AAFC Management Lead Barley and Oat Genomics Project – overview with focus on barley

Management Lead: Dr. Michèle Marcotte
Scientific Leads: Drs. Nick Tinker and Ana Badea
Agriculture and Agri-Food Canada

February 2020, Winnipeg

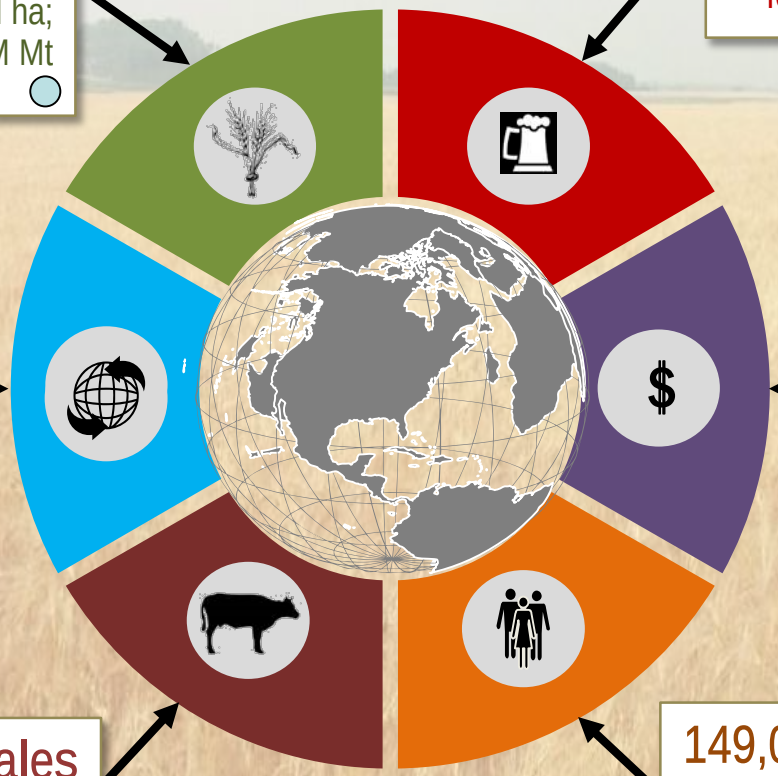
Canadian Barley

Canada's fourth largest crop

- Farmers seeded 2.7 M ha; produced 8.8 M Mt

$13.6 Billion in economic activity

- Domestic and Foreign demand for Canadian Beer



World's fourth largest barley exporter

- second largest malt exporter

$1 Billion in malt export sales

- Malt Barley and Malt

$740 million in feed sales

- 2.1M Mt domestic;1.95M Mt export

149,000 Jobs

- Spending on beer provided labour income in excess of $5.3 B in income

AAFC-Ottawa Research and Development Centre (ORDC)

Barley Breeding and Genomics

View of the Ottawa RDC main building

Barley Breeding – Dr. Raja Khanal, 2017

Central experimental farm

Cereal Genomics – Dr. Wubishet (Wubi) Bekele, 2019

AAFC-Ottawa Research and Development Centre

Barley Classes and Breeding Objectives

Classes

- ❖ Six-row feed
- ❖ Hulless for food
- ❖ Initial steps towards two-row malting

Objectives

- ➢ Higher yield
- ➢ *Fusarium* head blight tolerance
- ➢ Improved lodging resistance
- ➢ Superior quality for different final uses

AAFC-Brandon Research and Development Centre (BRDC)

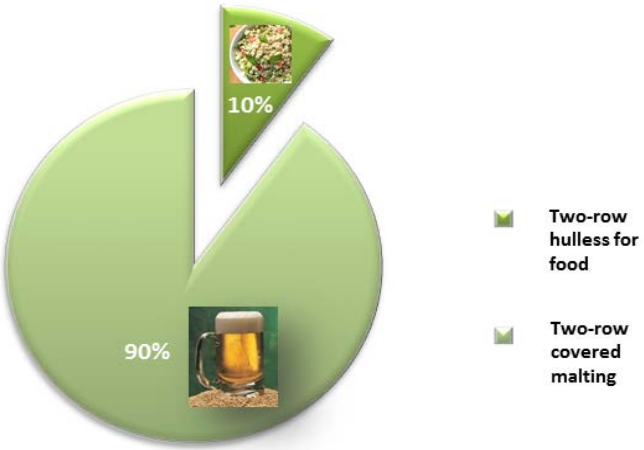
View of research land and station

Barley Breeding and Genomics

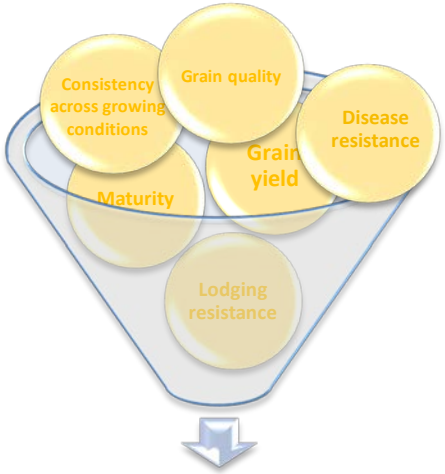
View of the BRDC main building

Barley Breeding and Genetics – Ana Badea, 2012

Barley Genomics – James Tucker, 2018



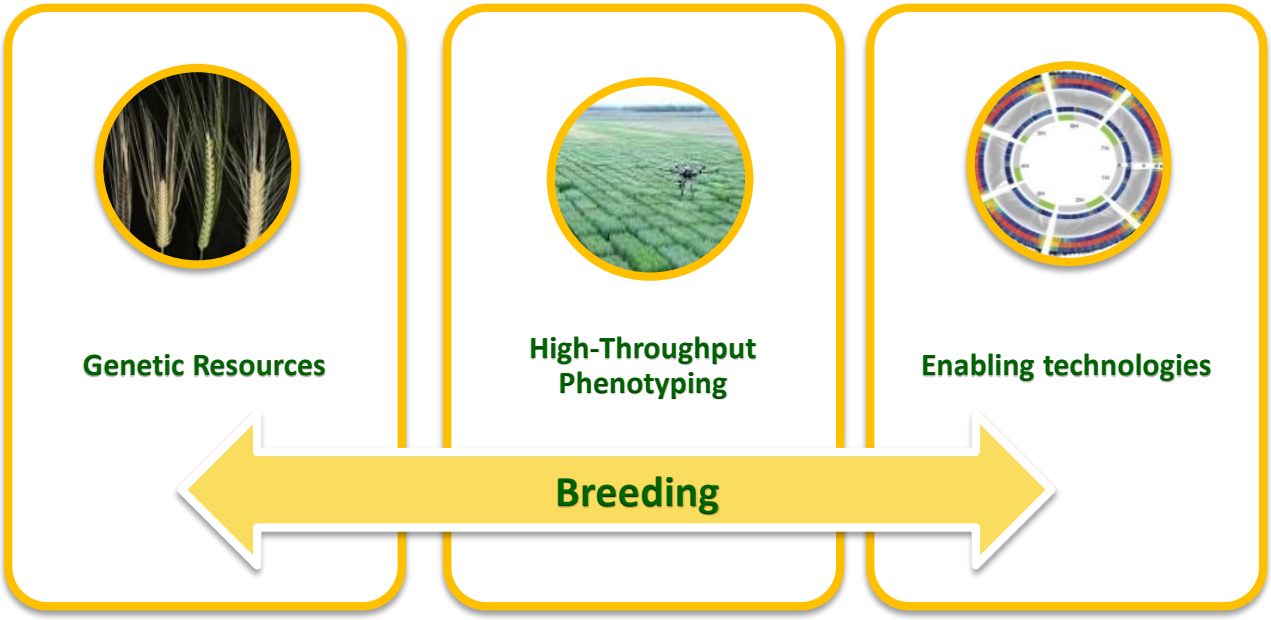
Distribution of effort per barley class



Elite germplasm/new improved cultivar

Breeding objectives

Next Generation Barley and Oat Breeding



Breeder's Tool Box v.2

TUGBOAT

(targeted, useful genomics for barley and oat)

- Length: 5 years (2019-2024)
- Funding: $1.5 M AAFC + $405 K enhancement from Genome Québec
  - (+ 405K matching leverage from McGill, POGA, and CFCRA)
- Main Goal: support the Eastern and Western Barley and Oat Breeding Efforts

Primary activities and outcomes

Activities

- Reference quality sequences of Canadian oat and barley germplasm
  - 4 complete barley genomes
  - 3 oat genomes + 2 wild ancestors
- High resolution barley and oat genomes founder panels
- Predictive database developed
- Genomic selection

Outcomes

- Predictive genome database tuned to Canadian germplasm
- Cooperative and effective genomic selection

Team Project

Breeding team

Raja Khanal, ORDC

Ana Badea, BRDC

Yan Weikai, ORDC

Jennifer Mitchell Fetch , BRDC

Kirby Nilsen, BRDC

Selection of plant material to be used; conduct and coordinate the collection of data for yield, FHB for the breeding populations grown in various environments across eastern and western Canada; provide support with data interpretation and results implementation.

Team Project

Genotyping and predictive biostatistics team

Nick Tinker, ORDC

Wubi Bekele, ORDC

Yong Bi-Fu, SaRDC

James Tucker, BRDC

Contribute to the reference genomes and will use data collected by the use of low-cost genotyping platforms and from multi-environment phenotype trials to build predictive models.

Team Project

Bioinformatics Team

Frank You, ORDC

Wayne Xu, MRDC

Conduct bioinformatics analyses and provide the required support for the work conducted by the other teams.

Collaborators

National

- Dr. Jaswinder Singh – McGill University – gene annotation and proof of concept of gene editing
- Dr. Brian Boyle – Laval University – DNA technologies
- Dr. Aaron Beattie – Crop Development Centre, University of Saskatchewan – advisory role and germplasm contribution
- Dr. François Belzile – Laval University – barley SNP platform

International

E.g.

- German genebank (IPK)
- International consortium in oat pan genomics

Progress to date

- ✓ Training data collected for 400 east and west barley lines
- ✓ Genotyping of training population initiated
- ✓ All specialized sequencing samples are prepared and passed QC
- ✓ All sequencing contracts in place: >$400K
- Sequencing will done by March 31

Canada

Acknowledgments

Agriculture and Agri-Food Canada

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

GenomeQuébec

McGill

Université Laval

University of Saskatchewan

Alberta Barley

Western Grains Research Foundation

SaskBarley Development Commission

Brewing and Malting Barley Research Institute

Manitoba Wheat and Barley Growers Association

Canadian Agricultural Partnership