RESEARCH PRIORITIES
GRAIN FARMERS OF ONTARIO

Revised June 2024

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, phosphorus, and potassium 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.
    - Improve decision support for making in-season nitrogen rate adjustments by determining the need for top-ups (e.g. accounting for rainfall and nitrogen losses) and optimizing upfront nitrogen application for effective later-season supplementation. (*new priority for 2024*)
- Identify critical soil and plant tissue micronutrient levels to update Ontario nutrient application recommendations.
- 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 utilized in minimal till/no-till cropping systems to balance crop productivity and nutrient losses (e.g., into standing cover crops).
- 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 Ontario crop production.
- Assess the validity and interpretation of soil health assessment tools to corroborate lab analyses of soil health indicators with field performance. (*new priority for 2024*)
- Develop strategies to optimize soil structure and minimize and remediate impacts of soil degradation (e.g., shallow and deep soil compaction, loss of soil organic matter, water/tillage erosion) with a focus on demonstrated cost-benefit analysis (factoring soil type into economics).
- Evaluate the economics and effectiveness of the biostrip till concept in improving soil health while maintaining or improving crop production. (*new priority for 2024)*

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, biostrip 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 with a focus on 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 and statistical methods to facilitate site-specific decision support tool development and validation.
- 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 crop models for Ontario grain crops that can be utilized in the development of YEN programs to more suitably evaluate current yield potential (e.g., generating data such as water use, light energy capture, conversion efficiency, harvest index, etc. to support crop modeling).

Weed, Disease, and Insect Pests Priorities

- Develop integrated weed management strategies that consider management and prevention of herbicide resistance (e.g., mechanical weed control, biological weed control), 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, 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 (e.g., *Bt*-resistant European corn borer (*specific priority pest added in 2024*)) 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 new/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 (e.g., by reducing moisture, minimizing spoilage, avoiding insect impacts, etc.) and reduce waste (e.g., grain bags).

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 & trait 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), European corn borer, 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
- Assess wheat varieties for their relative tolerance to preharvest sprouting and α-amylase expression levels to identify varieties with reduced risk of having low falling numbers at harvest. *(new priority for 2024)*

Variety selection tools

- Enhance variety performance trials and tools for variety selection (e.g., Gibberella ear rot resistance screening, straw yield of small cereals, etc.).