2021 CFCRA Research Summit Summary Report

February 2-3, 2021

Report prepared by Synthesis Agri-Food Network

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Introduction

The 2021 Canadian Field Crop Research Alliance (CFCRA) Research Summit, held virtually on February 2-3, 2021, was an opportunity for CFCRA researchers, funders and other stakeholders to discuss the new CFCRA research strategy, crop research priorities, collaboration, and innovative approaches to interdisciplinary research. During the event, speakers provided updates on planning for the next Canadian Agricultural Partnership (CAP) funding program, panelists discussed innovation and collaboration, and breakout group sessions were used to identify gaps and develop new research opportunities. Participants also engaged in a pre-meeting online workspace that primed the discussions for the event and provided research updates on current CFCRA research activities (CAP Soybean Cluster, Corn Project & Oat Project) as a background for all attendees to build upon.

The purpose of the summit was to:

- **A.** Share research updates from current CFCRA research programming
- **B.** Present a new CFCRA Research Strategy
- **C.** Gather feedback on refined and updated CFCRA Research Priorities
- **D.** Encourage the development of effective collaborations to address the new Research Strategy
- **E.** Identify innovative solutions to address research priorities with the new Research Strategy

The format of the event is summarized next in the Executive Summary, and detailed descriptions of the presentations and discussions are found in the full report. The input and views expressed during the summit will be considered as CFCRA finalizes our research strategy, including priorities, and prepares for future funding opportunities.

On behalf of CFCRA, I thank all the researchers, extension specialists, government and industry stakeholders who participated in this session. Thank you for engaging in this process and your generosity of time and experience. We received valuable and thoughtful input.

Lori-Ann Kaminski
President
Canadian Field Crop and Research Alliance (CFCRA)

Executive Summary

Overview of the Summit

The Canadian Field Crop Research Alliance (CFCRA) is a not-for-profit entity, made up of provincial farm organizations and industry partners, for the purpose of collaborating on research initiatives of mutual benefit. The goal of CFCRA is to advance the genetic capacity of field crops in Canada, particularly soybean, corn, wheat, barley, and oat. Since its inception in 2010, the CFCRA has invested in crop research in collaboration with the federal government during Growing Forward 1 (2010-2013), Growing Forward 2 (2013-2018), and the *Canadian Agricultural Partnership* Agri-Science cluster program (2018-2023). In anticipation of a new federal-provincial-territorial (FPT) agreement, CFCRA organized a Research Summit to share research updates from all 5 crops, gather feedback on the new CFCRA research strategy and updated research priorities, and generate ideas for innovative and collaborative research to address strategic goals and research priorities over the next 5-10 years.

The Research Summit was planned for early 2021 when Covid-19 pandemic placed restrictions on travel and in-person events. As a result, a two-day virtual summit was held on February 2-3, 2021 with over 80 participants in attendance including researchers and industry stakeholders. A complete list of registered participants is found in Appendix B.

Pre-Meeting Online Workspace

Summit attendees were invited to an online workspace in January 2021 in order to familiarize the participants with current CFCRA research progress, as well as prime participants for discussions and get them thinking about the topics in advance of the summit. The workspace topics included: video updates of research progress from the current CFCRA Research Activity leaders, a description of the new CFCRA research strategy, and proposed CFCRA research priorities for barley, corn, oat, soybean and wheat. Participants were asked questions throughout the workspace and these rankings and comments were presented during the summit to kick-start discussions. In total, 94 participants visited the workspace a total of 551 times and 40 participants provided comments. A summary of the workspace comments is incorporated into Sections II and III below.

AAFC Presentation

Brett Maxwell, AAFC presented information on the development of the Next Policy Framework (NPF) by the Federal-Provincial-Territorial (FPT) governments. The first phase of this process is to develop the high-level vision and priorities which are expected to be released in a Ministerial Policy Statement in July 2021. Science and innovation will remain a key plank and driver of growth in the NPF: Science is the 2nd largest program after Business Risk Management programs, but demands on this funding are expected to increase due to several factors including:

- More demand from traditional sectors (e.g., for new crop varieties)
- Pressure on government to respond and prioritize new issues (e.g., Covid-19 vulnerabilities (e.g. labour); environment/climate change/greenhouse gas (GHG) reduction)
- Emerging technologies (e.g., cellular agriculture, alternative proteins, vertical farming, sensing and imaging technologies, precision breeding techniques, artificial intelligence)

The impacts of the Covid-19 pandemic will impact the NPF and it is expected there will be pressure on decision making and prioritization with more limited funding available.

CFCRA Strategy Overview

CFCRA Vice-President Josh Cowan presented an overview of the new CFCRA Research Strategy. This strategy lays out the goals, framework and metrics that will align industry priorities with government priorities. The four goals of the strategy are:

1. Reduce **Greenhouse Gas Emissions (GHG)**
2. Expand **value-added production**
3. Remain sustainable, competitive and profitable in the face of ***climate instability***
4. Remain **responsive to *markets***, be **profitable** and **link farmgate value to market value**.

In order to address these four goals, a framework was developed that depicts how multi-disciplinary research activities will address four interconnected targets: diverse crop rotations, value-added products, improved nitrogen use efficiency, and reduced business risk (see Figure 1). These four targets all influence success in reducing GHG emissions balanced with a profitable agriculture sector.

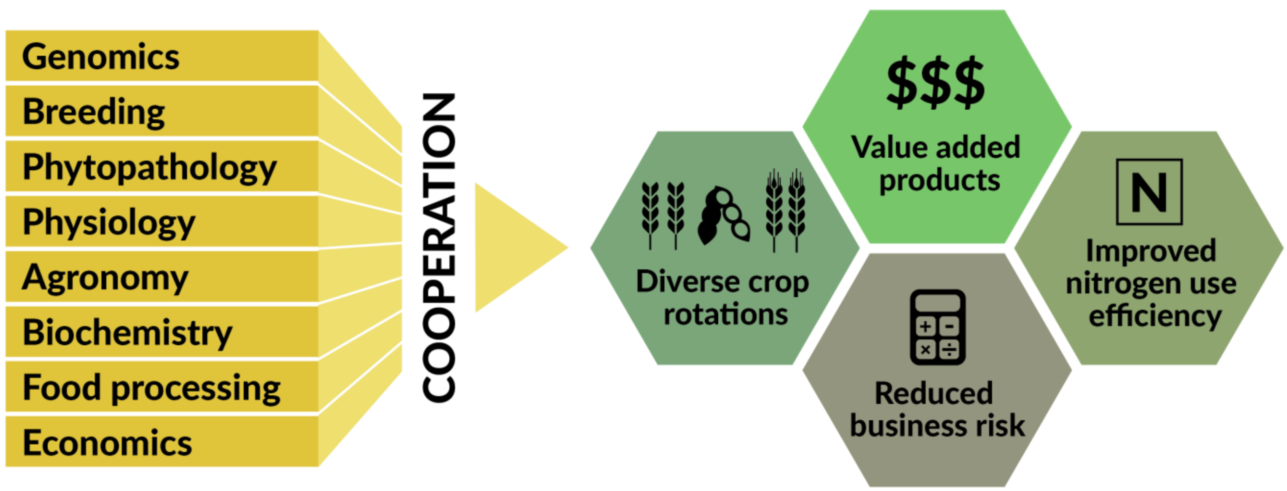

Figure 1: CFCRA Research Strategy Framework

An important element of research initiatives will be the connection of research plans to the strategy using metrics to demonstrate how research will advance the industry towards stated goals (see Section II for a list of suggested metrics).

Research Priorities

Draft research priorities were available in the workspace for participant feedback. These priorities were developed by the CFCRA Board in the fall of 2020 following discussions within each member organization. Overall, there was a high level of agreement with this version of the priorities, but suggested edits were captured in the online workspace. This feedback from the workspace will be considered when finalizing the cluster's research priorities. A full summary of the feedback can be found in Section III.

Breakout Groups

A breakout session was held with groups of 8-15 participants (including industry, government, and academic stakeholders) brainstorming ideas to identify innovative and creative ways to address research priorities. Designated table leads steered the groups through a series of questions and coordinated the capture of discussion notes from each table. Participants were divided into the following areas: corn genetics, GHG/agronomy, oat, soybeans (3 groups) and barley/wheat.

This table summarizes the breakout group discussions, with more detailed and comprehensive descriptions found in Section IV of this report.

High-Level Summary of Breakout Group Discussions	
Corn Genetics	❖ **Collaboration** and working in groups will be important to take advantage of synergistic opportunities e.g., interaction of the microbiome and corn genetics. Microbial adaptations may be an opportunity but are currently not well understood. ❖ There is a need for integration of genetics in **systems studies** (e.g., the interplay of agronomics and genetics of the crop.) ❖ Gibberella and Fusarium diseases are a strong research need. Is there an opportunity for the **corn microbiome** to provide solutions?
GHG/ Agronomy	❖ **Systems approach** needed to achieve the GHG reduction goal while still being profitable for farmers. For example, systems approaches are required to answer: What are the impacts of stacking loss reduction practices together? How do loss reduction practices impact both business risk reduction and nitrogen use efficiency? ❖ **Transdisciplinary** approaches are important to investigate complex systems, but it is expensive to do research this way. We also need **succession plans** for research so that we are not lacking in particular expertise or research capacity. ❖ To add value for growers, researchers need to **engage farmers** from the start and listen to what works for them ❖ **Phenomics and imaging** capacity will be important to develop.

Soybean	❖ Opportunities for **innovation** in soybean research include: imaging (including off-the-shelf technology that may be readily accessible and cost effective), machine learning and AI, creative ways to use automation and robotics in breeding, high throughput phenotyping and the expertise to handle big data from all omics, genome editing but cautiously with regard to export markets. Researchers need to coordinate and break out of ag applications and go to new areas for technology and for funding, not just typical agricultural sources. ❖ **Expertise** needs that were identified included: increasing the practical application of genomics into breeding, physiology, entomology, plant pathologists, biochemists, AI specialists. It is possible to use common populations across programs to be more efficient, but this can raise intellectual property issues. **Scale** in breeding program is also critical for efficiency. ❖ **Communication** is important within research projects but also in networking with other researchers to share problems and solutions. Communication also needs to be fostered between researchers and farmers and exporters in order to make sure research adds value. ❖ Researchers will need support in developing and measuring the **metrics** for all crops. Researchers will need guidance and the methodology will likely apply across crops; a standard approach should be developed. We need to apply agricultural economics to address the opportunity cost, the cost of NOT doing something. ❖ **Pest surveillance** is an important function to inform agronomy and breeding, to keep track of new species. Surveillance also ignites coordination between breeders and pest specialists - entomologists, pathologists, etc. We need to look for efficiencies in surveillance both by new technologies (e.g. drones) and by communication with agronomists. We need to build flexibility into funding programs to deal with emerging threats. ❖ There is growing importance for the Canadian industry and supply chain to demonstrate **sustainability** and we are behind some competitors in this regard. We are behind the US in this. To achieve the sustainability goals, we should consider interdisciplinary work across crops in a systems approach.
Barley/Wheat	❖ To make research more efficient and impactful, **ongoing funding** for long-term research is needed. Gaps between funding programs results in loss of efficiency and HQP (Highly Qualified Personnel). ❖ Progress in wheat and barley requires **tools to support breeders**, such as phenotyping, genotyping, and genomics. ❖ More **sharing of populations** would allow breeders to leverage resources more efficiently and provide other researchers with tools to advance innovative approaches (e.g., genomics capacity). ❖ There is a wide breadth of expertise and a strong willingness to collaborate and work together in wheat and barley research. Having multiple researchers

	developing wheat varieties does not have to be viewed negatively as duplication. **Multiple approaches** provide opportunity for collaboration and synergy. ❖ Interdisciplinary approaches are important for **smaller crops**, and this would fit well with new CFCRA strategy and crop rotation goal. ❖ There is sometimes difficulty with access to germplasm and patented genes, which presents **barriers to collaboration** and innovation. It is possible to work through these barriers, but it takes time.
Oat	❖ Both regional testing and macro-regional testing are important for oats because there are many **unique regions** with distinct practices and markets across Canada. ❖ The use of **predictive modeling** is an opportunity for oat research. ❖ **Gene editing** should be considered, at least to discover more about oat genomics. We don't want to be left behind, but funders, researchers, and consumers need to have confidence in the regulatory status of these tools. ❖ **Data management and bioinformatics** is an area for further development. Examples include: managing large chunks of data, or re-examining historical research using bioinformatics to mine existing data. ❖ In oats there is lots of interest in **interdisciplinary research**. Examples include: GxExM and NUE; more collaboration between east and west and internationally; some learnings from oats can transfer to barley. ❖ **Collaboration** is on-going and is working but could be even better. How do you create efficiency? What kind of budget do you need to do what you want to do?

Panel Discussions on Innovation and Collaboration in CFCRA Research Activities

Panelists from the short season soybean and oat activities were invited to share their experiences with collaborative research projects and introducing innovation into breeding programs. A high-level summary for some key takeaways is presented below and a more detailed summary of the panel discussions is provided in Section V.

<table>
<tr><th colspan="2">Key Takeaways from Research Panel Discussions</th></tr>
<tr><th colspan="2">Soybean Panel</th></tr>
<tr><th>Success Factors</th><th>Challenges</th></tr>
<tr><td>CFCRA was critical in helping the collaboration get started and this support was further leveraged by the Soyagen Genome Canada project.
Collaborating with experts in other areas allowed researchers to develop/adopt innovations on a greater scale and make faster progress than would have been possible individually.
Communication and relationship building are critical for success.
Find areas of complementarity to avoid competition or duplication.
Researchers must enter collaborations with a spirit of generosity and seek benefit for all collaborators.</td><td>Intellectual Property agreements can take time and may cause delays in material transfer, which can delay progress.
Funding programs for large-scale projects require significant time and effort and strong leadership at the application stage.
Management must support and foster collaborations.</td></tr>
<tr><th colspan="2">Oat Panel</th></tr>
<tr><th>Success Factors</th><th>Challenges</th></tr>
<tr><td>CFCRA played a critical role in seeing the possibilities for collaboration and encouraging the project.
Communication is key to making sure that expectations are clear and everyone can see the benefits of collaboration.
When introducing innovation into established programs, new tools must be designed with practicality for their intended use.</td><td>Introducing innovation can take time and force people to make compromises and change mindsets/practices.
Communication and information sharing throughout the project are important to understand how innovation and new tools will be adopted and used, so that they are developed with functionality in mind.</td></tr>
</table>

Meeting Notes and Outcomes

During the two-day meeting, participants took part in presentations, two panel discussions, and a breakout session aimed at identifying innovative ideas to drive research progress toward stated goals and priorities. Participants were also invited to participate in a pre-meeting online workspace, in which they were asked to review and comment on the research strategy and research priorities for each crop. This section of the report summarizes the outcomes from both the pre-meeting workspace and the meeting presentations and discussions.

I. Overview of Next Policy Framework Development

Brett Maxwell, Director, AAFC Innovation & Growth Policy Division, provided an overview of the current status of planning for the Next Policy Framework (NPF). The key takeaways from the presentation include:

- The current Canadian Agricultural Partnership (CAP) evolved from past frameworks, that supported six priority areas – grow **trade** and expand **markets**, advance **science and innovation**, **sustainable growth**, enhance **collaboration** across jurisdictions, and secure **public trust**.
- The Federal-Provincial-Territorial (FPT) governments are in the planning stages for the Next Policy Framework (NPF) and are seeking stakeholder feedback on the policy objectives for that NPF.
- The first phase will be to identify the high-level vision and priorities for the NPF, as agreed upon by the FPT governments. This is expected to be released in July 2021 (see timeline in Figure 2)
- Business Risk Management programs are the main component of the FPT agreements, but science is the second most-funded element of the frameworks.
- There will be stakeholder engagement sessions over the next year to help inform stakeholders of the NPF
- Science and innovation remain a key driver or growth, but there will be increased funding demands on the science envelope from various sectors:
    - Traditional sectors (e.g. variety development)
    - Pressure on governments to respond to new pressures, such as vulnerabilities in the agri-food system exposed by Covid-19 and ongoing environmental concerns (e.g. climate change). GHG emission reduction will continue to be a priority for the federal government.
    - Emerging technologies (e.g. cellular agriculture, vertical farming, alternative proteins, precision breeding techniques, artificial intelligence (AI) and sensing technologies). It is not clear currently how prominent a role these technologies will play in the NPF, but they are a topic of interest.

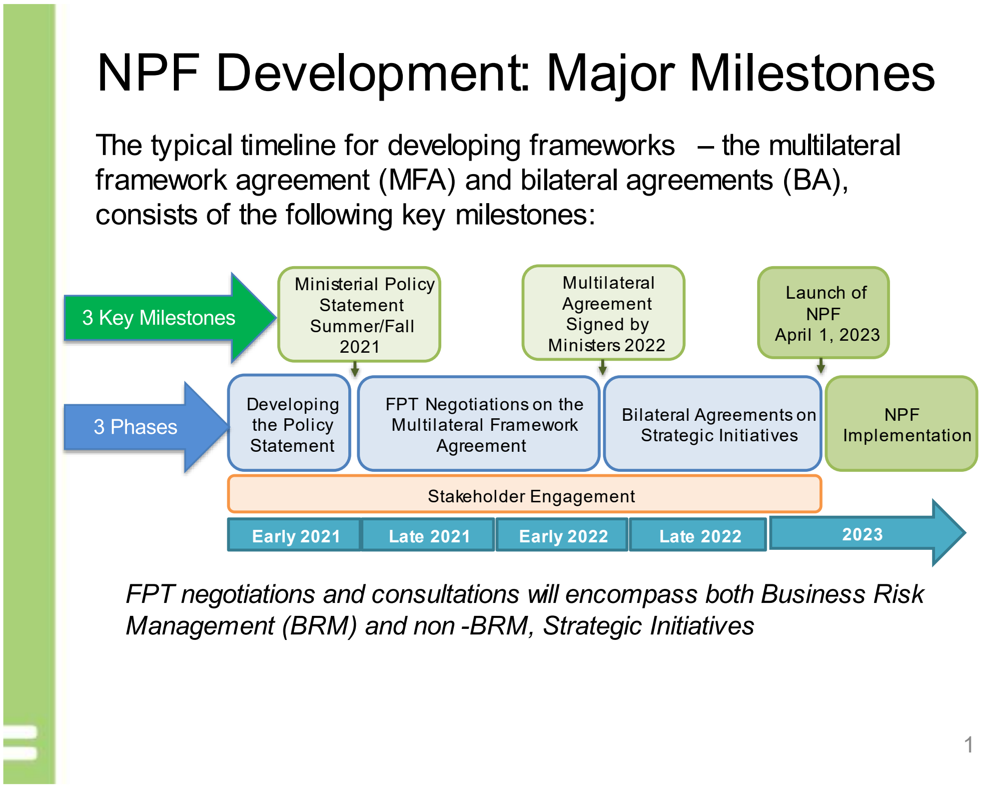

Figure 2: Timeline of NPF Development

After the presentation, a question and answer session highlighted the following points:

- Currently, researchers in Canada are hesitant to use advanced breeding technologies (e.g. CRISPR) because of uncertainty regarding the regulatory process for products of gene editing technologies. Health Canada is currently engaged in stakeholder consultation regarding the path to market for these technologies. Plant breeding innovation is a priority topic for federal government's Targeted Regulatory Review: Agri-Food and Aquaculture Roadmap.
- Industry-led research initiatives are a unique aspect of the agriculture policy frameworks and this has worked well. Industry does play a leadership role in developing program priorities, but the NPF also must respond to broader government priorities, such as environmental priorities. There has to be a balance between these government priorities and producer priorities.
- Agricultural research clusters should work in coordination with the ISED Superclusters and agricultural researchers should look for opportunities to coordinate research, avoid duplication, and leverage ISED funding.
- Historically, approximately 30% of Agri-Science program funding has supported breeding and genetic enhancement and these areas will continue to be a priority in the NPF. The difference between the commercial end of variety development and trait

development must be recognized; upstream activities will be more beneficial to a broader range of stakeholders.

II. CFCRA Research Strategy

Josh Cowan, Vice-President of CFCRA, presented an overview of the new CFCRA research strategy. The purpose of this strategy is to describe how industry priorities align with areas that have been identified as government priorities.

Scope of the CFCRA

Breeding, germplasm development and associated plant pathology work have been the backbone of research to-date as they play a key role in *climate change adaptation*. In terms of the development of commercial varieties, public sector variety development funded by CFCRA has been focused on places where the seed industry does not invest as strongly because of market size and conditions (e.g., small cereals and food grade soybeans).

Most agronomy and environment work for the five crops is handled provincially, so only major multi-province and AAFC/non-AAFC researcher agronomy collaborations have typically resided within the CFCRA.

The scope of current CFCRA-led *CAP* Cluster and Projects includes:

- **Breeding activities** for continuous variety improvement
- **Pre-breeding** for disease resistance and climate adaptation in soybean and corn
- Development of **genomic selection** research tools in soybean and oat to improve the rate of breeding progress
- Integrated **disease management activities**
- Crop-specific **agronomy research** to address N management in oat and corn
- Almost all activities are AAFC/non-AAFC researcher collaborations
- Activities integrate multiple disciplines
  (e.g., pathology, agronomy, breeding, germplasm development, and genomics)

Overarching goals of the strategy

In determining the 4 overarching goals of the strategy, CFCRA considered industry priorities as well as key federal government positioning statement documents. Included were; the Barton Report[1] which identified a target of "$75 billion in agri-food exports by 2027", the recent federal Minister's mandate letter[2] that calls to "*support the efforts of farmers and ranchers to reduce emissions and build resilience as key partners in the fight against climate change*", and a recent Agri-Food Innovation Council report[3] which recognized the key role of continually improving crop varieties, stating: "A genetically diverse

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[1] Unleashing the growth potential of key sectors (aka Barton Report). (2017), Advisory Council on Economic Growth.

[2] Minister of Agriculture and Agri-Food Supplementary Mandate Letter, Jan 15, 2021.

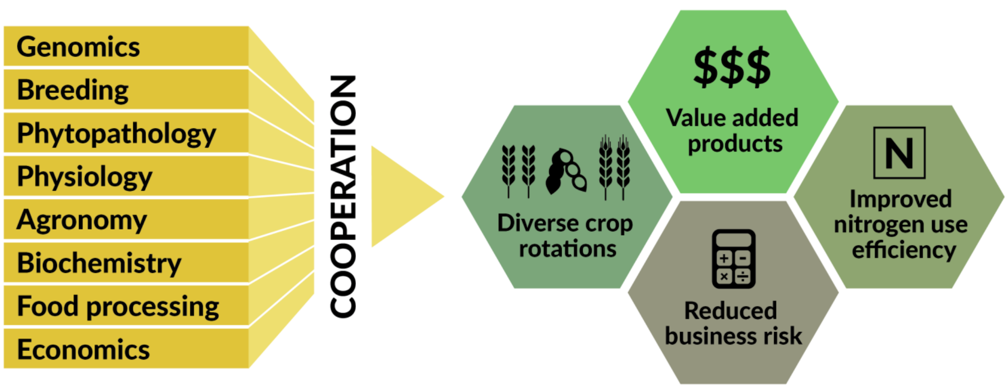
[3] Strengthening the Agri-Food Sector Post-COVID-19 (2020) Agri-food Innovation Council.

portfolio of improved crop varieties, adaptable to a broad range of ecosystems, and resilient to climate change is the foundation for food security and nutrition."
The four goals of the strategy are:

1. **Greenhouse Gas Emissions (GHG)** must be reduced to help meet Canada's targets in The Paris Agreement, and agriculture can contribute to this national goal. This includes more efficient use of inputs (e.g., N), reduced emissions and greater carbon sequestration.
2. Canadian agriculture should expand efforts in **value-added production**, which can lead to an expanded processing industry in Canada, new markets and economic growth.
3. Canadian agriculture should remain **sustainable, competitive and profitable in the face of *climate instability*** to stabilize and grow export markets, rural economies and community well-being.
4. Canadian farmers should be empowered to remain **responsive to *markets***, be **profitable** and **link farmgate value to market value**.

Strategy Framework

The framework to address these four goals involves four interconnected targets that all influence success in reducing GHG, as pictured below:



For each of the four targets in the framework, there are multiple opportunities for CFCRA to lead research progress, as shown in the table below:

Overview of CFCRA Target Opportunities	
Diverse Crop Rotations	
Opportunities	**Potential benefits**
-More small cereals in eastern Canada -Soybean and corn rotated with canola or wheat in western Canada	Reduced N_2O emissions and increased soil organic carbon Resilience to climate change and weather stresses

-Address the barriers to implementation of more diverse crop rotations on farm (e.g. integrate across disciplines to address the relative profitability of individual crops, agronomic limitations)	Protection against losses from diseases, insects, and weeds Yield improvements across rotational crops vs. continuous mono-cropping Improved farm income stability through income diversification (reduced price risk)
Value-Added Products	
Opportunities	**Potential benefits**
-Achieve minimum protein standards in commodity soybean in short season regions and explore protein quality opportunities (e.g., improved feed efficiency) -Improve competitiveness of high-value food-grade soybeans -Ensure target β-glucan levels for milling oat, and explore high protein oat -Malting barley variety selection -Breeding for market-defined wheat classes	Diversification of domestic and international markets Stability and growth of the Canadian food processing industry Resilience to trade disruptions (e.g., stability of high-value food-grade soybean exports during 2020 market disruptions that reduced commodity soybean exports to 6 year low) Improved economic viability of the crop on-farm (can encourage crop rotation diversity)
Nitrogen Use Efficiency	
Opportunities	**Potential benefits**
-Improve fertilizer 4R nutrient stewardship practices -Reduce excess application of nitrogen-based fertilizers -Reduce non-target losses, directly reducing the amount of N_2O produced in the soil via denitrification -Land management (adding N-fixing crops like soybean) -Improve genetics	Direct reductions in GHG emissions (e.g., N_2O) Reduced N input costs per unit of crop production
Reduced Business Risk	
Opportunities	**Potential benefits**
-Develop the components needed to encourage diverse crop rotations on farm that are resilient to climate change and weather stresses, protect against losses caused by diseases, insects, and weeds, are profitable for farmers and mitigate price risks, and provide stable supply for processors and end users	Diversification of domestic and international markets Increased resilience to the impacts of climate change Improved economic viability

Role of genetic enhancement in the strategy

Due to the funding landscape across Canada, genetic enhancement will continue to play a significant role in the CFCRA strategy moving forward. However, germplasm and variety development will need to work in concert with agronomy, value-added targets, crop rotation research and agricultural economics to achieve the targets.

Genetic improvement research should engage in the following overlapping areas:

- Increasing yield through genetics and crop rotation/management practices to **improve profitability of crops**, encouraging more diverse crop rotations
- **Stacking disease and pest resistance** that fits national or regional needs to improve yield stability, reduce pesticide use, and improve food and feed safety
- **Incorporating agronomic performance traits** such as standability, harvestability and abiotic stress tolerance to improve resilience in a changing climate
- **Improving and stabilizing grain and oilseed biochemical composition** to provide processors with suitable quality feedstock and farmers the best farmgate value
- Ensuring **performance of crops in novel rotations** designed to reduce net GHG emissions.

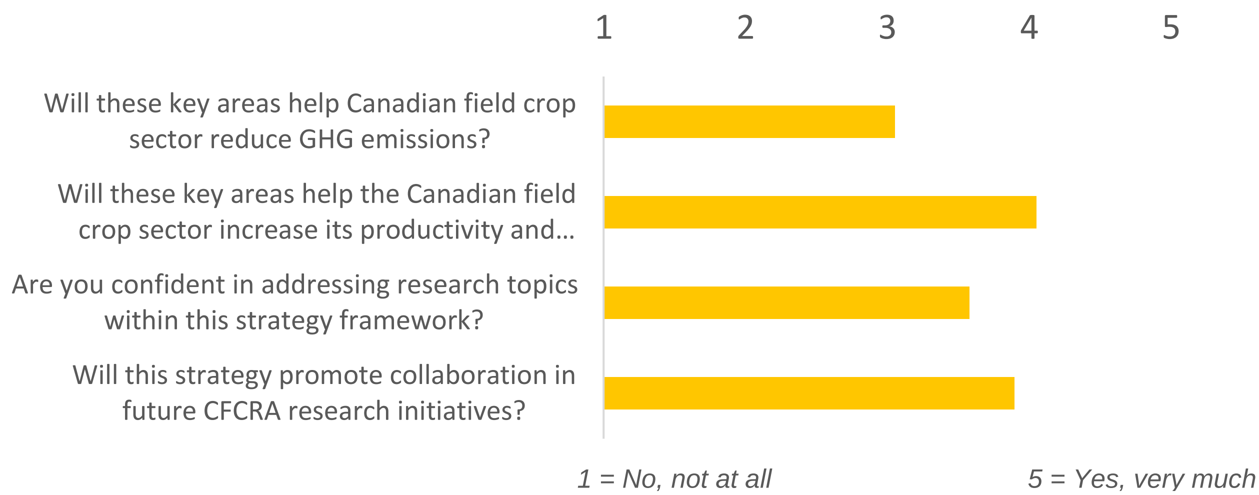
Measuring research impact

One important element of the CFCRA research strategy is the addition of metrics to measure the impact of research on the strategy targets, which are topics of strategic importance to industry and government funders. Potential metrics could include:

- Reduction in N_2O emissions (MMt CO_2 eq)
- Increased soil organic carbon sequestration (MMt CO_2 eq)
- More efficient N use per unit production
- Reduced N use value (input cost)
- Reduced GHG emissions via fuel per unit production
- Reduced pesticide inputs/risks
- Reduced energy inputs
- More acres of lower acreage crops in rotation
- Increased crop value
- Increased yield
- Increased profits
- Market expansion
- Increased domestic processing
- Increased food and feed quality

Summary of Participant Feedback on the Strategy

In the pre-meeting workspace, participants were asked several questions about the new strategy. Participants were asked to rate the aspects of the strategy, where *1 = No, not at all* and *5 = Yes, very much*:



Additional comments on the strategy from participants in the online workspace included:

*"We may be missing a topic of climate change resilience, where tolerance to **abiotic stresses** will add to production agriculture resilience…"*

*"…encourage **collaborations** among programs for each crop species to facilitate the creation of appropriate **platforms** for collecting larger and more reliable data."*

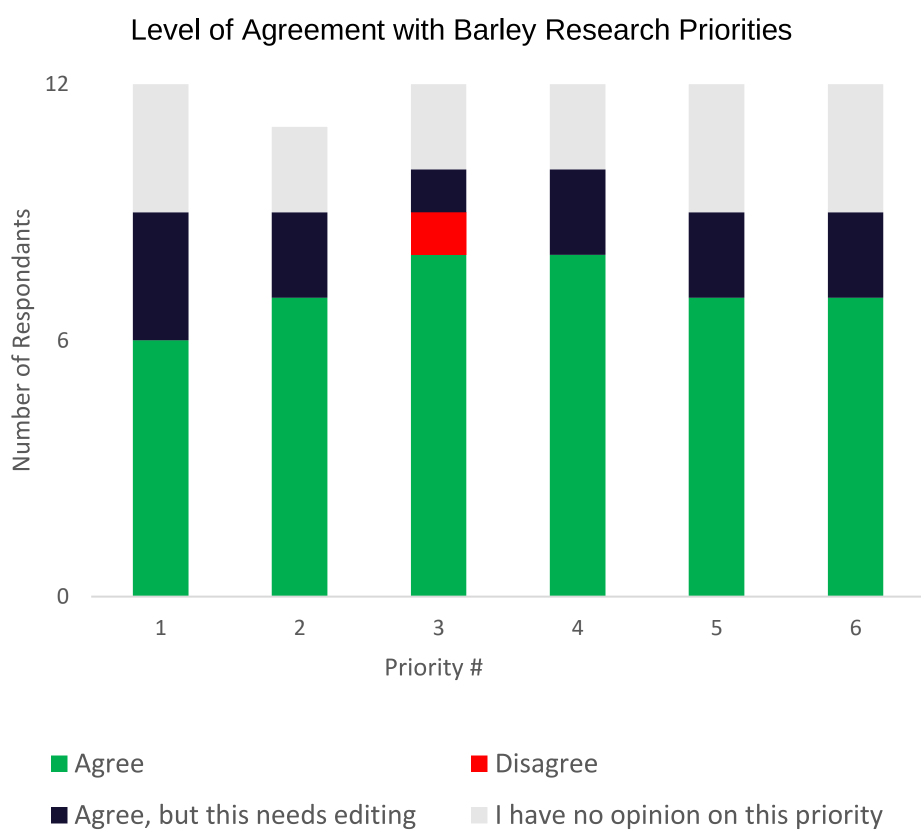
*"…one of the coming challenges is to increase our research capacity in capturing useful **phenotypic** information on a large scale."*

*"progress in oat innovation has been highly dependent on **basic science groundwork and strong international collaboration**"*

III. CFCRA Research Priorities

Lori-Ann Kaminski, CFCRA President, described the process used to develop CFCRA Research Priorities and Rob Hannam, Research Summit facilitator, led the group through some examples of what we heard. To prepare for a CFCRA call for LOIs later in 2021, a set of research priorities was developed by the CFCRA board, member organizations and stakeholders. The research priorities were posted on the online workspace for review by summit participants. The tables below show the draft priorities as well as a summary of the feedback from the online workspace. This feedback will be considered during the development of the finalized research priorities.

Barley Research Priorities



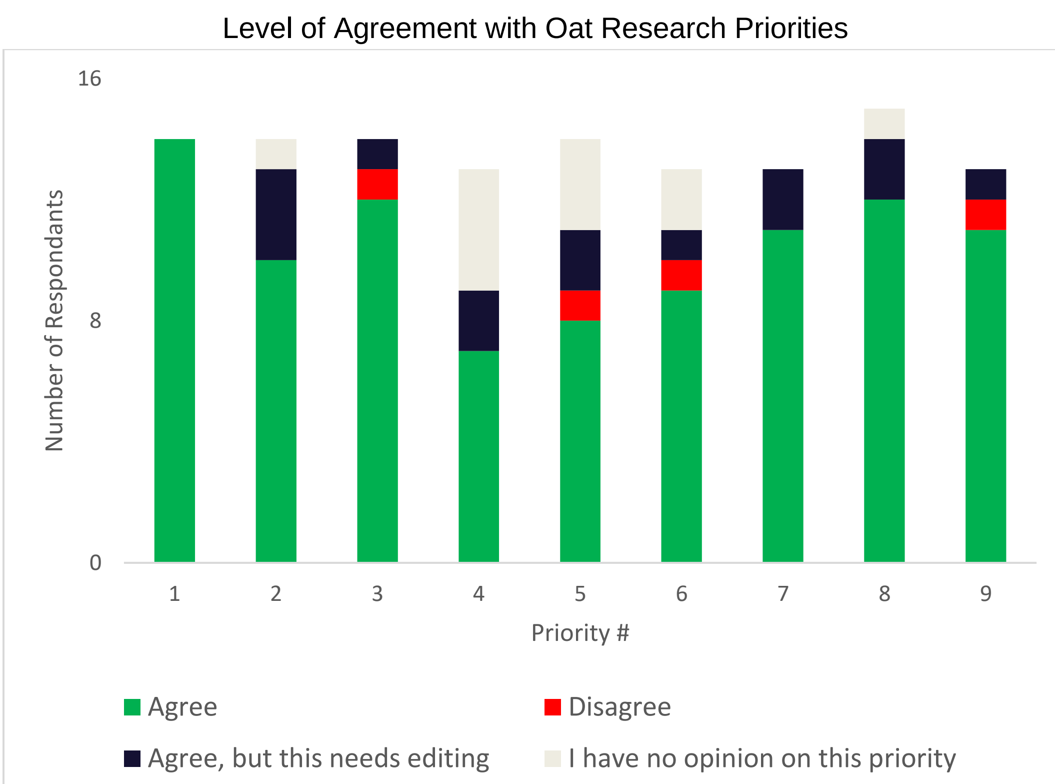
Barley Priorities	
Priority	**Summarized Feedback**
Priority 1: Increase yields of new barley varieties by ≥1.5% per year. Yield increases to be measured relative to provincial checks. New varieties must have good standability. Given the limited genetic variability of Fusarium head blight (FHB) resistance in 6-row barley, a focus will be on 2-row barley variety development.	- Yield stability is important; management will be a critical aspect of increasing and sustaining yield - There is still demand for 6-row barley - Need to consider protein levels also, depending on end use of variety - Is there a way to capture both genetic and management gains?
Priority 2: Stack durable disease resistance into new varieties with the agronomic traits listed above, breeding against current and emerging pathogen profiles in a variety's adapted region. Key diseases include: FHB, powdery mildew, scald, and net/spot blotch.	- Add ergot - Maintain flexibility to attract funding for future emerging diseases - Make better use of high yielding breeding lines by using genome editing to simple traits (e.g. resistance).
Priority 3: Develop effective management strategies for FHB.	- Suggested edit: "integrated" management strategies - Coordinate this FHB work nationally
Priority 4: Develop varieties with well-defined consistent quality parameters for feed and food uses	- Add malt barley as a focus area - Consider both pre- and post-harvest stages
Priority 5: Evaluate existing malt barley varieties for agronomic and market suitability in eastern Canada.	- Is there enough market size to justify development of malt varieties strictly for eastern Canada? - Genome editing is an opportunity to adapt good malt varieties for eastern Canada
Priority 6: To respond rapidly to changing pathogen profiles, develop a coordinated survey system for identifying current and emerging barley pathogens to improve management strategies, screen varieties, and identify and validate new sources of resistant germplasm.	- This would require significant resources - This overlaps with some other priorities - Projects should be coordinated to address multiple priorities and maximize efficiency

Corn Research Priorities

Corn Priorities	
Priority	**Summarized Feedback**
Priority 1: Develop new short season, cold-tolerant inbreds targeting 1800-2000 CHU, while building high yield potential relative to current commercial short season hybrids.	- Suggested edit: add "…*genetically-diverse* inbreds…"; inbreds do not have to be commercially viable but must bring unique characteristics to this maturity
Priority 2: Develop new inbreds with resistance to diseases and identify resistance genes to facilitate effective incorporation of disease resistance into new hybrid development. Key diseases include Fusarium/Gibberella, northern corn leaf blight (NCLB) and Goss's wilt. New inbreds must have good standability and must not have significant yield drag.	- Add "emerging diseases" (e.g., tar spot) - Add genetic inheritance of Goss' wilt tolerance - Develop the corresponding tools for breeders (e.g., markers)
Priority 3: For the inbred development targets above, develop new female inbred lines with a minimum of 40-50 units/acre yield, achieving a minimum bag weight of 15.0 kg/80,000 kernels. Develop new male inbred lines with good, prolific pollen shed, lasting at least 4-5 days.	- Raise the yield goal to 60 units/ac and the minimum bag weight to 16.5kg/80,000 kernels.

Priority 4: To respond rapidly to changing pathogen profiles, develop a coordinated survey system for identifying current and emerging corn pathogens to improve management strategies, screen inbreds, and identify and validate new sources of resistant germplasm.	No comments
Priority 5: Develop strategies to reduce nitrogen losses while maintaining and building yield.	- Water and drought often co-limiting for yield - There are other nutrients that can limit N potential too
Priority 6: Develop strategies to manage corn rootworm resistance to Bt corn.	No comments
Priority 7: Improve grain dryer efficiency to increase profitability and sustainability of corn production.	No comments

Oat Research Priorities

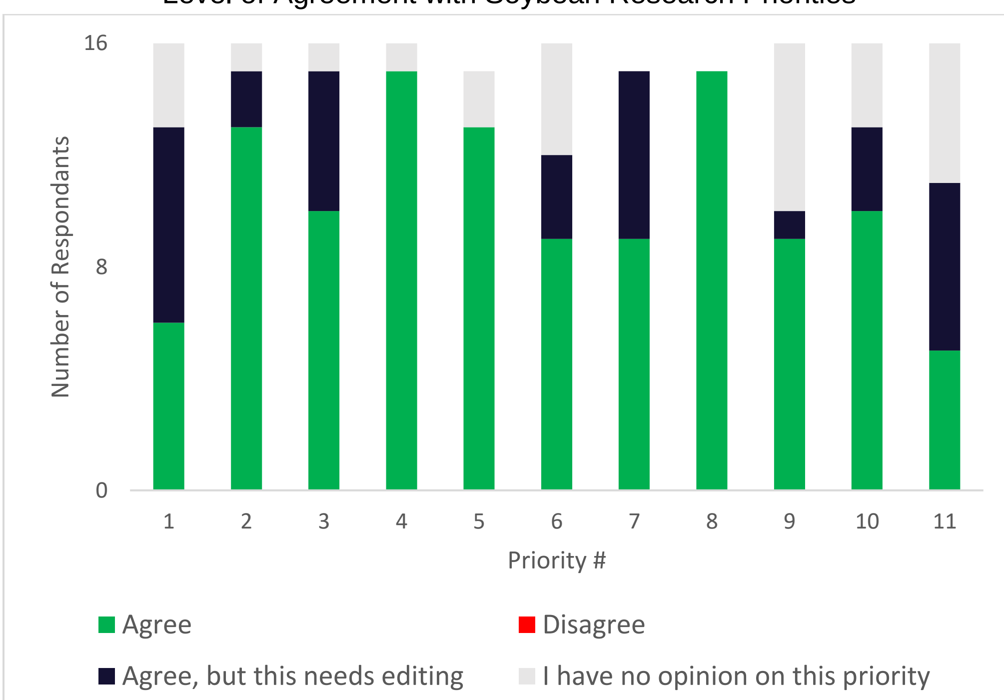


Oat Priorities	
Priority	**Summarized Feedback**
Priority 1: Increase yields of new varieties by ≥2% per year, while maintaining consistent quality and desired agronomic characteristics. New varieties must be early-maturing (to facilitate natural drydown), shatter resistant, and have exceptional standability. Yield increase to be measured relative to provincial checks.	- Breeding against re-growth can also help facilitate better drydown
Priority 2: Stack durable disease resistance into new varieties with the agronomic traits listed above, breeding against current and emerging pathogen profiles in a variety's adapted region. Key diseases include: oat crown rust, stem rust, yellow dwarf mosaic virus, and Septoria leaf blotch.	- Should Fusarium be added - Should Septoria be removed (not yield limiting) - This priority is useful in identifying the approaches towards high realized yield and quality - Have to balance stacked resistance approaches with both yield targets and speed to registration
Priority 3: Develop varieties with well-defined consistent quality parameters for milling.	- Add "*other uses*" so quality targets for other markets can be included - Clearly define the grain end-use so quality targets are clear for breeders
Priority 4: Increase stability, predictability and reliability of β-glucan levels in milling oat varieties across environments, targeting β-glucan levels >4.5%. β-glucan levels of ≥6.5% are not being targeted, as this is secondary to yield and other traits. Both genetic and agronomic combined solutions are appropriate approaches.	- Remove the "≥6.5%" statement; if a 6.5% variety was developed, and performed agronomically, it would be utilized - Current genotypes are quite stable for β-glucan level and consistency issues derive from environmental conditions; integrated agronomic management strategies for β-glucan levels are important.
Priority 5: Develop high protein oats for emerging protein market opportunities, targeting minimum protein levels of 20%.	- Is there a significant market opportunity for this specialty target? - Protein levels this high will reduce yield significantly - Dropping starch levels will increase oil; what are the targets or limits for starch and oil in a high protein variety?
Priority 6: Enhance genomic selection by leveraging Canada-wide training data, increasing use of multi-	- This would be difficult to do (e.g., the predictive reliability of genomic selection

trait and multi-environment models, and expanding the number of selected traits.	in extreme environments has not been established)
Priority 7: To respond rapidly to changing pathogen profiles, develop a coordinated survey system for current and emerging oat pathogens across Canada to improve management strategies, screen varieties, and identify and validate new sources of resistant germplasm.	- This would be resource-intensive and there are currently not enough plant pathologists for oat - Make use of the disease assessments currently conducted at oat plot locations; establish a network to maximize the use of the data
Priority 8: Develop fungicide and nitrogen recommendations for high yield, improved standability, and consistent quality across multiple environments and identify optimum seeding rates for high yielding oat management systems.	- Expand agronomic and integrated pest management research topic areas - Precision farming research could be an efficient way to assess multiple environments (e.g., variable landscapes within the same field)
Priority 9: Develop methods of cultivation and drying without the use of desiccants in the field.	- Suggested edit: Add "*Breeding for early maturity and against regrowth*…" - Suggested edit: Add "…at no yield reduction"

Soybean Research Priorities

Level of Agreement with Soybean Research Priorities

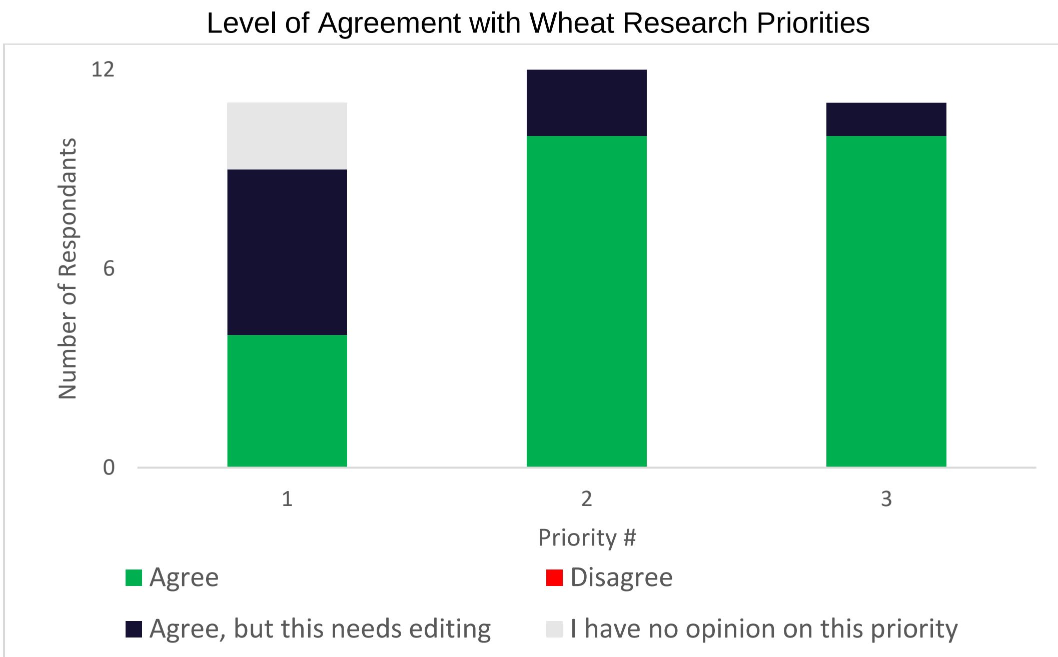


Soybean Priorities	
Priority	**Summarized Feedback**
Priority 1: Increase yields of soybean varieties by ≥2% per year. Yield increase to be measured relative to provincial checks. New varieties must have a minimum pod height of 12 cm from the soil surface to the bottom pod-bearing node to minimize harvest loss.	- 2% seems too ambitious especially if improving quality traits (e.g. protein; sugars for food-grade) or stacking disease resistance; 1.5% yield target is more realistic - Pod height appears as an issue in new production areas; plant density and harvest practices can reduce this issue; this is a separate issue from yield
Priority 2: Identify and validate new sources of resistance to key diseases and insect pests. Key diseases and insect pests include: soybean cyst nematode (SCN), sudden death syndrome (SDS), Phytophthora, root rot complexes, white mold, and soybean aphid.	- Suggested edit: Add “*and other emerging diseases and insect pests*” - Breeding solutions not always possible (e.g., some disease and pest interactions involve too many small genes to ever yield QTLs of significance; soybean pests express their presence, distribution and infection severity against a backdrop of complex rotation and management effects) - Include the development of integrated pest management tools
Priority 3: Stack durable disease resistance into new soybean varieties with the agronomic and quality traits listed above, breeding against current and emerging pathogen profiles in a variety’s adapted region.	- Consider that stacking for quantitative disease resistance such as white mould, SCN and SDS will be difficult and will most likely have significant tolls on yield - Suggested edit: “Identify QTL, resistance genes, and markers for durable disease resistance and stack traits when appropriate” - Edit: “C*ombine durable resistance sources...*” instead of “S*tack….*”? - Include the identification and validation of oligogenic sources of resistance
Priority 4: Identify early maturity genes and develop earlier maturing (MG 000) soybean varieties with good yield for short and very short season regions of Canada and with appropriate resistance to diseases and insect pests. Abiotic stress resistance (e.g.	- Growers need to have access to the longest maturity varieties that fit their production system and risk profile. Earlier varieties are important for new shorter season areas or to fit specific agronomic needs (e.g., a grower might

drought tolerance) is a particular priority for western Canada.	want an earlier soybean harvest to allow winter wheat planting) - Add cold stress tolerance as well
Priority 5: Increase and stabilize minimum soybean protein levels above 40% (dry matter basis) in new soybean varieties. This is particularly important for western Canadian soybeans that typically have lower protein. Concurrently, examine the value-added opportunities for high amino acid/low crude protein soybeans produced on the eastern prairies.	- U.S. Soybean Export Council is promoting its "Nutrient Value Calculator" which suggests the amino acid balance in "northern" (i.e. U.S.) soybeans provides additional nutritional value
Priority 6: Improve yield stability for soybeans grown in western Canada. Increased tolerance to iron deficiency chlorosis/saline soils, moisture extremes (excess moisture and mid-season drought) as well as growth under cooler conditions.	- Focus priority more on moisture extremes, not just for Western Canada; can be a national priority - Less focus here on growth under cooler conditions and tolerance to IDC/saline soils; developing soil management practices may be a better strategy
Priority 7: To respond rapidly to changing pathogen profiles and set timely objectives for research, expand coordinated surveys for current and emerging soybean pathogens (particularly root rot pathogens) and insect pests across Canada and use this information to improve management strategies, screen varieties, and identify and validate new sources of resistant germplasm.	- Two kinds of surveys are needed: 1. on-going phenotypic surveys that provide early warning of emerging threats, 2. Periodic phenotype/genotype surveys to inform precise breeding targets
Priority 8: Recognizing that soybean production systems vary substantially across Canada, develop system-specific management strategies against relevant weeds, diseases and insect pests.	- The spatial distribution of AAFC centres should enable us to capture the considerable differences in crop rotation and management across a region as vast as the prairies as well as between west-mid-east-Atlantic
Priority 9: Identify ideal nutrient management strategies for soybeans in western Canada and Atlantic Canada (i.e., inoculant recommendations; requirements and management of N, P, K, and S (4R management); rotational fertilization).	- Need to identify knowledge gaps for nutrient management to avoid duplication - Soybean can be comparatively unresponsive to nutrient management; should emphasis be on the impact of soybeans in rotation?
Priority 10: Investigate impact of soybean on overall crop rotation (N-credit benefits, economics, where do soybeans fit best in crop rotations, impact on rotations with peas and lentils for managing Aphanomyces root rot); effect of short soybean rotations; and impact of	- Can also highlight the role of soybeans in canola sustainability (e.g., lengthen rotations to manage canola disease)

soybean on soil biology (particular priority in western Canada).	
Priority 11: Determine how soybeans can be used in rotation to facilitate low-GHG emission cropping systems (i.e., through reduced N fertilizer, reduce tillage, etc., a particular priority in western Canada).	- This applies in all growing regions, not just the West

Wheat Research Priorities



Wheat Priorities	
Priority	**Summarized Feedback**
Priority 1: Develop new eastern Canadian wheat varieties with increased yield and yield stability, targeting a yield improvement of by ≥2% per year. Yield increase to be measured relative to provincial checks. New varieties must have strong straw with good lodging resistance, have high quality for end-users, and demonstrate good winter survivability (winter wheat).	- Harmonize targets with National Wheat Research Priorities? (e.g., Minimum of 130 kg/Ha (2 bushels/acre) yield increase every 5 years) - Shift to 1% yield increase per year - Change “high quality” to "appropriate quality” - Include yield/quality/FHB in here as those are core to registration

	- Pursue NUE in varieties; reducing inputs at current yields could be profitable and reduce GHG emissions - Genome editing may be a possible solution, but current regulatory uncertainty prevents its adoption
Priority 2: Stack durable disease resistance into new varieties with the agronomic traits listed above, with an emphasis placed on Fusarium head blight.	- Incorporate reduced DON accumulation into priority - Focus on MR or R wheat for FHB with DON equal or less than MR checks - Consider adding DON chemotypes and other mycotoxins
Priority 3: Develop effective management strategies for Fusarium head blight.	- Edit: Add "*integrated*" management strategies (IPM) - Include other crops into management strategies (e.g., factor in other hosts in rotation - barley, corn, etc.)

IV. Breakout Groups

Participants were split up into 7 breakout rooms to discuss crop- and topic-specific research. Each group was tasked with discussing the following four questions:

1. What ***innovations/innovative techniques*** would help CFCRA address these research priorities with greater progress/efficiency?
2. Given the new Research Strategy, what ***expertise or interdisciplinary collaborations*** do you need to bring to your projects to align with the strategy?
3. Are there other projects or priorities (from this or other crops) that you could bring your expertise to? ***How could you help those project be more efficient/make more progress?***
4. What are some ***creative approaches*** that could be used to address the goals of the new strategy? Try to offer ideas from both <u>*within*</u> your current research area and also from <u>*outside*</u> of your crop/area of research.

The following notes summarize the discussions of each Breakout Room.

Agronomy/GHG
What are some ***creative approaches*** that could be used to address the goals of the new strategy?
❖ **Systems approach** is needed to achieve the GHG reduction goal while still being profitable for farmers. For example, how do you stack loss reduction practices on top of each other (e.g., cover crops, rotations, enhanced efficiency fertilizer, tillage, etc.)? These practices are often studied independently, but we need systems approaches.

- It is not clear how practices affect business risk and GHG. For example, in Ontario, there is an opportunity to use mixtures of cover crops and diversify rotations, but it is not clear how this would impact business risk and improved N use efficiency together.

- **Tillage and no-till** practices need more in-depth research from GHG standpoint; we have a fair bit of research, but it is not tied to the farmer
- **Need longer term studies** that are a lot more holistic in terms of management
- Opportunities to see **where livestock would fit** in a cropping system (lots of gas-off with manure in piles)
- Why aren't we subsidizing enhanced efficiency products for farmers? (years with decent moisture or very high moisture have reduced N losses with the products; less so during dry years). Not a goal within private industry - sometimes subsidies are fickle
- **Federal government recently committed agriculture to 30% reduction in GHGs**
    - The AAFC target of 30% reduction in GHGs is likely actually possible with enhanced fertilizer efficiency, but how do we measure this impact?
    - Need a coordinated effort to identify and bundle practices for farmers that will be effective for them and at a reasonable cost
    - **Modelling needed,** as well as **verification** of N loss reductions. As examples, **37**% direct emission reduction can be achieved (MB), but indirect losses and ammonia losses still unclear; many products have entered market with N loss claims that are not backed up with robust research (and concentrations of inhibitors in individual products vary significantly) which makes it difficult for farmers to make decisions
    - **Carbon market** could be part of the solution to encourage change and reward GHG reductions (fertilizer manufacturers and oil & gas are interested in it)
- **Precision agriculture approaches:**
    - the equipment is ahead of the agronomy; we need statisticians to design experiments that can test many environments with limited reps
    - Need multidisciplinary teams to test the stability of products under variable landscapes and conditions; yield, N use efficiency, diverse crop rotations and economics all need to be factored in and **economics** need to be reported in a useful way for producers
- **Engage statisticians to help design simple and effective experiments that capitalize on multiple environments and keep costs down (have GHG treatment components in studies)**
    - Should start simplifying the on-ground experiment - looking at single replicate experiments conducted over multiple years and sites; Important to leverage geography across Canada (the many environments)
- **Room for small- and large-scale studies together** (or "Cadillac" sites and "satellite" sites)
- Coordination with the **Integrated Crop Agronomy Cluster** is an opportunity to do more of the longer-term rotation work as well
- **Soil moisture** is a key piece of information when making decisions about production systems
- Need to listen to farmers and what works in their circumstances (value is an important consideration) - **engage** users from the start

What ***innovations/innovative techniques*** would help CFCRA address these research priorities with greater progress/efficiency?

- How do **inoculants** factor into soy production? Is inoculant performance part of the reason for more N response in soybean in certain soils/environments?
- How do we encourage N use that matches **expected yield** (without there always being excess N applied)?
- Precision farming - technology is so far ahead of the agronomy - need the agronomy research looking at fertility in different field zones (similar weather)
    - Can use many sites (some larger scale), one rep, but different zones in a field to get stronger datasets
- Koch has some work (Premier Crop) doing **imagery to estimate growth and yield** (in US currently, not Canada)
- Soybean has a tradeoff - reduces N_2O emissions, but not great for soil health/C when at high frequency in a rotation
- Investigate **crop rotations** (e.g., wheat, corn, pea, cover crops) to improve C/soil health
- **Economics** is a huge gap – investigate ROI for the farm (using a combination of demonstration plots and research); address indirect challenges with diverse crop rotations, include whether in field or grain storage/drying
- Need to address **tillage vs. no-till**

Given the new Research Strategy, what ***expertise or interdisciplinary collaborations*** do you need to bring to your projects to align with the strategy?

- Everything **needs to be transdisciplinary** - economists, soil scientists, agro-ecologists, agronomists, statisticians, imagery, need farmer input as well (understand what they need for adoption). This type of research is very expensive; however, **many layers of objectives** can be included
- Careers can be too short of a time-frame for some of these problems (these are long-term problems) – develop a personnel succession plan to keep the knowledge base (and longer program lengths than 5 years to avoid losing personnel in funding gaps)

Corn Genetics

What are some ***creative approaches*** that could be used to address the goals of the new strategy?

- Climate change and carbon: There are implications of drying corn on the carbon balance of corn production and productivity-to-grain-moisture balances, especially drying in the northern environment. Stay green growth targets have led to stay wet and research needs to target different **senescence** patterns - adjust short growing season target to short season with included plant dry down.

- Most corn in NA grows to 10% moisture while we routinely deal with 20% (and higher) moisture to dry down. The seed business is in the solar energy capture business, and needs a better appreciation for the conversion of solar energy into starch. We don't have an understanding of (accounting for) the **carbon trade-off** in corn - the carbon required to dry versus the carbon capture of a full season crop.
- **Nitrogen leaching**: To what extent are nitrogen and other nutrients ending up leaching into the watershed (e.g., N into tile drains)? Answering this will require soil science expertise, engineering, hydrology, soil-water interface, physics and chemistry, water & nutrient cycling, soil biology, manure management, and environmental farm planning.
- **Nitrogen use efficiency**: The end use efficiency of grain produced per N; how to attain or maximize utility of N, 4 R approaches, systems approach with more agronomy collaboration**. Agronomically integrated systems** (optimized) are also important for disease & insect issues integrated with genetic improvement opportunities.
- Cover crops: Investigate the preceding cover crop timing to harvest to **maximize transfer of N or other nutrients** to the next crop. Where does the N & carbon go on termination? The weeks to harvest or termination timing is important to capture most of the N benefit.
- Genetics tailored to **production systems**: Hybrids that do well in organic production are not necessarily those that do well under conventional production. Create opportunity to work under challenge so that genotype(s) can do better under suboptimal conditions - weed pressure, adverse seeding conditions etc.; assess for performance while advancing yield.
- Climate change and **root establishment**: With wetter springs and drier summers roots may be established, but then not well adapted from a root establishment side. Ideas include: Build a better corn plant from a sense of early planting conditions; Use microbes to scavenge and damp down ethylene to enhance rooting; Breeding for this rooting trait and not have the sensitivities to wet springs.
- **Drought tolerance and anthesis-silk interval** (ASI): Inbreds that were developed without drought stress are the first to fall.
- Germplasm development: Corn unique in comparison to our other crops, as majority is purchased from private companies. What is the role for public germplasm enhancement programs? The problem is that within a large private breeding program, production for **northern corn environments** is not necessarily a priority. The vast majority of germplasm is being developed for the midwestern or eastern corn belts of the US. There is a role to play for the public sector to pursue greater understanding of **emerging disease issues** (e.g., Gibberella ear rot).
- **Plant architecture**: Are there opportunities to increase leaf area, leaf number, leaf morphology, longer ears, change flowering date, etc. Requires a multi-disciplinary approach to make sure we are not reducing yield within a row of corn.
- Microbial marker selection: There are opportunities to include **microbial markers in corn genetic selection**. Sometimes what breeders are identifying as low QTLs may be important markers of microbiome-corn interactions. For example, could biocontrol microbes applied to silks reduce Gibberella expression rate? Because the microbes are already resident in the plant is *there a benefit to doing direct microbial marker*

selection. There is something going on within the silk micro biosphere other than plant genetics that would help our end users. There is evidence that plants collected under extremes demonstrate the ability to host and take advantage of better microbial associations.

- **Microbial enhancement**: There are significant changes in microbial associations (elevated) when challenged in field conditions under Fusarium pressure. There are also nitrogen-fixing microbes on the silks. There are QTL's in other crops associated with microbes. This area needs more interdisciplinary research. Pollen is also a rich source of/for microbes. Is there inheritance of the microbiome? This has implications for seed production, stress tolerance, etc.
- Fusarium resistance: Interdisciplinary opportunity to **leverage wheat resistance** mechanisms. Current work on Fusarium and RNA seq correlations with candidate resistance genes.

What ***innovations/innovative techniques*** would help CFCRA address these research priorities with greater progress/efficiency?

- **Agronomically integrated systems** (optimized) are also important for disease & insect issues integrated with genetic improvement opportunities.
- Need to explore the relationship between NCL blight and other resistances; highly quantitative traits but good resistance available in germplasm
- Royalties and Licensing: In AAFC these do not come back to the breeding program - it is difficult to assess private industry interest in AAFC genetics

Given the new Research Strategy, what ***expertise or interdisciplinary collaborations*** do you need to bring to your projects to align with the strategy?

- Soil Science
- Microbiology
- Agronomy
- Engineering

Oat

What are some ***creative approaches*** that could be used to address the goals of the new strategy?

- Excellent opportunities for east/west to synergize. Additional genotype learning by expanding testing network.
    - Leverage **expanded environmental evaluation** to learn about what is applicable/marketable in the each of the 3 Mega Environments (ENCORE 2.0 for GS model development)

- Quantify an ideal system for testing across oat geographies – including microenvironments that influence farmer/industry decisions & use
  - Lean on collaborative partners to remove roadblocks
- Additional genomic knowledge/investment to identify, **understand gene presence/ function** to drive targeted selection for research priorities

What ***innovations/innovative techniques*** would help CFCRA address these research priorities with greater progress/efficiency?

- "**Breeding assisted genomics**" (= reverse engineering genotype-phenotype data that is already collected in GS training programs) to identify key genes associated with disease resistance and adaptation.
- Genome assembly and haplotype databases- understand and maximize efficiency of genomic tools (is part of making breeding-assisted genomics effective)
- Risk management - Need to balance **social acceptance** and use of genomic tools to preserve oat reputation, while continuously moving innovation/economics forward.
  - Education of the public on GMO vs gene editing
- **Data management** (i.e., recycle valuable phenotype data) and efficiency in breeding tools (e.g., miniaturization of genetic marker assays = reduced cost / more assays for the same price)
- Evaluate / Embrace/ Adopt technology - **digital phenotyping** (but need to walk before we run)

Given the new Research Strategy, what ***expertise or interdisciplinary collaborations*** do you need to bring to your projects to align with the strategy?

- Long term funding partners to keep the wheels turning
- Geneticists - more breeding methodology research
- Bioinformatics & digital imaging
- Agronomics – Agronomy is half of the success story of a crop. Macronutrients, micronutrients, use efficiency, crop drydown, etc. GXE in parallel to variety development
- Nano technology to increase effectiveness of existing tools/knowledge (e.g., micro-nutrient delivery using nano particles)
- Suite of tools to improve breeder efficiency (as per examples in previous question)
- Public Communication

Are there other projects or priorities (from this or other crops) that you could bring your expertise to? How could you help those projects be more efficient/make more progress?

- Share internal experiences with other groups to fast-track program development/progress
- Collectively re-discover what we already knew (example was work on oat protein from many years ago), update to today's thinking & use innovative tools
- Germplasm
- Global collaboration

- ❖ The AAFC oat and barley genomics effort was given as a good example of cross-crop learning and efficiency.

Soybean (Group A)

What are some *creative approaches* that could be used to address the goals of the new strategy?

- ❖ **High thru-put phenotyping**, in field situations
- ❖ Drought phenotyping- it is difficult to phenotype for drought, and it is does not happen every year in outdoor trials. Need reliable markers for drought selections
  - New phenotypes needed (hyperspectral, thermal) and need more investigation into drought
  - Need indoor (protected culture) facility access to test drought conditions
- ❖ Abiotic stress - hyperspectral, deal with plant stress
  - useful for varietal screening at high level
- ❖ Need statistics, data analysis capability
- ❖ How do we apply genomics to high throughput phenotyping?
- ❖ **How do we develop this tool/service (phenomics) and make this available?**
  - Difficult to be an expert in everything. Researchers need access to a centre of excellence or the expertise that is needed
  - This is strategically important and need to look for funding, good interest and moral support,
  - Look for opportunities to coordinate CFCRA with other programs (e.g., Genome Canada, NSERC Alliance)
- ❖ Platform (breeding population) via CFCRA that is diverse enough for the growing area that needs drought traits

What *innovations/innovative techniques* would help CFCRA address these research priorities with greater progress/efficiency?

- ❖ **Data collection** via UAV or drones can increase efficiency
  - Need a coordinated effort on data collection so that this can be shared
  - But it needs to be harmonized, so that this could be a shared platform, needs a lot of work on the equipment, methodology, validation, data analysis
- ❖ **Disease surveillance**
  - Don't always have a good idea about what disease pressure is in a particular region or site
  - A priority to understand this, need surveillance
    - Growers or breeder might be using the wrong genetic resistance
  - Pathogen profiles (PRR, Fusarium, etc.) required to incorporate the needed resistance gene into breeding programs

Given the new Research Strategy, what ***expertise or interdisciplinary collaborations*** do you need to bring to your projects to align with the strategy?
Surveillance ❖ Pathologists: how can we increase our efficiency in performing disease surveillance? Can local provincial extension people be utilized to provide observation? ❖ Better phenotyping; Better genotyping; New technology (e.g., molecular surveys) ❖ Drones - working out the protocols, use for grower fields to identify and better target those areas for sampling ❖ Select specific wavelengths for biotic/abiotic stress, then use over field scale ❖ For the platform, how do we collect data across breeding programs or plant populations and between programs? **Spatial dimension** ❖ West/East, then within West, within East ❖ Funding that encourages collaboration between organizations and locations ❖ Hurdle of narrow adaptational zones for soybean varieties – the ability to move germplasm in soybean is not like wheat, very regionally adapted
Are there other projects or priorities (from this or other crops) that you could bring your expertise to? How could you help those projects be more efficient/make more progress?
❖ **Collaboration across crops** (with canola example) pathogens can be studied together to better understand the pathogen, exchanges needed o We are organized by crop (generally speaking) o But maybe there are some areas to be better organized by cross species disciplines (e.g., For SCN, molecular screening can be used for other legumes (dry beans) ❖ Need a set of populations that will be tested to multiple locations for validation of methodologies related to **high throughput phenotyping**. ❖ Encourage collaboration; adaptation across such wide areas; moving germplasm is challenging more than wheat. ❖ **Sustainability** - key part of market development for soybeans for market access and trade o Sustainability guidelines coming o Various Certification programs can be used (e.g., ISCC EU biofuels standards, SAI platform, farm sustainability assessment FSA) o Collaborate with canola to see what approach for soybeans could be. ❖ A lot of CFCRA soybean participants are working on non-GMO, food types. This value-added market fits well with the CFCRA priorities. Could we collaborate further on the theme of reaching the **food quality standards** that markets desire? Sharing expertise, perhaps sharing some food quality evaluation techniques or lab facilities.

Soybean (Group B)
What are some ***creative approaches*** that could be used to address the goals of the new strategy?
❖ Generate a **research database** and share the deliverables; CFCRA could encourage cooperation and sharing of research information; host virtual check-in meetings during the program. Build teams based on shared goals; willingness and time are important considerations ❖ Need all aspects in a **team approach**: Food scientists can help take it to the next level (e.g., soya enhanced products); need more input from the crop physiology; economists need to be part of this team; computer software training is important, plant pathology extremely important for stable yields ❖ Engage with other parts of the **value chain**: The value of the project sometimes gets lost with the industry, so linkage and communication with industry is important. ❖ Establish **long term** studies, maximize the whole project.
What ***innovations/innovative techniques*** would help CFCRA address these research priorities with greater progress/efficiency?
❖ Taking what is done in the lab and then moving it to the field can be a challenge. The team approach fails if not working together reaching a set target. Keep looking at the main objective that you started with and **stay on target** ❖ CFCRA connecting those who need the external expertise with those that are willing to provide their expertise in that area (e.g., via a database). Annual meetings and sharing helps with **collaboration** and finding experts to address your needs ❖ Integrated approach from breeding that incorporates multiple fields, more environments and the adaptability of the germplasm ❖ **High throughput phenotyping** becoming a goal for many breeders and need people who can manage big data ❖ Database sharing and big data can be challenging if interdisciplinary components of projects are removed at the funding stage ❖ linkage with industry to keep up with tech updates. Big data, analyzing it. ❖ Establish **long term rotation studies**, field studies where researchers can all convene at those locations
Given the new Research Strategy, what ***expertise or interdisciplinary collaborations*** do you need to bring to your projects to align with the strategy?
❖ High throughput -omics approach (genomics, phenomics, metabolomics, etc. ❖ Big data experts ❖ Economists ❖ More environments - to see the adaptability of the germplasm

- ❖ Communications, especially around new technologies (e.g., gene editing); cannot use these technologies if regulatory and public acceptance unpredictable

Are there other projects or priorities (from this or other crops) that you could bring your expertise to? How could you help those projects be more efficient/make more progress?
❖ **Economists** need to join the team, identify and validate potential loss of value, return on investment, (e.g., disease loss estimates of SCN across North America and provide that potential ROI of a project in proposal.) ❖ Technology/k**nowledge transfer** to bring research knowledge back to the producers. Who is responsible for this? ❖ Field evaluation side – ask industry to evaluate how varieties doing in other environments - what is the reaction in the field. Engage provincial specialists, universities, AAFC ❖ Breeders need plant pathologists, biochemists, AI specialists. **Big data expertise** needed in ALL of the disciplines. ❖ Funders need to recognize that we need these **multidisciplinary** aspects to our proposals ❖ Use soybeans as an example of how to **introduce new alleles** if there is a lack of genetic diversity in a crop ❖ **Economics and metrics** - researchers need guidance to understand how to measure economics, GHG, and other metrics. What is most translatable to the grower?

Soybean (Group C)
What are some ***creative approaches*** that could be used to address the goals of the new strategy?
❖ Need to build more efficiency in scale of breeding program and make use of high throughput phenomics. Need to find creative ways to automate phenotyping. This will also translate across crops. ❖ Can the community build expertise in phenomics, optics, robotics, AI, engineering? Need for big data scientists around AI and machine learning. This goes beyond genomic selection, but also trait development, biochemical traits, precision ag. ❖ Phenomics and AI could dominate the breeding process. Genomics would play a role to pre-select, enrich populations for breeders. ❖ Practical breeding approaches will still be very useful, assisted by genomic selection and phenomics to get through large numbers of plots. Genomics can assist with enriching a program that has limited land resources. ❖ Even the use of NIR to study grains, oilseeds is phenomics, this is simple. Today there are basic RGB imaging that can be used to examine plots. Drones and imaging are available but needs collaboration with technology developers or current groups have adopted it already. ❖ Breeding programs can also access good breeding software today, not relying on spreadsheets entirely.

- Uptake of new technology is not easy, and small programs may struggle with this (e.g., drone imaging is a 'nightmare')
- Reach out to USask GIFs or other engineering groups, phenomics groups that have spent years developing some tools, and explore if they can be implemented in your own breeding program.
- Some tools breeders use (e.g., NIR) are too imprecise for amino acid content selection. Whereas genomics can augment this to study alleles at useful loci and how it connects to NIR for example. Could make NIR, an existing tool, more precise. The point of genomic analysis will enrich populations and select sets of lines that should be advanced or used as parents.
- Breeders and genomics groups need to work on common germplasm, populations. Genomic and phenomic analysis can measure large effects (e.g., by categorizing amino acid content by allele studies in large populations, you increase the precision of the selection process.
- As we grow more soybeans, should need less nitrogen, thus reduce GHG emissions. Soybean has not reached its maximum yield yet in the context of environment. This is good news - more yield possible by pushing into more diverse or stressful environments. How do we get more creative on complex traits? It starts with markers and genomics to connect genotype to phenotype. Need to keep soy attractive across the country. In the west, will need drought tolerance, early maturity.

What ***innovations/innovative techniques*** would help CFCRA address these research priorities with greater progress/efficiency?

- Imaging, drones, field camera platforms, combining genomics with existing tools (i.e., NIR) to make improvements in precision.
- Software, access to off the shelf software or apps related to phenomics.
- CRISPR (or other gene editing technology), genomic selection
    - need to identify target genes before gene editing, also need work on tissue culture to use gene editing.
- Need to be aware of PNT regulations and how they may change, consider path to market.
- Machine learning, AI will work in phenomics

Given the new Research Strategy, what ***expertise or interdisciplinary collaborations*** do you need to bring to your projects to align with the strategy?

- Practical genomics, integration of informatics with field programs, this is done by collaboration. Image acquisition and trained field experts, maybe cross training. "Boots in the field". Field level expertise, this takes time to train.
- Physiology as it relates to plant stress, biochemistry.
- Entomology and phenotyping pest infections. Agronomy/physiology.
- We need more space, locations, more plots, larger scale to make faster progress

Are there other projects or priorities (from this or other crops) that you could bring your expertise to? How could you help those projects be more efficient/make more progress?
❖ Work on common populations and study in multiple locations. All groups could study these from different angles, create BIG data. Is there IP issue? Can this be pre-competitive? ❖ Can we share the development of elite germplasm? ❖ Need to add phenomics expertise everywhere

Wheat/Barley
What are some ***creative approaches*** that could be used to address the goals of the new strategy?
❖ Collaboration important - wheat is a tricky crop. Need to keep programs funded and have other complimentary groups work together ❖ Wheat is competitive, there are 4 public breeders in East plus private activity. Access to funding is a challenge for some and we need to reward collaboration, **build synergies between non-competitors.** How can funding programs encourage this? ❖ **Research funding gaps** inhibit progress ❖ Barley research communications are important; need to catalogue barley research ❖ Increase collaboration across cereals (e.g. FHB in cereals). Measurement and benchmarking are key. o FHB - new chemotypes, mycotoxins, emerging problems due to climate change, crop rotation ❖ Genome editing needs collaborations (needs breeders, genome sequencing, etc.). Also needs a crop with big enough market ❖ Genetic resistance projects - There has been some feedback that there are chemical options so less need for genetic resistance. Need economic evaluation to determine what the optimal option is and the metrics need to consider these types of options and long-term implications (e.g., pesticide resistance management)
What ***innovations/innovative techniques*** would help CFCRA address these research priorities with greater progress/efficiency?
❖ **Phenotyping capacity -** need accurate and high throughput phenotyping, using effective toxin tests, not just DON, expand to catch new and emerging toxins, ELISA range is small but other techniques are expensive. Need to update the analytical methods to take advantage of all the rich data available. ❖ From barley strategy - need **tools to support barley breeders** (e.g., lodging, can only see if there is a lodging event, needs tools to screen for this), understand the traits to see relation and correlations between traits, bring in diverse genetics into germplasm, precision ag tools to benefit input use and efficiency. Malting barley varieties for the East - how does malt barley breeding fit into this strategy

- Using genomic information for barley improvement, need to collect info across programs to identify genomic info. New germplasm to identify new sources of disease resistance
- Breeders need to understand and integrate the end user's quality preference, to increase value. Incorporate more **quick tools for quality traits** (e.g., NIR) to prevent issues at registration. Need both yield and quality.
- Population development takes time, could be **sharing these populations** (e.g. for development of genomic selection tools and phenotypic as well. More integrated, more efficient
- We are missing insect resistance in the discussion, need to be aware, especially in light of climate change and increased overwintering
- Need an integrated approach to FHB - Still need FHB resistance in addition to pesticide and rotation as solutions.
- **Genome editing** could help in multiple areas but we need regulatory assurance before we can use it in variety development.

Given the new Research Strategy, what ***expertise or interdisciplinary collaborations*** do you need to bring to your projects to align with the strategy?

- Need genomics expertise and agronomy, NUE and quality.
- Need field data and funding to genotype. Need verification of genomic predictions. Need integration of breeding and genomic selection programs
- High throughput phenotyping capacity, toxicology, computational biology
- Genome editing work needs breeders, whole genome sequencing and transcriptomics and bioinformatics to identify candidate genes. Can CFCRA help genome editing researchers collaborate?
- Easy double haploid in hemp
- Knowledge of which disease or pest will be more prevalent in Eastern Canada (that may not be common today), for major crops.

Are there other projects or priorities (from this or other crops) that you could bring your expertise to? How could you help those projects be more efficient/make more progress?

- Disease studies – can study FHB across wheat, barley, corn (e.g., provide sites in SW Ontario, Ottawa for agronomy screening (e.g., Essex County for winter wheat; Elora location is good for crown rust testing in oat)
- Need to collaborate across areas to screen for winter survival and other traits; developing phenomics expertise for winter wheat, winter survival testing
- Geneticists can predict breeding values and genotypic values for trait/traits, know-how is transferrable across crops
- AAFC offers FTO, and can offer germplasm to collaborators with access to genetics; AAFC has the capacity to do longer term studies because they have permanent employees, can take smaller projects
- There are a lot of different funding organizations; funders need to work together more. Wheat has more access to more funding for agronomy, so **work together** more to include barley and other smaller crops. This fits into the **crop rotation strategy goal** as well.
- Clear communication of industry needs so projects are not reactive.

- ❖ Mentoring young researchers so we have a succession plan, particularly in barley
- ❖ Is there adequate **genetic variation**? Perhaps not in barley populations. Access to germplasm more challenging the East than West. If access to germplasm is a barrier, this should be addressed.
- ❖ Are there barriers to the **management of IP** when putting together projects? Can be an issue for some. (e.g., CRSPR tools, can use for research but unsure about commercialization.) So far, the IP issue is not a problem for wheat and barley researchers.
- ❖ Cerela's research expertise (breeding, crosses, solid agronomy trials in Eastern Canada, small genotyping capacity, phytopathogen cultivation and storage, active work on soybean, wheat, barley, oat, and hemp), can be applied to many disease testing and regional adaptation questions.

V. Panel Discussions

Two panel discussions during the summit showcased the importance of innovation and collaboration in CFCRA activities.

Panel #1: Short Season Soybean Activity

The soybean panel discussion demonstrated how three separate short season breeding programs came together to form one cohesive and unified breeding activity and explained how breeders work together by sharing and exchanging germplasm, offering multiple locations to test the performance of their materials in various geographies, etc. The panel discussion also discussed how public soybean breeders across Canada utilize the genotyping facilities at Laval University, showcasing another effective example of collaboration.

Panelists: Elroy Cober, AAFC Ottawa; Tom Warkentin, CDC – Usask; Louise O'Donoughue – CÉROM; François Belzile – Laval University **Moderator:** Rob Hannam, Synthesis Agri-Food Network

Goals of the Panel:

- ❖ Familiarize participants with the short season soybean project
- ❖ Discuss the value of bringing innovation into a research program
- ❖ Discuss the value of collaboration in bringing research programs together (e.g., efficiency, make more progress, test new ideas, etc.)
- ❖ Identify lessons learned, advice for other researchers regarding collaboration and innovation

Summary of the Panel Discussion

The CFCRA played a key role in connecting the researchers and encouraging collaboration. The researchers came together and determined what could benefit all of the programs (e.g., what testing sites and what germplasm exchanges were needed). The collaborative effort was further leveraged by the Genome Canada Soyagen project and the combined efforts fostered new capability and integration of new technology:

- Researchers moved to a more formalized way of doing things, including the support of allied scientists (e.g., grain quality, pests)
- Allowed the development and adoption of tools that were easily incorporated into breeding programs (e.g., high throughput MAS)
- Collaborations provided new complementary capacity (e.g., SCN work)
- Leveraging the CFCRA collaboration for the Soyagen project, and the genomic tools, resulted in a detailed understanding of maturity genes that could not have happened without the collaboration. Different maturity packages were subsequently deployed across the country.

Key Takeaways:

The "people" side of collaboration is very important (e.g., relationships, teamwork and leadership)

- Look for shared interests and complementarity (not competition). Look for opportunities in which everyone can bring something to the project and everyone can benefit as well.
- It takes time to build a successful collaborative atmosphere. Start with small pilots or exchange of a trial and build from there.
- Share your expectations so they are clear and realistic
- Regular communication is very important (e.g. yearly Soyagen meetings), Budgeting for these types of events, where researchers can share results and interact, builds the projects.
- Involve students and post docs in the collaboration so they can maximize the value of their training and learn from a broader group of researchers with distinct skills sets.
- Collaborative research is a team sport; everyone must be a willing partner and the project is bigger than one single lab

The "business" side of collaboration is also very important

- Intellectual Property concerns can be a barrier – if selections are going to be made on shared germplasm, there will need to be IP agreements that can take a lot of time and cause delays
- Collaboration requires support from management for the collaborations. Researchers can present a united front to outline the benefits of coordinating research and avoid the appearance of duplication.
- Succession planning is an important consideration. In order to have fruitful collaborations, need to have the right skills and capacity available.
- A lot of progress can be made with large-scale collaborations, but it requires a lot of effort to secure the funding and manage the gaps between funded projects.

Panel #2: Oat Breeding, Genomics and Agronomy Activity

The oat panel described how the collaboration allowed them to introduce innovation to oat breeding and include genomic selection and agronomy methods.

Panelists: Weikai Yan (AAFC, Ottawa, oat breeding; Nick Tinker, AAFC Ottawa, high throughput genomics/genomic selection in oat and barley; Wubishet Bekele, AAFC Ottawa, genomics-assisted breeding; **Moderator:** Rob Hannam, Synthesis Agri-Food Network

Goals of the Panel:

- Familiarize participants with the collaborative oat project – breeding, genomics, and agronomy
- Discuss the value of bringing innovation into a research program
- Discuss the value of collaboration in bringing research programs together (e.g., efficiency, make more progress, test new ideas, etc.)
- Identify lessons learned, advice for other researchers regarding collaboration and innovation

Summary of the Panel Discussion

As for soybeans, industry partners like CFCRA were key in bringing the oat collaboration together. The AAFC Ottawa-based oat breeding program was a mature program with a network of breeders and scientists in other locations, a grain nursey, and disease expertise. Introducing genomic selection into this working and successful oat breeding program was a risk but the researchers started with small pilot experiments and also made use of previously developed bioinformatics tools.

- ❖ The collaboration integrated genomic selection into the breeding program, which resulted in several very high yielding varieties that are now in registration trials and used as breeding parents.
- ❖ Researchers also identified the importance of combining genomic selection with visual selection and phenomics in order to retain important agronomic and/or quality traits
- ❖ The collaboration forced the development of practical genomic selection tools that can be easily integrated into a breeding program. Likewise, without this collaboration, the genomic selection work would have had cross validation but not practical outcomes for incorporation into a breeding program.

Key Takeaways:

- ❖ Having an established breeding program was critical for the success of this project, but it took extra time and patience to figure out what was possible and practical in order to minimize the load on the breeding program. The researchers had to put on a business hat in order to accept and work around technical limitations.
- ❖ Collaboration is no longer optional for researchers; it is necessary for everyone to grow. Be generous and sincere in acknowledging collaborations.
- ❖ Communication is key to building relationships. Be cautious about using emails to communicate – it can lead to misunderstanding and friction.
- ❖ Younger researchers should take some risks in talking about their research and being open to other ideas. Sharing ideas, without giving away secrets, is important.
- ❖ Collaborations often require everyone to make compromises and break out of their mindset.

Appendix A: CFCRA Virtual Research Summit Agenda

CFCRA
CANADIAN FIELD CROP RESEARCH ALLIANCE

ARCCC
ALLIANCE DE RECHERCHE SUR LES CULTURES COMMERCIALES DU CANADA

CFCRA Virtual Research Summit - Innovating for the Future

February 2-3, 2021 *(all times presented in Eastern Standard Time)*

PRELIMINARY AGENDA

PURPOSE: The purpose of the 2021 CFCRA Research Summit is to:

A. Present a new CFCRA Research Strategy
B. Gather feedback on refined and updated CFCRA Research Priorities
C. Encourage the development of effective collaborations to address the new Research Strategy
D. Identify innovative solutions to address research priorities with the new Research Strategy

January 6-22, 2021	Pre-meeting exercises posted (available for participants to contribute to by January 22, 2021)

Tuesday, February 2, 2021 *(all times presented in Eastern Standard Time)*

10:00AM EST	Welcome & Opening Remarks (Lori-Ann Kaminski, President, CFCRA)
10:15AM EST	AAFC Priorities for the next 5-10 years (AAFC Programs Branch Representative, TBD)
10:45AM EST	Presentation of CFCRA's New Research Strategy (Josh Cowan, Vice President, CFCRA)
11:05AM EST	BREAK
11:15AM EST	Review of CFCRA Research Priorities and pre-meeting work (Lori-Ann Kaminski, President, CFCRA and Rob Hannam, Synthesis Agri-Food Network)
NOON	LUNCH
1:00PM EST	Panel Discussion #1: *Innovation & Collaboration in Soybean Breeding* ○ Elroy Cober, Louise O'Donoughue, Tom Warkentin, & François Belzile showcase Canadian soybean collaborations and discuss genotyping innovations in soybean breeding
2:00PM EST	Wrap-up and overnight thinking exercise: **Overnight thinking task:** • Create a wish-list of 3 innovations that would help you reach your research targets faster • Given the updated CFCRA Research Priorities, think of 2 other research programs or disciplines that your expertise could be applied to. How would your expertise help those projects be more efficient/innovative? • Given the new Research Strategy, what expertise do you need to bring to your projects to align with the strategy?
2:30PM EST	Adjourn Day 1

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Wednesday, February 3, 2021 ***(all times presented in Eastern Standard Time)***

9:00AM EST	Day 1 Re-Cap (Rob Hannam, Synthesis Agri-Food Network)
9:15AM EST	Panel Discussion #2: *Innovation & Collaboration in the CFCRA Oat Project* o Weikai Yan, Wubi Bekele, & Nick Tinker to discuss how the CFCRA Oat Project merged a traditional breeding program with innovative new genomic selection approaches
10:00AM EST	BREAK
10:15AM EST	Breakout sessions o In small working groups, identify creative solutions to address research priorities with the new Research Strategy
NOON	Wrap-up and Next Steps
12:20PM EST	Closing Remarks (Lori-Ann Kaminski, President, CFCRA)
12:30PM EST	Adjourn

Appendix B: List of Registered Participants

PARTICIPANT LIST

First Name	Last Name	Organization
Annie	Archambault	Cerela
Jerome	Auclair	Sollio
Belay	Ayele	University of Manitoba
Matthew	Bakker	University of Manitoba
Wubi	Bekele	AAFC Ottawa
Richard	Belanger	Université Laval
Francois	Belzile	Université Laval
Andrew	Burt	AAFC Ottawa
Curtis	Cavers	AAFC Portage la Prairie
Scott	Chalmers	WADO
Chris	Churko	FP Genetics
Elroy	Cober	AAFC Ottawa
Lauren	Comin	CWRC
Tanya	Copley	CEROM
Josh	Cowan	GFO
John	Cutler	AAFC
Fouad	Daayf	University of Manitoba
Ron	Davidson	Soy Canada
Pam	de Rocquigney	Manitoba Crop Alliance
Eric	DeBlieck	Grain Millers
Ron	DePauw	SeCan
Daryl	Domitrik	MPSG
Craig	Drury	AAFC Harrow
Peter	Entz	Richardson
Milad	Eskandari	University of Guelph (Ridgetown)
Gina	Feist	BMBRI
Allison	Fletcher	SPG
Aaron	Glenn	AAFC Brandon
Blair	Goldade	SaskWheat
Lorne	Greiger	Prairie Agricultural Machinery Institute
Mehri	Hadinezad	AAFC Ottawa
Wade	Hainstock	POGA
Dave	Harwood	Corteva
David	Hooker	University of Guelph, Ridgetown
Anfu	Hou	AAFC Morden
Yafan	Huang	Performance Plants
Gavin	Humphreys	AAFC Ottawa
Lori-Ann	Kaminski	Manitoba Crop Alliance
Rigas	Karamanos	KOCH

Aida	Kebede	AAFC Ottawa
Raja	Khanal	AAFC Ottawa
David	Kikkert	Bayer Crop Science
Ajjamada	Kushlappa	McGill University
Randy	Kutcher	University of Saskatchewan
Tim	Laatsch	KOCH
Jamie	Larsen	AAFC Harrow
Yvonne	Lawley	University of Manitoba
Elizabeth	Lee	University of Guelph
Lewis	Lukens	University of Guelph
Baoluo	Ma	AAFC Ottawa
Dan	Maceachern	AAFC Charlottetown
Michele	Marcotte	AAFC
Holly	Mayer	AAFC Programs
Don	McClure	NuGen Seeds
Michel	McElroy	CEROM
Andrew	McKenzie-Gopsill	AAFC Charlottetown
Jim	Menzies	AAFC Morden
Aaron	Mills	AAFC Charlottetown
Benjamin	Mimee	AAFC Saint-Jean-sur-Richelieu
Ramona	Mohr	University of Manitoba
Kirby	Nilsen	AAFC Brandon
Louise	O'Donoughue	CEROM
Patricia	Ouimet	Pepsico
Gaetan	Parent	AAFC Quebec
Tom	Rabaey	General Mills
Manish	Raizada	University of Guelph
Istvan	Rajcan	University of Guelph
Lana	Reid	AAFC Ottawa
Jeff	Reid	SeCan
Silvia	Rosa	CEROM
Heather	Russell	AGC
Bahram	Samanfar	AAFC Ottawa
Leonid	Savitch	AAFC Ottawa
Laura	Schmidt	MPSG
Philippe	Seguin	McGill University
Mitra	Serajazari	University of Guelph
Steve	Shirtliffe	University of Saskatchewan
Jaswinder	Singh	McGill University
McKenzie	Smith	Fertilizer Canada
Daryl	Somers	Professional Writer
Stephen	Strelkov	University of Alberta
Lily	Tamburic-Ilincic	University of Guelph (Ridgetown)

Mario	Tenuta	University of Manitoba
Albert	Tenuta	OMAFRA
Nick	Tinker	AAFC Ottawa
Cassandra	Tkachuk	MPSG
Davoud	Torkamaneh	Laval/ University of Guelph
William	Van Tassel	PGQ
Owen	Wally	AAFC Harrow
Tom	Warkentin	University of Saskatchewan
Joann	Whalen	McGill University
Alex	Whittal	Horizon Seeds
Steve	Whyard	University of Manitoba
Shawn	Winter	Maizex
Allen	Xue	AAFC Ottawa
Weikai	Yan	AAFC Ottawa
Kangfu	Yu	AAFC Harrow
Alana	Yuill	Director General, Partnerships and Planning Directorate
Salah	Zoghlami	PGQ
Rob	Hannam	Meeting Facilitator
Carol	Hannam	Meeting Facilitator