RESEARCH PRIORITIES
GRAIN FARMERS OF ONTARIO

Revised June 2023

Investment in research is a long-term strategic initiative of the Grain Farmers of Ontario for the benefit of all barley, corn, oat, soybean, and wheat farmers. Ontario's grain farmers have sponsored and participated in decades of practical research that has resulted in economic gains and improved agricultural sustainability for Ontario farmers and the Ontario environment. Our goal is to invest in research and support innovation and knowledge transfer that will enhance farmer member profitability and sector competitiveness.

Grain Farmers of Ontario aims to address the research needs for barley, corn, oat, soybean, and wheat through four overall priority areas: **Agronomy and Production**; **Weed, Disease and Insect Pests**; **Crop Quality and Utilization**; and **Breeding and Genetics**. Within each priority area, Grain Farmers of Ontario invests funds in projects of high priority to Ontario farmers, strives to maximize public sector research investment, and encourages private sector research investment.

Each year Grain Farmers of Ontario identifies specific priorities toward which it would like to target increased research investment. This year, Grain Farmers of Ontario is placing a particular emphasis on research proposals targeting the following research priorities:

- *Integrate **4R nutrient stewardship practices for commercial fertilizer with other nutrient sources** (e.g., cover crops, manure application, biosolids) and validate 4R practices to improve farm profitability and reduce N losses and GHG emissions per unit of crop production.*
- *Develop **integrated weed, disease, and insect pest management strategies** that consider multiple management options, biology and epidemiology of the pest, and prevention of pest resistance to trait and pesticide control measures. Of particular interest are projects addressing **white mould in soybeans**.*
- *Develop effective **crop residue management practices** to minimize residue challenges, and maximize crop production, profitability and environmental sustainability under minimal tillage/no-till.*
- *Explore **revolutionary grain drying technologies to substantially improve grain drying efficiency** and explore **agronomic solutions for drydown** to improve profitability of grain production and reduce GHG emissions.*

These four key priorities are also included within the more comprehensive list of research priorities, classified by priority area, below.

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Agronomy and Production Priorities

Nutrient management

- Improve tools for making nitrogen rate decisions.
- Optimize plant use efficiency and profitability of nutrients, particularly nitrogen, phosphorus, potassium, sulfur, and calcium (e.g., 4R nutrient stewardship), and validate the effectiveness of 4R practices on farm, including their impact on nutrient losses, opportunities for reduced nutrient application requirements, reduced GHG emissions, and improved water quality.
- Identify critical soil and plant tissue micronutrient levels to update Ontario nutrient application recommendations (*new priority added in 2023)*.
- Integrate 4R practices for commercial fertilizer with other nutrient sources (e.g., cover crops, manure, biosolids, soil supplied nutrients) to refine application rates.
- Identify how manure can best be incorporated into minimal till/no-till cropping systems to balance crop productivity and nutrient losses.
- Develop a standardized accredited Ontario sulfur test.

Soil management

- Develop cost-effective soil health testing procedures (particularly the biological component) which can identify production systems that improve long-term soil health and resilience of barley, corn, oat, soybean, and wheat production.
- Develop strategies to minimize and remediate impacts of soil degradation (e.g., shallow and deep soil compaction, loss of soil organic matter, water/tillage erosion).

Integrated systems approaches to crop management

- Advance production systems to maximize profit, maintain or build soil health, improve crop resilience and reduce GHG emissions & nutrient losses (e.g., factoring in crop rotation, fertility, tillage system, and seeding). Consider the interactions among inputs, specific cropping practices, and environment for increased production, soil health and sustainability.
- Develop effective crop residue management practices to minimize residue challenges, and maximize crop production, profitability and environmental sustainability under minimal tillage/no-till.
- Develop innovative new cropping systems (e.g., intercropping winter wheat and soybeans, relay cropping soybeans into standing crops, bio-strip till systems, integrating soybeans into rotations north of New Liskeard to further harness the millions of arable acres in the Great Clay Belt, etc.) that can provide an opportunity for more crop diversity on challenging soils (e.g., heavy clay, sand, etc.).
- Identify and validate best management practices for effective integration of cover crops into field cropping systems to provide economic and environmental benefits.
- Identify profitable and sustainable agronomic solutions that facilitate crop drydown to reduce the post-harvest grain drying cost and carbon footprint.

- Identify and generate Ontario-specific datasets and tools to advance life cycle GHG accounting of Ontario grains (e.g., tools for refining estimates of soil organic carbon across temporal and geographic scales; data that can improve the accuracy of emission factors used to calculate N_2O emissions from fertilizer use and crop residue by crop and cropping system (including complete crop rotations)).
- Update herbicide compatibility data for common replant and/or follow crop scenarios (e.g., plant back intervals).

Precision agriculture tools, technologies & modelling

- Develop and validate site-specific/variable rate production practices that improve efficiency of inputs, support ecosystem services, and contribute to overall farmer profitability, demonstrating actual return on investment (ROI).
- Apply precision agriculture technologies and emerging statistical methods to agronomy research designs to better understand site-specific agronomy, ultimately supporting site-specific decision support tool development.
- Develop simple on-farm research protocols to facilitate site-specific decision support tool development and validation. (*new priority for 2023*)
- Identify the ROI (economic and environmental) of new autonomous equipment and disruptive-scale technologies that can add value to Ontario farms in the near-mid-term.
- Determine how to effectively implement innovative sprayer technology (e.g., nozzles, drones, variable rate sprayers, autonomous sprayers, etc.) to maximize ROI and opportunities to improve efficacy and reduce pesticide load.
- Develop an improved wheat yield model for the Great Lakes YEN to more suitably evaluate current wheat yield potential in the Great Lakes region (e.g., generating data such as water use, light energy capture, conversion efficiency, harvest index, etc. to support crop modeling). (*new priority for 2023*)

Weed, Disease, and Insect Pests Priorities

- Develop integrated weed management strategies that consider management and prevention of herbicide resistance, the biology of specific weed species, and how cropping system components like soil fertility, soil health, cover crops, and crop rotations influence weed seed return and control of common weeds.
    - Key weeds include Canada fleabane, lamb's-quarter, waterhemp, giant ragweed, common ragweed, perennial sow-thistle, foxtail, pigweed, wild carrot, & bluegrass.
- Develop integrated disease & insect pest management strategies that consider management and prevention of trait and pesticide resistance, the biology and epidemiology of specific diseases and insects, and the influence of crop rotations, cover crops, crop inputs, soil health, and natural enemies on insect pest and disease dynamics.
    - Key diseases and insect pests include *Fusarium* in wheat and barley, *Gibberella* in corn, tar spot in corn, corn rootworm, western bean cutworm, soybean cyst nematode (SCN), white mould, soybean sudden death syndrome (SDS), corn nematodes and other nematodes, foliar pathogens (e.g., stripe rust, Northern

corn leaf blight, powdery mildew, oat crown rust, etc.), seedling diseases, spider mites, slugs, and true armyworm.

- Develop effective management strategies, including forecasting tools, for mycotoxin producing pathogens (*Gibberella, Fusarium)*, insect pest vectors (e.g., western bean cutworm) and associated fungal toxin accumulation (e.g., DON) in the field and in stored grain.
- Develop strategies to address emerging weeds (e.g., Palmer amaranth), diseases, and insect pest risks from changing weather patterns, potential foreign introductions, and new resistant populations.
- Assess performance of herbicide programs when few control options exist for specific weed species or cropping systems (e.g., non-GM soybeans, wild oat in cereals, weed control systems without glyphosate or other at-risk active ingredients to meet market requirements).
- Identify, protect, and promote beneficial microbes and insects to manage weeds, diseases, parasitic nematodes, and insect pests in cropping systems.
- Survey and monitor economically important and emerging weeds, diseases (and *Fusarium* DON glycoside dynamics), and insect pests to identify changes in population structure and resistance to management strategies.
- Develop rapid, cost-effective predictive/diagnostic tools for farmers to improve pest management decisions.

Crop Quality and Utilization Priorities

Grain drying

- Explore revolutionary grain drying technologies to substantially improve grain drying efficiency, improve profitability of grain production, and reduce GHG emissions.

Grain quality

- Identify grain quality improvement opportunities to increase the farm-gate value of grain for specific end uses or identity-preserved markets.
- Identify production practices that improve grain quality for specific end uses leading to value-added markets.
- Identify simple and cost-effective grain storage and monitoring practices that maintain grain quality. (*new priority for 2023*)

Grain bioproducts

- Develop new bioproducts, with industry support, from barley, corn, oat, soybean, and wheat (e.g., industrial products, fuel, and bioplastics) linked to existing and emerging market opportunities that would eventually use at least 40,000 MT/year of Ontario grain, or provide price premium opportunities for Ontario's grain farmers, or increase the value and sustainable use of crop residues.

Breeding and Genetics Priorities

Variety development

- Develop high-yielding, high-quality, disease-resistant barley, oat, soybean (non-GM), and wheat varieties adapted for Ontario.
- Develop competitive new varieties for value-added, identity-preserved markets that provide significant economic opportunities for Ontario's grain farmers.
- Improve genetic resistance to important diseases and insect pests in Ontario including *Fusarium/*DON (and DON glycosides) in wheat and barley, *Gibberella/*DON (and DON glycosides) in corn, white mould, western bean cutworm, soybean cyst nematode (SCN), soybean sudden death syndrome (SDS), corn rootworm, corn nematodes and other nematodes, foliar pathogens (e.g., stripe rust, Northern corn leaf blight, powdery mildew, oat crown rust, etc.), seedling diseases, soybean aphid, and true armyworm.
- Identify and breed for environmental stress tolerance traits that will enable crops to perform well amid a changing climate (e.g., prolong grain fill period in wheat, barley, oat during high temperatures in June; improve soybean grain fill capability under August drought conditions; improve winter survival of winter wheat and winter barley).

Breeding tools

- Develop effective Gibberella ear rot resistance screening protocols for corn hybrids.
- Identify effective breeder-friendly markers and resistance genes for Gibberella ear rot of corn.

Variety selection tools

- Enhance variety performance trials and tools for variety selection.

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