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Ontario Genomics

Genomics for Agriculture **EXAGRI-FOOD:** Ontario's Strategic Opportunity

http://www.ontariogenomics.ca/Ag-Sector-Strategy/

Agenda



- Ontario Genomics
- Ag/Agri-Food Strategy Report
- Synthetic Biology
- Opportunity for Collaboration



OG Renewal



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VISION

Healthy Lives, Healthy Economy, Healthy Planet through Genomics Innovations

MISSION

We lead the application of genomics*-based solutions across key sectors of the economy to drive economic growth, improved quality of life and global leadership for Ontario.

WE DO THIS BY

1- Connecting scientists, ideas & partner organizations for collaborative genomics investment opportunities.



Return on Innovation: \$2.6B since 2000



Accelerating genomics innovations in Ontario



Since 2000, OG has leveraged \$2.6B for Genomics Research and Innovation for Ontario



Genomics is a Transformational Platform – OG's Strategic Approach Delivers the ROI





HEALTH

- Precision medicine to contain costs
- Rapid medical diagnoses
- Customized treatments
- Faster drug discovery



AGRICULTURE & AGRI-FOOD

- Food security
- Food safety
- Sustainable food sources
- •Quality traits
- Climate change mitigation & adaptation



- Healthy forests
- Decreased mine tailings
- Clean water
- Biochemicals
- Bioplastics
- Waste management

TRANSFORMATIONAL GENOMICS PLATFORM IN ACTION

Through Data, Tools, Applications and Ethical Responsibility

Convergence of Platform Technologies such as Genomics, Nanotechnology, Cloud Computing and AI & Machine Learning are driving exponential growth of new solutions

Outputs

Core Competencies and Strategic Approach



Our Toolbox enables genomics collaborations



Program Management – we provide in depth experience, skills and insights of the issues, risks, requirements, processes and solutions to enhance program performance



Expert Staff – we have a strong team with an amazing breadth of technical and business experience in academia, biotech and multinationals



Powerful Network – we know the genomics landscape across all sectors and are well connected with the key players and funders



Access to Funds – we are the sole channel for Genome Canada funding in Ontario, and we also help source other funds



Flexible Support – we run competitions with varying scope and size, from \$25k to \$10M per multidisciplinary, collaborative project



Outcomes Focus – our approach covers the continuum from idea generation to application and commercialization and is milestone driven



HEALTH



AGRICULTURE & AGRI-FOOD



- → Prediction of disease outbreaks
- ightarrow Rapid diagnosis
- \rightarrow PM treatment
- → Next gen drug discovery
- \rightarrow Quality traits and sustainable food
- → Clean-up of tailings and oil spills
- → Prevention and eradication of pests
- → Genomic selection of adaptable trees
- \rightarrow Increased carbon capture

Our Funding Toolbox: Industry Pull > Academic push

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\$54M in Agriculture & Agri-Food Genomics Research and Innovation so far....





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The Future is in Our Genes

Genomics Helping to Grow Ontario's

- Improve turkey health, welfare, feed efficiency & prod'n traits Hybrid Turkey – Guelph – \$6.0M GAPP
- Enhance Ontario tomato flavour more distinct & competitive Vineland Research & Innovation – Laval – \$1.8M GAPP
- Improve quality control in aged cheddar cheese manufacturing Parmalat Canada – University of Guelph – \$1.35M GAPP
- Increase yields in canola by 20% & carbon fixation per acre Benson Hill Biosystems – U of Guelph – \$3.7M GAPP
- Breeding pigs free of boar taint University of Guelph – \$100K PBDF
- Producing a polyphenolics-enhanced Ice Syrup Sweet & Sticky – CCOVI – \$25K Seed

Agri-Food Sector





Genomics Ensuring Sustainability of Agri-Food Sector



- Ensure honey bee sustainability by breeding healthy, diseaseresistant bee colonies able to survive harsh Canadian winters York University – UBC – \$25K Seed, \$7.3M LSARP
- Improve food traceability, safety and mitigate fraud International Consortium Initiative U of Guelph – 2014, \$40M
- Help combat crop diseases by identifying genetic markers that promote colonization of corn silk-associated probiotics SPARK - U of Guelph – \$25K
- Breeding dairy cows with reduced methane production Canadian Dairy Network – UofGuelph – UofA – \$10.3M LSARP
- Enhance benefits in amended soils by characterizing naturallyoccurring microorganisms within Spanish River Carbonatite Boreal Agrominerals – Wilfred Laurier/Algoma Seed – \$25K



Genomics Driving the Bioeconomy



- Engineered microbes to produce biochemicals from sugars Visolis – UofT – \$5.7M GAPP
- High value bio-based polymers from lignoceullose
 \$9.5M LSARP
- **Replace chemical fertilizers with nitrogen fixing bacteria** \$250k Disruptive Innovation grant
- Convert potent GHG methane to bioplastics \$30K SPARK
- Flavors and fragrances from renewable feedstock Ardra – \$100K PBDF
- Microbial communities as alternatives to chemical control Western University – \$25K SPARK



Story Behind the Ag/Agri-Food Strategy Report



- Ontario's strong & growing agriculture & agri-food sector is critically important for our health & culture
- Priority sector → Genomics based innovations & technologies provide significant opportunities to advance the sector
- Consultations across the country to feed into LSARP 2018
- Formalize an Ag-Omics strategy for Ontario to help inform our own programs & the province



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Genomics for Agriculture & Agri-Food: **Ontario's Strategic Opportunity**

- 20 one-on-one interviews with key Canadian & International Experts
- Regional event in Milton, Sept 2018 with 80 key stakeholders from the Ontario agriculture and agri-food sector
- Further input from select stakeholders for strategy finalization

May 2018

THANK YOU FOR YOUR INPUT!

http://www.ontariogenomics.ca/Ag-Sector-Strategy/

Ontario's contribution to the Canadian Ag/Agri-Food sector





- Well-positioned for significant growth - abundant arable land & water, stable well-established markets & political system, strong infrastructure, educated workforce
- Current trends represent both challenges & opportunities for the sector
- Advanced technologies being applied to enhance agricultural production & food processing

Genomics' Impact

- Genomics* technologies improve efficiency, quality & yield crop & livestock development
- Rapid advancement of the ag/agri-food sector due to uptake of new technologies (e.g. new cultivars, vaccines, improved agronomic practices, advanced mechanization)
- Considerable opportunity for genomics technologies producers are willing to adopt social acceptance communication is key



Ontario's Genomics R&D Capacity

Public, not-for-profit and for-profit private organizations working collaboratively

- Established research capacity 20 universities & 26 colleges agriculture, animal, food sciences & related practices
- Long-standing partnership & renewed 10-year \$713M agreement between OMAFRA & the University of Guelph; ARIO – 15 research stations
- Other research centres: AAFC London, Harrow, Guelph and Ottawa; 3 of 13 CFIA laboratories; VRIC & CCOVI
- Food & Beverage Ontario, LRIC and the ATCC including Oilseed Innovation Partners, Bioenterprise & OAFT
- Genome Canada, NSERC, AAFC, OMAFRA, OCE & Ontario Genomics



Sector Connections

- Genomics-based technologies, along with precision agriculture & artificial intelligence, will revolutionize the agriculture & agri-food sector
- These advances will have positive impacts for other priority sectors across Ontario & around the world

Rich Opportunity to Share Understanding Across Species



Enable Quick Responses to Feed our Ever-Changing World



Ensure Food Security for a Growing Population





Environment and Climate Change

- Climate change along with associated variable weather patterns will have a major impact on agricultural production
- A major focus of genomics R&D is on adaptation to & mitigation of the impacts of climate change

Adaptation:

- Warming weather & increasing GHG
- Weather extremes, water, pests & diseases
- Longer growing seasons, Northern Ontario
- Genomics can accelerate solutions for livestock & crops to adapt to the effects of climate change & the resulting impacts on our environment.

Mitigation:

- Reducing agricultural emissions: CO₂, CH₄, & N₂O
- Canada's goal to reduce GHG emissions by 30% below 2005 levels by 2030
- Increase photosynthetic capacity in plants & carbon sequestration in soil
- GHG from microbiomes altering microbiomes, development of more beneficial microbiomes

Biodiversity Genomics

Biodiversity

- Basis of resilient agriculture
- Includes all species crops, domesticated livestock & the variety within them
- Includes the ecosystem soil & water conservation, maintenance of soil fertility & biota, & pollination – all of which are essential to sustain agriculture & human wellbeing
- Allow adaptation to changing conditions, including climate change

Biodiversity Genomics

- New field that uses DNA, as part of a larger framework of integrated data, to answer questions about the diversity & processes that govern the patterns of life on the planet, & how they change
- DNA barcodes small fragment of an organism's DNA to identify the species to which the organism belongs
- Ontario is a leader, Centre for Biodiversity Genomics (CBG) at the UofG where the global DNA barcoding initiative was started

Societal Matters

- To flourish, genomics innovations must be addressed in the context of ethical & policy questions
- Policies should be advised by the views of a public that is accurately informed
- Educate & engage the public at large about advances in genomics, incl. ethical, legal & social implications
- Ensure that policy constructively addresses areas of public concerns of society towards genomics-based applications
 - Support More Efficient & Effective Decision-Making Practices



Agricultural Innovations are Complex & Differ from Jurisdiction to Jurisdiction



Understand the Varying Interests & Concerns of All Stakeholders



Ensure Capacity in a Coordinated Approach & Standardization



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Considerations: Stakeholder Feedback

- Synthesis Agri-Food Network......one-on-one interviews with 20 key regional & global experts
- Facilitated Regional Stakeholder Event Sept 25th, 2018 with 80 stakeholders from across the value chain

Key Opportunities:

- bioinformatics "multi-omics" data integration
- climate change adaptation & mitigation
- quality traits
- food processing
- systems biology
- phenomics
- rapid diagnostics
- microbiomes (all types)
- artificial intelligence & machine learning

Key Barriers:

- public acceptance
- data management & sharing
- costs & time to obtain regulatory approvals
- technology transfer
- availability of funding for R&D
- availability & access to research infrastructure
- development & availability of bioinformatics expertise
- funding for multidisciplinary teams
- costs of adoption of genomics technologies by some producers or commodity/industry groups

Considerations: Assessment Framework

To **determine priorities** going forward, an approach was taken that **focuses on desired outcomes** in areas **where ag/agri-food genomics innovations** can make substantial contributions to achieving major outcomes for the sector in the **context of a sustainable ag/agri-food system**







Genomics for Agriculture & Agri-Food:

Ontario's Strategic Opportunity

SIX RICH DOMAINS

for **Genomics** to Advance & Innovate Ontario's **Agriculture** & Agri-Food Sector

REPORT RECOMMENDATIONS

- 1 Multidisciplinary Research Augment multidisciplinary R&D using a systems biology approach, with a focus on increased understanding of microbiomes and their interconnectivity to human health.
- 2 **Sustainable Agriculture & Food** Prioritize programs for sustainable agriculture and food that consider the economy, the environment, and society, for crop production and livestock.
- 3 Advanced Processing Systems Enhance advanced manufacturing and processing systems for both food and industrial bioproducts, including fermentation and traceability.
- A Rapid Diagnostics & Biologics Develop rapid diagnostic methods to support regulation and trade, rapid disease detection and traceability in crops and livestock, and biologics to reduce the use of antimicrobials.
- 5 Address Barriers to Adoption Address barriers to the adoption of genomics innovations including issues related to data sharing, intellectual property, regulation and public acceptance.
- 6 Leverage Computational Biology & AI Leverage Ontario's strengths in computational biology and artificial intelligence to accelerate the development and application of agricultural genomics-based innovations.

g A Strategic Approach to Agriculture & Agri-Food

Ontario Genomics



SIX RICH DOMAINS

for **Genomics** to Advance & Innovate Ontario's Agriculture & Agri-Food Sector

RECOMMENDATIONS

Multidisciplinary Research Augment multidisciplinary R&D using a systems biology approach, with a focus on increased understanding of . Novel agricultural products microbiomes and their interconnectivity to human health.

Sustainable Agriculture & Food Prioritize programs for sustainable agriculture and food that consider the economy, the environment, and society, for crop production and livestock.

3 Advanced Processing Systems Enhance advanced manufacturing and processing systems for both food and industrial bioproducts, including fermentation and traceability.

A Rapid Diagnostics & Biologics Develop rapid diagnostic methods to support regulation and • Reduced use of antibiotics trade, rapid disease detection and traceability in crops and • Improved animal welfare livestock, and biologics to reduce the use of antimicrobials.

5 Address Barriers to Adoption including issues related to data sharing, intellectual property, • Greater commercial success regulation and public acceptance.

Leverage Computational Biology & Al Leverage Ontario's strengths in computational biology and artificial intelligence to accelerate the development and application of agricultural genomics-based innovations.

Recommendations are based on opportunities provided by genomics-based technologies and innovations to meet sector priorities in the context of enhancing a socially and environmentally responsible industry.

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BENEFITS · Accelerated innovations with multi-sector applications Healthier people More nutritious & flavourful foods Higher crop yields · Reduced use of pesticides Enhanced biodiversity Greater livestock performance Greater diversification of crops and specialty animal products

 Increased exports Improved processing efficiencies Reduced carbon footprint Better disease management

Enhanced food security

Genomics for Agriculture & Agri-Food: Ontario's Strategic Opportunity

2018 OntarioGenomics.ca

· More informed & engaged public Reduced trade deficit

Accelerated agricultural outputs Reduced waste Faster market applications Stronger Ontario bioeconomy

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Ontario Regional Program (ON-RP3) g



Ontario Genomics and Partners focus on Agriculture & Agri-Food in 2018-19

Paving the Way to Thought Leadership



\$25,000

Conseil national de

recherches Canada

NSERC CRSNG

HEALTH:

arbor

>>>IDT

FREDsense

National Research Council Canada

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BIOTECanada

BioLabs

CropLife

Spindle Biotech

TATUM

Accelerating Start-ups by Design

GE



A Vision for a Canadian Synbio Strategy

3 Pillars 3	Strategic, 'to areas where - decided by S	p down' programs/consortia in Canada can play a leadership role Steering Committee	Genome Canada Innovation Canada - SIF Private sector International
Bold Mission Driven Projects			
2 Seeding	Program for disruptive innovation in Engineering Biology	 Phased funding Flexibility Rolling Intake 	Tri-Council Genome Enterprise NRC-IRAP Province
Seeding Breakthrough lechnologies and Capabilities (Sandbox grants)			
 Establishment of foundries How many & how differentiated? Synergies are key - UK underutilization of 6 facilities 		Equipment not enough expertise/resources to help w/ experimental design; broader research community taking advantage of synbio tech	Genome Canada CFI NRC
Enabling facilities and expertise			

Our Ask – Collaborative Innovation

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horation da beople hv-design Genomics for Agriculture & Agri-Food: Ontario's Strategic Opportunity Accelerating genomics innovations through collaborative public-private partnership programs Opportunities to work together to drive economic growth, job creation, and leadership for Ontario's Agriculture & Agri-Food sector



THANK YOU

Discover how genomics can help you grow and innovate

www.OntarioGenomics.ca

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