OMAFRA Priorities for the Ontario Agri-Food Innovation Alliance Research Program 2019-2020

Ontario Ministry of Agriculture, Food and Rural Affairs

September 2019

FINAL

Ontario

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Introduction

Ontario Agri-Food Innovation Alliance

The Ontario Agri-Food Innovation Alliance (formerly the OMAFRA-UofG Partnership) is a collaboration between the Ontario Ministry of Agriculture, Food & Rural Affairs (OMAFRA) and the University of Guelph (UofG). Through the Alliance, OMAFRA and UofG work together to advance research and innovation that contributes to the success of the province's agri-food sector and promotes rural economic development.

On April 1, 2018, OMAFRA and UofG renewed the agreement governing the Alliance with a commitment of up to ten years. Alliance programming supports the intellectual capacity, infrastructure and networks that produce, synthesize, transfer and invest in world-class research, innovation, laboratory testing and veterinary capacity.

The Ministry's desired outcomes for the Agreement are:

1. Transparency and public confidence in the agri-food sector through the protection of public, animal and plant health, the environment, and Ontario's economy
2. The tools and ability to quickly and effectively respond to emergencies within its agri-food sector
3. An effective research and innovation system to achieve assurance in food safety, to protect animal, plant and public health and the environment, to grow Ontario's capacity to produce food, and to support a globally and domestically competitive agri-food sector
4. Development of future skilled capacity to be ready for employment opportunities offered by the agri-food sector and rural Ontario, including highly qualified veterinary capacity in place to meet Ontario's needs
5. Growth of third-party investment in agri-food and rural research, innovation and development, and data focused initiatives, and
6. Increased sharing and access to data to facilitate new agri-food and rural research and data analytics to inform government decision-making

The Research Program is a main component of the Ontario Agri-Food Innovation Alliance and provides funds for research projects that support the Agreement and the following strategic outcomes:

- Achieve assurance in food safety;
- Protect animal, plant and public health and the environment;
- Grow Ontario's capacity to produce food; and
- Support a globally and domestically competitive agri-food sector.

The University of Guelph administers the Alliance Research Program and makes recommendations on funding awards to OMAFRA.

Full details on the Alliance agreement can be found here.

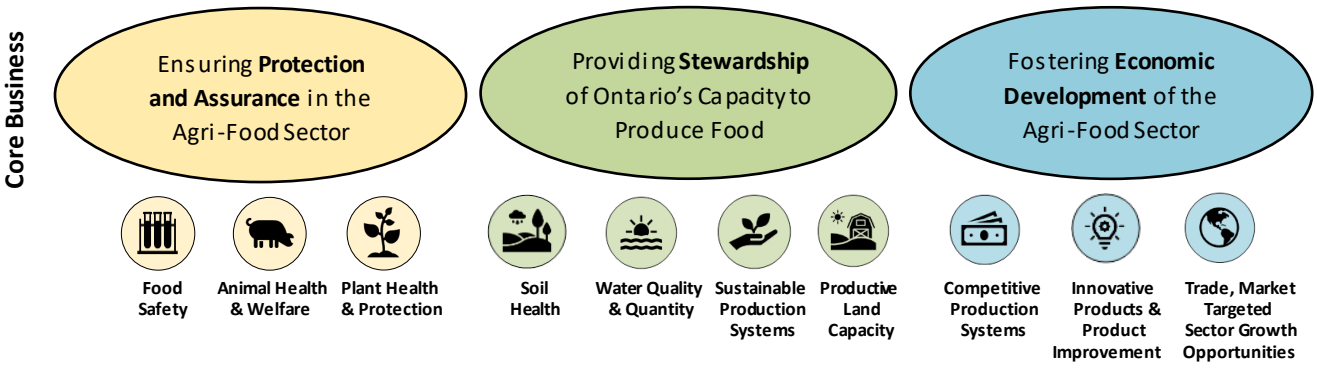
Overview: OMAFRA Research Priorities

The purpose of this document is to outline OMAFRA's research priorities that will be used to evaluate proposals received through the Alliance Research Program's 2019-2020 call for proposals.

OMAFRA is committed to, and has been working towards, the continuous improvement of its research programming, recognizing that research is an integral support to ministry core business areas, the sector and rural communities. As part of this process, in 2015 and 2016 the Ministry undertook a review of the research and information needs of government, clients and partners. More than 800 agri-food and rural stakeholders comprising farmers, food processors, rural communities and organizations, and commodity and farm organizations across the province were consulted. One of the key outcomes of that consultation was recognition of the critical role of the Agreement, and the need for the Ministry to enter into a renewed Agreement with UofG. In addition, OMAFRA undertook internal analysis and is implementing an enhanced and more flexible research priority-setting process to maximize research investments that support sector development and economic growth.

Improvements include a new ministry-wide, integrated approach to research priority setting that aligns research priorities with the Ministry's core businesses and objectives: Protection and Assurance, Stewardship and Economic Development. While many of the previous research themes remain relevant, they were established over ten years ago. The newly implemented research priority setting process has identified new research priorities that reflect the current needs of government and industry:

OMAFRA Research Priorities by Core Business



Each of these research priorities has a set of goals and research focus areas, in addition to five cross-cutting focus areas. Specific research questions for the 2019-20 Alliance Research Program together with the research problem/information gap and desired outcomes of the research are identified in the Appendix to this document.

Program applicants must clearly demonstrate that their proposal is within scope of OMAFRA's research priorities and fits with one or more of the research questions in the Appendix. **Proposals that involve the development of a product or service must include a Value Assessment Plan.** Additionally, five (5) specific research questions identified in the Appendix require a Value Assessment Plan.

PROTECTION AND ASSURANCE

Ensuring Protection and Assurance in the Agri-Food Sector

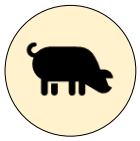
Food Safety

Goals

- Enhance public confidence in the sector to deliver on food safety, animal health, plant health, emergency management, and animal welfare expectations and demands.
- Anticipate, detect, mitigate and/or reduce food safety hazards along the supply chain.

Research Focus Area (refer to Appendix for detailed research questions)

1.1 Detection and Surveillance: Baseline data.



Animal Health & Welfare

Goals

- Enhance public confidence in the sector to deliver on food safety, animal health, plant health, emergency management, and animal welfare expectations and demands.
- Anticipate, detect, mitigate and/or reduce animal health hazards and antimicrobial use along the supply chain.

Research Focus Areas (refer to Appendix for detailed research questions)

2.1. Prevention and Control of Pathogens: Development and integration of effective prevention, mitigation and control methods for production limiting, new and

emerging diseases and pest (e.g. antimicrobials or vaccines, biosecurity best management practices, carcass management).

2.2. Development of BMPs: Development of best management practices to improve farmed animal welfare (e.g. housing, equipment, pain management).

2.3. Health, Welfare and Productivity of Young Animals: Reducing morbidity and mortality in young, farmed animals.

2.4. Emerging Pathogens and Pests: Identification and understanding of new and emerging pathogens and pests in farmed animals.

2.5. Detection and Surveillance of Pathogens and Pests: New detection and surveillance methods/technologies to identify new and emerging pathogens and pests in farmed animals.

Plant Health & Protection

Goals

- Enhance public confidence in the sector to deliver on food safety, animal health, plant health, emergency management, and animal welfare expectations and demands.
- Help strengthen the agri-food sector's sustainability and social license through increased utilization of Integrated Pest Management and other pest mitigation strategies.
- Anticipate, detect, mitigate and/or reduce plant hazards along the supply chain, and improve plant resilience and resistance.

Research Focus Areas (refer to Appendix for detailed research questions)

3.1. Biology of Current and Emerging Pests: Understanding of the biology, climate resilience, ecology and management of current and emerging pests, and resistance management. Includes identification, tracking, monitoring, biosecurity practices and protocols, diagnostics and surveillance.

3.2. Pathway Analysis: Risks of new/expanding transmission pathways/distribution patterns of pathogens/pests.

3.3. Detection and Surveillance: Risk-based detection and surveillance methods/technologies.

3.4. Integrated Pest Management: Improved integrated pest management strategies through efficacy studies; alternative control options; development of management strategies.

STEWARDSHIP

Providing stewardship of Ontario's capacity to produce food

Soil Health

Goals

- Protect and enhance soil health and water quality, supporting improved public confidence in the sector to deliver on sustainability expectations.
- Improve soil health and conservation to support agricultural productivity.

Research Focus Areas (refer to Appendix for detailed research questions)

4.1 Environmental Impacts of Management Practices: Environmental impacts of fertilizer use, nutrient management and integrated pest management.

4.2 BMP Development: Develop, validate and continuously improve practices and technologies to support water quality and quantity, soil health, and sustainable agri-food production and processing systems (environmental, economic, social).

4.3 Baseline Soil Health Information: Baseline soil health information (i.e. relationship between physical, chemical and biological components) and development of robust and measurable soil health indicators.

Water Quality & Quantity

Goals

- Protect and enhance soil health and water quality, supporting improved public confidence in the sector to deliver on sustainability expectations.

- Strengthen the agri-food sector's sustainability and social licence through improved water use and water quality.

Research Focus Areas (refer to Appendix for detailed research questions)

5.1 Analysis of BMP Adoption: Understand the behavioural, social and economic barriers or incentives to BMP adoption by the agri-food sector.

5.2 BMP Development: Develop, validate and continuously improve practices and technologies to support water quality and quantity, soil health, and sustainable agri-food production and processing systems (environmental, economic, social).

Sustainable Production Systems

Goal

- Strengthen the sustainability of the agri-food sector through (1) Soil health and conservation, (2) Improved water quality (e.g. reduced phosphorus runoff and pesticides), (3) Increased water/waste/energy efficiency and reduced GHG emissions, and (4) Increased utilization of 4Rs Nutrient Stewardship.

Research Focus Areas (refer to Appendix for detailed research questions)

6.1. Analysis of BMP Adoption: Understand the behavioural, social and economic barriers or incentives to BMP adoption by the agri-food sector.

6.2. Environmental Impacts of Management Practices: Environmental impacts of fertilizer use, nutrient management and integrated pest management.

6.3. BMP Development: Develop, validate and continuously improve practices and technologies to support water quality and quantity, soil health, and sustainable agri-food production and processing systems (environmental, economic, social).

6.4. Impact of Changing Ecosystems on Ag: Understand the impact of changing ecosystems and biodiversity on agri-food production and processing systems to support an adaptive and resilient agri-food sector.

6.5. Nuisance Assessment: Assess nuisance and potential disturbances from production systems (e.g. air/odour quality).

6.6. Environmental Impact of Ag Production: Understand and quantify the impact of agricultural production systems on the environment (e.g. GHG emissions) to help mitigate environmental impacts.

Productive Land Capacity

Goal

- Reduce the rate of loss of farmland through improved land use planning to support agricultural viability.

Research Focus Areas (refer to Appendix for detailed research questions)

7.1 Evidence to Support Land Use Policies: Evidence to inform land use policies to support policy and programs to protect farmland, support the viability of farmland operations and integrate land use with economic development.

7.2 Effectiveness of Land Use Policies: Assess effectiveness of existing land use policies to protect agricultural land and farm operations and support economic success of the agri-food sector and rural communities (e.g. Agricultural System, Minimum Distance Separation, Agricultural Impact Assessments, lot creation, on farm permitted uses).

ECONOMIC DEVELOPMENT

Fostering economic development of the agri-food sector and Rural Ontario

Competitive Production Systems

Goal

- Improve production efficiency, productivity, competitiveness and public trust efforts through technology adoption and innovation and technology development such a labour-saving technology or practices, automation, waste reduction, recycling, and increased water/waste/energy efficiency and reduced GHG emissions.

Research Focus Areas (refer to Appendix for detailed research questions)

8.1 Input Use Efficiency: Input use efficiency (e.g. alternative feeds, feed efficiency, automation in horticulture; irrigation efficiency in greenhouse, reproductive performance, food processing resource efficiency).

8.2 Improved Management and Processes: Improved management and processes (e.g. crop and livestock productions systems that improve yields and quality through agronomy, production practices, genetic methods, efficient fertilizer use).

8.3 Labour Access/Efficiencies: Research and evidence to support the development of strategies to ensure that the economic growth and sustainability of the agri-food sector is supported by adequate access to labour and/or labour efficiencies.

Innovative Products & Product Improvement

Goal

- Enhance competitiveness, profitability and growth of the agri-food sector through new or improved products.

Research Focus Areas (refer to Appendix for detailed research questions)

9.1 New Product Development: Investigate new products (physical products, services or processes) to improve marketability and profitability, meet consumer demands, and enhance productivity in the sector, from concept to prototype (e.g. alternative proteins, foods of the future, new crops, bioproducts).

9.2 Product Enhancement: Investigate means of enhancing products including: production conditions (e.g. plant establishment and survival in challenging environments); management practices; product trait development; new technology development and validation.

Trade, Market, Targeted Sector Growth Opportunities

Goals

- Growth of the overall agri-food sector through expansion of existing and access to new domestic and international markets.

- Improve economic performance of identified priority sub-sectors and increased production of niche and/or value-add products.

Research Focus Area (refer to Appendix for detailed research questions)

10.1 Targeted Sector Growth: Identify (in partnership with industry stakeholders), investigate and research opportunities to address targeted sector growth opportunities that will remove key barriers and improve competitiveness of the sector in the areas of: dairy goats, hazelnuts, aquaculture, greenhouse, maple syrup, processed vegetables, processed meats, baked goods and cannabis/hemp.

Cross-Cutting Research Focus Areas for all Research Priorities (refer to Appendix for detailed research questions)

Please note: Questions for the cross-cutting focus areas appear throughout the Appendix.

11.1. Climate Change Resiliency: Understand risks and mitigation strategies to support an agriculture and food sector that is resilient and adaptive to climate change.

11.2. Technology Development: Identification verification, validation, demonstration and adoption of new, innovative and disruptive technologies and practices to support a resilient and sustainable agriculture and food sector.

11.3. Performance Measurement: Measure performance through baseline information, trend and gap analysis, impact assessment, and BMP adoption to quantify and benchmark performance.

11.4. Rural Community Development: Understand the physical, human and economic conditions by which rural communities can grow and compete.

11.5. Value Chain Analysis and Development.

APPENDIX: OMAFRA Research Questions

Please note: Question numbers link to Research Focus Area identifiers in the main document.

Question Number	Research Priority	Research Focus Area	Research Question	Research Problem or Information Gap	Desired Outcomes
FOOD SAFETY					
1.1.1	Food Safety	Detection and Surveillance: Baseline Data	What are the residual levels and data required to establish better usage guidelines and withdrawal times in livestock for drugs that have no current documented withdrawal period and no established maximum residual limit (MRL); for example, dexamethasone in cattle culled for beef? What is an appropriate MRL for dexamethasone?	OMAFRA tests for the presence of veterinary drugs in food animals. Some of these drugs do not have an established maximum residual limit (MRL) against which to evaluate the residue level found. Moreover, there is a gap in data which would allow CgFARAD (Canadian Global Food Animal Residue Avoidance Databank) to determine the appropriate withdrawal times (based on residue level/depletion rate) for drugs administered to livestock. Knowing what the depletion rate is for different drugs in different species would be valuable information, to help Health Canada determine MRLs, and help CgFARAD determine appropriate withdrawal times.	Project results will help to establish the risk level of certain drugs administered to livestock that enter the Ontario market. The results may be used to inform changes to regulatory policy as well as veterinary care best practices. This work would provide some field guidance to vets/ producers.
ANIMAL HEALTH & WELFARE					
2.1.1	Animal Health & Welfare	Prevention and Control of Pathogens	What are the therapeutic tools and alternatives or management programs that will improve the prudent use of or reduce the need for pharmaceutical interventions such as antimicrobials, anthelmintics or other treatments? What are the impacts of these alternatives on animal and public health and economic and environmental sustainability?	There continues to be a requirement to shift practices to those that support protection and assurance of the agri-food sector while adopting more prudent use of antimicrobials and medications in agriculture. All sectors are looking for alternatives to antibiotics. There are also concerns highlighted by staff and industry regarding availability of pharmaceuticals for several species, e.g. small ruminants continue to face the issue of "off-label" use for most antimicrobials.	Outcomes include: identification of alternative prebiotics, probiotics and vaccines, alternatives to pharmaceutical use, and management strategies that can reduce the need for use of these; drug depletion and residue studies to validate timing and use concerns while ensuring food safety and animal health/welfare; reduced off-label drug usage.
2.2.1	Animal Health & Welfare	Development of BMPs	What are economically viable housing systems and management practices, which align with market and consumer demands and meet animal health and welfare needs?	There are several challenges with animal disease transfer, social interactions, mortality, environmental quality, management practices and labour efficiencies within different housing options. The diversity of housing systems means that there are diverse issues that need to be addressed in order to develop BMPs for individual systems and management practices.	Outcomes will include knowledge regarding housing systems and management practices that support economical, sustainable and efficient production, as well as optimized animal health and welfare.
2.2.2	Animal Health & Welfare	Development of BMPs	Are there new technologies or management practices that can eliminate the need for, or further alleviate and	There are currently few options available to reduce pain or stress during certain management procedures (i.e. dehorning, castration, tail docking, teeth clipping, hoof trimming) and these options often	Outcomes will include new best practices associated with common animal procedures,

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			prevent the stress and pain of, currently accepted practices/procedures?	require significant labour and/or cost to the producer. More options are needed to reduce time and cost requirements while ensuring pain/stress reduction.	or new technologies to reduce the need for these procedures.
2.2.3	Animal Health & Welfare	Development of BMPs	How can stress, pain and injuries be reduced during transportation, at livestock markets and at slaughter facilities?	Transportation, market and slaughter are crucial periods in animal production where research is needed to better address sources of animal health and welfare concerns. Livestock codes of practice (transportation time) are in flux and require evidence to support their development.	Codes of practices are under development for some species; knowledge from research could be used to guide evidence-based decision making. Handling, tools and best practices at market and slaughter facilities will be improved to support animal health and welfare.
2.3.1	Animal Health & Welfare	Health, Welfare and Productivity of Young Animals	How do we decrease morbidity and mortality of young farmed animals?	A prominent concern from multiple livestock sectors continues to be concern for reducing risk of disease and mortality in young livestock. Specific factors leading to disease and mortality are largely unknown for a number of species. Benchmarking the number of losses and cause of losses is needed to determine best practices or development of treatments to mitigate.	Outcomes include knowledge to support the livestock sector to improve morbidity and mortality rates in those industries with specific concerns; new recommended management practices; disease prevalence rates to better inform producers; development of solutions or treatments for producers to adopt.
2.4.1	Animal Health & Welfare	Emerging Pathogens and Pests	How can feed infected with mycotoxins be utilized for livestock without impacting animal health or performance?	With changing weather, mycotoxins are an increasing concern for animal feed; industries continue to struggle with mycotoxin loads and mycotoxin research has been identified as a high priority need.	Sectors that are predominantly grain-fed will be provided with information and mechanisms to alleviate negative health and nutrition effects or concerns of feeding grain contaminated with mycotoxins.
2.4.2	Animal Health & Welfare	Emerging Pathogens and Pests	How can the risk of new and expanding transmission and distribution pathways of pathogens and pests be identified (diagnosed), quantified and mitigated in a timely and cost-effective manner?	Results of this research will contribute to the ministry's leading role in prevention of, response to and recovery from agricultural related emergencies, help fulfill the Ministry's legislative responsibilities and fulfill commitments to our federal, provincial and industry partners in emergency management. Current gaps exist regarding zoonotic, tick borne and parasitic diseases that impact multiple species and humans. The growing change in climate also introduces new concerns.	Outcomes of research will support the ministry responding to agricultural emergencies, and the prevention and control of new and emerging risks to the agri-food sector.
2.5.1	Animal Health & Welfare	Detection and Surveillance of	What new detection and surveillance methods can be used to identify and quantify new and emerging	Results of this research will contribute to the Ministry's leading role in prevention of, response to and recovery from agricultural related	Research outcomes will include new detection and surveillance methods, or technology

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Question Number	Research Priority	Research Focus Area	Research Question	Research Problem or Information Gap	Desired Outcomes
		Pathogens and Pests	pathogens and pests in a timely and cost-effective manner?	emergencies, help fulfill the Ministry's legislative responsibilities and fulfill commitments to our federal, provincial and industry partners in emergency management. Detection and surveillance research helps to facilitate timely response to changes in frequency and distribution of pests and pathogens.	needed to better identify and quantify new and emerging pathogens and pests in a timely and cost-effective manner.
11.2.1	Animal Health & Welfare	Technology Development (cross-cutting)	What policy tools (education, incentives, legislation etc.) would be most effective to support behaviour change (e.g. adoption of best practices for biosecurity and animal management practices) within specific commodity sectors?	It is important to determine and identify policy tools (education, incentives, legislation, etc.) related to assisting farmers with the adoption of new best management practices and understand any associated economic and sustainability considerations (e.g. cost of transitioning dairy farmers to cost and labour efficient alternative housing systems; understanding the cost of production of 1L of goat milk and management to make this more effective; policy work around programs to reduce disease on farms).	Research will help provide an understanding of what motivates producers to adopt a best practice. The results would assist commodity associations and OMAFRA to modify tech transfer approaches to increase uptake of best practices.
11.3.1	Animal Health & Welfare	Performance Measurement (cross-cutting)	What are the economic implications to agriculture as a result of the changing use patterns of pharmaceutical interventions, including limiting usage to treatment and use of alternative prevention practices?	More limited use and alternative products or practices present a number of unknowns with regard to their impacts on the economics of the sector that need to be understood.	Results include increased confidence in supporting initiatives to reduce treatments like antimicrobials or support for use of alternatives, based on outcomes that validate economic sustainability of industries that adopt new practices/products.
PLANT HEALTH & PROTECTION					
3.1.1	Plant Health & Protection	Biology of Current and Emerging Pests	How can better identification and efficient and effective risk-based detection and surveillance in new and emerging pests improve grower strategies for managing these pests?	New and emerging pests are continually appearing and better ways to identify and manage them before they become an issue are needed.	Research outcomes will improve the identification, tracking, monitoring and management of new pests entering Ontario.
3.2.1	Plant Health & Protection	Pathway Analysis	How can plant health biosecurity risks associated with distribution channels be mitigated?	Knowledge is required to better understand distribution channels, spatial separation of imports (or packing sheds) and local production.	Research outcomes would identify risk pathways and distribution channels and reduce the infection of plant pests.
3.3.1	Plant Health & Protection	Detection and Surveillance Plants	What are new or more effective on-farm plant pest diagnostic techniques and tools?	Growers need faster diagnostic tools. There are several barriers to existing tools including cost analysis, confidentiality and the difficulty of interpreting results.	Research outcomes will identify easier, rapid, farm-level disease diagnostics.

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3.4.1	Plant Health & Protection	Integrated Pest Management	How can integrated pest management strategies be used to combat new and existing pest (weeds, insect, nematodes, diseases like virus) problems in all crops?	Integrated pest management systems need to be employed by sectors that are significantly impacted by the lack of pesticides available to growers.	Research outcomes will inform the ministry of new product registrations and possible alternatives.
3.4.2	Plant Health & Protection	Integrated Pest Management	What integrated pest management strategies can be developed for horticultural production systems that incorporate pesticides, alternative control measures, host resistance and/or take a systems approach to controlling pests, disease and weeds?	Resistant weed species require new integrated management strategies due to the limitation of post emergent herbicide options for specific crops. This is also identified as a top priority by industry.	Research outcomes will include knowledge regarding tillage and timing in crop cycle, use and type of biodegradable mulch, robotic weed pullers, planting densities, row width, fertilizer placement.
3.4.3	Plant Health & Protection	Integrated Pest Management	How can biocontrol strategies be better incorporated and utilized in greenhouse production?	Research is needed to better understand the role biocontrol agents can play in managing pests in greenhouse production (e.g. greenhouse floriculture).	Research outcomes will inform and improve existing integrated pest management strategies.
3.4.4	Plant Health & Protection	Integrated Pest Management	How can integrated pest management programs evolve to deal with the loss of key pest management tools including fungicides and insecticides on fruit and vegetable crops?	With the loss of several key pest management tools expected in 2021-2024, Integrated Pest Management programs for some Ontario crops will require re-assessment to determine where gaps may occur in crop protection.	Research outcomes will identify new or alternative management tools for crop protection.
3.4.5	Plant Health & Protection	Integrated Pest Management	How can mycotoxins (e.g. Gibberella) be managed in order to reduce toxins in grains and whole plant?	Knowledge is required to better understand mycotoxin producing pathogens and associated fungal toxin accumulation in the field and in stored grain in order to improve effective management strategies.	Research outcomes will reduce the impact of mycotoxins on crop marketability and utilization.
3.4.6	Plant Health & Protection	Integrated Pest Management	How can Gibberella ear rot be better managed in order to reduce vomitoxin (DON) in corn?	DON was a significant issue for Ontario growers in 2018 and was identified as a top priority for industry in 2019.	Research outcomes will reduce the impact of mycotoxins on corn marketability and utilization.
3.4.7	Plant Health & Protection	Integrated Pest Management	What new biocontrol agents can be identified and developed for commercial production and sale throughout Canada from endemic sources?	Biocontrol agents are highly restricted, and no new agents have been identified since 2011. New biocontrol agents will need to be created in-house to remain competitive, especially in new crops like cannabis.	Research outcomes will identify new biocontrol agents and improve the overall health and production of new and speciality crops.
11.2.2	Plant Health & Protection	Technology Development (cross-cutting)	How can greenhouse vegetable producers improve disinfection and sanitation (e.g. new technologies and/or processes) throughout the production cycle?	With the threat of highly transmissible diseases (e.g. Tomato Brown Rugose Fruit Virus), producers need options to clean and disinfect tools and equipment regularly, efficiently and effectively throughout the production cycle, to increase biosecurity.	Research outcomes will inform and improve existing biosecurity protocols.

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SOIL HEALTH					
4.1.1	Soil Health	Environmental Impacts of Management Practices	What are the economic impacts of soil degradation and different land management practices (i.e. crop rotation, tillage, crop residues, cover crops, compaction and other practices)? Conversely, what is the return on investment in terms of time and money for farmers adopting soil health practices (e.g. conservation tillage, cover cropping, and soil amendments)? What economic modeling tools and approaches are best to estimate economic effects?	This was also identified as a priority in 2018 that has not yet been addressed. Ontario requires research to establish how soil management practices affect soil health and, in turn, producers' return on investment in order to identify strategies that can benefit the environment and the economy.	Outcomes include a better understanding of the economics of soil degradation and the significance to the Ontario agriculture sector.
4.2.1	Soil Health	BMP Development	What are the opportunities for integrating grazing systems into crop rotations including: i) Grazing crop residues ii) Grazing purpose-grown short-term annual forages within an annual crop rotation (e.g. BMR sorghum sudangrass) iii) Grazing different cover crops iii) Grazing perennial crops integrated into a long-term rotation with annual crops (e.g. 8 year rotation of 5 years of pasture followed by 3 year CSW) iv) Identifying opportunities for contractors to provide these services to existing grain crop growers	There has been a notable and recent historic shift from perennial to annual crops in Ontario. This has increased the frequency of activities that result in soil disturbance (i.e. tillage, compaction, etc.). This is strongly correlated with decreased soil health metrics (i.e. decreased organic matter and aggregation, increased bulk densities, etc.). Annual and perennial forage systems can mitigate some of these effects, provide additional profit-centres for farms, while also benefiting subsequent annual crop yields. Research and anecdotal experiences from South America suggest that integrating grazing systems into crop rotations can be successfully implemented, but there is a lack of evidence exploring these integrated systems in Ontario.	Outcome will be a report that provides better understanding of opportunities to integrate grazing systems into existing grain crop rotations, together with options/recommendations to enable this integration.
4.3.1	Soil Health	Baseline Soil Health Information	How can producers assess soil health in different production systems? (E.g. grain production vs. specialty crop production.)	Crop producers want to improve soil health and want to know how to accurately measure their progress.	Outcomes include an analysis of how soil health differs in field crops, horticultural crops, and specialty crops and tangible ways to assess soil health, either through soil tests, or combined with some other methods.
4.3.2	Soil Health	Baseline Soil Health Information	How does soil carbon relate to soil organic matter and soil health?	We know that soil carbon is important to assessing soil health, but we do not know enough about how important it is. Further, soil carbon can differ across different soil types, so it is not a one-size-	Outcome is a better understanding of the relationship between soil carbon, soil organic matter and soil health.

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				fits-all indicator and we need to understand how we can use soil carbon as a measure of soil health.	
4.3.3	Soil Health	Baseline Soil Health Information	What are the chemical properties that differentiate humified soil organic matter from plant residue?	To develop indicators of soil health, we need to improve our understanding of soil organic matter, which is derived from decomposed plants. OMAFRA needs research that examines this process of decomposition and what it tells us about soil organic matter.	Outcome is technical guidance and information about how to distinguish between soil organic matter and decomposing plant residue.
11.1.1	Soil Health	Climate Change Resiliency (cross-cutting)	How do climate variability and extreme weather events impact the physical, chemical, and biological properties of soil, including cycling of carbon, water, and essential plant nutrients; erosion and sedimentation; and the resilience of soils to support agricultural production and other ecosystem goods and services?	This is a USDA National Institute of Food and Agriculture (NIFA) research priority that is equally important in an Ontario production context using Ontario-based parametres.	Outcome is a better understanding of soil health and agricultural production in a changing climate.
11.1.2	Soil Health	Climate Change Resiliency (cross-cutting)	What are the co-benefits of soil health management practices for farmers (e.g. pest control, reduced input costs) and the environment (greenhouse gas emissions and water quality)? Does soil health contribute to less variation in yield year-over-year?	This was also identified as a priority in 2018 but has not yet been addressed. Ontario requires research to identify the ways in which soil management practices intended to improve soil health may also contribute to improved crop production and broader environmental benefits.	Outcomes will produce evidence that supports the pursuit of the private and public benefits of soil health.
WATER QUALITY AND QUANTITY					
5.1.1	Water Quality and Quantity	Analysis of BMP Adoption	What are the most cost-effective management practices for producers to reduce phosphorus losses in different production systems?	OMAFRA promotes a number of best management practices and this research would examine the costs to producers and the expected environmental benefits. This is a large undertaking, so the research could be designed to examine only the most practical and preferred best management practices.	Outcome is a ranked and costed comparison of management practices for producers to reduce phosphorus losses.

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5.2.1	Water Quality and Quantity	BMP Development	What are the opportunities for farmers to increase riparian/shoreline protection in regionally significant areas?	There is a lack of reliable data and knowledge that can help determine whether there is increased value, effectiveness and improvement of the overall environmental and economic performance of an agriculture operation through protecting rural shorelines and wetlands.	Outcomes include costs and benefits of preventing erosion, soil and nutrient loss, enhanced biodiversity and rural flood management; and demonstration that low-cost, incentive-based protection of shorelines and wetlands can help with drought, flooding, nutrient and pollutant loading, biodiversity and improvements to local watersheds over time.
11.1.3	Water Quality and Quantity	Climate Change Resiliency (cross-cutting)	How can we better assess climate change storm event- driven nutrient loadings from agriculture?	There is a lack of reliable data and evidence on non-point source nutrient loadings.	Outcomes will provide greater evidence to demonstrate that large storm events are contributing to the majority of the loadings, and that if better dealt with on farm and in communities environmental outcomes will improve.
11.1.4	Water Quality and Quantity	Climate Change Resiliency (cross-cutting)	How can we better assess agricultural vulnerabilities to climate change storm events (e.g. soil loss, nutrient loss, infrastructure damage) and the response to associated adaptation strategies?	Evidence appears to indicate that the greatest problems occur during the 4 to 5 intense weather events that are happening on average each year. It would be helpful to have decision-making tools to select the most appropriate strategy to avoid the risk of increased environmental and economic loss/impacts.	Outcomes include better risk assessment tools and adaptation strategies at the farm level to improve positive economic and environment farm outcomes and performance.
11.2.3	Water Quality and Quantity	Technology Development (cross-cutting)	What are the opportunities and barriers for nutrient/ phosphorus trading (e.g. recovery and reuse technologies; recovery from water/wastewater as a commodity) on a lake basin scale (e.g. Lake Erie basin) in Ontario?	While nutrient trading is a recognized market-based policy instrument that involves voluntary exchange of nutrient credits from sources of low cost to those with high cost, its use is limited. Nutrient trading is actively being piloted in the United States as part of the Great Lakes Water Quality Agreement.	Outcomes include a greater understanding of how nutrient trading could benefit Ontario's agriculture sector and how to design and implement a successful nutrient trading system.

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SUSTAINABLE PRODUCTION SYSTEMS					
6.1.1	Sustainable Production Systems	Analysis of BMP Adoption	What are the barriers (behavioural, social and economic) to adoption of BMPs?	Adoption of BMPs and participation in BMP cost share programs is limited to a certain segment of the farm population. More information is needed to understand the barriers to broader uptake. Is it the message, the messengers, market conditions, risk, uncertainty etc.? Research is already underway on soil health BMPs. This question is meant to capture the adoption of other BMPs (i.e. water quality and quantity etc.).	Outcome is a report which outlines key barriers, and suggestions for how to overcome these barriers in terms of program design, communications, or other approaches and tools not currently in the government toolbox.
6.1.2	Sustainable Production Systems	Analysis of BMP Adoption	Crop Rotation: A. Crop production systems i. What are the barriers to and options for incorporating more perennial crops (i.e. forages, pastures, biomass crops) in corn and soy rotations in southern Ontario? (E.g. profitability, markets, specialized equipment, culture.) How do we overcome these barriers? ii. How does crop rotation increase resilience of the overall cropping system with respect to water availability of soils?	The production of corn and soy in southern Ontario is seen as limiting the improvement of soil health if other crops are not included in rotation. By examining evidence of barriers and options for including more crops in rotation, it may be possible to find ways to increase the practices.	Outcome is a report directed at corn and soy producers that examines ways to incorporate more perennial crops in corn and soy rotations while maintaining or increasing profitability.
6.1.3	Sustainable Production Systems	Analysis of BMP Adoption	Crop Rotation: B. Livestock production systems i. What is the best source/ rate/time/place for crop nutrients applied to the following: - Alfalfa - Perennial cool-season grasses - Sorghum-sudangrass and other warm-season annual grasses - Perennial warm-season grasses	While forage harvesting technology has kept pace with North America, forages are the only field crop we still fertilize with methods used in the 1980s. Very little work has been done in Ontario in the last 20 years; we are 30-40 years behind leading jurisdictions in pasture management BMPs.	Outcomes include greater capacity for agronomic and production systems research in forage crops and pastures in Ontario. Research from other jurisdictions suggests good forage/pasture management improves soil health and carbon sequestration. Need to develop BMPs for forage/pasture in Ontario based on Ontario research.

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			ii. How do grazing management practices influence soil carbon sequestration in Ontario, pasture yield, and profitability? iii. What is the soil health starting point for fields managed under rotations with perennial forages in Ontario? (Benchmarking exercise; perennial forages are likely different from annual crop rotations)		
6.1.4	Sustainable Production Systems	Analysis of BMP Adoption	What are the strongest influencers that impact behavior change related to adoption of Best Management Practices?	What are the primary drivers behind decision making leading to behavior change.	The desired outcome is new knowledge of the key drivers to current behavior change decision making. Drivers could include economics, values, peer learning, labour saving, etc.
6.1.5	Sustainable Production Systems	Analysis of BMP Adoption	What kinds of incentives, disincentives or other policy tools (e.g. a financial or other incentive) are most likely to prompt a change in customer behaviour to reduce the amount of green bin waste that is generated at food service establishments?	There needs to be a better cost/benefit analysis of food wastage in ICI sectors such as the food service industry. Increased knowledge of lost money by customers and food service establishments is expected to lead to a reduction in food wasted.	Outcome is a decrease in food waste at food service establishments.
6.1.6	Sustainable Production Systems	Analysis of BMP Adoption	How do we encourage new entrants to agri-environmental programs? What do we know about those who have never or seldom participated in government or other agri-environmental programs? What are the tools, information and communication tactics and strategies to reach producers who have never shown any interest in these programs?	How can the majority of Ontario farm land owners, who are currently non-adopters of government Environmental Stewardship programs, be engaged to improve the environmental performance of their lands? What are the interests, priority action areas, and best communications channels that appeal to such land owners? How can citizens who do not support government cost share programs be engaged in improved environmental stewardship?	Outcomes include a better understanding of target audiences, and a strategy to target and increase enrollment in agri-environmental stewardship programs using new approaches.

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6.2.1	Sustainable Production Systems	Environmental Impacts of Management Practices	How can economic benefits from cover crops (e.g. grazing, harvested as forage) be realized without compromising environmental benefits? i) Investigate various grazing/forage harvest strategies for cover crops and evaluate their profitability and impacts on environmental benefits. ii) Determine site and/or operational characteristics that increase the probability of profitably utilizing cover crops while realizing environmental benefits.	Cover crops provide long-term benefits to soil health and crop productivity, but short-term benefits are often not clearly apparent. Producers that rent land on short-term contracts represent a large and increasing acreage of Ontario farmlands. These producers are unlikely to implement cover crops; they would assume the costs but are unlikely to see the benefits. Research suggests there are opportunities to sustainably monetize cover crops within the year of implementation. Investigating these opportunities and providing guidance to producers would provide more incentive for adoption and could lead to increased cover crop acreage.	Outcome is a report with recommendations on how to utilize cover crops (e.g. grazing strategies, forage harvest at certain conditions, etc.) so that economic and environmental benefits are realized. The report would consider operational and site-specific characteristics.
6.2.2	Sustainable Production Systems	Environmental Impacts of Management Practices	How can the environmental impact be improved for livestock sectors while maintaining productivity?	Knowledge is required to ensure that livestock operations reduce their environmental footprint in the greatest possible capacity. There is interest in also demonstrating the positive impact that some sectors may potentially have on the environment (e.g. grazing sectors).	Research outcomes will identify methods for improving farm efficiency and best management practices that reduce environmental impacts while meeting production goals and ensuring animal health and welfare.
6.2.3	Sustainable Production Systems	Environmental Impacts of Management Practices	What are the potential impacts of climate change on animal production systems in Ontario and how can they be mitigated?	Knowledge is required to better understand and interpret the impacts of climate change on animal production systems in order to mitigate negative impacts or adapt to changes without compromising animal health, welfare or production.	Research outcomes will inform producers and industry about issues to be aware of in order to take necessary steps to mitigate.
6.2.4	Sustainable Production Systems	Environmental Impacts of Management Practices	How can agricultural producers and processors of packaging materials benefit from increased use of compostable packaging materials?	There is a need for evidence that shifting to compostable packaging materials is cost efficient and effective.	Outcomes include increased awareness by agriculture producers and processors; decrease in landfilled materials by ag producers and processors.
6.2.5	Sustainable Production Systems	Environmental Impacts of Management Practices	What barriers affect the recovery, processing and distribution of organic food waste for use as an organic amendment on farms? How can transportation costs and other challenges be overcome?	Food and organic wastes are often distant from many farms needing soil amendments. Such soil amendments are often not widely available or are available at prices too high for widespread use. There is a need for greater understanding of the organizational approaches that would enable efficient acquisition of organic amendments by individual farmers without high transaction costs.	Desired outcome is increased amount of recovered organic food wasted used as a soil amendment.

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Question Number	Research Priority	Research Focus Area	Research Question	Research Problem or Information Gap	Desired Outcomes
6.2.6	Sustainable Production Systems	Environmental Impacts of Management Practices	What are the barriers for municipalities/private processors to begin accepting and processing certified compostable products? Are there other opportunities to up-cycle organic waste materials currently being sent for composting or anaerobic digestion? What system changes would be required for compost facilities to stream compostables at the front end (currently facilities are designed to manage food waste and will need upgrades to process compostable products and packaging, as they are slower to compost than food waste)?	Compostable products and packaging such as cutlery, cups, take-out containers and coffee pods are not accepted in municipal organic waste collection systems in Ontario.	Outcomes will help support food processors and businesses invest in environmental solutions that the public are asking for; removal of barriers through open conversation with all partners.
6.2.7	Sustainable Production Systems	Environmental Impacts of Management Practices	What compostable packaging options can the food and beverage processing sector rely on to successfully reduce waste? What are the barriers to ensuring certified compostable products and packaging are diverted from disposal and how can they be overcome? To what extent are consumers willing to pay a premium to acquire a compostable version of a product (or the packaging used for a product) versus a conventional one made from non-compostable materials?	It is difficult to assess and understand: whether compostables properly compost; levels of cross-contamination with non-compostables, and; the results of micro plastics contaminating compost or digestate and, ultimately, agricultural fields.	Outcome is a better understanding of how soil quality may be affected by the end products from compost and digestate.
6.3.1	Sustainable Production Systems	BMP Development	What are economically viable best management practices for field and horticulture crops that align with market and consumer demands, and sustainable resource use?	There are several challenges with crop systems management practices and labour efficiencies within different commodities. The diversity of crops creates the need to develop BMPs for individual systems and management practices.	Outcomes will include knowledge regarding cropping systems management practices that support economical, sustainable and efficient production, as well as optimized plant health and integrated pest management.
6.3.2	Sustainable Production Systems	BMP Development	How do current Ontario crop fertility recommendations meet production advancements (new varieties, updated production practices for horticulture crops such as potato, ginseng, asparagus, hazelnut, new apple varieties)?	Other competitive jurisdictions (e.g. Quebec) have recently reviewed provincial crop recommendations. There is a need for Ontario to also review crop fertility recommendations to ensure both crop production and environmental stewardship goals are being addressed.	The desired outcome is that Ontario fertility recommendations reflect the current state of production advancement.

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6.3.3	Sustainable Production Systems	BMP Development	How do nutrient stewardship practices (4R) apply to horticulture crop production?	4R research is critical for horticulture crops because these crops, especially annual horticulture crops, typically require higher soil test levels of phosphorus and potassium than oilseeds and grain crops for maximum economic production. There is a need for Ontario research that supports and validates nitrogen, phosphorus or potassium fertilizer guidelines for new and current horticulture crops in order to mitigate under- and over-fertilization, and related economic and environmental costs. Research is needed to improve crop nutrient use efficiency and minimize environmental losses (especially those crops in the Lake Erie watershed areas). There is also a need for Ontario research that supports and validates best timing and placement of fertilizers for horticulture crops in general, and for those destined for the certified organic market.	The outcome of this research will be new and/or updated nitrogen, phosphorus and potassium fertilizer guidelines for new and currently grown horticulture crops. The new and/or updated fertilizer guidelines would be approved by the Ontario soil Management Research and Services Committee (OSMRSC) and included in OMAFRA crop production guides and updated in and/or added to AgriSuite. This would provide growers with fertilizer guidelines and reduce over applications of fertilizers.
6.3.4	Sustainable Production Systems	BMP Development	How do current non-stewardship programs affect adoption of new practices to benefit environmental sustainability objectives (e.g. soil health, decision to retire marginal farmland) and how can they be used to increase their contribution to sustainability objectives?	There is generally a lack of cross compliance between the qualifying requirements for participation in business support programs, and requirements linked to environmental performance of the land.	Outcomes include evidence to show the impact of Business Risk Management (BRM) programs on the long-term investment tendencies of producers (e.g. does participation in BRM influence long-term investment tendencies related to building resiliency?).
6.4.1	Sustainable Production Systems	Impact of Changing Ecosystems on Ag	How can production efficiencies at the whole farm level be improved using crop and livestock management systems?	Producers often segregate production systems to make management decisions. Methods or strategies to evaluate the system at the whole farm level is needed to improve production efficiency and stewardship.	Research outcomes will identify methods for improving whole farm efficiency and best management practices that improve environmental stewardship on the farm.

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6.5.1	Sustainable Production Systems	Nuisance Assessment	What are the technologies that could mitigate odour emission from cannabis production systems (warehouses and greenhouse)? What is the effectiveness, cost, and ease of use of these systems?	With dramatic growth in the cannabis production sector, the need to reduce odour emissions from cannabis production systems has been identified as a key need in relation to rural nuisance issues. Cannabis is a new sector and it is unclear what technologies work and what factors contribute to the selection of different technologies. New and retrofitted greenhouse cannabis systems and warehouses require demonstration and validation of odour control solutions in order to have confidence in the application of new technology. This research will support action on these odour issues.	Outcome is a report which outlines technologies applied, and systematic measurement and outcomes of odour emissions reductions.
6.5.2	Sustainable Production Systems	Nuisance Assessment	What best management practices (genomics, setbacks, siting, breeding, variety selection, windbreaks) help mitigate odour in all cannabis production systems?	Odour from cannabis production facilities impacts municipal land use regulations and property value. In this new sector producers do not know how to reduce odour in cannabis operations. We need to provide producers with a wide range of tools and practices to help mitigate odour issues in cannabis operations.	The desired outcome is the identification of odour mitigation strategies that assist producers in reducing odour from cannabis operations.
6.6.1	Sustainable Production Systems	Environmental Impact of Ag Production	How can agriculture validate and adopt better water quality practices on farm? (e.g. nutrient management, greenhouse feedwater, wash water, wilo seepage, decreased nutrient runoff.)	Links to (draft) Ontario environment plan and interest in Great Lakes Water Quality.	Results of this research will contribute to ministry efforts in addressing environmental issues and reducing nutrient runoff.
6.6.2	Sustainable Production Systems	Environmental Impact of Ag Production	How can Ontario reduce the amount of excess food going to waste?	There are barriers that exist to increasing the amount of surplus, edible food that is recovered in Ontario (e.g. infrastructure gaps; social attitudes such as misconceptions about perishability and stigma associated with recovered food).	Outcomes include: decreased amount of excess food going to landfill; food recovery being further promoted and accepted as a means of reducing food waste in Ontario.
6.6.3	Sustainable Production Systems	Environmental Impact of Ag Production	What are the barriers that prevent increased acceptance of pre-retail source separation of food waste and potential compostable bioplastics adoption?	There are solutions that should be implemented pre-retail that support increased source-separation levels. There are also apparent barriers to compostable bioplastics adoption that should be explored. There seems to be resistance to change existing systems and approaches.	Outcomes include: increased amount of pre-retail source separation, and adoption of compostable bioplastics; decreased amount of food waste going to landfill.
6.6.4	Sustainable Production Systems	Environmental Impact of Ag Production	What are the costs and benefits of farming on marginal soil/land, e.g. is there a way to place a value on the role of wetlands in supporting agricultural operations and soil health?	There is a lack of data to support conclusions about the cost benefit of crop farming on lands that are considered low yield potential (poor soil, former wetlands and low areas etc.).	Desired outcome is better decision making by farmers and increased environmental benefits.

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11.1.5	Sustainable Production Systems	Climate Change Resiliency (cross-cutting)	What are the environmental outcomes of perennial agriculture biomass crops and feedstocks (e.g. reduced greenhouse gases, decreased nutrient runoff)?	This research links to Ontario's (draft) environment plan and interest in addressing climate change.	Results of this research will contribute to ministry efforts in addressing environmental issues and reducing Ontario's greenhouse gas emissions footprint.
11.1.6	Sustainable Production Systems	Climate Change Resiliency (cross-cutting)	What are the tools, programs, and systems required to enhance the agriculture sector's capacity to anticipate and assess risk (e.g., pest and disease outbreaks for animals and plants) under future climate change conditions? Do our current systems help us anticipate our response needs under changing climate conditions? Do we have an appropriate surveillance system for plants, and if not, how can one be developed/ improved?	Dramatic global environmental changes are already affecting food production, health and ecosystems, and the IPCC and UN have indicated the world is ill-prepared for future risks. There is a need to understand what is required to build the sector's capacity to be adaptive and build resiliency to climate risk.	Outcomes include: evidence to inform development of policies and approaches to manage risk and improve sector resilience; a report that provides an understanding of the sector's capacity to make climate-smart/adaptive decisions, it's readiness to take adaptive action, and the tools, programs, and supports required to help the sector anticipate and plan for future risks in Ontario
11.1.7	Sustainable Production Systems	Climate Change Resiliency (cross-cutting)	What barriers are preventing the uptake of green infrastructure?	OMAFRA needs a better understanding of why green infrastructure is not common as a rural stormwater management solution or within a municipal drain.	The desired outcome is an increased number of green infrastructure installations as a means to addressing rural stormwater management and as part of a municipal drain.
11.1.8	Sustainable Production Systems	Climate Change Resiliency (cross-cutting)	What are the opportunities for Ontario to participate in carbon offset programs? What are the economic thresholds required to make offsets a feasible opportunity for Ontario agri-food sector? What offsets are more feasible in Ontario and why?	There is a lack of understanding around the feasibility of carbon offsets as an economic incentive for Ontario farmers and food processors.	Outcome is a synthesis of costs and benefits, and life cycle analysis of cropping/ livestock systems.
11.1.9	Sustainable Production Systems	Climate Change Resiliency (cross-cutting)	What are the growth opportunities and challenges for domestic and export markets related to sustainability and/or other global market pressures (e.g. climate change impacts on global food supply security)?	As the global demand for sustainably produced food, fibre and fuel increases and becomes a stronger driver of market access/competitiveness, there is a need to understand how Ontario's market development policies and programs can support the sector to take advantage of these emerging growth opportunities.	Outcome is a report that provides a better understanding of Ontario's relative position to become a global leader in sustainably produced food and how this could influence Ontario's competitiveness both globally and domestically by differentiating its products.
11.2.4	Sustainable Production Systems	Technology Development (cross-cutting)	Which markets provide the greatest potential for new agri-clean technology product development (e.g. biofertilizers, agri bio-based products, water, energy,	Knowledge is required to ensure clean technology program design is successful for both adopters and producers of clean technology.	Outcomes is to inform effective and efficient clean technology policy and program design to

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			waste reduction) that could inform policy and programming?		meet Ontario's sustainable economic and environmental goals.
11.2.5	Sustainable Production Systems	Technology Development (cross-cutting)	What is the extent of on-farm plastic use (bale wrap, input packaging, etc.)? Are more sustainable alternatives available and if so how do the costs compare? Are there opportunities for farmers to produce sustainable alternatives?	Waste plastics are a growing problem. It would be useful to have a more comprehensive understanding of the extent of the problem on farm and in rural processing facilities, and to examine alternatives to existing plastic use, and opportunities for farmers to develop these alternatives.	Outcome is a report that examines the extent of the problem and potential opportunities.
11.2.6	Sustainable Production Systems	Technology Development (cross-cutting)	What are the best agricultural based feedstocks in Ontario for producing Renewable Natural Gas (RNG) from anaerobic digestion? What are the barriers to/solutions for access to the supply chain?	OMAFRA is interested in identifying innovative feedstock materials or combinations of feedstock materials that would improve the operational efficiencies of on-farm anerobic digestors (Regulated Mixed Anaerobic Digestion Facility-RMADF). This will improve economic development in the ag sector and improve business opportunities for farmers and brokers.	Research outcomes will help create new markets for agriculture sourced feedstock materials as well as increase performance of anerobic digestors.
11.2.7	Sustainable Production Systems	Technology Development (cross-cutting)	Can pyrolysis or gasification technology be implemented as a cost-effective means to process organic and other waste materials in Ontario that may not be suitable for current waste diversion methods (e.g., packaged food waste)? Is the resulting biochar suitable for agronomic uses in Ontario?	As part of the (draft) Made in Ontario Environment Plan, the Province is considering ways to reduce waste, including a possible ban on organic materials going to landfill. Ontario needs to explore possible new diversion methods, such as pyrolysis or gasification technology, to manage waste that may no longer be permitted in landfills. Peer review scientific literature on the use of biochar for carbon sequestration/soil enhancement is very limited.	Outcomes include cost of pyrolysis and gasification as an alternative to organic waste landfill disposal; opportunities/challenges to using biochar as a soil amendment in Ontario.
11.4.1	Sustainable Production Systems	Rural Community Development (cross-cutting)	How can stormwater management in rural and urban areas be integrated, especially in near-urban and developing areas?	Rural stormwater management involves farm ditches, municipal drains, floodplains, streams and rivers. How are we managing stormwater in rural areas differently than in urban and near-urban areas and how can we better integrate these systems for better overall stormwater management?	Outcome is a report that compares urban and rural stormwater management and identifies ways in which the systems can be better integrated.
11.4.2	Sustainable Production Systems	Rural Community Development (cross-cutting)	How can the on-farm storage and reuse of water in rural and suburban areas be improved for quality and quantity management, including further use such as irrigation and other rural needs (e.g. firefighting)?	OMAFRA requires a greater understanding of how water in rural settings can be better utilized.	Outcome is a report that examines water use in a rural context and identifies opportunities to use and reuse water more efficiently.

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11.4.3	Sustainable Production Systems	Rural Community Development (cross-cutting)	What are the opportunities to establish new green infrastructure in rural and suburban areas as a component of regional water management?	Research demonstrates that the use of green infrastructure has the potential to transform rural infrastructure developments by adding economic, social and environmental benefits. Integrating green infrastructure into overall planning strategies may resolve some of the challenges facing Ontario's rural and suburban communities.	Outcome is a report outlining opportunities for green infrastructure as part of regional water management in rural and suburban Ontario.
11.4.4	Sustainable Production Systems	Rural Community Development (cross-cutting)	How are assets managed for rural drainage systems?	This research will provide information on how municipalities and other agencies manage rural municipal drainage assets.	Outcome is a report that assesses how assets are managed in rural drainage systems.
11.4.5	Sustainable Production Systems	Rural Community Development (cross-cutting)	What are the benefits and costs of riparian wetlands in rural drainage systems?	This research will provide information on how riparian wetlands function in rural drainage systems?	Outcome is a report that assesses the role of riparian wetlands in rural drainage systems.
PRODUCTIVE LAND CAPACITY					
7.1.1	Productive Land Capacity	Evidence to Support Land Use Policies	What land use planning tools that support standard farm practices could be used within the Ontario planning context (e.g. site plan control, setbacks, zoning restrictions, odour control by-laws) to help address odour and nuisance lighting nuisance issues related to cannabis production systems.	While many municipalities have recognized that the growing of cannabis is an agricultural use, they struggle to understand how best to address odour impacts on neighbouring land uses while protecting standard farm practices, enabling economic development and promoting agricultural production. Lighting is also a nuisance issue. There is a need to explore, through a jurisdictional scan, tools and techniques used in other jurisdictions which have potential to address both odour and lighting issues within the existing land use planning legislative framework. Additionally, we need to understand the potential impacts these land use tools may have on the sector and on other agricultural operations.	Outcomes include: Reduce nuisance complaints and issues between cannabis operations and neighbouring land uses. Planning tools that address both odour and lighting issues and help ensure that guidelines work together. Facilitate the effective siting and development of cannabis production operations to allow for the economic expansion of the sector while addressing concerns related to nuisance issues and normal farm practices. Bring greater consistency to municipal decision making and land use planning approvals related to cannabis production across Ontario.

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7.2.1	Productive Land Capacity	Effectiveness of Land Use Policies	Given pressures to develop prime agricultural areas, do Ontario's lot creation policies need to be adjusted?	Project aims to assess the impacts of Ontario's Provincial Policy Statement lot creation (severance) policies by providing a province-wide evaluation of the extent and nature of rural non-farm development across Ontario between 2010 and 2019. Data on rural lots created during this time period is incomplete, making it difficult to predict or understand implications for the continued growth and development of Ontario's agricultural industry.	Outcome is a report that builds on earlier research on severances (1990-1999; 2000-2009) and provides data on severances from 2010-2019, relevant local and provincial land use policies in place, impact on agriculture, and policy changes or other alternatives to ensure farmland availability.
COMPETITIVE PRODUCTION SYSTEMS					
8.1.1	Competitive Production Systems	Input Use Efficiency	How can precision agriculture technologies support cost-effective animal production?	Development or validation of precision tools and technology to improve production and efficiencies is required.	Outcomes include improved labour efficiencies on farm, evidence-based decisions and other cost-effective strategies to improve animal production.
8.1.2	Competitive Production Systems	Input Use Efficiency	Which forage production systems/strategies optimize yield and quality in a short growing season?	Knowledge regarding production management practices, systems and strategies for animal feed are required to better prepare livestock sectors province-wide that deal with shorter growing seasons.	Research results will provide best management practices for livestock producers that graze animals.
8.1.3	Competitive Production Systems	Input Use Efficiency	What are the best options / technologies to increase energy efficiency in greenhouse vegetable, other produce, flowers, ornamental plants, herbs, and cannabis operations? What are the energy efficiency practices/ technologies that can decrease GJ/M2 used to produce Kg of product (e.g. dehumidication)? What are the multiple benefits of energy efficiency in greenhouse production (e.g. reduced cost, input efficiency, reduced light pollution)? What are the opportunities for alternate energy for heating greenhouses?	The greenhouse sector is a heavy user of energy and is highly reliant on natural gas and electricity, which represents a significant input cost. Other forms of energy are needed to help the sector grow. It is currently constrained by access to alternative sources.	Outcomes include: the greenhouse sector decreases its energy consumption and increases productivity; greenhouse operations have access to alternative sources of energy; more of the greenhouse sector transitions to year-round production.
8.1.4	Competitive Production Systems	Input Use Efficiency	How can supplemental lighting be implemented in greenhouse production to improve plant quality and reduce grow time and costs?	New knowledge is required for growers to identify the best lighting options for production efficiencies and productivity.	Research outcomes will include adoption of optimal lighting solutions.

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8.1.5	Competitive Production Systems	Input Use Efficiency	How can precision agriculture technologies be used to improve efficiency and offer opportunities for economic and environmental gain (e.g. research and production)?	The challenge is the volume of data and how to better utilize it. Strategies to mine and utilize data are required for farm management decisions.	Research outcomes will provide evidence-based information for farm management decision-making.
8.1.6	Competitive Production Systems	Input Use Efficiency	What environmental strategies or new technologies can be used in greenhouse production to reduce carbon emissions per unit produced (e.g. renewable energy, breeding for low light and temperature varieties, more insulated greenhouse coverings, etc.)?	Knowledge is required to ensure that greenhouse growers reduce their environmental footprint in the greatest possibly capacity.	Research outcomes will identify methods for improving greenhouse efficiency and best management practices that reduce carbon emissions while meeting production goals.
8.2.1	Competitive Production Systems	Improved Management and Processes	What ingredients, feeding programs, cropping systems and/or feeding technologies can improve the cost of production for livestock and final product quality while minimizing the environmental footprint?	The cost of feed is one of the largest inputs in the cost of production for livestock. Finding ways to improve feed utilization and efficiency can beneficially impact all sectors.	Outcomes include improved feed utilization and efficiency, reduced costs for producers and greater competitiveness of provincial and national industries.
8.2.2	Competitive Production Systems	Improved Management and Processes	How can genetics improve product quality, animal welfare, animal health and production efficiency?	There are untapped opportunities to improve animal production through the use of genetics. Optimizing selection of traits for aspects like disease resistance, or basic genetic information about animal breeds, can be utilized to bring provincial/national research up to the scale of that in other jurisdictions.	Genetics will provide more robust animals that can sustain various levels of environmental stress.
8.2.3	Competitive Production Systems	Improved Management and Processes	How can reproductive performance be improved?	Reproduction is distinctly different from genetics research and should be treated as such. There is an opportunity for reproductive efficiencies for many sectors to decrease costs, labour requirements, and improve animal health.	Results include improved animal fertility and other cost-effective breeding strategies.
8.2.4	Competitive Production Systems	Improved Management and Processes	What has been the impact of industry policy decisions, production practices and management practices on preparing or responding to animal health threats?	OMAFRA requires a better understanding of the effect of policy decisions, production and management practices on threats to agriculture and related public health.	Results of this research will contribute to the Ministry's leading role in prevention of, response to and recovery from agricultural related emergencies, and help fulfill the Ministry's legislative responsibilities and commitments to our federal, provincial and industry partners in emergency management.

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8.2.5	Competitive Production Systems	Improved Management and Processes	How does lighting in the greenhouse environment affect biological control programs or IPM in general (e.g., change in pest species occurrence and pressure under lit conditions)? What changes / improvements are required for pest management programs to optimize performance under artificial lighting conditions (e.g., needed improvements in biocontrol efficacy or opportunity to use agents that would normally overwinter)?	New technologies / production practices are needed to enable the greenhouse sector to transition to year-round production. Lighting is a critical component of this transition. There is a need to better understand disease and pest pressures and to evaluate pest and biocontrol dynamics under artificial lighting conditions. There may be improvements (or reductions) in biocontrol efficacy or the opportunity to use agents that would be overwintering under typical winter conditions. Alternatively, pest species occurrence and pressure may change for artificially lighted crops. Cultivar selection may help address disease issues that become more prevalent in year-round production (e.g. powdery mildew).	The greenhouse sector is seeing a transition to year-round production and there is a need to access technologies and processes to facilitate this transition and to support its sustainability. Research outcome is a better understanding of the impacts of this transition on pests and diseases and their management (IPM).
8.2.6	Competitive Production Systems	Improved Management and Processes	How can ventilation systems in livestock barns be designed to improve air quality characteristics (such as relative humidity, carbon dioxide, methane, ammonia and hydrogen sulphide levels)?	Existing livestock barn ventilation systems are generally designed to manage temperature only and not air quality. The air quality to which livestock is exposed does not only impact animal health and welfare but also can have a significant economic impact on the farmer. For example, high goat kid and dairy calf mortality rates caused by continued exposure to high relative humidity and ammonia adds cost in terms of medication, vet bills and replacement animals. Barn electrical systems corroded through exposure to high relative humidity and corrosive gases (ammonia and hydrogen sulphide) is the leading ignition source for barn fires. Methane gas generated in under-floor liquid manure pits can serve as the fuel to increase barn fire size very quickly. The barn ventilation system that adequately manages these barn gases is a first line of defence in mitigating barn fire risk.	Outcomes include: improve the health and productivity of livestock by improving the air quality within barns; improve the living conditions for livestock and further improve the public perspective of Ontario's livestock sector; inform the Ministry and the Ontario livestock sectors on the design of effective and cost-effective ventilation systems to manage air quality in livestock housing throughout the year.
8.2.7	Competitive Production Systems	Improved Management and Processes	How do we maximize the economic return of growing industrial hemp/cannabis? What are the agronomic and production practices needed to optimize plant growth and productivity to take advantage of the entire plant and flower for Cannabidiol (CBD) extraction? What are the processing technologies needed/available to harvest and process the crop efficiently and cost effectively to use the entire plant?	Cannabis/hemp is a new legal crop in Canada and the majority of cultivation licences are in Ontario. Outdoor production is expected to increase for cannabis and industrial hemp and CBD extraction poses a new economic opportunity for the industrial hemp sector. There is increasing interest in hemp for CBD from growers and industry, but production information is a major gap. Research is needed to understand the best way to cultivate hemp for CBD, to	Outcomes include: inform OMAFRA on production and processing practices to optimize new uses of this crop to enable knowledge translation and transfer (KTT) to growers and the sector; support the sector in leveraging this new economic opportunity for which Ontario has a first-mover advantage.

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				harvest CDB from large acreage hemp (processing) and the logistics of supplying to licensed processors.	
8.2.8	Competitive Production Systems	Improved Management and Processes	How can crop quality and environmental impact be addressed using soil health and/or nutrient management strategies in crops (e.g. root and bulb vegetables, indoor and outdoor production)?	Knowledge is required to better understand production management practices in crops and specifically in root and bulb vegetables.	Research outcomes will identify best management practices for root and bulb vegetable production and improve environmental outcomes and crop quality via soil health.
8.2.9	Competitive Production Systems	Improved Management and Processes	What production and market strategies can be used to improve the long-term profitability of crops (e.g. forages, cannabis, maple syrup, hazelnuts, winter cereals, aquaculture)?	Knowledge is required to better understand production practices, consumer preferences and purchasing behaviours in order to improve the long-term profitability of various crops.	Research outcomes will include knowledge regarding consumer behaviour and marketing strategies needed to improve the long-term profitability of crops.
8.2.10	Competitive Production Systems	Improved Management and Processes	What production and market strategies can be used to improve the long-term profitability of leafy and crucifer vegetables?	Knowledge is required to better understand production practices consumer preferences and purchasing behaviours in order to improve the long-term profitability of leafy and crucifer vegetables.	Research outcomes will include knowledge regarding consumer behaviour and marketing strategies needed to improve the long-term profitability of these crops.
8.2.11	Competitive Production Systems	Improved Management and Processes	How can agronomic practices improve production efficiencies of new crops (e.g. greenhouse strawberries) and specialty crops?	New knowledge is required in propagation and establishment, fertility and water requirements, season extension, harvesting methods and post harvest handling and storage in new and speciality crops.	Research outcomes will include best management practices in establishing new crops, pre and post harvest handling, fertility and water requirements.
8.2.12	Competitive Production Systems	Improved Management and Processes	How can genetics enhance perennial crop health, pest and disease tolerance, and winter survival in Ontario (e.g. grapes, hazelnuts, tender fruit, apples, winter wheat, alfalfa)?	Knowledge is required to better understand production practices and advance varieties with desired traits.	Research outcomes would identify production practices and varieties that improve survivability over winter.
8.2.13	Competitive Production Systems	Improved Management and Processes	How can the marketable season of horticulture crops be extended using management, genetics and post harvest storage (e.g. greenhouse production, potatoes, garlic, apples)?	Reducing our reliance on imports and providing local produce year-round is important to Ontario's economy.	Research outcomes will identify options for extending our marketable season in Ontario.

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8.2.14	Competitive Production Systems	Improved Management and Processes	How can nutrient use in plant production be optimized in order to reduce input costs, promote plant health and manage water runoff?	This is still a priority area for the edible sector especially with rising costs of labour and competitive markets. Efficient production will allow for optimal returns to offset these costs.	Research outcomes will improve production efficiencies and competitiveness including environmental stewardship.
8.2.15	Competitive Production Systems	Improved Management and Processes	What strategies are needed to optimize the use of nutrients (organic and inorganic) in all crops (e.g. nitrogen, phosphorus, sulphur and potassium)?	Strategies are needed to improve the cost of production, environmental stewardship and labour efficiencies.	Research outcomes will improve nutrient use.
8.2.16	Competitive Production Systems	Improved Management and Processes	How can new genetic technologies be used to develop resilient high-yielding and high-quality varieties adapted to Ontario's changing climate?	Knowledge is required to better understand and advance varieties with improved quality and yield traits.	Research outcomes will identify varieties that improve quality and yield adapted to Ontario conditions.
8.2.17	Competitive Production Systems	Improved Management and Processes	What traits and agronomic practices are important and can be improved for Ontario forage production (i.e. legumes, grasses and cover crops)?	Knowledge is required to better understand production practices and advance varieties with desired traits.	Research outcomes would identify production practices and varieties that perform well in Ontario.
8.3.1	Competitive Production Systems	Labour Access/ Efficiencies	What is the 5 to10 year forecast for accessing lower skilled labour for greenhouse, livestock, horticulture and food processing sectors? How does access and availability to skilled and unskilled labour impact Ontario's agri-food sector competitiveness with the United States (north-eastern states, Washington, California, Texas and Florida)?	A comparative study could help address existing information/knowledge gaps - greenhouse industry labour needs - minimum wage regulations, changes, and impact - labour access conditions for the greenhouse sector - labour off-setting production practices - current agronomic factors which could make it advantageous or disadvantageous for greenhouse production in the area - current market considerations which could make it advantageous or disadvantageous for greenhouse production in the area - other production considerations which could be assessed include building costs and regulations, access to inputs, etc.	Research outcomes would provide a comprehensive understanding of the advantages, opportunities, gaps, challenges, and threats as they relate to labour and productivity in greenhouse production in Ontario and North Eastern/Central United States.
8.3.2	Competitive Production Systems	Labour Access/ Efficiencies	What attracts new comers into the agri-food sector? What policy and programs exist that focus on recruiting, developing skills etc.? How can programs and policies be improved? What is the demographic profile of new comers that enter the province with an	New comers are a segment of Ontario's population who could help to overcome labour gaps in the agri-food sector. The Ministry needs to better understand which government levers (policies and programs) currently exist to support new comers working in the agri-food sector. In addition, it is important to understand the number of new comers	Research will help the Ministry to understand if current government levers are helping new comers find careers in agri-food, to remove barriers to new comers wishing to work in the agri-food sector and to promote

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			agriculture background? How many new comers face barriers to w orking in ag, and w hat are the barriers?	arriving in Ontario seeking careers in agri-food but facing barriers to w orking in the sector.	new comers' participation as skilled w orkers in the agri-food sector.
8.3.3	Competitive Production Systems	Labour Access/ Efficiencies	Given the grow ing labour shortage in Ontario ag, w hat are the opportunities/ solutions that should be explored to help address the labour shortage beyond the Temporary Foreign Worker Program (TFWP)?	The TFWP mainly serves to bring foreign unskilled w orkers into Ontario to address labour shortages in the sector. How ever, there continues to be labour shortage issues. It is therefore important to examine and develop tangible solutions to the low er skilled labour shortage in the agri sector through additional methods beyond the TFWP.	Outcomes w ill help to identify alternative methods for recruiting low er skilled w orkers (including domestic w orkers) to meet the labour demands of the sector.
8.3.4	Competitive Production Systems	Labour Access/ Efficiencies	How can automation systems address labour needs in horticulture production (e.g. mushrooms, apples, tender fruit, greenhouse vegetables)?	High labour costs and shortage of labour in all horticulture crops has become a challenge and the industry is looking for automation-based solutions.	Outcomes w ill inform producers of the cost benefit of using automation as w ell as the initial investments needed.
11.2.8	Competitive Production Systems	Technology Development (cross-cutting)	What are the barriers to innovative automation and robotics technology adoption in the agri-food sector? Where adoption of innovative automation and robotics has taken place, w ere the original reasons for making the investments achieved/w ere the outcomes positive, negative or neutral?	Innovative technology is an important component that w ill help the agri-food sector increase its competitiveness and productivity. Automation and robotics adoption can also reduce critical labor shortages. It is therefore important to understand any barriers, perceived or otherw ise, that negatively impact the adoption of this technology. In addition, it is beneficial to know the outcomes of adoption in automation & robotics, and w hether the outcomes w ere positive, negative, or neutral.	To remove barriers to automation and robotics adoption by the sector, w here possible, through use of government levers and advocacy. To understand the outcomes of investment in automation & robotics, and w hether or not the objectives for adopting w ere met.
11.2.9	Competitive Production Systems	Technology Development (cross-cutting)	What technologies/ production practices are needed to enable the greenhouse sector to transition to year-round production? How can the application of robotics, automation and AI improve production practices for sustainable year-round production?	The greenhouse sector is seeing a transition to year-round production and there is a need to access technologies and processes to facilitate this transition and to support its sustainability.	The desired outcome is that more greenhouse operations adopt innovative technologies that increase productivity and enable transition to year-round production.
11.2.10	Competitive Production Systems	Technology Development (cross-cutting)	Plastics: What opportunities exist for the Ontario Agri-food sector to reduce consumption of petroleum-based plastics? What alternative packaging options are possible for Ontario food and beverage businesses that are cost effective and appealing to the consumer?	In Canada, plastics recycling has typically been conducted at off-shore locations, but recent limitation on the shipping of plastic w aste has resulted in an increased cost to dispose of plastics and increased demand for new w ays to recycle plastics w ithin Canada. The development of plastic recycling or reuse capacity w ithin Ontario w ould address the plastic w aste issue as w ell as create a new revenue stream from the sale of the recycled plastic feedstock.	Outcomes include: to identify new w ays for Ontario's agri-food sector (including prime production and food and beverage businesses) to verify and adopt new and innovative technologies and practices to support the recycling, reuse or replacement of plastic products generated by the sector; to support

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			What technically and economically viable opportunities exist to re-use, recycle and replace petroleum-based plastics currently in use at agricultural operations including farm, orchard, greenhouse, nursery and food processing operations?	In addition, research into the replacement of single-use plastics with alternate materials or methods is required as the federal government has plans to place a ban on single use plastics by 2021. Potential areas of research include bioplastics, engineered fuel pellets, repurposing into alternative materials (e.g. bricks from used rockwool).	the development of new and disruptive technologies and services (including a new service sector) to support a more sustainable agriculture and food sector by reducing the agri-food sector's reliance on petroleum-based plastics, including single-use plastics; to satisfy objectives in the (draft) Made-in-Ontario Environment Plan on recycling and reducing plastic waste.
11.2.11	Competitive Production Systems	Technology Development (cross-cutting)	Food and Organic Waste: What are the opportunities for Ontario's agri-food sector to generate revenue from and establish markets for materials that are currently treated as food and/or organic waste? Food and organic wastes include unsold crops (e.g. crop residuals, horticulture, nurseries and greenhouses), cheese whey and skim milk. Potential revenue sources include conversion into food products, nutriceuticals, nutritional supplements, Renewable Natural Gas (RNG) and use in anaerobic digesters, biochar, animal feed, and other new products. Research on economic opportunities and environmental impacts of hide disposal is also in scope.	There is a gap in knowledge on how best to manage mixed organic waste streams (including food and organic waste) in a cost effective and/or profitable way. Options could include: converting culled fruit and vegetables to food products, including centralized de-packaging of food waste, solutions for rural municipalities, solutions for rural food processing businesses, achieving quality targets for contaminants, availability and cost of technologies, regulatory pathways, balance between feedstock volumes and end-use destinations. Disposal of non-edible meat processing waste (like hides) is also an issue.	Outcomes include: to identify and validate innovative technologies and practices to reduce the volume of edible, but undesirable, products going to landfills; to satisfy objectives in the (draft) Made-in-Ontario Environment Plan on the reduction and diversion of food and organic waste from businesses; to inform Ministry policies supporting the development and expansion of the renewable natural gas (RNG) sector.
11.2.12	Competitive Production Systems	Technology Development (cross-cutting)	What are the costs associated with the current existing irrigation water treatment options to meet Canadian Council of Ministers of the Environment (CCME) irrigation quality guidelines (100 E. coli/100mL) for Ontario horticulture crops? What are the critical thresholds for plant pathogens (e.g. Pseudomonas spp., Botrytis cinerea, Fusarium spp., Phytophthora spp., Pythium spp., Rhizoctonia solani, Nematodes, Viruses) in irrigation water to	There is a lack of economic evaluations of the different types of treatment options for different sizes of operations and sources of water. There is a lack of information on the thresholds at which different plant pathogens will impact the productivity and saleability of horticulture crops. Research is needed to aid producers in determining the optimal system for irrigation system for their operation.	Outcome include: to increase the adoption of irrigation equipment by Ontario's horticulture crop sector to improve resiliency and quality of products; to help farmers adopt new treatment technologies for irrigation water to avoid the spread of pathogens both in food products and in crops; to inform the Ministry's cost share programs targeted to irrigation systems.

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			avoid yield losses which cause economic impact to Ontario producers?		
11.2.13	Competitive Production Systems	Technology Development (cross-cutting)	Are there existing high Cannibidiol (CBD) hemp varieties that can be adapted and licensed for Canadian production and/or can new high CBD hemp varieties be developed in Canada?	As a result of regulatory change, the hemp industry can now extract CBD for a rapidly growing CBD product market. Current Canadian hemp varieties have been bred for high grain and/or fibre content and have relatively low CBD content.	Research in this area will provide Ontario with the opportunity to be a global leader in hemp production and CBD products, as it is an emerging market.
11.5.1	Competitive Production Systems	Value Chain Analysis and Development (cross-cutting)	What scale would make investments in recirculation technology economical for expansion of land-based aquaculture, and the expansion of domestic value chain?	Currently, genetics and primary inputs are being imported from the United States. Advancements in recirculation technology will allow for domestic input sources to be utilized; for example, supplying eggs and fingerlings. In addition, this will service land-based aquaculture by allowing for expanded production and varieties.	This research will allow for a variety of new species for land-based aquaculture and increase the availability of domestic input sources, such as eggs and fingerlings for fresh water-based aquaculture.
INNOVATIVE PRODUCTS & PRODUCT IMPROVEMENT					
9.1.1	Innovative Products & Product Improvements	New Product Development	How does changing consumer behaviour and demographics affect new product development in the food sector and its economic opportunity? What is the opportunity for new products to be built into online predictive options? How can data be leveraged to influence the scope of new product development?	Online consumers are re-purchasing grocery products based on predictive analytics. There is a need to understand the impact on new product development for food manufacturers as instore impulse purchase/new product visibility declines. There are up to 15,000 new products developed in North America's food markets every year. Among retail products, the success rate is less than 1%. Disruptive technology and consumer shopping practices which divert consumer exposure to existing new product promotion practices such as in-store sampling will need to be re-considered and revised for meaningful outreach to virtual consumer purchasing behaviour. Ontario is the unique launchpad for new product innovation and introduction in North America.	Desired outcomes include; growth of nimble and flexible private label and sample size production facilities in the province that also serve a niche to core functions of transnationals that are too large to enter this market in North America; application of lessons learned from other sectors (e.g. sample packs of cosmetics) to the food industry.
9.1.2	Innovative Products &	New Product Development	What agronomic/production practices and post-harvest processing technologies (including nanotech	Due to limited research, there is a lack of understanding of what potential bio-based products (and hence crops) industry would like	Outcomes include a better understanding of production practices and post-harvesting

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	Product Improvements		based approaches) will ensure consistent feedstock supplies, optimize plant biomass and meet existing industry standards for the production of bioproducts and bioproducts applications? **Note: Proposals must include a Value Assessment Plan.**	to see developed. Over 42% of bioproducts establishments use agriculture biomass as a primary input. There is increasing consumer demand for bio-based sustainable products substituting fossil based, but limited agronomy research to drive development. Strong agriculture supply chains for bioproducts manufacture require consistent feedstock supplies. First generation biofuel industries in Ontario and globally are transitioning to biorefineries for efficient utilization of feedstock inputs and co-products streams and for higher returns. Bio-based feedstocks must also meet industry standards for the products they will be replacing. Ontario's advanced manufacturing strengths have the advantage for using biofibres, but many research gaps exist, and technology scale-up is a challenge.	practices and technologies to support production of consistent and quality feedstocks that meet quantity and quality demands by manufacturers.
9.2.1	Innovative Products & Product Improvements	Product Enhancement	What are the desirable traits for field grown and greenhouse vegetables and fruits identified by consumers and how can these be bred into lines to improve consumer satisfaction and increase market accessibility? What are the opportunities for genomics to offer disease/pest tolerance, improved environmental response (e.g. artificial lighting, cold tolerance) and other improved attributes (e.g. taste) in field grown and greenhouse vegetables and fruits? **Note: Proposals must include a Value Assessment Plan.**	Vegetable and fruit varieties that meet customer demands for preference (e.g., taste, look, shape, shelf life) as well as varieties that have traits that support adaptation/response to environmental conditions and disease/pest tolerance are increasingly sought. The contribution of genomics research to support the development of desired varieties is growing. There is an opportunity for the Ministry to support research in this area to provide varieties accessible to the sector.	The outcome is to improve desirable qualities of greenhouse products accessible to the greenhouse sector.
9.2.2	Innovative Products & Product Improvements	Product Enhancement	What is the level of genetic diversity in rainbow trout and how can this diversity be leveraged to create optimal genetics to increase efficiency and yields for Ontario producers? **Note: Proposals must include a Value Assessment Plan.**	Industry has been advocating for rainbow trout genetics that are catered to Ontario's climate and growing conditions.	This will enhance efficiencies in net pen production in Ontario through customized genetics catered to Ontario's climate and growing conditions.

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11.2.14	Innovative Products & Product Improvements	Technology Development (cross-cutting)	What are opportunities for advanced technologies, services, or processes that enhance the competitiveness, profitability and growth of Ontario's agri-food sector to recover resources (excluding plastics and food/organic waste), develop co-products, minimize inputs, and/or maximize outputs? Proposals must include an economic impact assessment. **Note: Proposals must include a Value Assessment Plan.**	Ontario's agri-food sector has the potential to become a leader in developing and demonstrating processes and services that support Ontario businesses along the value chain.	Ontario's agri-food sector is a leader in developing and implementing innovative solutions and serves as a model for other jurisdictions.
11.2.15	Innovative Products & Product Improvements	Technology Adoption - cross cutting	What is the accuracy of the carbon sequestration values currently used for Ontario in the Holos GHG program, given these values were developed at a federal level in the absence of specific Ontario data?	OMAFRA is planning to release an updated Agrisuites software in the Fall 2019 which will include AAFC's Holos estimate of carbon sequestration through agricultural practices. Many assumed values used in Holos for Ontario will lack detailed Ontario-specific data. This evaluation will prioritize which numbers require immediate further research, or where new, improved values already exist and need to be incorporated into Holos or Agrisuite.	This research will: support a more sustainable agricultural sector by validating new practices to reduce the greenhouse gas emissions from field crops and livestock; satisfy the (draft) Made-in-Ontario Environment Plan's objectives for GHG reductions; improve the accuracy of OMAFRA's GHG projections.
TRADE, MARKET, TARGETED SECTOR GROWTH OPPORTUNITIES					
10.1.1	Trade, Market & Targeted Sector Growth Opportunities	Targeted Sector Growth	What is the impact of urban gentrification in or around the fast-growing Greater Golden Horseshoe (GGH) on existing agri-food clusters? What land use planning and other tools could be used to retain these businesses, foster their growth, and ensure the agri-food processing sector continues to thrive?	Information is needed on how Ontario can retain legacy food clusters adjacent to residential developments and ensure existing and newly developed employment lands can adequately serve the existing agri-food supply chain. This research question is also relevant to the Productive Land Capacity theme as it complements OMAFRA's Ag System work which links the agricultural land base and agri-food network, including food and beverage processors, in the Greater Golden Horseshoe (GGH). The objective is to look beyond land use planning to more	Ontario's agri-food sector has the resources and supports needed to be a global leader for niche products. The province has a greater understanding of existing economic cluster locations in the GGH which can then be leveraged to create new or to grow emerging cluster locations in Ontario. Niche markets can be products, technology and/or services.

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				holistically support a thriving agri-food sector. The research topic also builds on MMAH's identification of Provincially Significant Employment Zones (PSEZ) in the GGH. MMAH is considering further actions related to building these PSEZ economic clusters; addressing land use compatibility will be part of that effort. They will be looking to OMAFRA and other ministries to assist with this work.	
10.1.2	Trade, Market & Targeted Sector Growth Opportunities	Targeted Sector Growth	What are the opportunities and requirements for accelerating growth of high potential targeted sectors (e.g. hazelnuts, hops, maple syrup, aquaculture, cannabis)? How can a value-network approach support the growth of these sectors?	There is a lack of basic marketing information for new and specialty crops in Ontario.	Outcomes will help support trade, market and targeted sector growth opportunities.
11.2.16	Trade, Market & Targeted Sector Growth Opportunities	Technology Adoption – cross cutting	RNG Resource Economics: How much renewable natural gas (RNG) will come to the market place under different market conditions (e.g. price for RNG, credits for GHG emissions) and different feedstock conditions (e.g. availability of food waste and other organics)?	There is a gap in knowledge of how the production of renewable natural gas will be impacted by a series of economic factors (waste diversion targets, federal biofuel policy, natural gas expansion). This research addresses industry questions in support of the RNG Resource Cluster Tool.	Outcomes include: increase the adoption of renewable natural gas production on farms throughout Ontario; support the adoption of Renewable Natural Gas (RNG) in favour of a more sustainable agriculture and food sector by converting manure and food/organic waste into RNG; inform Ministry policies supporting the RNG sector, including how to support the sector in a variety of markets and feedstock conditions; assist Ontario in satisfying objectives in the (draft) Ontario Environment Plan on diversion of food and organic waste from landfills.
11.5.2	Trade, Market & Targeted Sector Growth Opportunities	Value Chain Analysis and Development (cross-cutting)	How can bio-based feedstocks for biomaterials, biochemicals and bioenergy be identified, developed and commercialized? What policy instruments, incentives and/or changes to provincial and municipal regulations, supply chains, market structure, and/or infrastructure need to be developed to facilitate the growth of Ontario's bio-based sector domestically and abroad to support transition away from petroleum-based products and processes.	There is increasing interest in transition away from petroleum-based products and processes. The demand for increased plant-based products is expected to drive new economic opportunities for purpose grown feedstocks/biomass, organic residues/food wastes and other bio-based by-products. For example, Michelin plans to reduce its industrial carbon footprint by 50% by 2050 and Lego launched a range of plant-based plastic toys in 2018. Other companies/retail stores in the value chain, such as IKEA, Lego, Danone, Walmart, and Nestlé are incorporating policies for reducing	Better understanding of emerging opportunities for Ontario bio-based sector focusing on new markets for Ontario's agricultural operations.

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			Note: Proposals must include a Value Assessment Plan.	fossil-based products and processes with those that are bio-based. Understanding these new market opportunities (and their challenges within current understanding) for Ontario is important.	