

Cross-Cutting Crop Research Priorities

Introduction

The Future Field Crop Research Needs process was launched in January 2021 and completed in November, as part of WGRF's 40th anniversary. Over 300 farmers, agronomists, scientists, industry and WGRF Class A members participated, resulting in a document of cross-cutting crop production issues and research needs. WGRF considers "cross-cutting crop production issues" as those issues common to at least two or more of the fifteen crops eligible for WGRF funding (barley, canaryseed, canola, chickpea, corn, fababean, flax, lentil, mustard, oats, pea, soybean, sunflower, wheat and winter cereals). WGRF will continue to fund crop specific research, however as Crop Commissions/Associations have crop specific research interests and share these with WGRF, crop-specific research issues were out of scope in this process.

In the winter of 2021 WGRF contracted Drs. George Clayton and Stephen Morgan Jones of Amaethon to gather views from farmers, agronomists, scientists and industry on the future of western Canadian field crop production in the short (5 year) and longer term (10- 20 years). This culminated in the Amaethon Report "Survey on Future Changes in Crop Production on Prairie Farms and Implications for Research".

WGRF hosted a virtual workshop in July 2021 to develop the implications for research and knowledge transfer specific to cross-cutting crop production issues, based on the Amaethon report. A report was generated and posted on WGRF's website.

Based on the Amaethon Report and the Summer Workshop Report WGRF drafted a summary report titled "Cross-Cutting Crop Research Themes" for consideration by WGRF Class A Members at a virtual workshop in November 2021. The document was categorized into six themes containing 24 issues, over 100 research questions and numerous KTT messages (Appendix One). Views provided by Class A Members confirmed the importance of the issues and research questions to western Canadian grain farmers.

Following the Members Workshop the document was updated and titled "WGRF Cross-Cutting Crop Research Priorities." On November 16th the WGRF Research Committee reviewed the document to determine which of the issues and research questions are most important for WGRF to communicate as cross-cutting crop research priorities. The Research Committee's recommendations contain six themes, 17 issues, and 66 research questions. KTT messages (and activities) were excluded from the document and will be considered separately.

The Research Committee is recommending that the Board adopt the following as "WGRF Cross-Cutting Crop Research Priorities." Following Board approval, the document (or an amended version) will be communicated as WGRF's Cross-Cutting Crop Research Priorities.

Theme 1: Weed Management

Herbicides have been relied on for current conventional crop production for several decades now, however, producers are increasingly challenged by the development of weed resistance, fewer herbicide options, new weeds and spread of other weeds. Of particular concern is the potential for further glyphosate resistance. The following are issues and questions of interest to farmers.

Issue 1: Assessing and predicting the continually evolving situation (high priority)

- What are the most prevalent weeds in western Canada and what are their geographic footprints, and therefore, what should farmers be watching out for as they expand territory? Assess technologies/methods that can be developed or employed for monitoring weed issues.
- What are the most prevalent herbicide resistance weeds, and which are the most problematic?
- Which weeds and/or herbicide resistance issues are likely to become issues or bigger issues?
- What are the factors which influence weed behavior?
- Will climate and weather cycles influence weed behavior and proliferation/spread in western Canada?

Issue 2: Alternative weed management practices that farmers might employ in the future (high priority)

- What are the practices that should be used to avoid further loss of existing herbicide tools?
- As more of the key currently available herbicides become less effective, what will be the practical and economically viable weed management options, either singularly or, more likely, in combination?

Issue 3: Loss of glyphosate as an effective herbicide (high priority)

- What can farmers be doing today to avoid further glyphosate resistance?
- What weeds will be the most problematic to control in a potentially glyphosate-free system?
- Assess each use of glyphosate (pre-seeding, in season, pre-harvest) to find which uses can be replaced to preserve glyphosate as a viable tool.

Theme 2: Disease Management

Crop diseases have the potential to significantly reduce yields and affect quality. The greatest risk is when host, pathogen and environment collide in a perfect way, to the advantage of the pathogen. Any one of these may be influenced either in a minor or major way to interrupt disease progression. Currently, crop genetic resistance is relied on to a great extent, however fungicides are also utilized. Production issues identified in the discussions relate to increased disease pressure, loss of seed treatments, increasing fungicide resistance, lack of new chemistries, and the erosion/breakdown of crop resistance. The following are issues and questions of interest to farmers.

Issue 1: Assessing and predicting the continually evolving situation (high priority)

- What and where are the most problematic cross cutting diseases and disease resistance issues affecting multiple crops in western Canada? (recognize that there are limited cross-cutting diseases, however management of the farm system influences each disease). Assess technologies/methods that can be developed or employed for monitoring disease issues.
- Which diseases are expanding their impact and are likely to become more impactful in the future?
- What are the factors influencing significant disease outbreaks, impacting yield and/or quality?
- How can pathogen genomics be efficiently integrated in the monitoring process to track race structures for development of control strategies and products?
- How do weather cycles and climate change affect diseases in western Canada?

Issue 2: Understanding crop diseases (high priority)

- What are the mechanisms and sources of plant resistance?
- What are the population genetics and how is the disease evolving?
- What are the vectors of pathogen, mode of infection and disease spread?
- What are the effects of above and below-ground plant architecture traits on disease?
- What are the effects of plant spacing, biotic and abiotic stresses on crop disease?
- What are the positive and negative interactions between pathogens and other microbes?

Issue 3: Control strategies (high priority)

- Are there new technologies which can be developed or improved to rapidly advance the development of resistant crop varieties?
- Are there more strategic ways to manage fungicides and varietal resistance to conserve their efficacy as tools into the future?
- Develop and assess diagnostic tools for in-field disease evaluations.
- Assess sensor technologies be developed to effectively recognize pathogens in the field for spot spray or variable rates via smart ag technologies.

- Improve forecasting and decision-making tools which integrate severity of risk associated with disease occurrence and a suite of mechanisms for disease control, including seed selection, scouting, fungicide use, crop sequence and rotation, crop potential, crop price, economics, and weather factors.
- Are there new technologies that can be developed or adapted for control of crop diseases?
- What are the cumulative effects of an integrated approach to controlling crop diseases?

Theme 3: Insect Pest Management

While some insect pests can be unpredictable, others are quite cyclical and somewhat predictable with forecasting tools developed by entomologists from Western Canada over the years. There is also interest in beneficial insects such as pollinators, and those which help to control pests. The following are issues and questions of interest to farmers.

Issue 1: Assessing and predicting the continually evolving situation (high priority)

- What and where are the most problematic insect pests and insect resistance issues affecting multiple crops in western Canada? Assess technologies/methods that can be developed or employed for monitoring insect pests and beneficials.
- What are the factors influencing insect pest outbreaks?
- Which insect pests are expanding or likely to expand their impact and what should farmers be watching out for?
- Adapt and improve prediction modelling for insect pests for affordable, real-time risk assessments, forecasting and decision-making.
- Are there improved technologies/methods that can be developed or employed for monitoring insect pests and beneficials?
- How will climate change affect insect pests and beneficial insects in western Canada?

Issue 2: Understanding crop insect pests and beneficial insects (high priority)

- What is the biology, behavior and impacts of specific insect pests and beneficial insects?
- Understanding the relationship between beneficial insects, pest insects and habitat (including crop species and marginal lands, field edges).

Issue 3: Control strategies (high priority)

- Which beneficial insects are assisting with insect pest control and what are the economic implications of the loss of beneficial insects, including pollinators, to farmers?
- Continue to develop/validate economic thresholds for insecticide application decision-making tools, expanding to include more insect pests and other critical factors such as beneficial insects.
- What are the multi-year implications of applying specific insecticides on a single farm or field in a single year or multiple years at different levels of insect pressure?
- What scouting tools can be developed or enhanced for the use of farmers and agronomists, either in a single field or broader scale?
- How are insects and control measures affected by other elements of crop production, including agronomic practices (crop rotations, etc) and systems and vice versa?
- Are there new technologies that can be developed or adapted for control of crop insect pests?

Theme 4: Plant Nutrition

There continues to be interest and need for greater nutrient use efficiencies to maintain and enhance economic and environmental health. Does precision agriculture have potential for an expanded role in plant nutrition, and if so, what is needed to take it to another level of effective application from a public research perspective? How will farmers replace the nutrients which are utilized by crops as expectations increase for both production and environmental protection? Farmers are increasingly interested in understanding and improving soil quality. The following are issues and questions of interest to farmers.

Issue 1: Assessing and Monitoring of Soil Health and Plant Nutrition Issues (medium-high priority)

- Periodically assess the status of soil quality/health and plant nutrition issues on the prairies.
- What tools can be used or developed to anticipate and monitor the plant nutrition and soil fertility issues which have impacts on crop production?

Issue 2: Increasing nutrient use efficiencies (high priority)

- How do we increase nutrient use efficiencies further? Assess new chemical forms or coatings, timing, rate, placement, precision applications, and/or new/improved genetic efficiencies.
- Develop ways to integrate new products and practices for farmer application.
- Update, verify and publicize nutrient removal rates, fertilizer rate recommendations, including adjustments for improved varieties and expanded crop choices, modern practices, new products, and local conditions.
- Soil tests – further development of on-site nutrient testing to better synchronize nutrient applications to crop use (in particular, N). In-field sensor development?
- Is there a need to improve the N and P tests? Testing for soil function?
- Plant tissue tests – further develop publicly available plant tissue data to inform plant tissue testing for deficiency/sufficiency of macro and micronutrients.
- Improve genetic approaches to help identify nutrient use efficiency.
- Are there differences among crop species in the way they make use of low or high nutrient environments?
- What are the fertilizer recommendations that reflect the needs of a full crop rotation cycle?

Issue 3: Understanding soil/root interactions, soil biology, soil quality and soil resilience (medium-high priority)

- What is the relationship between nutrient use efficiency and soil quality?
- Develop a better understanding of the relationship between microbial functions and crop residues, nutrient transformations and crop yield.

- Do we know the prevalence and impacts of change of soil pH in western Canada? Is acidification of soils significant to nutrient use efficiency, crop disease and growth? If so, what management practices should farmers adopt?
- What are the impacts and corrections for soil compaction and soil drainage?
- Are existing methods adequate or are there new methods that could be developed to efficiently measure the impacts of field management on soil microbial function and soil quality?

Theme 5: Response to Weather Variability and Climate Change

Farmers face several risks in their businesses, a significant one of which is weather. The tendency for increased extreme weather events is predicted. What will be the impacts on risk management, crop growth, crop pests (weeds, diseases and insects) and soils? How will farmers manage crops and associated risks in the future? The following are issues and questions of interest to farmers.

Issue 1: Understanding weather variability and climate change (medium-high priority)

- How do we weather-proof cropping systems to be more flexible and more resilient? Develop an understanding of weather variability and climate change and the positive and negative effects on crops, cropping systems, pests (insects, weeds, diseases) and plant nutrition and what it means for crop production in western Canada.

Issue 2: Adaptation to weather variability and climate change (high priority)

- Create adapted crop management practices and tools on regional and local levels.

Issue 3: Develop methods for reducing greenhouse gas (GHG) emissions and capturing carbon on farms for farmer benefit (high priority)

- Develop an understanding of GHG emissions as they relate to nutrient management, agronomic practices and cropping systems.

Theme 6: Sustainable Resource Management

Farmers are continuously looking for better ways to conserve resources and maintain profitability. Direct seeding has been the norm in western Canada for the past 25-30 years, providing many benefits to the protection of soils and economics of farming. Needs associated with the integration of multi-faceted management issues and opportunities are often defined as cropping system questions. The following are issues and questions of interest to farmers.

Issue 1: Soil Quality/Soil Health (high priority)

- How do we define and quantify soil health and how do management practices such as tillage or lack of tillage, green manures and cover crops, intercrops and diverse crop rotations affect it?
- Benchmark soil health measurements.
- How is soil health linked to productivity and profitability?

Issue 2: Cropping Systems (high priority)

- What are the impacts of different cropping systems in terms of production, soil and water resources, nutrient use efficiencies, pests, economics, greenhouse gas emissions, C sequestration?
- Within cropping systems, are there adjustments needed to manage evolving biotic and abiotic issues, examples such as pesticide resistance, soil and pest issues, residue issues, hotter or colder, wetter or drier conditions?
- What conservation tillage practices can be developed where row cropping is becoming the norm?