2017-18 OMAFRA Research Themes: Consolidated Priorities

OMAFRA Research Advisory Network

Ontario Ministry of Agriculture, Food and Rural Affairs

August 2017

Table of Contents

1: Purpose of this Document

The *2017 OMAFRA Research Themes-Consolidated Priorities* document is the consolidated outcome (updated priorities) recommended by the Theme Advisory Groups (TAGs) established under the OMAFRA Research Advisory Network (ORAN) for each of OMAFRA's seven research themes. The main objective of this document is to communicate annual updated research priorities for use directly in the OMAFRA-UofG Partnership Research Program call, and to inform calls for proposals under other OMAFRA-funded research programs.

2: Agri-Food and Rural Policy

2.1 Definition and Scope of the Theme

Ontario's agri-food sector and rural regions are significant contributors to regional economies and to the province. A key policy concern for OMAFRA is how to facilitate the sustainable development and long-term success of the agri-food sector and rural regions while ensuring that the public interest is served.

The strongest proposals will be evidence-based and collaborative, drawing on the combined strengths of more than one researcher at the University of Guelph in order to respond to the relevant policy questions. By extension, the ministry is also interested in proposals that link with relevant research capacity and expertise with other universities and research institutions. In such cases, successful proposals may feature cross-institutional collaborations in which the primary investigator is at the University of Guelph but related research activities in other institutions are funded under the same proposal.

The research priorities in this theme are focussed on three core areas to help build expertise and support evidence based policy development to facilitate the sustainable development and long-term success of the agri-food sector and rural regions. They are outlined below:

A. ECONOMIC GROWTH

This theme will examine economic development opportunities for the agri-food sector, as well as rural regions. Specific areas of focus are:

- Trade, sector development and competitiveness
- Industry measurement to track performance and growth
- Business risk management
- Rural human capital
- Infrastructure and rural economic development

B. STEWARDSHIP

For this theme, research will explore what data, tools and analysis are required:

- To inform the development of policies to better manage and conserve resources and address climate change
- To ensure agri-business sustainability

Issues for research in this core theme will also include farmland protection, resource and energy conservation, soil heath, and water management.

C. PROTECTION/ASSURANCE

Research under this theme will examine the role of industry, government and others in enhancing public trust in all aspects of Ontario's agri-food sector production practices.

For each of the Agri-Food and Rural Policy research priorities below, policy issue statements and questions are provided. These questions provide context and are intended to guide researchers in the development of appropriate approaches to fulfill the overarching policy objective.

2.2 Agri-Food Policy Research Priorities

A. ECONOMIC GROWTH

2.2.1. Trade and Competitiveness

Policy Objective:
Ensure that Ontario's agri-businesses remain competitive in domestic and global markets in response to changes in the international trade landscape.

Policy Issue Statement and Questions:
Canada and Ontario compete in global markets with large jurisdictions such as the United States (U.S.), European Union (E.U.), China and Brazil. Expanding exports to countries that do not have a free trade agreement with Canada can be a challenge, particularly when the countries have free trade agreements with Canada's competitors. Even in countries where Canada has free trade agreements, Canada and Ontario may have difficultly increasing exports if there are already well established supply chains with imports from Canada's competitors.

To increase competitiveness, Canada recently completed trade agreements with the E.U. and South Korea. The Canada-Korea Free Trade Agreement (CKFTA), which came into force in 2015, will put Canada on an equal footing with key competitors such as U.S. and E.U. who benefit from tariff rate reductions from earlier free trade agreements with South Korea.

Canada was a signatory to the Trans-Pacific Partnership (TPP) Agreement which was finalized but cannot take effect because the U.S. has withdrawn from the agreement. The failure of the TPP could reduce the potential for Ontario to increase exports to some Pacific Rim countries, particularly if the Regional Comprehensive Economic Partnership agreement with China, India and some TPP signatories such as Japan, Australia, New Zealand and Vietnam is completed. While the TPP in its current form cannot be implemented without the U.S., the remaining signatories could modify the agreement. An agreement without the U.S. could provide Canada with a competitive advantage relative to the U.S. in some Pacific Rim countries.

Canada, U.S. and Mexico are expected to renegotiate the North American Free Trade Agreement (NAFTA). The U.S. policy objectives for negotiations are unclear and the expected outcome is uncertain. Ontario-U.S. trade is critical for businesses and workers on both sides of the border.

Ontario has and will continue to take action by working closely with the federal government and provincial counterparts to ensure Ontario's interests are front and centre in trade discussions.

To inform policy development, an understanding of how potential changes in international agreements could impact Ontario's agriculture and food system is important in identifying strategic opportunities.

In expanding exports, Ontario agri-food businesses could focus on catering to niche markets, on product differentiation and leveraging Canadian's reputation for safe high-quality agri-food products. Identifying ways to further develop the Canadian brand for the 21st century could be important in expanding exports.

- What are the options for Ontario's agri-food sector to remain competitive in the global market place?
- What would be the impacts on Ontario agri-food businesses from different changes to the international trade landscape?
- Can Ontario's agri-food sector be competitive in the global market place by differentiating its products? How? Where can Ontario's agri-food sector be most competitive? What are the appropriate target markets? Which commodities are likely to be competitive? How can less competitive commodity groups adapt to improve their competitiveness? How have the answers to these questions changed as a consequence of recent and emerging changes in international trade agreements and world markets?
- What resources are available to the sector to encourage product differentiation and export development? What support is the Ministry in a position to provide? What can the Ministry do to encourage Ontario agri-food investment to promote competitiveness and take advantage of new market access opportunities?

Expected Outcome:
The research will provide advice on the mechanisms as well as performance indicators for long-term trade competitiveness and sustainability.

2.2.2. Industry Measurement for Growth and Competitiveness

Policy Objective:
Provide the Ontario agri-food industry with the metrics and data needed to measure growth and benchmark competitiveness across their respective sectors and value chains.

Policy Issue Statement and Questions:
In 2013, Premier Wynne issued the Agri-Food Growth Challenge to the Agri-Food sector to double its growth (GDP growth rate) and add 120,000 jobs by 2020. Following on the Challenge, in October 2015, the Agri-Food Growth Steering Committee provided Minister Leal with seven recommendations. One of the recommendations included building sub-sector measurement systems and creating indicators that measure progress towards increasing the competitiveness of a sector relative to competitive and comparable jurisdictions. Sub-sector measurements and data will support a culture of measurement and evidence-based decisions and comparisons. Research should address at least two of the following:

- Develop a conceptual framework to be used to identify relevant measurable performance indicators.
- What are the critical indicators that can be identified and measured to benchmark and assess the competitiveness of selected agri-food sub-sectors (e.g. physical, production, price, financial, resource management indicators for dairy sheep, dairy goat, and aquaculture)?
    - From the above analysis, what are the emerging gaps that reduce the sub-sector's competitiveness?
    - What are the options for government to support efforts to improve sub-sector level competitiveness?
- What are the drivers of growth opportunities in these sub-sectors under investigation, along the supply chain in Ontario?
- The development of the supply-disposition tables for commodities, particularly where data are currently not available. There is a need to build provincial level supply and disposition tables for the agri-food sector, especially for commodities that have limited data. Provide data that would be helpful for developing a supply- disposition table for the sub-sectors under investigation.

Expected Outcome:
Development of key performance measurements, tools, indicators and methods for various agri-food sectors and protocols for measuring progress and benchmarking. The ability for the measurements and databases created to be maintained and regularly updated as part of a culture of measurement. The information generated will then help the industry to strategically allocate resources to maximize industry growth and profitability.

2.2.3. Food and Beverage Processing – Barriers to Growth, Firm-level Investment, and Research Capacity

Policy Objective:
Build on recent research findings and leverage related ongoing research to develop a better understanding of the uniqueness of Ontario's food and beverage processing (FBP) sector, and challenges that hinder growth in the sector or sub-sectors.

Policy Issue Statement and Questions:
Challenges in Ontario's (FBP) sector are generally similar to other Ontario manufacturing sectors, including lagging productivity and innovation, regulatory burden, need for skilled labour and high input costs (e.g. energy and labor). Investment in research and development (R&D) and capital is the key to productivity growth. However, the food and beverage processing sector continues to have under-investment in capital, low R&D spending, and unique cost drivers surrounding supply management, food safety and perishability.[1]

---

[1] Science, Technology and Innovation Council (2015), "**State of the Nation 2014: Canada's Innovation Challenges and Opportunities**"; Conference Board of Canada (2015), "**How Canada Performs: Innovation, Provincial and International Benchmarking**"; Organization of Economic Cooperation and Development (2015), "**Overall assessment and recommendations**", in Innovation, Agricultural Productivity and Sustainability in Canada; Agricultural Institute of Canada (2015) "**Leading Innovation and Sustainability: An Agricultural Research Policy for the 21st Century**" (released September 10, 2015); Agri-Innovators Committee (2014) **Report to the Minister of Agriculture and Agri-Food**; and Food and Beverage Ontario (2015), "**Report on Ontario Food and Beverage Processing Industry Innovation**".

Growth and Competitiveness Challenges:

- Are there barriers to growth of Ontario's FBP sector or specific sub-sectors?
- Where can growth be expected in the sector over the next 2-5 years?
- Are there areas within the sector where shrinkage may occur?
- What are the sector's competitive advantages that can be built upon?
- What are the key factors influencing investment by small to medium food and beverage processing enterprises to significantly grow sales?
- What are the key factors influencing location by small to medium food and beverage processing enterprises?

Research and Development Capacity:

- What is the capacity of R&D at the firm-level for various FBP business sizes? What types of R&D activities are undertaken and how is R&D defined?
- Does / could firm-level R&D support productivity improvements in Ontario's FBP firms?
- What is the relation between investment in R&D and the presence of R&D staff at the firm-level?
- What models are used internationally to bridge the gap between firm level R&D and academic research (e.g. Wageningen (Netherlands); Ontario's UofG partnership) that requires business partners? What model could be used / replicated in Ontario?

Expected Outcome:

Evidence-based identification of:

- Ontario's FBP sector / sub-sector competitive advantage.
- Barriers to Ontario's FBP growth, particularly productivity growth.
- The factors shaping firm-level decision-making related to R&D investments.
  The factors shaping the growth of firms based on size (Large: more than 500 employee; Medium: 100 - 500 employee; and Small: less than 100 employee).

2.2.4. Essential Regional-scale Agri-food Linkages

Policy Objective:

To strengthen agri-food value chain linkages through increased provincial-municipal-industry collaboration within the Greater Golden Horseshoe (GGH).

Policy Issue Statement and Questions:

Collaboration is needed between provincial and municipal governments and industry to better understand and strengthen agri-food value chain linkages in the GGH region. Economic development and land use planning are two key areas of government involvement that could be further integrated to support essential agri-food value chain linkages at a regional scale. This work would consider whether there are existing Ontario value chains that GGH agri-business could tap into and GGH value chains that could expand. Projects should build on the Analysis of Food and Farming Assets in the Greater Golden Horseshoe (Synthesis, 2016), using NAICS codes from the asset mapping project and data from Analyst input/output analysis to determine the contribution of GGH businesses to Ontario value chains.

While this research would focus on the GGH region, it would continue to develop a model for municipal-provincial collaboration that may be applicable to other areas of Ontario.

- What are the key decision makers, value-chain leaders and organizations that influence available services, infrastructure and human capacity for agriculture in the GGH?
- What are the essential linkages between primary agriculture, support services and infrastructure at a regional scale in the GGH, building upon previous research such as the Agri-Food Asset Mapping project?
- What are the constraints or obstacles for regional-scale agri-food linkages?
- Identify the best combinations of tools to assess and actions to strengthen these linkages (e.g., economic development, land use planning).

Expected Outcome:
Outline options and recommended actions for municipal planning and economic development decisions that have the greatest positive impacts on agriculture. For example, the results may be used in developing regional agri-food strategies or in evaluating the impacts of a new development on the agricultural support network.

Further build upon and advance the findings of existing agri-food asset mapping research to develop easy-to-use tools for municipalities to understand what services and infrastructure are available to agriculture in the region (for example, web-based mapping tools and data sharing).

Identification of import replacement potential and other means of strengthening the value chains e.g. capitalizing on the tremendous opportunity of having a major urban population at its doorstep.
The research will provide additional information to assist municipalities in implementing and conforming to the GGH Agriculture System by 2021.

2.2.5. Business Risk Management (BRM) Payments and Producer Investments

Policy Objective:
Provide the appropriate risk management programs that are comprehensive in scope and effective in helping to manage the impacts of production losses, severe market volatility, extreme events and disasters. The intent is to give producers confidence to invest in their farm businesses to manage risks that are less severe and contribute to making the sector competitive, innovative and adaptable.

Policy Issue Statement and Questions:
One intended benefit of BRM programs is to encourage investment in Ontario's farm operations to innovate and increase competitiveness within a highly volatile sector that is significantly impacted by weather and world markets.

- Do Ontario's BRM programs provide a suitable business climate of confidence to invest?
- How would one assess the optimal level of assurance that provides producers with the confidence to make long-term investments in their operations?
- How effective are BRM programs in encouraging agricultural producers to make long-term investments impacting productivity or profitability in their operations?

- Assess the effectiveness of BRM programs in encouraging agricultural producers to make investments in public goods in their operations, such as environmentally sustainable management practices?

Expected Outcome:
Provide evidence to show the impact of BRM programs and long-term investment tendencies of producers.

2.2.6. Food and Beverage Processing and Bio-economy

Policy Objective:
Ontario's food and beverage processing sector (FBP) and the Bio-economy are predominantly composed of small-to-medium-sized enterprises (SMEs) – almost 99 per cent of the businesses. Both these sectors are important economic drivers for the agri-food value chain. The recent shift in Ontario's policy environment with the introduction of the Climate Change Strategy (including the Climate Change Action Plan and the cap and trade system) presents potential challenges as well as opportunities for these businesses in terms of their competitiveness. However, the ministry currently does not have access to data to assess the competitiveness challenges and/or opportunities in terms of business size. Research is needed to fill this information/data gap, and to enable the ministry to develop evidence-based policy and programs to enhance sector competitiveness as they transition to a low-carbon business model.

Policy Issue Statement and Questions:
- How does GHG emissions reduction and affiliated process/technology innovation impact firm level competitiveness by size (small, medium and large) in the short, medium and long term?

What do experiences of firms (by size) in other jurisdictions (e.g., British Columbia, Québec and California) tell us in this regard?
- How do changes to environmental or other policies (e.g. labour) affect a firm's bottom line and its decision to further invest, consolidate or move production to another jurisdiction?
- Do the factors that influence decision-making change depending on the size of the firm?

Notes:
- Researchers are expected to consider the above noted changes within the broader policy environment (e.g. the cumulative impact of the Ontario minimum wage, Climate Change Action Plan, Cap and Trade, Waste-free Ontario Act and electricity prices relative to other jurisdictions).
- Researchers are expected to acquire firm-level data using collection tools (e.g. surveys), develop firm specific case studies and a firm-level database that can be updated over time.
- Researchers should recognize that access to firm-level data would enable researchers to investigate other questions (e.g. R&D could be connected to innovation in recycling, improved productivity and reduced GHGs).

Expected Outcome:
Fill a critical data/information gap related to a low-carbon shift in FBP and Bio-economy sectors to inform future policy and program initiatives, including through waste management.

B. STEWARDSHIP

B1. Climate Change Mitigation

Where possible, climate change related research will build on and/or link with relevant work completed or underway by other ministries, primarily the Ministry of the Environment and Climate Change (MOECC). OMAFRA will facilitate inter-ministerial linkages as appropriate.

2.2.7. Food Waste in Agri-Food

Policy Objective:
Minimize agriculture and food's contribution to climate change and support industry compliance with Bill 151, the Waste-Free Ontario Act.

Policy Issue Statement and Questions:
Ontario's food and beverage processing sector (FBP) is the 2nd largest manufacturing industry in the province, contributing $12.1 billion in GDP (2016) and employing 94,454 people (2016). The sector has strong potential to further enhance its competitiveness and significantly reduce greenhouse gas (GHG) emissions if it takes steps to reduce waste and improve energy/water-use efficiency. In Canada, a significant amount of organic/food waste produced by FBP businesses ends up in landfill, contributing to GHG emissions. Of the total waste produced by the agri-food value chain, almost 18 per cent is contributed by the FBP sector.

Ontario has recently adopted two key policy measures to move towards a low-carbon (Climate Change Action Plan) and waste-free economy (Waste-Free Ontario Act, 2016). These policy developments present an excellent opportunity for Ontario's FBP sector to reduce its organic food waste footprint, thereby reducing its contribution to GHG emissions and improve waste management.

Research projects should address one or more of the following:

- Comparative analysis of existing efforts to reduce/recycle/re-use waste internationally.
- What policy tools, practices and technologies are employed by government, industry and non-government organizations in other leading jurisdictions and what are the barriers to implementing them in Ontario?
- How can food waste and other materials be reused/recycled to maximize GHG emission reductions and energy value? What policy and regulatory changes are necessary to maximize GHG emission reductions from food waste and other materials?
- How can government leverage actions of the non-profit sector to promote the reduction of food waste?
- What barriers exist to increasing the amount of surplus, edible food that is recovered in Ontario (including infrastructure gaps and social attitudes, such as misconceptions about perishability and stigma associated with recovered food) and how can food recovery be further promoted as a means of reducing food waste in Ontario?

Expected Outcome:
Fill a critical data gap related to food waste and its impact on climate change.

2.2.8. Opportunities for the Agriculture and Food Sector to Transition to a Low-carbon Future

Policy Objective:
Identify opportunities to target incentives for greenhouse gas (GHG) reduction initiatives in agriculture and food. The research will be used to inform the development of future programs, and provide analysis to guide sector investments, help reduce GHG emissions, and support their ability to compete and thrive in a low-carbon economy.

Policy Issue Statement and Questions:
There are limited data regarding Ontario's agriculture and food sector emission sources and sinks. There is a need to gather data to identify areas of greatest opportunity for the agri-food sector and rural communities to be part of the solution. More data are required to understand where unexplored opportunities (including reducing fossil fuel consumption) are to focus investments in the agri-food sector, achieve GHG emission reductions, and benchmark against a 'business as usual' approach and measure future progress.

The key challenge for the sector in the coming decades will be achieving continued economic growth and increasing food production at the current (or reduced) rate of energy, resource and land use (input versus output efficiency). To remain productive and competitive while growing, the sector will need to transform to reduce agriculture's carbon footprint.

Research projects should address one or more of the following:

- What is the relative potential for GHG emission reduction from on farm practices (e.g. trees on farms, conservation tillage, manure management, precision agriculture, cover cropping, and biodigesters) by type of production system- in isolation, and as a suite of complementary activities as part of a systems approach? What are the most cost-effective GHG reduction measures (technology or practice) with the greatest number of co-benefits (economic, social, and environmental) by commodity, process adoption, transportation mode, production system or product? What are the co-benefits and can the benefits be quantified (economics, air or water quality, biodiversity, etc.)? Are there opportunities to tailor solutions at the regional or landscape level?
- What are the opportunities for the agriculture sector to participate in offsets?
- Based on current best practices and available technology, how much could Ontario's agriculture and food sector emissions be minimized by 2020, 2030, and 2050, while achieving Ontario's agri-food economic growth targets? Which types of agriculture and food production will face more challenges in transitioning to a low-carbon economy?
- What are the anticipated impacts and unintended consequences of Natural Gas Renewable Content targets and the likely adoption of purpose-grown energy crops to meet those targets? If 1% or 2% or 5% of Ontario's natural gas is replaced with RNG from energy crops, what impact will this have on agricultural systems in Ontario (e.g. soil health, run-off, etc.)?

Expected Outcome:

- Comprehensive evidence to measure the performance of OMAFRA's contributions to the Climate Change Action Plan, and to support prioritization of focus areas and policy tools.
- Comprehensive evidence to be used in OMAFRA's Agricultural Soil Health and Conservation Strategy to guide recommendations and actions.

- Food production will transition to lower emissions intensity production and biological emissions will be reduced from on-farm production systems through increased uptake of best practices and technology.

B2. Climate Change Adaptation

2.2.9. Resilience in the Food Production System

Policy Objective:
Increase our understanding of climate change risks and opportunities over time, to guide policies that will build resilient food systems, in order to support food security for future generations.

Policy Issue Statement and Questions:
- Agricultural productivity is particularly sensitive to the effects of climate change. The Intergovernmental Panel on Climate Change has concluded that dramatic global environmental changes are already affecting food production, health and ecosystems, and that the world is ill- prepared for future risks. There is a need to assess the broad economic risks and opportunities for Ontario's agriculture and food processing sectors.

Research projects should address one or more of the following:
- How will global climate change affect food supply security in Ontario (including food supply imports and exports), and how can the government help ensure food supply security for future generations in light of those changes?
- What are the key economic risks and opportunities for Ontario's food production system (including agriculture and food and beverage processing) over the next 20 years, resulting from the predicted impacts of climate change in Ontario and on the global food system? How can government best position the industry to address specific risks associated from climate change, such as risks to plant health (from new and emerging pests)? Can we translate lessons learned (e.g. from animal health disease response) to ensure an appropriate response to risks associated with climate change?
- Building on the Ontario Climate and Agriculture Assessment Framework developed by Ontario Centre for Climate Impacts and Adaptation Resources, what are the impacts at the regional or landscape level and are there opportunities to tailor solutions? Analyze the methodology developed by OCCIAR and assess and how it can be used to update analysis over time, as new information becomes available.
- What are the potential consequences of climate change-related impacts on water availability and access (or security) for agriculture and food operations? What is the status of water availability and access for agriculture across the province, considering water sources (precipitation, groundwater, and surface water), infrastructure and competing uses? How does Ontario's competitive advantages in agriculture vary across the province taking into account projected climate-change-related impacts on water availability and access (e.g. considering proximity to Great Lakes and other major water bodies, not in areas with sensitive groundwater systems or prone to low water)?
- What barriers exist to producers and/or processors to adopt climate change adaptation practices? Do the factors that influence adoption of these practices change depending on the size of the farm/firm? Are there other factors that influence uptake?

Expected Outcome:

- Evidence to support delivery of OMAFRA's climate change adaptation plan commitments and the Climate Change Strategy.
- New information for stakeholders that will guide their decisions in adopting new technology and practices.

B3. Sustainable Agriculture and Food System

2.2.10. Sustainable Agriculture and Food System

Policy Objective:

Optimize the sustainability of our agriculture and food system to preserve and enhance Ontario's capacity to produce food, and to ensure access to healthy, affordable food for present and future generations.

Policy Issue Statement and Questions:

a) Agricultural Soil

OMAFRA is working with industry stakeholders to develop an Agricultural Soil Health and Conservation strategy in response to increasing concerns over declining soil health through loss of organic matter and loss of soil structure leading to erosion risk. Long-term reduction in forages and pasture, simplification of crop rotations, increases in fall tillage and other factors are thought to be the causes of this change. Reversing these trends poses economic, social, technological, environmental and scientific challenges. A new systems approach to cropping to build soil health can be challenging to current approaches. On-farm learning systems, experimentation and advice appear to be important factors in stimulating change and supporting the longer-term implementation of the soils strategy.

- What has research revealed to date about the state of soil health in the range of Ontario soils (e.g. soil organic matter, fertility, soil structure)? What are the key indicators and functions for the chemical, physical, and biological aspects of soil health at the local, regional and provincial scale? What is the list of soil health parameters that should be measured?
- What are the trends in cropping practices affecting soil health, including changing types of crop rotation, changing crop types, fall and spring tillage?
- What are the economic impacts for the land owner of physical soil degradation? What are the long and short-term economics associated with adoption of a system of complementary practices benefiting soil health, evidence from Canada, Ontario and other jurisdictions? What is the overall long term economic impact of cover crops within cropping systems? What are the best methods to quantify the economic aspects for soil health?
- What is the return on investment in terms of time and money for farm managers adopting soil health practices (e.g. impact of implementing conservation tillage, cover cropping, soil amendments, improving soil ecology etc. on productivity and inputs required, carbon sequestration and GHG emissions, and water quality etc.)?
- How do current business risk management programs like crop insurance affect adoption of new practices to benefit soil health? Would change in program parameters foster change?

- What types of tools, incentives or strategies would be the most effective in encouraging farmers (focussing on non-adopters) to make changes to their management practices with the intent to improve/maintain soil health? What are the conditions that would encourage adoption?
- What are the market opportunities (beyond farm gate) for alternative crops that are part of a more diversified crop rotation?

Expected Outcome:
Effective evidence to be used in the development of policies to support Great Lakes water quality, improvements to soil health as well as all policy/program work related to the effective implementation of on-farm best management practices.

It is expected that researchers will compare current evidence with past studies.

b) Environment

Policy Objective:
Optimize the sustainability of our agriculture and food system to preserve and enhance Ontario's capacity to produce food, and to ensure access to healthy, affordable food for present and future generations while minimizing environmental impacts of agricultural production.

Policy Issue Statement and Questions:
Lake Erie is the smallest in volume and shallowest of the Great Lakes, and has the closest proximity to agricultural production, placing it under a high degree of stress. As a result it is the warmest and most biologically productive, creating ideal conditions for algal growth.

For more than a decade, the occurrence of toxic and nuisance algae blooms in Lake Erie has been increasing. The increased occurrence of algal blooms in Lake Erie is influenced by many factors including excess nutrients, climate change and invasive species. Phosphorus is the primary nutrient driving increased algal blooms in the Lake and comes from multiple sources, including both urban and rural.

All sectors will have a role to play in improving the health of Lake Erie. In terms of the land base, agricultural land uses make up more than 75% of the land area delivering non-point sources of Phosphorus to Lake Erie. The agriculture sector will need to address this challenge.

- What are the most effective policy tools (e.g., education, peer-to-peer learning, demonstration farms, incentives, disincentives, legislation etc.) to improve Great Lakes water quality and reduce loss of nutrients from agriculture land (e.g. nutrient management, soil management, water management/drainage, etc.)?
- What is the efficacy of voluntary vs regulatory approaches to adopting best management practices in achieving long-term change in behaviour? How effective have existing and past cost share programs been at promoting the adoption of best management practices that have been identified as making significant contributions to reducing phosphorus loadings from crop and livestock farms?
- How do different land tenure (short-term versus long-term rental) arrangements affect the uptake of land stewardship practices? What policy options exist to increase adoption of

land stewardship practices (including those with water quality benefits) on rented land and how could they be implemented in Ontario and the Lake Erie basin?
- What policies and strategies are most effective in helping the agriculture sector capture multiple benefits related to climate change, water quality and soil health?
- What information is available on microclimates in Ontario that enable specialty crop production? How can these areas with microclimatic conditions be defined either locally or at a provincial level?

Expected Outcome:
Best available science will be used in the development and assessment of policies and programs to support Great Lakes water quality, reduction in phosphorus loss, and other associated co-benefits.

2.2.11. Influencing Behaviour Change in the Agri-Food Sector

Policy Objective:
In the midst of calls for a modern system of government featuring less regulation and a commitment by government to undertake evidence based decision making, there is an opportunity to develop and explore new behaviour modifying policy tools that enable a competitive environment for Ontario's agri-businesses, improve production standards and enhance environmental stewardship (e.g., antimicrobial resistance, water quality, soil health) while meeting consumer and citizen expectations.

Policy Issue Statement and Questions:
A more concerned and informed citizen/consumer base with the strong ability to influence agri-food production, higher incidents of potential animal and human health food-based threats, in addition to a deteriorating environment, are elevating expectations for production practices previously regarded as niche to become mainstream market standards. Failure to adopt these new standards could result in lost opportunities to gain market share at best, or worst – loss of market share and/or margins.
Research is needed to provide the evidence to support policy and program development that drives behaviour change to optimize the sustainability of our agriculture and food system to preserve and enhance Ontario's capacity to produce food, and to ensure access to healthy, affordable food for present and future generations.

- What are the factors that influence a farmer's management choices in cropping and soil management (e. g. short or long term economics, social factors, family and social relationships, management experience etc.)? What are the factors that influence and lead to increased adoption of beneficial management practices by the agriculture sector in the area of environmental stewardship (e.g., reducing impacts of agricultural production practices on water quality and soil health), and antimicrobial use? What types of communication and learning approaches best support the adoption of a system of complementary practices to benefit soil health (social science, marketing research, and adult education)?
- What are the current barriers to adoption beneficial management practices?
    - Which perceived barriers are within the purview of the government to influence?
    - What changes in production practices deter (voluntary) adoption of higher standards or best management practices and how?

    - Where the issue is a high cost of adoption, what are the best policy tools to bridge the transition to new management practices? Is there a business case for government investment in these practices?
    - Are there perverse program incentives and/or regulatory restrictions that deter or prevent innovative production practices that may result in better outcomes?
- Which policy tools are most effective at driving behavior change?
    - What types of learning approaches and knowledge transfer best suit adoption of systems of practices to benefit ecosystem health (social science, marketing research, adult education)?
    - What government approaches best support beneficial management practices in the areas of stewardship and animal welfare etc.? How can existing government programs (e.g. BRM (farm income support programs)) be leveraged to achieve multiple objectives or broader societal outcomes?
    - How wide is the gap between current practices, regulatory requirements and public expectations? Where are the opportunities to integrate within existing government policy and programming?
    - What is the return on investment in terms of time and money for farm managers adopting stewardship practices (e.g. impact of implementing conservation tillage, cover cropping, soil amendments, improving soil ecology etc.), accounting for productivity and inputs required, GHG emissions and removals, water quality and other environmental benefits?

Expected Outcome:
A set of recommendations on how to motivate desirable changes in behavior of the agriculture sector, particularly when there is no clear economic incentive that motivates that behaviour change; and, increased adoption and measurement of environmentally beneficial management practices.

2.2.12. Land Use Planning

Policy Objective:
To better understand and develop practical responses to key issues affecting agricultural land use and agricultural viability.

Policy Issue Statement and Questions:
As part of the province's commitment to fostering a thriving agri-food sector, the updated land use plans for the Greater Golden Horseshoe take an agricultural system approach. An agricultural system includes areas of productive and protected farmland as well as an agri-food network that includes agri-food value chains. While the agri-food network is mapped in OMAFRA's Agricultural System Information Portal, more needs to be known about existing value chains, local content and import replacement opportunities, and existing and potential future extension of these value chains beyond the GGH.

Under the land use theme, research is required in a number of key areas that affect the viability of agriculture and may have a bearing on provincial policy and guidance.

Researchers will address the following questions:

- Are provincial land use policies on lot creation being implemented consistently? Are the types of lot creation still permitted in provincial land use policies appropriate and relevant to the agricultural sector? For example, are surplus farm dwelling severances still appropriate? Are they relevant and useful to the long term health of the agricultural sector? Under what conditions or limitations are they appropriate or helpful?
- What other mechanisms, besides lot creation, might address concerns that smaller land holdings need to be provided for niche farming and beginning farmers?
- What other forms of agricultural production (e.g. mushroom operations) or other types of agricultural buildings, structures and activities (e.g. bunker silos) would benefit from the development of tools that can calculate setbacks between incompatible land uses? If a setback tool was developed, what amount of separation distance would be appropriate and how would it be calculated? What would be the economic implications of imposing a new setback tool on various agricultural sectors – both in terms of costs and benefits? What evidence could be used to support the development of a setback tool, and to determine an appropriate calculated setback?
- Based on a jurisdictional and research scan and analysis, what are economic, social, and environmental and land use impacts of aggregate extraction operations on adjacent farms livestock and crops?
- What are appropriate measures (i.e. setbacks and buffers and other best management practices) to avoid, minimize and mitigate aggregate extraction impacts (e.g. dust, noise, water) on livestock and animals?

Expected Outcome:
The research will provide essential information to OMAFRA and the Province about how to better protect agricultural land and create a thriving agri-food sector.

2.2.13. Effects of Trade Policies on Sustainability

Policy Objective:
To better understand the implications of/relationship between agri-food trade policies and programs on the sustainability of Ontario's agriculture and food systems, including rural communities.

Policy Issue Statement and Questions:
Trade patterns can influence production scale, composition and technique – all of which have significant environmental and social implications for agricultural producers, processors and rural communities.

OMAFRA, Ontario and Canada have an ambitious export agenda to drive economic growth, however there is limited information about how Ontario's market development policies and programs will affect the long term sustainability of Ontario's food production capacity, food system, and rural communities.

There is a need to explore opportunities to achieve economic development goals while also advancing toward environmental and social objectives, including soil health, water quantity and

quality, climate change mitigation and adaptation, vibrant rural communities and long-term food security for Ontarians.

Researchers will address the following questions:

- What are the challenges and opportunities with respect to the three pillars of sustainability, for Ontario's agri-food businesses and rural communities of food imports and exports by global region (e.g. North America, Asia), compared to local production for local consumption:
    - Economics (e.g. size of farms, number of farms, farm ownership vs. rental, Ontario farm payments, farm input costs, agri-food sector employment and consumer food prices;
    - Social (e.g., food security); and
    - Environmental (drivers) adoption of best management practices on farms (e.g. use of cover crops, diversified crop rotation and reduced tillage.

Expected Outcome:
The research will provide essential information to OMAFRA and the Province about how to best plan for and manage the consequences arising from changes in trade policies, to optimize economic, environmental and social outcomes.

C. PROTECTION ASSURANCE

2.2.14. Antimicrobial Resistance

Policy Objective:
In support of preserving the efficacy of antimicrobials for human and agricultural uses, policy objectives are to:

- Translate the antimicrobial resistance knowledge to help stewardship practices through the methods/manner appropriate for the targeted sector (e.g., swine, poultry, etc.).
- Improve awareness and understanding of antimicrobial resistance in agriculture and food producing sectors through identifying and establishing innovative and effective outreach, education and training that elicits measurable improvements in producer and veterinary behaviour.
- Improve livestock producer and veterinary understanding of effective practices (e.g., alternative products, husbandry practices, etc.) that improve animal health and reduce the need for antibiotics.

Policy Issue Statement and Questions:
There is increasing concern over antimicrobial resistance (AMR) affecting human and animal health in many parts of the world, including Canada. Antimicrobials used in agricultural systems in feed or water for long periods for routine prevention or growth promotion can encourage resistance. A shift is needed to more prudent use of antimicrobials in agriculture, human medicine and public health applications. Prudent use means antimicrobials are not used excessively or indiscriminately. Many industry and professional organizations have developed or are developing guidelines for antimicrobial stewardship in animals and people.

- What are the costs and benefits of alternative husbandry/management practices related to reduced use of antimicrobials?

- What are the economics of a shift from preventive use to use for treatment only for a sector or a producer?
- What policy tools (e.g., education, incentives, and legislation) would be most effective from a cost and sustainability perspective to help the agriculture sector adapt to instituting these changes?

Expected Outcome:
Prioritize risk management options, provide information and support for evidence-based decisions and animal health policy.

2.3 Rural Policy Research Priorities

2.3.1. Rural Human Capital

Policy Objective:
To better understand the opportunities for rural communities and provincial rural economic development programing to foster human capital retention, attraction and development.

Policy Issue Statement and Questions:
Many rural areas across Ontario are facing a number of human capital related challenges. Fertility rates are below replacement levels, the population is getting older, more people are graduating out of the workforce than younger workers entering it, young people are leaving to find opportunities, immigrants are not settling in rural areas and rural residents tend to have lower levels of education. These demographic trends pose several challenges for rural areas' economic well-being, including:

- Qualified worker shortages/employers having difficulty filling jobs;
- Capacity to innovate;
- Capacity to attract, retain and expand businesses;
- Local demand for goods and services;
- Municipal tax revenue; and
- Centralization or consolidation of core services (e.g. schools).

Ontario's rural communities that have the vision to build their economic development strategies on the foundation of stable, long-term human capital will prosper. Skilled, well-educated human capital adds to a municipality's value for existing and prospective businesses and makes the municipality more attractive to a more diverse group of businesses. It can lead to increased business investments, more jobs and a stronger economy. This is further exemplified in a knowledge-based economy; where business success depends on an economy that relies on the skills, knowledge and experience of its labour force.[2]

[2] L.J. Beaulieu and D. Mulkey (1995), "**Investing in People: The Human Capital Needs of Rural America**"; Donald, B., D. Morrow, and A. Athanasiu (2003), "**Competing for Talent: Implications for social and cultural policy in Canadian city-regions**"; Florida, R. (2002), "**The Economic Geography of Talent**"; Florida, R. (2002), "**The Rise of the Creative Class**"; Gertler, et.al. (2002), "**Competing on Creativity: Placing Ontario's Cities in North American Context**"; Hall, H. and B. Donald (2009), "**Innovation and Creativity on the Periphery: Challenges and Opportunities in Northern Ontario**";

- What approaches have other jurisdictions utilized to successfully foster human capital development at the local and regional level (i.e. skills development, immigrant attraction/retention, youth retention, participation of underrepresented groups, workforce attraction/retention)? How have these initiatives contributed to rural economic development?
- How can provincial rural economic development programming best encourage and support human capital retention, attraction and development in rural areas at the community and regional level?

Expected Outcome:
This research will provide essential information to OMAFRA and the Province about how to enhance provincial rural economic development programming that is focused on encouraging and supporting human capital retention, attraction and development in rural areas at the community and regional level.

Research will also identify strategies for rural Ontario communities to develop, attract and retain skilled, well-educated human capital.

2.3.2. Infrastructure and Rural Economic Development

Policy Objective:
To better understand (qualitatively and quantitatively) the capacity of rural Ontario communities to respond to infrastructure pressures (e.g. population growth and decline, changing demographics, changing weather patterns, aging infrastructure, and shifting economic landscapes and priorities) and the resulting economic implications for those communities with limited capacities to respond to these pressures.

Policy Issue Statement and Questions:
Strong and sustainable infrastructure is recognized as a backbone of community vitality and economic development and growth. Fiscal realities, shifting economies, aging infrastructure, population growth and decline, and a changing climate are just a few of the many pressures facing rural municipalities as they seek to effectively manage infrastructure assets (e.g. core infrastructure such as roads, bridges, water and wastewater) and accommodate adequate infrastructure service levels (e.g. wired, wireless and satellite high-speed broadband). Strengthened asset management planning and inter-community partnerships are just some of the ways in which rural communities are responding to these infrastructure pressures. However, infrastructure gaps remain that could present long-term economic challenges for rural Ontario communities.[3]

OCED (2007), "**Human Capital: How what you know shapes your life**"; Rigby, D.L. (2003), "**Geography and Technological Change**"; Romer, P. (1992), "**Two Strategies for Economic Development: Using Ideas and Producing Ideas**"; K. Stolarick, et.al. (2010), "**Creativity, Tourism, Economic Development in a Rural Context: the Case of Prince Edward County**"; and Warda, J. and J. Zieminski (1996), "**Building and Innovative Canada: A Business Perspective**".

[3] Advisory Council on Economic Growth (2016), "**Unleashing Productivity through Infrastructure**"; American Society of Civil Engineers (2016), "**Failure to Act: Closing the Infrastructure Investment Gap for America's Economic Future**"; Association of Municipalities of Ontario (2012), "**Towards a new Federal Long-Term Infrastructure Plan: AMO's Submission to Infrastructure Canada**"; Canadian Centre for

Research is required to better understand, both qualitatively and quantitatively, the varying capacities of rural Ontario communities to respond to infrastructure pressures.

- *Capacity* refers to the ability of a rural community to ensure services are provided on a sustained basis in pursuit of its own objectives. Capacity considerations could include: fiscal (e.g. tax base, ratepayer base, government funding); human resources (i.e. staffing); and knowledge (e.g. asset management planning expertise).
- *Infrastructure pressures* could include various population growth patterns (e.g. rapid decline, stagnation, and rapid growth), adapting to a changing climate, aging infrastructure, and changing economic landscapes (e.g. business decline, growth and/or introduction of new types of businesses).

Research should also seek to address the economic implications for those rural communities that may have limited capacity to respond to these infrastructure pressures.

Research projects should seek to address the following questions:

- Using qualitative and quantitative methods, what are the capacities of rural Ontario communities to respond to infrastructure pressures? Describe how these capacities vary between communities and whether there are any prevalent capacity problems.
- What are the short and long-term economic implications facing rural communities with limited capacity to respond to infrastructure pressures?
- What immediate and long-term government actions are required to address these capacity issues? Are current government funding models for infrastructure conducive to addressing these capacity issues? Have governments in other jurisdictions adapted their funding models to accommodate for various infrastructure pressures facing rural communities?

Expected Outcome:

This research will help to: inform OMAFRA and the Province on the varying capacities of rural Ontario communities to respond to emerging infrastructure challenges; and demonstrate the potential economic implications of these capacity gaps. This information is expected to help inform future discussions on rural infrastructure policy and program development and guide strategic investments.

Policy Alternatives (2013), "**Canada's Infrastructure Gap: Where it came from and why it will Cost so Much to Close**"; Conference Board of Canada (2010), "**The Economic Impact of Public Infrastructure in Ontario**"; McKinsey Global Institute (2013), "**Infrastructure Productivity: How to Save $1 Trillion a Year**"; and University of Toronto, Institute on Municipal Finance & Governance (2014), "**Provincial-Municipal Relations in Ontario: Approaching an Inflection Point**".

Note to Researchers: Please note the following linkages to priorities described in other themes to identify potential synergies and opportunities:

- **Climate change** has been identified as a priority for other research themes.
- **Animal Production Systems** and **Emergency Management** also includes priorities related to **antimicrobial resistance**
- **Products and Value Chains** also includes priorities related to value chain development and assessment, trade and rural development.
- **Food for Health** includes priorities related to accessing healthy food through food skills and food literacy
- Researchers seeking help in identifying potential priorities and collaborators may contact UofGuelph's Research Program Director or OMAFRA Theme Research Analyst

3: Bioeconomy - Industrial Uses

3.1 Definition and Scope of the Theme

The Bioeconomy-Industrial Uses theme encompasses three major areas of focus, all of which involve use of agriculturally-derived biomass to produce some type of bioproduct. The three major product categories considered are:

Biomaterials - includes bioplastics, biobased blends, natural fibre composites, biobased nanocomposites, biofoams, biorubber, biobased paints and coatings, bioadhesives and bioinks, and natural fibres, as well as the resulting end products (e.g. textiles, carpets, mats), rigid components (e.g. tiles, panels, beams and posts, tubes/pipes, casings, or other formed products), or granulated products (e.g. chips, pellets, dust).

Biochemicals – includes industrial chemicals (e.g. cleaners, lubricants, sealants, solvents,), intermediate biochemicals (e.g. ethylene), chemical inputs/feedstocks for production of other products (e.g. oils, phenols, resins) and biotech products where at least part of the product is a biological organism or a component thereof (e.g. enzymes, molecular probes, microbes, yeast, bacteria). Biopharmaceuticals and cosmetics are considered in the Bioeconomy-Industrial Uses research theme whereas nutraceuticals and functional foods are excluded as they are considered under the Food for Health theme.

Bioenergy – includes energy feedstocks (e.g. ethanol, methanol, butanol, biodiesel, bio-oil, biogas, pellets, hog fuel) as well as the end products (e.g. electricity, thermal energy).

3.2 Bioeconomy – Industrial Uses Research Priorities

3.2.1. FEEDSTOCK RELATED RESEARCH

Feedstock-Related Research is defined as research to create unique, sustainable, and/or more robust bio-based/organic feedstocks with the aim of long-term market viability and societal benefit. This includes research on organic waste streams and research into logistics/delivery of feedstocks, farm gate processing, storage, and transportation.

Priority areas for research are:

a) Utilization of agricultural based residue and by-product streams to create value-added bioproducts such as residue and byproduct streams including crop residues, and low or negative value byproducts (e.g. glycerol and lignin from biofuel industries); medium value residues such as Distillers' Dried Grains with solubles (DDGS) from corn ethanol industries, CO2, and food processing waste streams. For example, research into the economic utilization of residue and byproduct streams at the site where residue is generated will be considered. Such research should also include aspects of environmental sustainability;

b) Development of new or improved crops beyond traditional or existing commodity crops. Examples include:

    i. Agronomy (yield and agro-climatic suitability), selection, breeding and use of biotechnology to improve current or develop emerging crop plants with identity preserved traits for specific industrial chemicals/ products/ applications, stress tolerance, value-added feedstock for advanced manufacturing like biopharmaceuticals;

    ii. New crops or cultivars of existing crops for biofuel and other industrial applications, such as paints, coatings, lubricants and solvents applications;

    iii. Algae and agroforestry (e.g., use in bioproducts/processes linking benefit to agri-food sector and rural communities).

    iv. Development of new or improved crops beyond traditional or existing commodity crops. Examples include:

c) Feedstock development, quality development, production optimization, feasibility of storage and supply chain logistics of biobased feedstocks for biomaterials, biochemicals, and bioenergy.

3.2.2. PROCESSING TECHNOLOGIES RESEARCH

The Processing Technologies Research is defined as research into methods and processes for converting/refining feedstocks to enable cost-competitive products for a variety of industrial uses. This type of research should work towards an integrated approach. Processing technologies that lead to novel or more efficient uses of biobased feedstock are desirable. The ultimate outcome of this type of research is increased value, either of a single component, or across products. This type of research includes development of processing technologies that are scalable to meet local

needs as well as the needs of larger facilities. OMAFRA in particular needs research outcomes focused on the agri- technology side of this component.

Priority areas for research are:

a) In support of a circular economy, total utilization and integrated production of food/feed/specialty crops and high value/added value co-products (e.g. biorefinery, processing strategies for reuse of biobased industrial residues; fractionation of processed food/feed/specialty crops to capture high value co-products which remain after processing and conversion technologies have been utilized).

b) Biological (including genomic, enzymatic, yeast), thermal, chemical and/or mechanical (on and off farm) processing including nanotechnology-based approaches of the optimized plant biomass to yield bioproducts and enhancement of processes for economic and environmental benefits. For example: cost effective methods and efficient processes for conversion of agricultural feedstock and development of enhanced quality parameters.

c) Integration of biobased inputs with existing manufacturing industries (e.g., understanding of fossil-based processes and other biobased replacement opportunities); computer based models in bioproduct processing for input/output costs (gas, waste heat, feedstock preprocess to end products); processing technologies for use of biobased feedstock that are responsive to manufacturing issues; this could span all areas of bioenergy, biofibre/biocomposites, or biochemical.

3.2.3. BIOPRODUCT DEVELOPMENT RESEARCH

Bioproduct Development Research is defined as scientific research undertaken with the objective of incorporating the results (if successful) into particular product applications. The product may be entirely bio-based, an ingredient substitution, or biomass used in combination with fossil fuels. This includes products made from Ontario woodlots, but not boreal forests. Forest products/residuals may be a component or part of a blend, but a product which is 100 per cent from the boreal forest is not included in this definition. OMAFRA would benefit from collaborative research with other ministries and universities in Ontario which are recognized leaders in this research area.

Priority areas for research are:

Value added bioproducts (e.g. plastics, complex chemicals, high-end bio-materials, enzymes, veterinary/pharmaceutical drugs, cosmetics/ personal care products, latex, biopesticides, enabling biotechnology such as microbial tools/products for bioremediation and to drive bioprocesses), particularly those that have Canadian feedstock inputs, immediate processing opportunities and market applications. Examples include:

a) Advanced biofuels, higher-chain alcohols, drop-in fuels, biocrude, biochemicals for platform chemicals and bioalcohol from ligno-cellulosics;

b) Development of biochemicals and biomaterials from corn, soybeans, algae, other crops, and agricultural residue streams, as equal or superior (e.g. performance, environmental and health benefits) substitutes/ supplement for petrochemicals;

c) High performance micro-fibres, nano-fibres, nanoparticles, nano coatings and carbon fibres for light-weight, structural composite applications; biobased lubricants, durability

d) Bio fillers, composite reinforcement fibres, and biochemicals from agricultural residues and biofuel, agriculture and food processing co-products streams.

e) Carbonization, graphitization, pyrolysis of biomass for advanced biocomposites; advanced carbon material for green materials (e.g. super capacitors for battery applications)

f) 3D printing and bioproducts development & manufacturing for biomedical & automotive applications, mold design

g) Sustainable packaging for consumer products like toys, food packaging (recyclable, compostable, high barrier) and circular economy- waste to value added bioproducts applications

3.2.4. BIOECONOMY – INDUSTRIAL USES POLICY RESEARCH

Bioeconomy policy research is defined as research undertaken to help inform government decision-making. Research can include both economic and environmental impacts of the bioproducts sector, as well as identify areas where government initiatives or other tools may help stimulate further development of the sector to enable a successful bioeconomy in Ontario.

Over the last several years, OMAFRA and the Ontario government have made substantial investments in the bioeconomy. As the ministry continues to support the agri-food industry to deliver on the Premier's Growth Challenge to double its annual growth rate and create 120,000 jobs by 2020, efforts are also afoot to develop a robust performance measurement system for the agri-food sector, which will also help inform the ministry's policy and program development in the future. OMAFRA, therefore, is also interested in the development of performance measures that are related to bioproducts production in the province, including the use of agricultural feedstock for the production of bioproducts. Specific priorities for this year include research that focuses on:

- A time series of the quantity of Ontario agricultural feedstock that goes towards the production of bioproducts domestically and internationally;
- A time series of the rate of adoption of emerging crops use for bioproducts production in Ontario; and
- The competitiveness of Ontario's current agricultural feedstock for bioproducts production

Other areas of interest for Bioeconomy policy research include:

a) Economic research on bioproducts (e.g. biochemicals/biomaterials/ Bioenergy). Specific examples include:

    i. Feasibility of transitioning from conventional manufacturing to biobased or hybrid production using agricultural sources;

    ii. Economic viability of the development of bioproducts (biochemicals, biomaterials, bioenergy) including the biorefinery concept (e.g. several streams of value addition for the same feedstock), full utilization concept, or implications of public policies for bioproducts development;

iii. Barriers to scaling up of biochemical/biomaterial industries;

iv. Economic and other related impacts (e.g. impacts to other sectors, improved health, land use changes) of biochemical/biomaterial value chain development, including economic returns to primary producers;

v. Identification of gaps (economic, technology and infrastructure, intellectual property protection) in bioproduct value chains;

vi. Economics and barriers of using waste stream materials and other feedstock; competitiveness advantage of integrating waste (e.g. food processing waste), agricultural, and forestry feedstock supply chains in attracting platform biochemical firms to Ontario.

vii. Scan and inventory of regulatory requirements for any bioproducts or process to reach commercial viability.

b) Research into sustainability (e.g. indirect land use changes, specifically intensification; soil and water impacts), and life cycle impacts, which can be integrated into planning stages of research projects. This research would consider the short and long-term implications of biochemical/ biomaterial development with a view to enhancing their competitiveness. Specific examples include:

i. Life cycle analysis of bioproducts versus conventional petroleum-based products (e.g. quantifying the environmental impacts, including assessment of GHG emissions reductions) and economic benefits associated with different feedstocks, processing technologies, processes and products);

ii. Development of standards and performance indicators for bioproducts (quality standards of feedstocks and bioproducts to meet industry requirements, as well as environmental, human health and food safety standards).

c) Identification of incentives and disincentives that are or are not working in North America or other jurisdictions, related to the adoption and utilization of feedstocks for biochemicals and biomaterials. Specific examples include: research on risk mitigation to be an early adopter of greener products or new crop/market switching; risk management for new crops; procurement; and the role of financial sectors/structures.

d) Study on consumer awareness/ perceptions/demand on bioproducts (e.g. retail market trends and demand for bioproducts).

e) Study on the infrastructure, and regulatory/policy barriers (municipal, provincial, and federal) to organic waste use.

f) Study on the cumulative impact of multiple climate change and clean technology policies on feedstock use in the province for biofuels and bioproducts.

Note to Researchers: Please note the following linkages to priorities described in other themes to identify potential synergies and opportunities:

- The **Products and Value Chains** research theme has priorities related to **product and value chain development and assessment** that may be relevant to bioeconomy projects.
- The **Plant Production System** theme also has priorities related to the development of new bioproducts (e.g. **product diversification** priority).
- Biopharmaceuticals and cosmetics are considered in the Bioeconomy-Industrial Uses research theme whereas nutraceuticals and functional foods are considered under the **Food for Health** theme.
- Researchers seeking help in identifying potential priorities and collaborators may contact UofGuelph's Research Program Director or OMAFRA Theme Research Analyst

4: Emergency Management

4.1 Definition and Scope of the Theme

The Emergency Management research theme focuses on emerging, re-emerging or endemic pathogens and pests in livestock and crops that require (or may require) an immediate and comprehensive response for containment that cannot be handled with typical resources. The theme is rooted in "One Health" at the interface of livestock, ecosystem and human health, with a focus on agriculture. The Emergency Management research theme has an emphasis on evaluating and mitigating the impact of emergencies on Ontario's agricultural sector and related public health through the lens of the core components of emergency management: prevention, preparedness, mitigation, response and recovery.

Note: Research related to food safety is funded outside of the OMAFRA/UofG Partnership, through the OMAFRA Food Safety Research Program. Applicants interested in applying for funding for food safety projects should apply to that program. The next call for proposals is anticipated in spring 2018.

4.2 Emergency Management Research Priorities

The research priority areas for the Emergency Management Research Theme are:

- Economic Analysis
- Threat Identification and Prioritization
- Detection and Surveillance
- Pathway Analysis
- Prevention and Control of Pathogens and Pests.

Successful research proposals will align strongly with at least one of the specific research needs identified in the following priority areas.

4.2.1. ECONOMIC ANALYSIS

Emergency management initiatives and policies need to achieve their intended benefits while being cost effective for the agricultural sector. Information regarding the economic impact of emergencies is needed to weigh the costs and benefits of investing in emergency management to support the agricultural sector and protect public health.

Specific research needs:

- Quantify the costs and evaluate the effectiveness of emergency management best practices through analysis of emergency situations world-wide to identify and/or develop appropriate economic tools to guide emergency management resource allocation.
- Estimate the potential economic impact of emergencies and evaluate the costs and benefits of potential risk-reducing interventions in order to prioritize risk management options and support science-based decision and policy development with respect to emergency management activities.
- Evaluate the economic impact of changes in animal management practices that may result from trade negotiations as they relate to animal and product security, biosecurity, traceability and movement. (e.g. What impact would changes to supply management have on the cost of managing an emergency?)

4.2.2. THREAT IDENTIFICATION AND PRIORITIZATION

There is a need to identify and prioritize emerging, re-emerging or endemic pathogens and pests that require (or may require) an immediate and comprehensive response for containment that cannot be handled with typical resources. It is also important to understand the conditions under which these pathogens and pests may become a threat (e.g. due to changes in the environment). Results of this research will guide and facilitate optimization of resources to strategically manage risk to commercial agriculture and public health.

Specific research needs:

- Identify and prioritize the impact of changing environmental factors (including climate change) on the distribution and spread of pathogens and pests.
- Identify and describe the effect of policy decisions, production and management practices on threats to agriculture and related public health within the scope of this theme (see 4.1).
- Identify and quantify the risks of new or expanding transmission pathways or distribution patterns of pathogens and pests.
- Define and quantify the risk of pests and pathogens to agriculture and/or public health associated with the increase in the production of food in urban areas.

4.2.3. DETECTION AND SURVEILLANCE

Surveillance is important to animal, plant and public health and essential to ensuring the safe trade of plants, livestock, and animal and food products. Detection and surveillance of pathogens and pests helps to facilitate a timely response to changes in frequency and distribution.

Specific research needs:

- Define and collect baseline data about pathogens and pests within the definition and scope of this theme (see 4.1).
- Identify, evaluate and where appropriate merge existing data sources (e.g. agriculture and livestock sources, veterinarians, non-government organizations) that could be used to support emergency management in order to better predict, identify and understand potential short and long term threats to the agricultural sector.
- Identify and evaluate efficient and effective risk–based detection and surveillance methods and technologies.
- Detection and surveillance for antimicrobial resistance and pesticide resistance within the scope of this theme (see 4.1).

4.2.4. PATHWAY ANALYSIS

Pathway analysis is a systematic assessment of the pathways along which a pathogen or pest might enter or move within and between Ontario farms resulting in an outbreak in plants, animals or humans.

Specific research needs:

- Identify and model transmission factors for pathogens and pests that pose a threat to Ontario agriculture and public health within the definition and scope of this theme (see 4.1).
- Identify and describe transmission or distribution pathways that facilitate the spread of pathogens and pests within the definition and scope of this theme (see 4.1 - above).

4.2.5. PREVENTION AND CONTROL OF PATHOGENS AND PESTS

Preventing the introduction of a pathogen or pest is the most effective means to avoid or minimize risk, and can be considered the most cost-effective approach to emergency management. Effective prevention and control strategies that are affordable and can be broadly implemented are required. Research is required to support the development of new products, new approaches and best management practices.

Specific research needs:

- Develop effective prevention and control measures for pathogens and pests within the definition and scope of this theme (see 4.1 - above).
- Assess barriers/facilitators to the adoption of prevention and control methods within the scope of this theme (see 4.1). Example includes (but is not limited to) the impact of data confidentiality during an emergency.

- Emergency management response. Research needs include:
    - Identify and evaluate best practices for emergency management communications that considers the diverse stakeholders involved in the emergencies.
    - Research and development of efficacious strategies to support emergency response. Examples include (but are not limited to) development diagnostic tests and vaccines.
    - Evaluation and comparative analysis of emergency control measures.
    - Development and evaluation of humane methods for the mass destruction and disposal of livestock which minimize environmental impact.
- Assess the efficacy of existing traceability systems.

Note to Researchers: Please note the following linkages to priorities described in other themes to identify potential synergies and opportunities:

- Please refer to the **Production Systems** priorities for research needs relating to animal health, plant protection and antimicrobial resistance.
- Researchers seeking help in identifying potential priorities and collaborators may contact UofGuelph's Research Program Director or OMAFRA Theme Research Analyst

5: Environmental Sustainability

5.1 Definition and Scope of the Theme

The Environmental Sustainability (ES) research theme focuses on maintaining the ability of natural resources (soil, air, water and biodiversity) to support and strengthen agriculture, food and bioproduct sectors and rural communities by evaluating environmental, economic, and social perspectives. In order to support long-term sustainability of the agri-food sector (agro-ecosystem and food system) and address the concerns of society, OMAFRA invests in this research theme to:

- Understand the agriculture and food sectors potential risks and benefits to soil, water, air and biodiversity resources;
- Provide science for the development of credible and evidence-based government policies, programs and initiatives;
- Assess the effect of environmental policies on the agri-environment, agri-food sector's economics and rural society; and
- Identify opportunities for agriculture, food, and bioproducts sectors, and rural communities to provide solutions for societal environmental challenges.

5.2 Environmental Sustainability Research Priorities

The Environmental Sustainability research theme is focused on three main priority areas as given below.

- Understanding the drivers and stressors influencing the agri-food system's interaction with the natural environment
- Managing effects of the agri-food system using best management practices (BMPs) that consider economic, environmental and social implications
- Measuring provincial impact and defining optimum agri-food system management practices

The above three priorities are built on a continuous improvement approach to address ES research needs that support a sustainable agri-food system. Figure 1 describes the ES research continuum, linkages between research priority areas and desired outcomes of research to achieve the overall goal of the sustainable agri-food system.

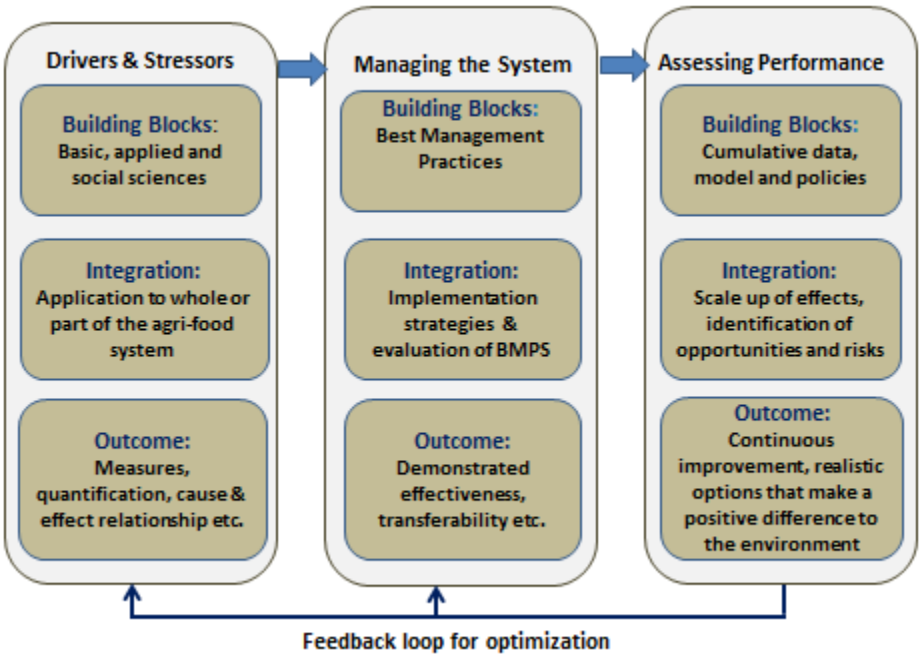

Figure 7.1: Environmental Sustainability Research Continuum

The three research priority areas are described below with key deliverables. Research proposals should clearly describe how they address one or more of the following priorities.

5.2.1. UNDERSTANDING THE DRIVERS AND STRESSORS INFLUENCING THE AGRI-FOOD SYSTEM'S INTERACTION WITH THE NATURAL ENVIRONMENT

An understanding of science that influences biophysical processes and resiliency of the agri-food system is necessary for environmental sustainability. Data and information that relate, describe and quantify environmental, economic and societal/behavioural changes of the agri-food system due to different drivers and stressors inform policy, program and management decisions. The agri-food system is both influenced by and influences the natural environment (climate, soil, water, air and biodiversity). Therefore, a detailed understanding of these relationships allows more effective management strategies. The role of various land use and agri-food practices on the quantity, fate and pathway of contaminants, and soil health needs to be understood and quantified. Concerns for water quantity and quality span many scales from farm to municipality to watershed to the Great Lakes basin. The implications of climate change for water management and other elements of agri-food production in Ontario, such as opportunities for expanding agriculture to the north, carbon sequestration and soil health, need to be anticipated and understood. This research area seeks to provide science to assist with proactive response options by the agri-food system due to different drivers and stressors in the context of the environment. Research projects need to consider linkages and collection of holistic and integrated datasets for soil, air, water, biodiversity, land management and economics, facilitating understanding of cumulative effects.

This research area will:

- Explain and quantify how drivers and stressors affect various biophysical processes of the agri-food production system. The examples of drivers and stressors include:
    - changing production practices,
    - land use,
    - climate change,
    - energy,
    - drainage,
    - farm enterprise composition and ownership,
    - increased market competition,
    - end-consumer influence,
    - technologies like precision technology, biotechnology,
    - species diversity legislation,
    - Great Lakes water quality - particularly as it relates to phosphorus.

- Quantify the impacts (benefits and risks) of agri-food production practices on soil, water, air and biodiversity. The topics of research include:
    - impacts on soil health,
    - soil degradation and loss,
    - soil carbon sequestration,
    - water quality and quantity,
    - odour, particulate matter and GHG emission, and
    - wild pollinators.
- Deliver cost- effective and efficient methods to measure the changes in the biophysical processes due to drivers and stressors on the agro-ecosystem. Life cycle studies

describe and quantify soil health, air emissions, water use and water quality and rate of behavioural adaptation.

5.2.2. MANAGING EFFECTS OF THE AGRI-FOOD SYSTEM USING BEST MANAGEMENT PRACTICES (BMP) THAT MEASURE ECONOMIC, ENVIRONMENTAL AND SOCIAL IMPLICATIONS

This research area supports the development of scientifically credible and cost-effective BMPs including recommendations for their transferability, prioritization and placement. The goal is to thereby reduce adverse effects or accrue benefits of agri-food production. Evaluation and validation projects are desirable even though a practice may not be considered “new or innovative”. On-farm or model farm research should be used as much as possible to assess practicality, define antagonism/synergy between BMPs and improve the adoption of BMPs that are validated. Integrated systems analysis should be used to put the biophysical, economic and behavioural considerations together. Investigation of the link between field scale and watershed scale effectiveness of BMPs is required to assess water quality or other benefits.

This research area also focuses on demonstration and valuation of the public benefits which the management of the agro-ecosystem provides in addition to the goods resulting from agricultural biodiversity (e.g. food and fibre production) which are already well recognized by society and have monetary value established through existing markets.

Continued development, evaluation and validation of BMPs are important to quantify trade-offs between soil/water/air/biodiversity impacts and environmental/economic/ social/ behavioral aspects of a practice.

This research area will:

- Develop new (or improve existing) methods, practice, farm level decision support tools, and technologies to reduce environmental risks and capture opportunities (including food safety, carbon sequestration) from economically sustainable agri-food production.
- Identify indicators or metrics to measure environmental, economic, social and biodiversity benefits or consequences of agri-food system management.
- Evaluate potential impacts of multiple BMPs and market opportunities of environmental stewardship facilitating greater use of BMPs.
- Analyze producer behaviour and willingness to adopt BMPs for policy, program development and KTT (Knowledge Translation and Transfer) leading to greater adoption of best practices.
- Assess the impact of various environmental policies, practice and technologies in Ontario for agricultural production and food processing.
- Understand the impact of BMPs/changes on the whole farm system including economics, practices, biodiversity, market opportunities, social license etc.
- Analyze and provide foresight on market opportunities for agricultural production that pertains specifically to environmental stewardship and sustainability.

5.2.3. MEASURING PROVINCIAL IMPACT AND DEFINING OPTIMUM AGRI-FOOD PRODUCTION SYSTEMS

Once we understand and quantify the underlying biophysical processes and adopt best practices to manage the agri-food system, it is important to measure agriculture and food's ability to effect changes that meets social, economic and environmental goals. There is a need to confirm that environmental improvements expected through BMP adoption are being achieved at different scales and in different combinations. This research uses risk/benefit assessment to define realistic options and develop what level of BMP adoption is required. It answers the questions "So what" by defining agri-environmental targets and the additional value or consequences for practices outside this range. The public values environmental benefits such as habitat, species protection, groundwater recharge and wetland filtering, and benefits to the producer such as agro-ecosystem resiliency and productivity which result from some adopted systems and practices. Quantification of the benefits and risks of sustainable agri-ecosystems is an objective of this research area that considers foresight or scenario development, and beyond the farm to sector to provincial scale.

This research area will:

- Forecast what level of BMP adoption is necessary to achieve desired environmental outcomes considering critical areas, critical mass for change and benchmarking for potential to effect change.
- Define the targets, confidence level and limitations for achieving soil, air, water and biodiversity quality to support sustainable agri-food production.
- Develop accountability to support provincial targets for environmental benefits. If we are not seeing a change why not?
- Create realistic options that support provincial scale BMP adoption by answering how and what is needed from farmers, food producers and land managers.

Note to Researchers: Please note the following linkages to priorities described in other themes to identify potential synergies and opportunities:

- **Climate change** is identified as a priority in other research themes.
- **Environmental Ecosystem Impact** is a priority areas under **Production Systems**
- Researchers seeking help in identifying potential priorities and collaborators may contact UofGuelph's Research Program Director or OMAFRA Theme Research Analyst

6: Food for Health

6.1 Definition and Scope of the Theme

The Food for Health research theme focuses on enabling:

- improved health for Ontarians through agri-food products
- increased competitiveness of Ontario's agri-food sectors through food for health

Research into food production, processing, distribution, retailing, access, and skills needs to be undertaken to improve Ontarians' health, help reduce health care costs associated with diet, and improve market opportunities for Ontario growers, manufacturers and related businesses.

Proposals should demonstrate:

1. **Targeted benefits to Ontario** (i.e. economic, social, environmental, competitiveness etc.)
2. **Collaboration** (e.g. with industry, grower groups, Ontario food for health initiatives, researchers in diverse fields/locations);
3. **Demand driven research** (i.e. have an established audience for the research outcomes);

Note:

Any projects under the Food for Health research theme developing a product, technology or service should include an analysis of the market opportunity for the product, technology or service to create value for Ontario, called a **Value Assessment Plan (VAP)**. The VAP includes components such as the stakeholder or group anticipated to benefit, the potential path to market, etc. that need to be considered in the early stages of the product/technology/service development process. See the Products and Value Chains research theme section of this document for more detail about preparing a VAP. It is expected that collaboration with a business resource or individual be built into the research proposal if the researcher does not have knowledge or resources to complete the VAP. Researchers may also wish to review the Products and Value Chains research theme priorities to consider an application to, or in part to, that theme.

6.2 Food for Health Research Priorities

6.2.1. POLICY, REGULATIONS, INVESTMENT, AND THE ECONOMY

This priority focuses on research that increases competitiveness for Ontario's agri-food sectors related to food for health and improves Ontarians' health through food. A key audience for this research is OMAFRA program and policy staff.

Proposals should focus on one or more of the following:

- Evaluate the benefit to Ontario of serving freshly-prepared meals made from fresh, locally available foods, in broader public institutions such as colleges and universities, schools, and municipalities (e.g. daycare, recreation centres).
    - Consideration should be given to multiple outcome measures, such as but not limited to seasonality, cost of fresh locally available food, nutrition, institutional budgets for food, health outcomes, user satisfaction, food waste and environmental footprint.
- Explore opportunities to create jobs in Ontario that relate to food for health.
- Examine how climate change and/or sustainable food production interact with food for health and access to healthful food in Ontario (e.g. soil health).
- Examine how to improve Ontarians' health using government-implemented policies, programs, regulations and behaviour change theories related to food (e.g. nutrition labelling, menu labelling, front-of-package labelling, advertising to children, trans fat, sodium and sugar reduction approaches, nudge based approaches to improve health).
- Explore how technologies (e.g. QR Codes, smart phones, retail video displays, websites) and additional information and logos on packaging influence information-sharing and inform consumer choice:
    - Do these change awareness of mandatory on-label health messages (e.g. allergen warnings, nutrition facts table, health claims)?
    - Are third-party endorsement systems that address consumer values and perceptions (e.g. fair trade; animal welfare; GMO free; halal; vegan, etc.) perceived as trustworthy and credible as other types of information on food packages?
- Identify, scan and analyze a model or models from other jurisdictions that could be adapted to Ontario to improve Ontarians' health through food and increase competitiveness for Ontario's agri-food sectors through food for health.

6.2.2. CONSUMERS AND HEALTHY CHOICES

This priority seeks to examine the opportunities and challenges facing consumers when choosing and utilizing healthful foods.

Proposals should focus on one or more of the following:

- Creation of tools to measure attributes of food literacy* and food skills** within the local food and public health context in order to reach consensus about the level of food literacy and food skills held by Ontarians. Consumer motivation to apply food literacy and food skills should also be a consideration.
- Appropriate models to determine the actual or estimated number of Ontarians who prepare meals with local food for family and friends, and/or make local food more available through food service providers.
- How to encourage healthy eating behaviours (e.g. nudge based behavior change, specific food skills, social license, public trust, public education campaigns).

- Apply the previous three bullets to Indigenous communities' traditional foods in Ontario. For example, traditional food literacy and food skills and their relationship to healthful eating and development of local/regional food systems; the role that traditional and local foods could play in addressing health outcomes – including mental health.

* *Food literacy* is the ability of an individual to understand food in a way that they develop a positive relationship with it, including food skills and practices across the lifespan in order to navigate, engage, and participate within a complex food system. It's the ability to make decisions to support the achievement of personal health and a sustainable food system considering environmental, social, economic, cultural and political components. *Reference – Cullen, T. et al.* Food Literacy: Definition and Framework for Action. *Canadian Journal of Dietetic Practice and Research*, 2015, 76(3): 140-145. http://dcjournal.ca/doi/abs/10.3148/cjdpr-2015-010

** "At an individual and household level, *food skills* are a complex, inter-related, person-centred, set of skills that are necessary to provide and prepare safe, nutritious, and culturally acceptable meals for all members of one's household." *Reference - Vanderkooy, P. Food skills of Waterloo Region adults. Fireside Chat Presentation. 1-20-2010. Online: www.chnet-works.ca*

6.2.3. UNDERSTANDING LINKAGES BETWEEN FOOD AND HEALTH

To meet this priority, the research project must build on or evaluate an Ontario program, policy or project. Examples of an Ontario program, policy or project that a research proposal could build on or evaluate include: the Fresh from the Farm **program;** Making Healthier Choices (menu labelling) **policy**; and a Growing Forward 2 **project**. More examples are listed below.

The research project must focus on improving Ontarians' health and increasing opportunities for Ontario agri-food competitiveness. The research proposal must make a strong and specific case for how the research benefits Ontario. Research proposals must also make a strong and specific case for how the research relates to the chosen Ontario program, policy, or project.

Applicants are encouraged to align their research proposal under this priority (6.2.3) with a sub-priority listed in 6.2.1 and/or 6.2.2.

More examples of Ontario programs, policies and projects:

The Healthy Kids' Strategy (policy); Healthy Kids' Community Challenge (program); Ontario School Food and Beverage Policy; Student Nutrition Program; First Nations Student Nutrition Program; Northern Fruit and Vegetable Program; Making Healthier Choices Act (menu labelling) (policy); Local Food Act (policy); Growth Plan for Northern Ontario (policy); and Ontario's Climate Change Action Plan (policy); projects previously funded by the Greenbelt Fund, projects previously funded by the Local Food Fund, projects previously funded by Growing Forward 2; projects previously funded by Ontario Trillium Foundation.

In preparing your proposal for this research priority area, consider:

- Collaboration or partnership is required (e.g. with a relevant association or third party administering an Ontario program, policy or project; with an Ontario program, policy or project; with a stakeholder who could benefit from the research).

- A letter of support from a relevant association or third party administering the program, policy or project (e.g. Greenbelt Fund, Ontario Trillium Foundation Grant Recipient) is encouraged with the research proposal, to indicate the demand for the proposed research.
- Care should be taken to ensure collaborations/partnerships respect the needs of all collaborators/partners (e.g. arms-length relationship; IP negotiations).
- This priority is not intended for projects that build solely on previously-funded OMAFRA-UofG partnership or OMAFRA open research program (New Directions, Food Safety) research project(s).

Note to Researchers: Please note the following linkages to priorities described in other themes to identify potential synergies and opportunities:

- **Climate change** is identified as a priority in other research themes.
- Research on access to healthy, affordable food is included in **Agricultural and Rural Policy** priorities.
- Product quality improvement priorities in **Production Systems – Plant** focus on the introduction of traits for human health
- Researchers seeking help in identifying potential priorities and collaborators may contact UofGuelph's Research Program Director or OMAFRA Theme Research Analyst.

7: Products and Value Chains

7.1 Definition and Scope of the Theme

This research theme focuses on product and value chain development that anticipates market opportunities for Ontario's agri-food and rural sectors to create a strong and resilient regional economy and support the Premier's Agri-Food Growth Challenge by encouraging innovation. New products and value chains in these sectors face challenges during their initial start-up phase while more developed products and value chains find difficulty at the scale-up phase; this theme hopes to address these issues.

Within this theme "**product"** encompasses:

- physical products or technologies in/for the marketplace (e.g. food products, enhanced agricultural commodities, retail technologies, processing technologies, robotics, etc.);
- services, on their own or as a part of a physical product or technology; and
- organizational processes, or collaborative initiatives.

A **value chain** in this theme is defined as a strategic partnership among inter-dependent businesses and potentially other organizations that collaborate to create value resulting in improved competitive advantage for all members in the value chain. The result is market-focused collaboration.

The definition of **value** in this theme includes:

- market value, derived from the sale of products, services and technology solutions;
- competitive advantage that benefits businesses through the value created by improving efficiency, reliability, quality, customer responsiveness and innovation;
- improved economic performance of Ontario's agriculture, food and rural sectors; and
- socio-economic value including improved environmental sustainability, enhanced corporate social responsibility and regional economic development.

The strongest proposals will be collaborative, drawing on the combined strengths of more than one researcher, using a multi-disciplinary approach, and engaging early with any collaborators who can increase the likelihood of the product and/or value chain entering the marketplace and/or being valuable to Ontario industry. Successful projects will demonstrate that appropriate links have been made between the laboratory and the market place.

Research projects funded under this theme have to address an opportunity or solve a problem in a manner that creates value.

Proposals must include a Value Assessment Plan (VAP). The goal of the VAP is to demonstrate the value (as defined above), of your proposed project and to identify and communicate the thinking and planning required for product or value chain development success.

Complete the VAP document, save it to your computer, and append it to RMS as a PDF with your application.

7.2 Products and Value Chains Research Priorities

7.2.1 PRODUCT DEVELOPMENT AND ASSESSMENT

Product development and assessment projects can include research done on any aspect of product development from initial concept to prototype development to scale-up manufacturing and marketing, or inbound and outbound logistics and services that might be added to create value at any point in the value chain. Make connections/partnerships to increase the potential for your research to have a beneficial impact for Ontario.

Proposals should focus on one or more of the following:

a) An in-depth research analysis of a product or value chain outlining the economic feasibility and benefits for Ontario agriculture, food and rural sectors (above and beyond those conducted in the Value Assessment Plan). Aspects of your work might include: Intellectual property analysis; product development process analysis; analysis of opportunities for improvements related to climate change; technical feasibility study on ingredient supply (commercial) and availability, equipment, process, packaging, shelf-life etc; and scale-up analysis for Ontario agri-foods.

b) Develop a prototype that is ready to be commercialized.

c) Investigate climate change/sustainability related to a product or value chain. For example, product development of clean technologies for agriculture and food processing that reduce energy and/or water usage; improve waste water management, greenhouse gases, etc.; opportunities to use low value products (also known as waste)?

7.2.2 VALUE CHAIN DEVELOPMENT AND ASSESSMENT

The value chain development and assessment priority focuses on the effective development of specialized value chains for Ontario based entrepreneurs (SMEs small and medium sized enterprises). Value chains can be built to develop and market a new product, improve competitive advantage, create other socio-economic or regional development benefits. Research should provide results that will help the development of a new value chain for Ontario and/or guide SMEs and/or other organizations to viable, value added opportunities.

Proposals should focus on one or more of the following:

- Increase Domestic Market Access –
    - Ontario's domestic marketplace demands a large quantity and variety of foods that can be produced within the province. This sub-priority seeks to identify one or more increased domestic market access opportunities, how Ontario's agri-food sector could successfully realize this opportunity with Ontario-produced and/or -processed foods using Ontario ingredients, and if possible, through collaboration and partnership, implement opportunities identified. Areas of research might include regulatory challenges at the municipal, provincial, and federal level and potential solutions to realizing this opportunity by accessing existing resources, partnering with business and/or government to address challenges.
- Do Consumer Research –
    - Ontario's marketplace and export food marketplaces are becoming less homogeneous with a greater diversity of products being demanded by consumers with specific product attributes (e.g. organic, local, no added hormones, no antibiotics, gluten-free etc.). These markets offer opportunities for Ontario firms and products. More research is required to determine market premiums across the value chain associated with specific product attributes or bundle of attributes within a market along with which product attributes are critical to success in that market.
    - Social license can drive market trends. Research how to optimize the value of social license for members of a value chain (e.g. acceptance of practices by consumers; requests by retail for free-from, organic, local, gluten-free, etc).
- Make a Value Chain work –
    - Investigate how to apply, and the impact of applying, a strong and integrated food value chain model from another jurisdiction (i.e. Netherlands, Israel, UK, Australia, others) in Ontario. Could investigate resources and tools used by these jurisdictions (i.e. communication, trust-building, engaging SMEs along the value chain, value chain resources).

- Regional Economic Development –
    - Economic development strategies require effective collaboration between a myriad of stakeholders in the private and public sector including multiple levels of government, regional organizations, non-government organizations, individual businesses and industry associations. This sub-priority is focused on value chain research to improve economic outcomes for rural Ontario. For example, develop and assess a value chain to build capacity in rural Ontario beyond infrastructure needs; research the true cost of monoculture and the value chain economics of diversification in agriculture.
    - Investigate how lenders view farms that practice "sustainable agriculture" vs traditional.
    - Evaluate sustainable opportunities and engage with partners to move agriculture and food value chains north, particularly in view of a changing climate. Some key opportunity areas are cereals, beef, aquaculture, new food processing.

- Climate Change
    - Develop a value chain to reduce agri-food and related waste in Ontario. For example, agriculture and/or food products into animal feed and/or packaging, decrease need for water, improve process inefficiencies.
    - Investigate opportunities to establish metrics / standards for sustainability along the agricultural supply chain.
    - Determine opportunities and challenges of urban agri-food value chains for climate change, and economic benefit to Ontario.

Note to Researchers: Please note the following linkages to priorities described in other themes **to** identify potential synergies and opportunities:

- **Agri-Food and Rural Policy** theme (e.g. a priority for Value Chain development specific to the Greater Golden Horseshoe area)
- **Animal and Plant Production Systems** theme (e.g. product diversification and product quality improvement research priorities).
- **Bioeconomy** theme (e.g. bioproduct development research priority)
- **Food for Health** theme (e.g. development of a food for health product)
- **Climate change** is identified as a priority in other research themes.
- Researchers seeking help in identifying potential priorities and collaborators from OMAFRA and other organizations may contact UofGuelph's Research Program Director or OMAFRA Theme Research Analyst

8: Production Systems

8.1 Definition and Scope of the Theme

One approach to identifying what is in-scope for this theme is to pose the following questions, the answers to which would direct where Production Systems research resources should be applied. The first two questions are hypothetically posed to farmers and the third to the research community.

For farmers:

How can I enhance my farm productivity and profitability? (economic, stability and new challenges/opportunities)

How can I adapt to societal or external pressures and variables? (links to other themes)

For researchers:

What do we need to do to answer these questions for farmers? (This approach is termed "reverse engineering". When the market or society provides the direction, Production Systems research engages to provide the solution.)

Definition and Scope of the Theme

First and foremost, Production Systems research must focus on production research and profitable agriculture. Secondly, the Production Systems research capacity can be employed to incorporate the needs of other themes into profitable systems.

The Production Systems Theme encompasses the development of agricultural production systems that will enhance profitability of agricultural production, while incorporating issues, opportunities and advances arising from related research areas that address the greater societal environment within which production agriculture operates, including environmental sustainability, emergency preparedness, end product expectations with regard to food (healthy eating) and non-food (industrial) uses, value chain opportunities and agriculture and economic development policy directions.

Production Systems – Key Research Areas

Plant Protection – Research in this area includes improving Integrated Pest Management (IPM), understanding the biology, ecology and management of current and invasive pests. This includes identification, tracking and monitoring, identifying biosecurity practices and protocols (especially related to maintenance of trade) and improving diagnostics and surveillance techniques to improve pest management and manage pathogen resistance.

Animal Health and Welfare – Research in this area includes production limiting diseases (including detection methods – e.g. prions), zoonotic diseases related to production, animal welfare/behaviour, antimicrobial resistance and the use of non-antibiotic therapeutics, emerging

and foreign animal diseases, biosecurity and traceability, diagnostic techniques and disease surveillance methods.

Production Efficiency – Research in this area includes profit enhancement and improved efficiencies, reductions in labour, energy saving technologies and processes, reduced input costs, more efficient use of land, labour, energy, etc., waste stream reduction and reuse, alternate livestock feeds.

Environmental/Ecosystem Impact – Research in this area includes resource use, including water management, environmental impacts on natural and man-made environments, alternate pollinators, alternate energy generation, climate change induced challenges and opportunities, reduction of harmful emissions, maintain biodiversity.

Product Quality Improvement – Research in this area includes studies focusing on the introduction of traits for human health (e.g. omega 3, lycopene, Vitamin E), the introduction of traits to enhance value – (higher oil content), new markets or new products, storability and post harvest extension/shelf life.

Product Diversification – Research in this area includes new product development and associated production systems, climate change response (e.g. different crops), or different production strategies, or expansion of crop production to different land, market research to determine market demand and/or consume preferences for new products and/or uses.

Genetic Technologies and Reproductive Technologies – This research area focuses on genetic and reproductive technologies necessary to develop research in new products and specialty crops, enhance the marketability of existing products, improve productivity in pest management, environmental and end-use quality traits and to maintain our gene pool.

These descriptions of the broad key research areas above will be used to evaluate Tier II proposals for the Plant and Animal Production Systems theme for 2015-2016.

8.2 Plant Production Systems Research Priorities

NOTE TO RESEARCHERS: **Proposals must clearly identify which specific priority is being addressed as well as how the proposed research will address a specific priority. Proposals that do not address the specific priority areas indicated below will not be eligible for Tier I funding and may be better suited for Tier II funding.**

All research areas apply to both conventional and organic production systems

8.2.1. PRODUCT QUALITY IMPROVEMENT

Edible Horticulture:

- Improve product quality and shelf life **of berries** through the entire value chain (i.e. crop management, postharvest management, packaging, storage)
- Develop an easy-to-use test to identify buddy sap prior to processing into **maple syrup**.
- Identify and remediate factors 1) causing pesticide residues in **Ginseng production** and 2) leading to risk perceptions of pesticide use by the public**.**

- Improve product quality of **fruiting vegetables** specifically around harvest and along the entire fruiting vegetable value chain.
- Investigate methods to optimize **tomato** solids, quality and yield through drip irrigation/fertigation, various soil types and/or through genetics.

Ornamental Horticulture:

- Understand and improve plant establishment and survival in challenging environments, especially with regards to root growth in container **nursery production** and compacted soils.

Field crops:

- Identify production practices that improve **barley** (malting barley), **oat** (β-glucan), **soy** (protein quality, sugar levels: sucrose soy milk, dessert tofu, and isoflavones), **wheat** (protein levels and health benefits) and **edible bean** quality for specific end uses leading to value-added markets.
- Investigate conditions causing brown seed and increased free fatty acids in **canola,** including genetic- environment (GxE) interactions to improve quality and marketability.
- Investigate harvest and storage technology for **forages** to reduce losses, improve quality and marketability.

8.2.2 PLANT PROTECTION

Edible Horticulture:

- Develop integrated pest management strategies for **horticultural production** systems that incorporate pesticides, alternative control measures, host resistance and/or take a systems approach to controlling pests, disease and weeds.

Ornamental Horticulture:

- Research is needed for more effective and sustainable control of insects, weeds and disease in **ornamental plant production and landscape maintenance**. In greenhouse floriculture the primary focus should be on biocontrol strategies.

Field crops:

- Resistance identification and management strategies for fungicides, effective management of Fusarium pathogens and associated mycotoxin accumulation, soybean cyst nematode (SCN), soybean sudden death syndrome (SDS), foliar diseases, oat crown rust, seedling diseases,root rots, alternaria, sclerotinia and club root.
- Chemical and biological control options for pests of **canola**, as well as control thresholds, reproductive biology, scouting practices, and agronomic practices that mitigate damage by pests including: swede midge, striped flea beetle, and crucifer flea beetle, (issues are in order of priority).
- Develop effective management strategies that consider resistance identification, and root and leaf disease management for pests and pathogens in **edible bean production.**
- Develop integrated weed management strategies that consider management of herbicide resistance, and/or biology and ecology of specific weed species.

- Develop management strategies (non-pesticide or biopesticide) for insect pests and/or define early-season soil insect thresholds.

8.2.3 PRODUCTION EFFICIENCY

All Horticulture

- Develop and evaluate automation systems or other strategies to improve high labour costs and availability of labour in all horticulture crops.

Edible Horticulture:

- Develop soil health and/or nutrient management strategies that improve crop quality and/or environmental sustainability in **bulb and root vegetables**.
- Develop strategies to improve long term profitability of **leafy and crucifer vegetables** that improve production efficiency and market diversification.
- Develop agronomic practices and efficiencies for new and **speciality crops**. Examples include propagation and establishment, fertility and water requirements, season extension, harvesting methods and post-harvest handling and storage issues.
- Viticulture research to improve grapevine health and winter survival

Ornamental Horticulture:

- Utilize water more efficiently in ornamental plant production with strategies that are economically viable and commercially practical.
- Develop strategies to optimize the use of nutrients in plant production in order to reduce input costs, promote plant health and manage water runoff.
- Develop strategies to improve irrigation water quality by optimizing source water, irrigation systems and/or storage and recirculation systems.
- Improve energy efficiency in greenhouse production. Strategies to reduce energy use that are economically viable and commercially practical.
- Strategies to improve plant production with supplemental lighting.

Field Crops:

- Develop strategies to optimize the use of nutrients in field crops, particularly nitrogen, phosphorus, sulphur (including developing a test for sulphur) and potassium.
- Validate precision agriculture technologies for use as agronomy research tools that improve efficiency and accuracy of data generation to better address experimental variables and offer opportunities for economic gain.

8.2.4 ENVIRONMENTAL ECOSYSTEM IMPACT

Edible Horticulture:

- Develop strategies to improve environmental sustainability in **greenhouse vegetable production** through reducing carbon emissions per unit produced (e.g. renewable energy, breeding for low light and temperature varieties, more insulated greenhouse coverings, etc.); and /or improved management of greenhouse waste.

Field crops:

- Effectively integrate cover crops into field crop cropping systems (including identifying crop, soil, and/or environment benefits & detriments).
- Identify soil health parameters (i.e. soil organic matter, soil carbon, soil structure, water holding capacity, pH, etc.) including soil ecology and practices affecting crop resilience under various stresses.
- Identify the impacts of various tillage systems on phosphorous and nitrogen best management practices in various major soil types that would ensure productive crops and mitigate nutrient losses (considering both short term and long term effects of phosphorus use).
- Identify and validate best management practices and risk assessment tools for phosphorous in terms of both crop productivity and potential for phosphorous loss (in soluble and particulate forms) throughout a year, including consideration of soil type and weather.
- Investigate production practices for their efficiency and effectiveness at sequestering carbon, along with the practicality and profitability of these practices.
- Assess the function of soil biology and microbiology populations, their effect on the soil, and the implications of farming practices on these populations (e.g. tillage, commercial fertilizer, fumigation, cover crops).

8.2.5 PRODUCT DIVERSIFICATION

Edible Horticulture:

- New variety acquisition, development, best management and commercialization process in **tender fruit production**.

Ornamental Horticulture:

- Understand market trends, quantify environmental benefits, identify what plants to grow, when to supply them, and how to present and market them.

Field crops:

- Develop bioproducts and new food uses that are connected to existing and emerging market opportunities.

8.2.6 GENETIC TECHNOLOGIES

Edible Horticulture:

- Identify and evaluate new **potato** lines that can help to provide a 12 month supply of high quality potatoes to the Ontario fresh and chip processing industries through value added traits such as early maturity, long term storage-ability and nutritional potential, any of which would serve to enhance the competitiveness and profitability of the Ontario potato industry.

Field crops:

- Develop high-yielding, high-quality **barley, corn, oat, soybean, and winter & spring wheat** varieties adapted to Ontario, with genetic resistance to important pathogens including Fusarium in wheat and barley, and corn, foliar pathogens,

soybean cyst nematode (SCN), soybean sudden death syndrome (SDS), Phytophthora, root rot complexes, seedling diseases, and oat crown rust.

- **Forage** varietal effects on management factors, such as Neutral Detergent Fiber (NDF) and fiber digestibility (milk/beef/acre), Roundup Ready alfalfa, manure tolerance and yield response, intensive cutting schedules, and other parameters.
- High yielding **edible bean** varieties and varieties with resistance to the most important diseases; improved quality traits (seed size, seed coat integrity, seed coat colour)
- Development of high yielding spring and winter **canola** varieties adapted to Ontario conditions expressing resistance/tolerance to insects and diseases, improved stand-ability for direct harvest, low pod shatter, tolerance to frost, and specialty oil profiles.

Note to Researchers: Please note the following linkages to priorities described in other themes to identify potential synergies and opportunities:

- The Production Systems '**Product Diversification**' priority has potential linkages to priorities under the **Products and Value Chains and Bioeconomy** research themes.
- **Climate change** is also a consideration in other themes, particularly **Environmental Sustainability** and **Agri-Food and Rural Policy** research themes.
- Researchers seeking help in identifying potential priorities and collaborators may contact UofGuelph's Research Program Director or OMAFRA Theme Research Analyst

8.3 Animal Production Systems Research Priorities

NOTE TO RESEARCHERS: Proposals must clearly identify which specific priority is being addressed as well as how the proposed research will address a specific priority. Proposals that do not address the specific priority areas indicated below will not be eligible for Tier I funding and may be better suited for Tier II funding.

Priorities that do not identify a specific sector apply to all livestock species.

All research areas apply to both conventional and organic production systems

8.3.1. ANIMAL WELFARE

Research is needed to:

- Investigate economically viable housing systems and management practices in **poultry, pork, veal and rabbits** that align with market and consumer demands and

which meet animal health and welfare needs.

- Investigate techniques that alleviate and prevent the stress and pain associated with currently accepted animal management practices, injury and poultry & livestock housing in **pork, dairy and poultry** production.
- Reduce stress, pain and injuries during transportation, at livestock markets and at slaughter for **veal, beef, goat and dairy** sectors.

8.3.2 ANIMAL HEALTH

Research is needed to:

- Reduce the use of medically important antimicrobials by:
    - Investigating alternatives to antimicrobial treatments (natural or manufactured) and/or;
    - Investigating management programs/tools that reduce the need for antimicrobial treatments. (Areas of research might include genetic selection, nutrition, biosecurity, herd and environmental management).
- Quantify the contribution of livestock and antimicrobial use in livestock to antimicrobial resistance, and quantify the impacts of reduced antimicrobial use in animals.
- Reduce the risk of disease and mortality in **sheep, goats, veal and mink.** Areas of research might include: validation of the efficacy of existing vaccines, protocols and anthelmintics, ration formulations for high yielding stock, housing design, neonatal management, reduction of stress and genetic selection.
- Investigate and validate precision agriculture technologies for animal health, particularly for enhanced disease detection and diagnosis.

8.3.3 PRODUCTION EFFICIENCY

Research is needed to:

- Identify factors impacting feed efficiency including nutritional programs with by-products, alternative feeds, or non-human-consumable feed ingredients, and the use of new technologies or treatments that improve feed efficiency.
- Improve efficiency in **poultry and swine** production driven by electricity prices.
- Identify new technologies that will enable production efficiencies in the **poultry and beef** sectors.
- Understand the nutritional requirements of **goats** during different stages of development and production.
- Investigate genetic and/or reproductive management methods to maximize production efficiency.
- Benchmark production costs to identify means of sustainably increasing profitability and farm business resiliency.

- Investigate and develop production management practices suitable for animal agriculture in northern Ontario.

8.3.4 PRODUCT QUALITY IMPROVEMENT

Research is needed to:

- Investigate means to produce highly marbled and high yielding **beef** carcasses that meet consumer demands.
- Investigate means to cost effectively improve **sheep** wool quality.

8.3.5 ENVIRONMENTAL/ECOSYSTEM IMPACT

Research is needed to:

- Reduce the environmental impacts of beef and pork production while maintaining productivity. Specifically around the reduction of phosphorus through feed **in beef and dairy production** and manure management programs **in beef and swine.**
- Measure the potential impact of climate change on animal production systems in Ontario and develop methods to mitigate expected effects of climate change on animal welfare, health and productivity.

Note to Researchers: Please note the following linkages to priorities described in other themes to identify potential synergies and opportunities:

- Please refer to the **Emergency Managementtheme** when dealing with new or emerging diseases.
- Please refer to the **Agri-Food and Rural Policy** and the Emergency management theme for other priorities relating to **antimicrobial resistance**
- **Climate change** is also a consideration in other themes, particularly **Environmental Sustainability** and **Agri-Food and Rural Policy** research themes.
- **Products and Value Chains** priorities (e.g. Identify new technologies to enable production efficiencies in the poultry and beef sectors)
- Researchers seeking help in identifying potential priorities and collaborators may contact UofGuelph's Research Program Director or OMAFRA Theme Research Analyst.