and food industries.

Key achievements to date:

- **CDC Valdres:** two-row hulless food barley variety registered with CFIA (reg. #8955) in March 2020. Characterized by very high beta-glucan content, good yield, strong short straw, excellent threshability and grain plumpness, and a good disease package. Marketed by Tomtene Seed Farm.
- **CDC Renegade:** two-row hulled forage variety registered with CFIA (reg. #9225) March 2021. Smooth awn variety with high forage yield potential, good grain yield and physical grain quality, improved forage quality, short straw and a mixed disease package. Marketed by SeCan.
- Received registration support for TR17163 (2019) and TR19175 (2021). Both two-row hulled feed barley varieties with high yield potential, good lodging resistance, similar grain quality, and intermediate to moderate resistance to tested diseases. Marketed by SeCan.

PROJECTS

VARIETY DEVELOPMENT (CONTINUED)

CROPSNPS: AN ULTRA-LOW COST GENOTYPING APPROACH IN BARLEY

Project lead: Dr. François Belzile, Université Laval	**Timeline:** 2018-2023
Status: Ongoing	

Project goals:

- Develop low-cost, medium-coverage genotyping tools for barley that will reduce genotyping costs, speed up the usage of DNA markers by breeders, and enhance our ability to select superior lines in response to a changing climate and other emerging threats.

Key achievements to date:

- Developed consensus genetic maps for barley containing information that will be relevant and useful to the respective research communities.
- "NanoGBS" – Success proof-of-concept for a miniaturization of the GBS genotyping process published in February 2020. Expected to contribute to reducing plastic use and cost per sample for BGS library preparation, which will facilitate adoption of marker applications where high throughputs and costs are currently limiting.
- Map data will also be uploaded onto crop-specific databases to ensure it is widely available to researchers.

NOTES FROM OUR RESEARCHERS

"THERE IS A LOT OF ENERGY, EXCITEMENT AND PASSION AROUND BARLEY AND THE PRODUCTS MADE FROM IT - THAT MAKES WORKING WITH THIS CROP A LOT OF FUN."

DR. AARON BEATTIE

"PROMOTING BARLEY AS A HEALTHY INGREDIENT FOR FEED COULD POTENTIALLY OPEN UP A MARKET OF 25 MILLION PIGLETS ANNUALLY IN CANADA ALONE."

DR. RUURD T. ZIJLSTRA

"THE CAMARADERIE OF WORKING WITH COLLEAGUES AND PRODUCERS ON BARLEY AND ADDRESSING PRODUCTION AND DISEASE ISSUES HAS BEEN INSPIRING AND IS SOMETHING THAT I TRULY CHERISH."

DR. THOMAS KELLY TURKINGTON

PHENOTYPING BARLEY BREEDING LINES AND GERMPLASM FOR DISEASE RESISTANCE

Project lead: Dr. Thomas Kelly Turkington, Lacombe Research and Development Centre, Agriculture and Agri-Food Canada	**Timeline:** 2018-2023
Status: Ongoing	

Project goals:

- Help develop barley varieties with increased disease resistance, in order to decrease biotic production risks, improve crop yields and quality, lower production costs, reduce pesticide inputs and ultimately lead to more marketable products.

Key achievements to date:

- Conducted large scale Co-op Trials throughout Alberta in which inoculated materials were grown and screened for disease resistance. Data from these trials will be used to inform further trials and proposals for advanced registration of lines.
- Inoculated, grew out and screened material from western Canadian breeding programs and cooperative test trials at AAFC Lacombe's scald, spot-form and net-form net blotch nurseries.
- Set up a pilot spot blotch nursery at AAFC Lacombe.
- Coordinated with FCDC Lacombe to screen materials for resistance to loose and covered smut using growth room facilities. Accessing these growth rooms allowed for inoculation and growth of material that otherwise wouldn't have occurred due to COVID-19 restrictions.
- Coordinated with Alberta Agriculture and Forestry (AAF) to screen for scald resistance at the Crop Development Centre North (CDCN) location. AAF was able to conduct their large scale scald nursery screening for the western cooperation test trials when COVID-19 restrictions prevented AAFC Lacombe's large-scale scald nursery from proceeding.

PROJECTS

FEED BARLEY

ENHANCING THE COMPETITIVE VALUE OF BARLEY IN SWINE DIETS

Project lead: Dr. Ruurd T. Zijlstra, University of Alberta

Timeline: 2019-2023

Status: Ongoing

Project goals:

- Increase the competitiveness of barley for swine diets by substantiating how and why barley provides value-added benefits to swine as more than just a source of energy.
- Nurture increased demand for barley as an ingredient in swine feed.

Key achievements to date:

- Assessed the effects of the varying chemical compositions (amylose, beta-glucan and fibre) of barley cultivars on digestibility in pigs. Concluded that whole grains high in fermentable fibre (i.e. beta-glucan) in certain barley cultivars decreased the diet digestibility of phosphorus and calcium.
- Assessed the digestibility of nutrients and growth performance for pigs fed different fermentable carbohydrates. Concluded that steam-explosion did not increase the nutrition value of barley, but that replacing wheat with barley maintained growth performance in weaned pigs.

NOTES FROM OUR RESEARCHERS

"WORKING TOGETHER IN A VERY FUNCTIONAL NETWORK OF SCIENTISTS ALLOWS US TO BE EXTREMELY EFFECTIVE WITH THE FUNDS WE ARE GIVEN. THE COLLABORATIVE NATURE OF BARLEY RESEARCHERS IS QUITE SPECIAL AND BEING INVOLVED WITH THIS GROUP IS VERY REWARDING."

JAMES TUCKER

DISEASE MANAGEMENT

BARLEY PATHOGEN VARIATION AND SURVEILLANCE: IMPLICATIONS FOR MANAGING HOST RESISTANCE AND FUNGICIDES

Project lead: Dr. Thomas Kelly Turkington, Lacombe Research and Development Centre, Agriculture and Agri-Food Canada

Timeline: 2018-2023

Status: Ongoing

Project goals:

- Build a better understanding of pathogen variation, to help breeders develop resistant varieties and integrated strategies to prolong the effectiveness of host resistance and fungicide applications.

Key achievements to date:

- Gathered data related to the prevalence and severity of existing barley diseases, including Ramularia leaf spot caused by *Ramularia collo-cygni* and genotypic and pathogenic diversity in the spot blotch pathogen from the prairie region.
- Gathered current information on shifts in race frequency for scald or net blotch in central Alberta and stripe rust in North America, collected isolates and net-form net blotch isolates to use in breeding and made progress on identifying resistant genes to these diseases.

PROJECTS

DISEASE MANAGEMENT (CONTINUED)

DEVELOPING BARLEY GERMPLASM WITH IMPROVED RESISTANCE TO FUSARIUM HEAD BLIGHT AND OTHER BIOTIC STRESSES FOR WESTERN CANADA

Project lead: James Tucker, Agriculture and Agri-Food Canada, Brandon Research and Development Centre

Timeline: 2018-2023

Status: Ongoing

Project goals:

- Improve competitiveness of malting and food barley varieties for western Canada by improving resistance to fusarium head blight, cereal leaf diseases and other biotic stresses that currently affect barley production.

Key achievements to date:

- Three large disease nurseries (FHB, leaf disease, and stem rust) were conducted at Brandon, MB, and a network of pathologists were used to characterize resistance levels of materials for breeding programs.
- Multi-location testing of FHB was successful at two to three auxiliary locations annually (Ottawa, Morden, and Charlottetown).
- Canadian lines were also evaluated internationally with several entries showing relatively low DON levels compared to American breeding materials.
- Breeders and users in cooperative testing systems obtained high quality pathology data within a time frame where they could employ it for advancement decisions. Several new potential resistance sources have been identified for multiple diseases, and continue to be evaluated.

NOTES FROM OUR RESEARCHERS

"MORE AND MORE BREWERS BELIEVE THAT MALT MADE FROM A PARTICULAR VARIETY OF BARLEY CONTRIBUTES UNIQUE FLAVOURS TO THEIR BEER."

DR. YUESHU LI

MALTING & BREWING

EXAMINING AND DEFINING FLAVOURS AND AROMAS IN MALTING BARLEY VARIETIES

Project lead: Dr. Yueshu Li, Canadian Malting Barley Technical Centre

Timeline: 2018-2022

Status: Ongoing / extended for one year

Project goals:

- Help the industry fully understand the sensory and flavour profile of different malting barley varieties and identify which sensory attributes (flavours and aromas) in beer are benefited by specific barley characteristics.

Key achievements to date:

- Sourced several barley varieties from three locations across the Prairies. Quality analysis, micro- and pilot malting and pilot brewing trials were conducted. Physical and chemical analysis was conducted on the malts, wort and beer produced, along with sensory evaluation of the beer.
- Preliminary results showed significant differences among barley quality, malt quality and brewhouse performance due to variety and growing region.
- Several volatile organic compounds (VOCs) are known in beer and expected to contribute to the overall aroma and flavour of beer. Of the compounds measured about half showed at least one source of variation to be signification between variety, location and their interaction in preliminary results.
- Initial descriptive sensory analysis of the wort and beer showed no difference in sensory attributes evaluated by panelists, despite the statistically significant differences detected by instrumental methods. Additional sensory parameters and measures to improve flavour standard accuracy, as well as additional training to strength panelist proficiency are being explored.

PROJECTS

MALTING & BREWING (CONTINUED)

IMPROVING MALT BARLEY'S PERFORMANCE FOR THE BREWING PROCESS

Project lead: Dr. Yueshu Li, Canadian Malting Barley Technical Centre	**Timeline:** 2018-2022
Status: Ongoing / extended for one year	

Project goals:

- Help the industry understand how Premature Yeast Flocculation (PYF) works in order to help Canadian malting and brewing companies avoid production loss and will provide the entire malting barley value chain with better testing methods.
- Encourage more barley to be selected for malting use, particularly in years with less favourable growing conditions.

Key achievements to date:

- Conducted micro-malting and pilot scale malting trials on samples of different barley varieties infected with fusarium head blight or spot blotch pathogens. DON accumulation in the raw barley and produced during malting were analysed. Conclusions are that its not only the pathogen, but also the processing conditions to which the barley is exposed that plays a big role in the formation of PYF.
  - o Preliminary results indicated that fusarium can become active again at steep and during germination leading DON production, which is why DON levels in finished malt can be higher than that in the raw barley.
- Developed a rapid PFY test method fordetecting PYF in brewing that offers significant improvement over the old detection method (ASBC's Yeast 14 PYF Detection Technique) in testing time, wort preparation procedure and yeast requirement.

CROP MANAGEMENT

REDUCING THE IMPACT OF FUSARIUM HEAD BLIGHT IN BARLEY THROUGH IN-CROP MANAGEMENT STRATEGIES

Project lead: Dr. Thomas Kelly Turkington, Lacombe Research and Development Center, Agriculture and Agri-Food Canada	**Timeline:** 2018-2023
Status: Ongoing / 2020-2021 field season pushed to 2021-2022	

Project goals:

- Determine how we can better reduce FHB and potential mycotoxin contamination in barley and ultimately improve the quality of the resulting malt.
- Make barley a more attractive cropping option for producers and improve the end product for maltsters.

Key achievements to date:

- Assessed the impact and interactions of water volume, seeding rate, and fungicide application timing on FHB development, barley productivity and DON contamination and assessed whether dual applications of fungicide provide additional benefits in relation to FHB development, barley productivity and DON contamination.
- In general, initial results showed grain plumpness and 1000 kernel weight increased slightly with increasing water volume, decreased slightly with increasing seeding rate, and were slightly higher for fungicide-treated grain than the untreated control. However, site specific differences were observed across all parameters and continue to be investigated.
- Continued malt quality assessments in order to generate data for final outcomes of project.

PROJECTS

CROP MANAGEMENT (CONTINUED)

STUDYING THE INFLUENCE OF PRECEDING LEGUMES AND NITROGEN MANAGEMENT ON MALT BARLEY YIELD AND QUALITY ACROSS CANADA

Project lead: Dr. Aaron Mills & Dr. Breanne Tidemann, Agriculture and Agri-Food Canada

Timeline: 2018-2022

Status: Ongoing

Project goals:

- Develop better guidelines for managing protein levels, by determining how to successfully grow malting barley after legume crops across Canada.
- Help barley producers make more informed choices regarding their cropping systems and potentially increase yield while maintaining quality, thereby increasing profits.
- Help develop practices to minimize nitrogen inputs, reducing the environmental impacts of growing malting barley.

Key achievements to date:

- Fertility and nitrogen rate was determined based on the establishment year of the preceding crop, to emulate crops in rotation in producer fields, for the year in which malt barley was grown.
- Preliminary mixed model analysis was conduced on data received to date investigating the impacts of the preceding crops and nitrogen regimes. Initial analysis showed preceding pulse crops led to higher yield and 1000 kernel weight across the country, but questions remain about the impact on malt barley quality. Head counts and yield varied between legume treatments and locations.
- Completed the field component of the study, and are awaiting the results of the malting analysis to fully complete the activity.

NOTES FROM OUR RESEARCHERS

"A GOOD CROPPING SYSTEM IS A DIVERSE CROPPING SYSTEM. WE NEED AS MANY PROFITABLE CROPS AS WE CAN GET IN ORDER TO KEEP THINGS AS DIVERSE AS POSSIBLE."

DR. AARON MILLS