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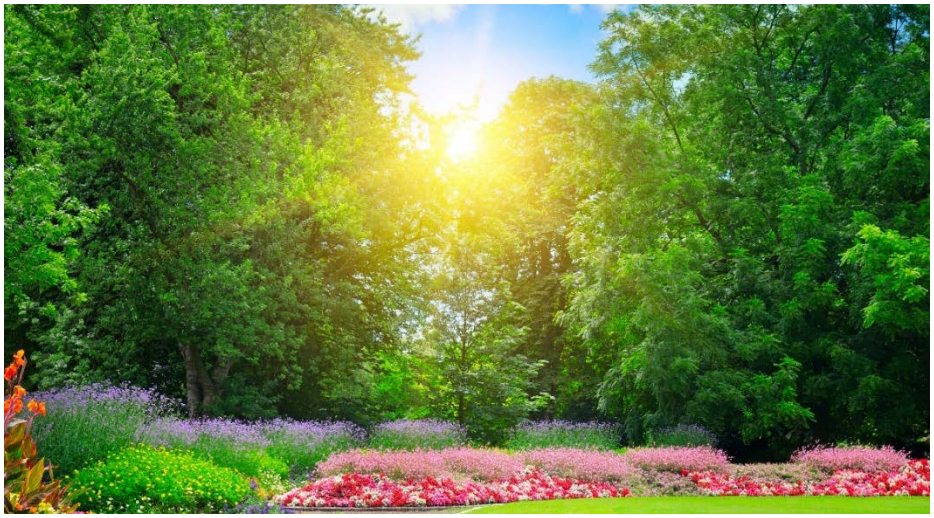
RESEARCH & INNOVATION CENTRE

Ontario Horticulture Research Priority Report 2022



ONTARIO FRUIT & VEGETABLE GROWERS' ASSOCIATION

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FLOWERS CANADA GROWERS

Contents

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Introduction

Innovation and research can be a driving force that enhances growth, profitability and sustainability in any sector, including horticulture. To achieve the greatest impact from investments in research and innovation, there is a need for a co-ordinated, strategic approach that achieves a balance of both short and long term goals.

Horticulture is a unique and challenging sector due to its sheer diversity, with around 150 different fruit and vegetable crops, thousands of ornamental species plus mushrooms, maple syrup and honeybees. Defining research priorities for this large, diverse sector is a challenging task that requires co-ordinating input from many different groups.

As part of our renewed commitment under the *Canadian Agricultural Partnership*, Vineland Research and Innovation Centre (Vineland) facilitates the collection of the Ontario horticulture sector's research priorities. These are then used as input for OMAFRA's priority setting system, they are used to shape Vineland's own research strategy and they are provided to Agriculture and Agri-Food Canada and other research providers to assist them in meeting the needs of the Ontario industry.

Vineland's role in this process is simply as a facilitator, the actual delivery of research projects will continue to include the University of Guelph, AAFC, Vineland and any other research providers.

Approach

Priority-setting is an evolving process for which Vineland has worked alongside the major sector organizations for more than ten years to develop a process that ensures the research needs and opportunities of the sector are identified.

One of the fundamental principles that has shaped this process is the need for narrowing the focus of the priority list. A shorter, more specifically-worded priority list is more realistically aligned to the level of available resources and provides much clearer direction to funders and research providers.

The consultation process is focused on grower representation where sector groups are invited to nominate their own representatives to participate. In a few cases where sector groups are absent or otherwise lack capacity to determine research priorities, OMAFRA crop specialists are nominated to represent the category. Wherever possible, a full value chain perspective is taken although it can be challenging to bring together what can be disconnected or even competing groups within the sector.

Due to the diversity of crops, production systems and consumer markets, separate processes are conducted for the edible and ornamental horticulture sectors.

Participants in the process are encouraged to take a big picture view of the long term growth and sustainability of their sector in order that the priorities achieve a balance of long and short term goals. In this context, “short-term” refers to a goal that could be achieved in one to three years in a single research project and “long-term” goals may take many years to achieve with multiple projects, grants and researchers involved.

Specific topics for evaluation and registration of pesticide products are not considered in this process as they are covered by the Minor Use Pesticide Program.

As research priorities generally remain fairly consistent from one year to the next, formal priority setting meetings are held only every three to four years. In interim years, sector groups are given the opportunity to edit their priority list to reflect any new issues that may have arisen. This report is prepared and distributed each year to include the latest updates.

The development of a research strategy or priority list is the first step that helps to provide focus and direction. Then, actually implementing these priorities requires leadership from both industry groups and researchers. Both need to work together to come up with specific project ideas and matching funds and develop proposals for applying to research funding programs.

Edible Horticulture

Sector Consultation

A sector-wide research consultation was co-hosted by Vineland Research and Innovation Centre (Vineland) and the Ontario Fruit and Vegetable Growers Association in January 2017. This meeting allowed grower groups to discuss areas of common interest and share their approaches to decision making and research-funding. The priorities themselves were determined by the individual associations and representatives for each crop category and included in this report, updated annually.

Pest Management (including pests, diseases and weeds) is a high priority need for virtually all horticultural crops and tends to be front of mind for many growers dealing with these issues on a daily basis. In order to maintain a balanced perspective and encourage big picture long term thinking with a range of research topics, pest management is automatically included as one priority with up to four additional ones reserved for other topics. Grower representatives are invited to provide further details to identify the specific pest problems and desired solutions for their crops.

All priorities in this report are recorded as submitted by the designated representative with only minor adjustments made to ensure they align to the five priority format. Numbering has been used where clear prioritization has been indicated, otherwise, bullet points are used to indicate non-ranked priorities.

Edible Horticulture Research Priorities by Crop Group

Pest Management Priority: All Crops

Developing 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.

Apples

Pest Management

Development and adoption of sustainable Integrated Pest Management (IPM) practices and resistance management for conventional and organic orchards. Research could include:

- Strategies for management of fire blight.
- Development of an integrated approach for difficult diseases and disorders. For example, but not limited to, the canker complex and replant disease complex.
- Evaluate the efficacy of sprayer application methods. For example, but not limited to, border sprays, alternate row spraying and use of new equipment designs.
- Due to the loss of broad-spectrum crop protection products, evaluate management strategies and pesticide efficacy.
- Investigate new application or IPM technology.
- Strategies for monitoring, intervention and management of invasive species and emerging issues. For example, but not limited to, BMSB, Spotted Lanternfly and Sudden Apple Decline (SAD).

Other

1. Technology, Mechanization, Automation & Efficiencies

Increased production efficiencies through the use of the latest technologies and precision agriculture. Priorities (not ranked) include, but are not limited to:

- Labour efficiencies
- Pest management and crop protection efficiencies
- Weather risk efficiencies
- Water use efficiencies
- Modelling (for example, Ontario solutions using existing models for crop load management and integrated pest management)
- Remote sensing, software development and robotics
- Technology in storage and packing efficiencies
- Orchard design

2. Sustainable Practices

Optimizing sustainable cropping practices for conventional or organic production according to variety and climatic conditions. Research could include:

- Crop load management
- Training systems
- Carbon capture
- Irrigation
- Fertigation
- Soil management
- Nutrition

3. Maximizing Quality & Minimizing Losses

Crop maturity management and post-harvest storage conditions and treatment strategies with the goal of delivering a larger percentage of high-quality fruit for the fresh market. Research could include:

- Post-harvest research developing storage regimes for in-demand varieties

- Optimal harvest management and timing
- Strategies to reduce storage disorders

4. Variety & Rootstock Development and Evaluation

Variety and rootstocks development and selection according to consumer preferences and their performance in the different regions with the goal of achieving greater market share. Research could include:

- New variety breeding and evaluation
- Scion and Rootstock evaluation (i.e. winter hardiness, drought efficiency)
- Genomics
- Consumer preference studies

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Berries

Pest Management

1. Insect and Disease Management – Berry growers are faced with several challenging insect and disease pests that have a serious impact on the economic viability of growing berries.
    a. Spotted Wing Drosophila – this pest has become common in all berry growing areas of Ontario. New products have been registered but there continues to be a need for products with short harvest intervals. Continued research is needed on long term strategies for this pest including cultural management and education as well as the feasibility for biological controls including predators and parasites of SWD. It is critical that AAFC and other institutions stay abreast of biological control options that are occurring in other parts of North America as well as around the world.
    b. Anthracnose – fungicide resistance to pyraclostrobin (FRAC group 11) fungicides has been documented in Ontario and there is a need for additional products to manage this disease. Disease resistant cultivars and or management techniques used for propagation could also play a role in managing this disease.
    c. Neopestalotiopsis – a new disease of strawberries this pathogen is very aggressive damaging strawberry roots, crowns, leaves and fruit. There are no products labelled in Canada for this disease and there is not a lot known about management with fungicides. The disease has been found in Ontario but because it has similar symptoms to other strawberry pathogens it may be hard for growers to detect that they have Neopestalotiopsis. Surveying and sequencing will help us understand the disease.
    d. Cyclamen Mite – with the loss of endosulfan this pest has caused an increased amount of damage in strawberry. Additional products and alternative management strategies are needed to combat this challenging pest. Cyclamen mite control is critical for the plant growers to supply the industry with clean plants.
    e. Bacterial Diseases – Angular leaf spot is a bacterial disease that affects the leaves and calyx in strawberries. There are limited control options, including cultural controls such as minimizing overhead irrigation, which is not a viable option in growing conditions that are dry or where frost protection is needed. Spray options require frequent applications to supress the disease. Control options need to be explored for this disease.
    f. Virus Complex – virus complexes have caused significant damage to the Ontario strawberry industry. Growers are now managing aphids as a way of managing this complex. Blueberry and raspberry plants are also impacted by virus. Recognizing and management of virus is critical to surviving the impact from virus infections. Clean plants are critical for minimizing the impact of viruses.
    g. Western Flower Thrips – this pest has become very serious as there are few to no effective control products. The use of biological control needs to be evaluated and management protocols need to be put in place.

h. Soil Borne Diseases -- optimizing soil health is the key to healthy berry industry. Berry growers have seen decline in berry plantings as a result of soil borne diseases and nematodes. Growers have had to depend on fumigation to manage the complex of soil diseases. Fumigants are expensive and several formulations have or are being phased out of production in Canada. Further research is required to find tools to manage soil borne diseases and increase general soil health. It is critical that berry growers can purchase clean disease-free nursery plants and thus Canadian nurseries require the tools needed to supply these clean plants.

1. Soil Health – optimizing soil health is the key to a healthy berry industry. Berry growers have seen a decline in berry plantings as a result of soil-borne diseases and nematodes. Growers have had to depend on fumigation to manage the complex of soil diseases. Fumigants are expensive and several formulations have or are being phased out of production in Canada. Further research is required to find tools to manage soil-borne diseases and increase general soil health. It is critical that berry growers can purchase clean disease-free nursery plants and thus Canadian nurseries require the tools needed to supply these clean plants.

2. Pest Management Products – There continues to be a loss of older broad-spectrum pest control products. For long term viability of the berry industry it is critical that these products have their registrations maintained or be replaced with effective materials. Resistance management is a real concern where in some cases growers are limited to one or two products to control pests which lead to no opportunity of rotation to preserve the efficacy of these products. Resistance management via cultural control methods and grower education should be a priority. To be useful these products must have workable pre-harvest intervals as well as re-entry intervals. There is a need to continue to register new products and to harmonize these registrations with the U.S. to ensure we do not continue to be at a competitive disadvantage. There is an opportunity to limit worker exposure, reduce crop residues and increase efficacy through the use of pest management treatments through drip irrigation. Registrants should be encouraged to continue to investigate this option.

Other

1. Production Systems/Robotics/Labour - the number one expense to berry growers is labour with the majority of cost being for harvest labour. Robotics, harvest aids and other labour-saving technologies need to be investigated and optimized for Ontario berry growers. Cultivation robots could be used to help growers with tillage, spraying, night-time application and more.

There is an increased interest in new or alternative production systems including the use of artificial media, protected culture and season extension techniques. Interest has stemmed from soil health issues as well as the need to optimize labour and to take advantage of extended production seasons to market locally produced berries. It is critical to seek and test new production systems. OMAFRA staff should be encouraged to travel to find new technologies and have the opportunity to test and implement with growers in Ontario

2. Pest Management Products - There continues to be a loss of older broad-spectrum pest control products. For long term viability of the berry industry, it is critical that these products have their registrations maintained or be replaced with effective materials. Resistance management is a real concern where in some cases growers are limited to one or two products to control pests which lead to no opportunity of rotation to preserve the efficacy of these products. Resistance management via cultural control methods and grower education should be a priority. To be useful these products must have workable pre-harvest intervals as well as re-entry intervals.

   There is a need to continue to register new products and to harmonize these registrations with the US to ensure we do not continue to be at a competitive disadvantage. There is an opportunity to limit worker exposure, reduce crop residues and increase efficacy through the use of pest management treatments through drip irrigation. Registrants should be encouraged to continue to investigate these options. Exploring options such as ozone, peracetic acid, and UVC technology would also limit residues. The berry industry would benefit from the use of macrobiological options and incorporating bee vectoring as a management tool.

3. Breeding and Evaluating New Cultivars – For the future of berry industry there is a need for the development of varieties suited to Ontario conditions. Specifically, priority should be in developing new greenhouse strawberry varieties, early strawberry varieties that have excellent heat tolerance and disease resistance, and machine harvest-ready cultivars. This can be accomplished by plant breeding in Ontario as well as evaluation of new cultivars developed in jurisdictions outside of the province. Research evaluations should include comprehensive testing on the four types of growing systems, field, plastic, tabletop, and greenhouse. Continue to breed and evaluate new strawberry cultivars that the industry has invested research dollars and time.

   Growers need to have knowledge of berry performance before investing in varieties that may not be suited to our conditions. Improved cultivars and better understanding of management could lead to expansion of the industry and increased profitability for growers as well as increased tax dollars with an expanded industry.

4. Product and Quality Marketing – - It is critical to continue to develop and expand the trend of buying local. The “Buy Local” movement is critical for the success of both on farm marketers as well as wholesale producers. Price support for local will be critical in managing increased picking costs as a result of an increased minimum wage. Product quality at the wholesale level may be the most limiting factor to the expansion of the Ontario berry industry. Ontario growers need to supply quality fruit that stands the rigors of the wholesale marketing chain. Determining the most cost-effective method of storing and preserving quality of fresh berries utilizing modified atmosphere technology and any other storage technologies for all the major berry crops is needed. This can also include the development of more environmentally acceptable packaging as well as breeding cultivars that are suitable to Ontario conditions and meet the needs of the wholesale marketing system.

5. Fertigation/Irrigation – there is a need for modernization of benchmarks for irrigation and fertilization of berry crops grown under different growing systems. Growers would like recommendations that provide sustainable and efficient use of both fertilizer and water. New production systems including day neutral strawberries, fall bearing raspberries, protected culture and soilless media production need to be addressed. Fertigation scheduling for highbush blueberries grown under Ontario conditions needs refinement. A survey developed for knowledge transfer for fertigation and irrigation practices would benefit berry growers.

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Bulb and Root Vegetables

Including but not limited to: carrots, onions, leeks, shallots, beets, rutabaga/turnip, radishes, sugar beets, parsnips, garlic, horseradish, sweet potatoes

Pest Management

- Sugar beets: Cercospora Leafspot, Rhizoctonia Root Rot, Aphanomyces Black Root
- Table Beet: Cercospora, Rhizoctonia, leafminers, leafhoppers, aphids, weeds
- Onion: Develop strategies to manage Stemphylium leaf blight; Improve onion maggot control strategies with the loss of chlorpyrifos
- Garlic: Develop management strategies to control bulb and stem nematode

Other

1. Develop soil health and/or nutrient management strategies that improve crop quality and/or environmental sustainability in bulb and root vegetables. Areas of research could include (but are not limited to): root health/soil-borne disease, soil organic matter, soil biodiversity, resiliency, fumigation alternatives; mitigation of soil compaction; intercropping options; interactions between applied nutrients; crop varieties and harvest date; interactions between applied nutrients; crop quality (including storage characteristics) and variety; interactions between nutrient applications, soil type and water use; best practices for soil amendments and/or cover crops, best practices for nutrient loss, and best practices for nutrient use efficiency. Research should address barriers to adoption and long-term economic impact.

2. Develop strategies that improve product quality in bulb and root vegetables (including storage quality and percent marketable product).

3. Provide options for product diversification within the bulb and root vegetable sector. Projects should include a market analysis and consider consumer trends.

4. Develop strategies and identify barriers to adoption for water management best practices in bulb and root vegetables that considers the any or all of (but not limited to) the following variables: soil type, nutrient management, product quality + yield, irrigation system type, water sourcing, drainage, surface water management (note water management is not a high priority in sugar beets).

   Onion

   1. Enhance crop quality going into storage by improvement soil health and/or nutrient management strategies

   Garlic

   1. Determine ideal environmental storage parameters for long term storage of hardneck cultivars
   2. Improve curing protocol to reduce cure time and reduce pest pressure going into storage
   3. Develop new cultivars better suited to Ontario growing conditions

For further information contact:

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Leafy Vegetables and Brassicas

Including but not limited to: asparagus, spinach, celery, broccoli, cabbage, cauliflower, lettuce, salad greens, leafy herbs, rhubarb, Brussels sprouts

Pest Management

- Brassicas:
    - Develop aphid control strategies to replace the use of Admire™ systemic insecticide in Brussels sprouts
    - Improve cabbage maggot control strategies replace the loss of chlorpyrifos
    - Enhance Alternaria control in all Brassica crops, but with a focus on Brussels sprouts and storage cabbage
- Asparagus:
    - improving field management of Stemphylium and rust;
    - Enhance asparagus rust management and improve resistance by developing new cultivars
    - understanding Stemphylium resistance in the relationship between the fern and spear.
- Spinach
    - Enhance control strategies of Anthracnose, Colletotrichum spp., Cladosporium, and Stemphylium spp. leaf spot
    - Improve seedcorn maggot control strategies
    - Develop management strategies for Fusarium wilt caused by Fusarium oxysporum f. sp. Spinaciae
- Celery:
    - Develop cultivars resistant to celery leaf curl or enhance celery leaf curl management in the field

Other

1. Develop strategies to improve long term profitability of leafy and crucifer vegetables that consider options to improve any or all of: labour efficiency, production efficiency and market diversification.
    - Asparagus: Develop high yielding, high quality, disease and replant resistant asparagus cultivars; identify the physiological basis of longevity in asparagus and assess genetic architecture for the trait; and conduct field testing of potential new asparagus varieties.

2. Develop strategies to improve leafy vegetable and crucifer vegetable sector resilience to extreme weather and climate change. Strategies could include: adaptations to changing season length and temperature patterns, new varieties that tolerate extreme conditions and/or longer seasons, models to predict vegetable harvest scheduling (like a degree day model, instead of days to harvest), adaptations to excess rain.
    - Celery: Develop strategies and identify barriers to adoption for water management best practices that reduce overhead irrigation in July and August to limit bacterial and fungal leaf pathogens in celery

3. Develop strategies to improve soil and nutrient management with a focus on phosphorus management in relation to Lake Erie water quality. Strategies should consider multiple interacting variables including nutrients, plant varieties and soil type.

4. Food safety – especially in lettuce and leafy green production.

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Fruiting Vegetables

Including but not limited to: peppers, tomatoes, cucumber, pumpkin, squash, green/wax beans, green peas, sweet corn, eggplant, melons, zucchini

Pest Management

- Nematodes (common to many crops)
- Field Tomatoes: Bacterial disease (primarily spot, but including speck and canker), Fruit rots, Root health (disease, nematode, tired soils/replant issues), mitigation if chlorothalonil use restricted
- Field Peppers: Bacterial disease, Fruit rots, including *Phytophthora capsici* (also bacterial soft rot, anthracnose, plus improved identification of causes); Tarnished plant bug; Pepper weevil
- Eggplant: phytophthora (*P. capcisi*), verticillium, mites, Colorado potato beetle, broadleaf weeds, grassy weeds

Other

1. Crop production systems research, in particular practices aimed at improving harvest quality. Research may include the analysis of the economic benefits of quality improvement practices at any point (or multiple points) along the fruiting vegetable value chain; analysis of existing data; developing new data through crop research, comparing production systems, harvest or post-harvest practices. Research should develop best management practices for quality improvement that can be applied to Ontario.

2. Develop best management practices for improving and maintaining soil health in fruiting vegetables considering any or all of the following: short rotation, root health/soil-borne disease, cover crops, soil amendments, soil organic matter, soil biodiversity, and resiliency. Research should include evaluation of barriers to adoption (reduce them) and the long term economic benefits to growers and society.

3. Develop strategies for nutrient management to maximize crop production while minimizing environmental impact in fruiting vegetables. Successful projects will emphasize phosphorus management in relation to a number of variables including runoff, fertilizer application (method, timing, rates) and impacts on Great Lakes quality. Impacts on loss or use-efficiency of other nutrients should be considered.

4. Develop irrigation and water management strategies for optimal crop quality and yield in fruiting vegetables. Variables of interest are water use efficiency, critical irrigation times, cut off times, fertigation, run off, and management in extreme weather. Adaptation to both water shortages and to extreme rainfall events are of interest.

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Ginseng

Pest Management

Identify the cause and develop solutions for replant disease of ginseng

Other

1. Identify the Causes and Develop Solutions to Skin Diseases and Disorders that Affect the Marketability of the Root (pre- and post-harvest)
2. Labour Saving Technology (e.g.: debudding, robotic weeding, automatic grading, etc.)
3. Identification and Remediation of the Factors that Lead to Pesticide Residues in Ginseng and Other Non-Target Effects of Pesticide Use
4. Improve Ginseng Seed Viability and Seed Survival

For further information contact:
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Grape and Wine

Pest Management

- Identification and mitigation of Leaf Roll and Red Blotch
- Multicoloured Asian Lady Beetle (replacements for synthetic pyrethroids)
- Powdery Mildew, Black Rot, Fruit Fly, Brown Marmorated Stink Bug
- Sour Rot

Other

1. Viticulture Research
    - Quality improvement (canopy management, pest management, etc.)
    - Vitis certification (local vine proliferation/supply)
    - Winter injury
    - Spray programs strategies (rotation, feedback mechanism)
    - Short and long term effects of viruses on plant performance
    - Clonal and sub-clonal stability (assessing trueness to type)

2. Oenology Research
    - Clonal sensory evaluation
    - Post-frost picking strategy and must handling in the winery
    - Crop level vs. quality (i.e. color, tannin development)
    - Sparkling wine, icewine, late harvest
    - Operations of winery (i.e. filtration, yeast, nutrients)
    - Site selection (terroir)

3. Market Research
    - Export/market development
    - Forecast of “winning” varieties and style of wine
    - Sparkling wine profiles
    - Sensory and consumer science

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Greenhouse Vegetables

Pest Management

- Tomato Brown Rugose Fruit Virus,
- Residue-free crop protection tools
- Pest management products and approaches that are compatible with biocontrol agents

Other

1. Environmental Sustainability
    - Energy efficiency research aimed at reducing carbon emissions per unit produced, including: renewable energy projects, breeding for low light and temperature varieties, more insulated greenhouse coverings, etc.
    - Reduced or improved management of greenhouse waste

2. Production Efficiency
    - Strategies to support the transition to year-round production
    - Water and nutrient use efficiency that support emerging production technologies
    - Labour efficiency, including robotics and automation

3. Product and Market Development
    - Identify products suited for new and emerging markets both domestically and abroad for both consumer and food service segments
    - Maintain or improve the quality of Ontario greenhouse produce through consumer and/or market research, directed breeding programs, postharvest management and/or supply chain improvements

4. Technologies for light abatement in greenhouses

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Honey Bees and Pollination

Pest Management

1. Further development of effective IPM, diagnostic tools, nutrition and queen health recommendations, best management practices and food safety programs for controlling Varroa mites and other pests and diseases referred to in OMAFRA's list of existing/emerging bee diseases, including treatment-resistant pests and diseases.

2. Investigate methods to improve bee immunity to pests and diseases on all levels.

Other

1. Assess and improve queen quality, genetics and management in Ontario and promote utilization of Ontario bee stock. Investigate methods to improve queen viability and survival, early queen production and overwintering of queens.

2. Determine the risks and develop best management practices for bee colonies moved for pollination, for alternative pollinators and for new pollinator systems. This should include investigating:
    a. the impact of pollination services on bee health and mortality
    b. methods to protect bees providing pollination services from the negative effects of pesticide application
    c. biosecurity and the effects of mixing managed pollinators
    d. the effects of mixing managed pollinators with native bee species

3. Conduct a long-term survey of hive products (honey, wax, pollen, propolis, etc.) from honey bee colonies to investigate the extent of environmental chemicals (agrochemicals & agrochemical residues). Investigate the adverse effects of these chemicals, including synergistic effects, on bee health, bee reproduction and the environment.

4. Investigate methods to increase pollinator forage and habitat in order to offset land use that has negative effects on pollinator populations.

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Maple Syrup

Pest Management:

Asian Long-horned Beetle (ALHB) is currently the single most serious potential threat to maple trees in Ontario. TreeAzin (approved to control Emerald Ash Borer in ash trees) has been used as a treatment but lab results indicated high residues in both sap and syrup of treated trees. TreeAzin is not yet registered for use in Canada in food products so it is not yet possible to do the research to determine if sap and/or syrup flavor is affected.

Other

1. Develop an easy to use test to identify buddy sap prior to processing into maple syrup (e.g. – possibly similar to using litmus paper for detecting pH). [Note – this would be of great help to all maple syrup producers across Ontario and beyond. It would increase the production and quality of maple syrup by avoiding off-flavours from buddy sap]

2. Determine how to best clean and sanitize storage barrels to prevent/minimize mould-damaged syrup.

3. Determine at what temperature and for how long it is required to preheat small glass bottles prior to hot-packing with maple syrup to prevent/minimize mould-damaged syrup. [Note – it is virtually impossible to remove all mould spores from maple syrup, but syrup should be hot-packed into clean containers in conditions that are as hostile to mould growth as possible. Small glass containers seem to be the most problematic due to the high mass of glass and relatively small amount of syrup that cools quickly upon contact]

4. How to best prevent maple decline on acidic soils (Canadian Shield).

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Mushrooms

Top Priorities

- Automation and other technologies to address the high costs and availability of labour
- Analysis and validation of the nutritional value and potential health benefits of mushrooms, especially on immune system responses and the potential for treating or mitigating the effects of certain chronic health conditions.
- Improving environmental sustainability:
    - Improving energy efficiency and carbon footprint in mushroom production
    - Packaging
- Strategies for improving food safety and preventing listeria contamination

Pest Management

In mushrooms, pest management research is less of a priority than other research areas. From time to time white mold and sciarid flies can be a problem. There is also a limited number of products available and approved for use to treat certain pests on mushrooms.

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New and Specialty Crops

The Specialty Crops sector consists of over 100 different commodities that are typically grown on small acreages in Ontario. These include, but are not limited to, sweet potatoes, tigernut, okra, and other non-traditional vegetables, specialty fruit including haskap, kiwiberries, and pawpaw, medicinal herbs including cannabis, culinary herbs, lavender, hops, truffles, hazelnuts and other tree nuts.

Other

- Developing agronomic practices and efficiencies: e.g. pruning and pollination; fertility and water requirements; season extension; improving winter survival of certain perennial crops (e.g. lavender and hazelnuts); and harvesting methods / post-harvest handling and storage issues.
- Research on efficient production methods that impact labour, energy, and water requirements.
- Propagation of high quality nursery stock for vegetatively propagated crops (e.g. lavender, hops, haskap, hazelnut, truffles):
    - True to type nursery stock
    - Pest free (e.g. disease, virus)
    - Inoculated nursery stock (i.e. truffles)
- Germplasm development: Breeding/selection programs and research on efficient propagation of new germplasm resources adapted to Ontario growing conditions, resistant to key pests, and relevant to Ontario market preferences.
- Develop local supply chains for new and specialty crops by identifying emerging crop opportunities, the sector partners and their needs, understanding purchasing and sourcing practices, and accelerate technology adoption to meet market requirements. Additional areas of market development requiring research include:
    - Understanding market requirements (marketability, consumer preferences, etc.)
    - Consumer education
    - Cost of production information
    - Access to processing facilities
    - Value added opportunities

Pest Management

Field research on pest management including weeds under Ontario conditions (e.g. conventional and organic pest control products, pest identification, IPM, pesticide resistance management, product timing and rotations, identification of pest-resistant germplasm). Examples of specific pest management needs include:

- Viruses in all specialty crops but especially hops, hemp/cannabis, sweet potatoes, specialty berries, and tree nuts.
- Vertebrate pests in all specialty crops especially birds in haskap and tree nuts, squirrels in hazelnuts, mice and voles in root crops such as ginseng and sweet potatoes.
- Basil downy mildew.

- Bacterial blight of cilantro, plant bugs and aphids on all herbs.
- Invasive pests in specialty crops including spotted wing drosophila in specialty berries, brown marmorated stink bug in hazelnuts and specialty field crops, spotted lantern fly in hops.
- Powdery mildew, root rots, plant bugs, scale, stink bugs, caterpillars, insect borers in haskap.
- Downy mildew, powdery mildew, cone diseases, Diaporthe blight, mites, and leaf hoppers in hops.
- Black rot, grubs, and wireworms in sweet potatoes.
- Grubs and wireworms in tigernut.
- Weevils in tree nuts.
- Chestnut blight and chestnut gall wasp.
- Downy mildew, powdery mildew, botrytis head blight, white mould, insect borers and various other insect pests in cannabis and industrial hemp.
- Eastern filbert blight, bacterial blight, and bud mite in hazelnuts.
- Four lined plant bug, Phytophthora root rot and Septoria leaf spot on lavender.
- Potato leaf hopper, mites, black hull, root rots, and leaf spots of peanut.
- Leaf and stem feeding caterpillars, tarnished plant bug, downy mildew, and fungal leaf and stem blights of quinoa.
- Bacterial pod and leaf diseases of sesame.
- Weed control in all crops.

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Potatoes

Pest Management

Evaluate cultural, biological and chemical methods to reduce the incidence of soil borne diseases and blight.

Other

- 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.
- Develop a breeding program that considers disease resistance, focusing heavily on common scab. Low N, P, K requirements and drought tolerance as priority traits
- Identify selections and cultivars that are adapted to environments with lower fertility and water availability. Improve water use efficiency by altering timing and use of new irrigation technologies
- Identify and evaluate tablestock lines for value added traits that may have a positive effect on human health.

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Tender Fruit

Pest Management

Invasive species management: strategies to combat new invasive species such as Brown Marmorated Stink Bug (BMSB), Spotted Wing Drosophila (SWD) and Spotted Lantern Fly (SLF).

Other

1. Increase labour and operational efficiencies. Improved processes and systems that reduce impacts of and/or costs for:
   - Pruning, thinning, harvesting and packing;
   - Pest and disease management for the top 3 diseases: Fire Blight, Black Knot, Bacterial Spot
   - Adverse weather management.

2. New variety acquisition, development, best management and commercialization processes that result in:
   - Higher value varieties suited to Ontario growing conditions and marketplace needs;
   - Varieties that can better withstand climate change pressures such as excessive heat and drought
   - An increase in organic production;
   - Fast tracking of virus-free commercial production of promising varieties; and
   - Disease resistance - especially to Fire Blight, Black Knot and Bacterial Spot.

3. Increase post-harvest quality:
   - Optimal harvest timing, packing, and cold chain management systems, treatments and practices to increase quality and shelf life.
   - Irrigation, water and nutrient use:
   - Processes and systems to maximize efficiencies.

4. Irrigation, water and nutrient use:
   - Processes and systems to maximize efficiencies.

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Ornamental Horticulture

Sector Consultation

A research priority list was originally generated from input provided at a broad industry consultation with the floriculture and nursery-landscape sectors held in January 2015. The list was updated and ranked in 2017 at a small group meeting of Landscape Ontario and Flowers Canada (Ontario) representatives. In 2018, the LO and FCO research chairs reviewed the priority list and agreed to move the labour issue up to a higher ranking. For the current report, updated LO priorities were incorporated into some of the underlying detail but the overall ranked list was not changed.

Prioritization Criteria

- Size of Opportunity or Problem: What is the size or the reach of the research problem or opportunity for discovery? e.g. How much of the sector does it relate to? How many growers / businesses are affected and stand to benefit from the solution? How much potential uptake will it have?
- Economic Impact: To what degree does research in this area improve the sector's market share, growth and enterprise profitability? E.g. Does it create a superior product, increase yields or reduce production costs in a significant way? To what extent will it improve the competitiveness of Ontario's sector?
- Socio-Environmental Impact: How will this research benefit the environment and/or broader society? e.g. Will it enable sector businesses to reduce their environmental footprint? Will it create jobs, reduce pollution or meet other societal needs?
- Probability of Success: How likely is this area of research to succeed relative to the investments required? How do the risks weigh up against the possible returns?

Ontario Ornamental Horticulture Research Priority List

(ranked)

1. **Reduce water use by 20 percent.** Utilize water more efficiently in ornamental plant production with strategies that are economically viable and commercially practical.
2. **Optimize nutrient use.** Develop strategies to optimize the use of nutrients in plant production in order to reduce input costs, promote plant health and eliminate nutrient runoff.
3. **Improve irrigation water quality.** Develop strategies to improve irrigation water quality e.g. by optimizing source water, irrigation systems and/or storage and recirculation systems, managing algae growth.
4. **Reduce labour costs.** Identify issues and opportunities for driving down labour costs in the sector.
5. **Improve energy efficiency.** Strategies to reduce electrical, energy and fuel use that are economically viable and commercially practical.
6. **Pest control.** Research 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.
7. **Improve plant establishment and survival.** Understand and improve plant establishment and survival in challenging environments, including: root growth in container nursery production and compacted soils; reducing low temperature injury; and soil amendments using wastes from other industries.
8. **Supplemental lighting.** Strategies to improve plant production with supplemental lighting.
9. **Consumer research.** Understand market trends, quantify environmental benefits, identify what plants to grow, when to supply them, and how to present and market them.

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