2017-20

FOOD FROM THOUGHT

Agricultural Systems for a Healthy Planet

Mid-term Report

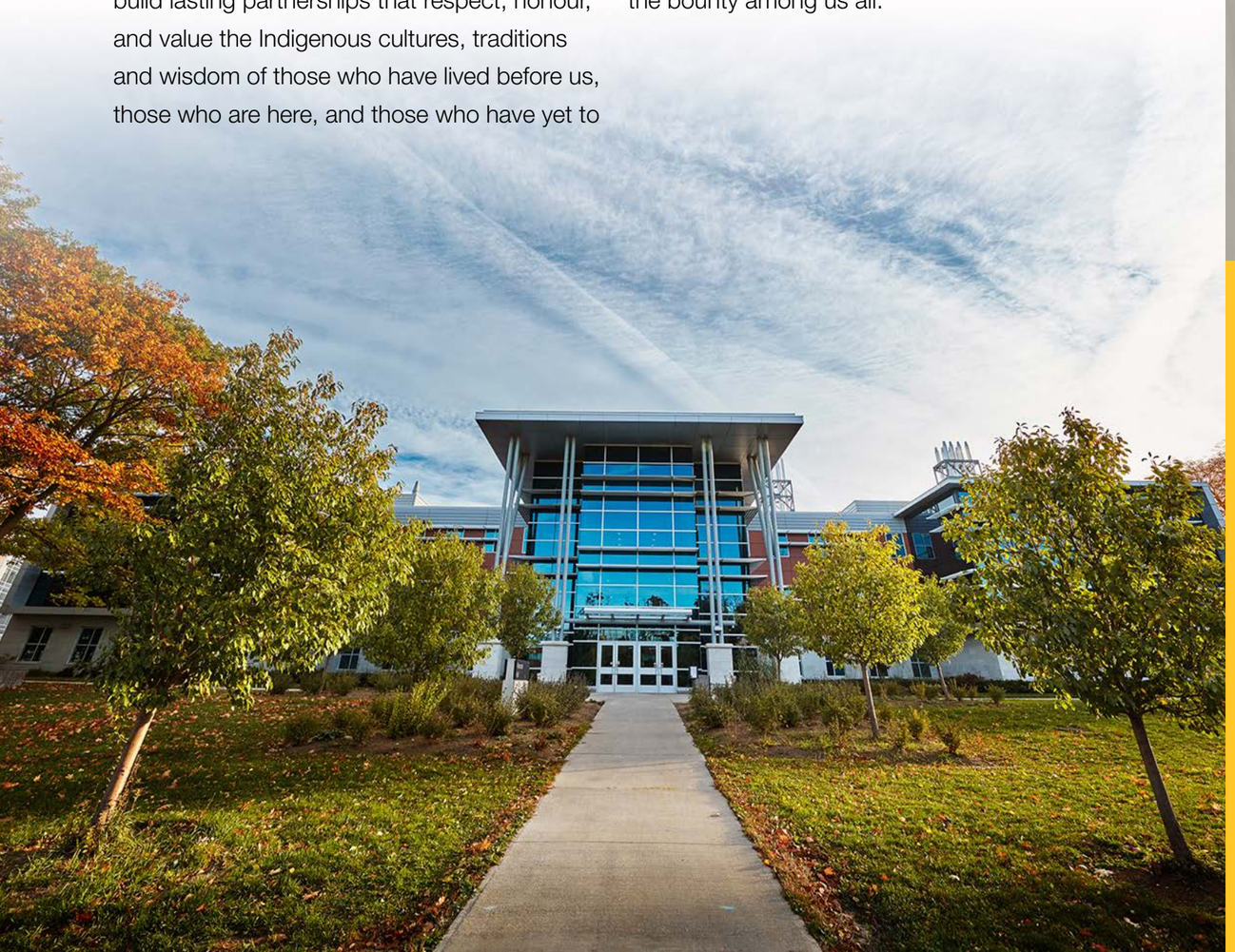
UNIVERSITY of GUELPH

IMPROVE LIFE.

STATEMENT OF **LAND ACKNOWLEDGMENT**

We acknowledge that the University of Guelph resides on the treaty lands and territory of the Mississaugas of the Credit, and we recognize and respect our Anishinaabe, Haudenosaunee and Métis neighbours. The work presented in this annual report has occurred on lands with rich Indigenous connections, and we aim to build lasting partnerships that respect, honour, and value the Indigenous cultures, traditions and wisdom of those who have lived before us, those who are here, and those who have yet to come. In particular, the Dish with One Spoon Covenant, an important pre-colonial agreement between Nations that then lived across much of what is now southern Ontario into Quebec and the state of New York, reminds us that we must inhabit the land and use its resources (the dish) wisely, as we use the one spoon to share the bounty among us all.

Nicole Berardi, PhD candidate, loads plant tissue into a centrifuge.



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MESSAGE FROM THE **VICE-PRESIDENT, RESEARCH, AND SCIENTIFIC DIRECTOR**

MALCOLM CAMPBELL
Vice-President, Research

EVAN FRASER
Scientific Director

Welcome to the Food from Thought Mid-term Report. July 2020 marked the midpoint of the research program, and this milestone provides an opportunity for us to celebrate what's been achieved so far and to recognize our impact on catalyzing research to create transformative solutions and agricultural systems for a healthy planet.

Food from Thought will look back on 2019 as a positive and successful year. We made significant progress toward achieving our goal to position Canada as a global leader in the development of innovative solutions that improve the sustainability and productivity of agricultural production at global, landscape, and micro scales.

However, at the time of this report, COVID-19 continues to create immense challenges for our agri-food systems, including the interruption of food supply chains around the world. Through careful and nimble planning, Food from Thought researchers were able to continue their projects while also becoming active contributors in response to the emerging questions and needs surrounding COVID-19.

Food from Thought research is helping to create a safer world and is enabling science-based decision-making during the COVID-19 response

Food from Thought launched a webinar series in partnership with the Arrell Food Institute and the One Health Institute that provided a platform for our researchers, some of the University of Guelph's foremost agri-food experts, to answer questions about food and agriculture. They discussed, among other things, the pandemic's impact on Canada's food system, the effects of food insecurity on racialized communities and the future of agriculture technology and labour. Food from Thought researchers offered their expertise and advised government, industries and the general public on topics related to food safety, sustainability and production during this extraordinary period.

Recognizing accomplishments and keeping an eye toward the future of agri-food

As we navigate these challenging times, Food from Thought researchers continue to achieve scientific excellence and produce influential research in livestock production, crop sciences, food safety and livestock health, biodiversity, ecosystem services, and integrated food systems that will result in lasting and sustainable changes in agriculture and food production.

In three years, Food from Thought has:

- Empowered University of Guelph researchers to learn, discover and create bold solutions to tomorrow's food production challenges.
- Provided high-quality training and experiential learning opportunities to graduate students, our next generation of research pioneers, through the Highly Qualified Personnel (HQP) Scholarship Program, which resulted in research projects to create innovative solutions for real-world agri-food challenges.

These are a few highlights of our progress, and we invite you to continue reading this report to learn more about Food from Thought's leading-edge research projects and their impact on increasing the capacity, sustainability and safety of our food production systems.

Our successes could not have been possible without the contributions, commitments and leadership of the Food from Thought team and those involved in our Steering Committee, International Scientific Advisory Council and Strategic Advisory Board.

We are thankful for the crucial support from our partners and collaborators whose investment and engagement in our program have bolstered our research and the training provided to graduate students. We look forward to our continued partnership in the years ahead.

As always, we would like to acknowledge funding from the Canada First Research Excellence Fund. Through this investment, Food from Thought is accelerating the development of trail-blazing research to position Canada at the forefront of the agricultural revolution.

AGRICULTURAL SYSTEMS FOR A HEALTHY PLANET

Food from Thought: Agricultural Systems for a Healthy Planet is a research program led by the University of Guelph, funded in part by a $76.6-million grant from the Canada First Research Excellence Fund.

Food from Thought is tackling the challenge of how to feed a growing global population by advancing our understanding of the complex interplay between farming practices and the environment

The program's goal is to increase the sustainability and productivity of global food production by leveraging the power of big data, agri-food, and biodiversity science.

Food from Thought is positioning Canada as a global leader to create agricultural systems for a healthy planet on global, landscape, and micro-scales through four key strategies: cutting-edge research; training the next generation of agri-food leaders; innovation, commercialization and knowledge mobilization; and increasing the University of Guelph's capacity for data science expertise through faculty recruitment and by catalyzing the development of an integrated data-sharing and analytics platform.

THE FOUR PILLARS OF **FOOD FROM THOUGHT'S IMPACT**

- Leading-Edge Research
- Training Future Agri-Food Leaders
- Innovation and Knowledge Mobilization
- Leveraging the Power of Big Data

OUR VISION

Our vision is to transform our understanding of the ecosystems we depend on for food, at scales that range from planetary to microcosmic. At the same time, we want to increase the capacity, sustainability and safety of food production systems without undermining environmental health, ecosystem services or livestock health and welfare.

Food from Thought will create and implement next-generation information management systems, decision support tools, and digital applications that intelligently collect, analyze and apply massive amounts of data from crops, livestock and the environment. This new digital agricultural research platform will provide solutions to identify food fraud, reduce food safety risks, refine pesticide and fertilizer use, monitor soil and crop health, predict and manage animal health, control pathogens and track emerging infectious disease threats.

OUR MISSION

Food from Thought has three distinct missions:

1. **Global Scale Mission** – Transforming agriculture's impact on biodiversity
2. **Landscape Scale Mission** – Sustainably intensifying production
3. **Micro-Scale Mission** – Enhancing food and livestock health

PROGRAM HIGHLIGHTS

This section captures some of the noteworthy and memorable Food from Thought milestones over the past four years. Read the following pages for more and, if you don't already, please follow us on Twitter @UofG_FfT for real-time updates.

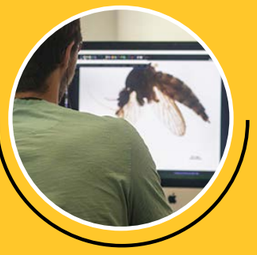
Participants discuss research and collaboration opportunities at the Big Data Workshop hosted by Food from Thought on June 27, 2019.

DECEMBER 2016

The Canada First Research Excellence Fund awards the University of Guelph $ 76.6 million to support the development of innovative solutions that improve the sustainability and productivity of agriculture.

MAY 2018

Food from Thought's first annual meeting brings partners and stakeholders together to discuss how to leverage and apply big data to the core challenges of sustainably increasing the productivity and safety of the world's agri-food systems.



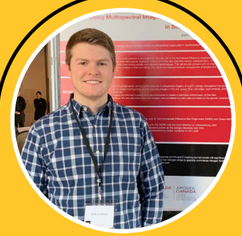
2017 - ROUND I FUNDING AWARDED

$5.8M invested in the Centre for Biodiversity Genomics.

Twenty-six research projects spanning seven themes and covering topics from conception to consumption are awarded more than $8M in research funding.

JANUARY 2019 – RESEARCH INTEGRATION SYMPOSIUM

A day for Food from Thought researchers, students, and staff to share and connect. Food from Thought principal investigators shared 3- to 5-minute updates on their FfT-funded research projects.



2019 - ROUND II FUNDING AWARDED

$7.5M invested in the Centre for Biodiversity Genomics.

Twenty-eight research projects spanning seven themes, including crops, livestock and food safety, are awarded more than $9.2M in research funding.

$1M awarded to five digital ag research projects focused on the development of novel digital, data-driven applications, analytics, and decision-support tools for the agri-food sector.

JUNE 2019 - RESEARCH EXCELLENCE SYMPOSIUM AND FOOD FROM THOUGHT'S ANNUAL MEETING

Food from Thought and the Arrell Food Institute co-hosted the first Agri-Food Excellence Symposium showcasing Food from Thought research and providing opportunities to network and build collaborations with partners and participants from around the world.

OUR IMPACT IN NUMBERS

165
EXPERT FACULTY
RESEARCHERS

MORE THAN
$35 MILLION
INVESTED IN RESEARCH OPERATIONS

MORE THAN
550,000
YOUTUBE VIEWS

NEARLY
300
ACADEMIC PUBLICATIONS

300+
OUTSTANDING GRADUATE STUDENTS
AND POST-DOCTORAL FELLOWS

500+
PARTNERS,
KNOWLEDGE USERS & COLLABORATORS

55
PATENTS

NEARLY **1,000**
OUTREACH EVENTS
& MEDIA INTERVIEWS

61
HQP SCHOLARSHIP
AWARDS

9
RESEARCH TRAINING PROGRAMS ATTENDED BY
3,000+
STUDENTS & FACULTY

13
POLICY
FELLOWS

5
COPYRIGHTS

FUNDING ALLOCATION

- 66% RESEARCH
- 11% MANAGEMENT & ADMINISTRATION
- 9% KNOWLEDGE MOBILIZATION, INNOVATION & COMMUNICATIONS
- 7% NEW FACULTY HIRES WITH DATA EXPERTISE
- 5% GRADUATE TRAINING PROGRAMS (NON-RESEARCH)
- 2% RESEARCH FACILITY UPGRADES

25,000+
GOOGLE SCHOLAR
CITATIONS

NEARLY
300
MEDIA INTERVIEWS
WITH PRINCIPAL INVESTIGATORS

MORE THAN
1,500,000
WEBSITE VISITS

NEARLY
200
KEYNOTE
SPEECHES

TRAINING FUTURE
AGRI-FOOD LEADERS

In 2019, Food from Thought, in partnership with the Ontario Agri-Food Innovation Alliance and the Arrell Food Institute, redesigned its scholarship program to enhance the program's ability to provide high-quality training to Food from Thought-funded graduate students. This new program brings together the former Food from Thought Research Assistantship Program and the Ontario Agri-Food Innovation Alliance-led HQP Program. The result is an experientially based opportunity that enhances students' training while maintaining the core objectives of Food from Thought's original Research Assistantship.

The new Highly Qualified Personnel (HQP) Scholarship Program launched with a cohort of 19 graduate students in the 2019-20 academic year and included a 2-semester graduate level training course called Innovation and Entrepreneurship in Agri-Food Systems. This eight-month course aims to expose students to a wide range of agri-food related challenges and provide mentorship in the "foundational skills" of project management, teamwork, plain language communication, and conflict resolution. Students work in groups to collaborate with NGOs, government agencies, or businesses on agri-food projects and are tasked with developing a work plan and final deliverables. Through these projects and a series of modules, students build knowledge and competencies in business development, communication, social innovation, and entrepreneurship.The result is a win-win opportunity for both students and community partner organizations. The HQP program provides the training ground for a diverse group of multidisciplinary scholarship recipients to practise and refine their critical thinking and collaboration skills. In return, partner organizations are linked with a dedicated, multi-disciplinary team to work through a real-world organizational challenge.

HQP scholars Leticia Reis, Chloe Alexander and Anna Welboren (from left to right) take time out for a photo while working on a group project.

HQP TRAINING THROUGH
COMMUNITY ENGAGEMENT

The SEED Fresh Food Rx Pilot: Addressing Food Insecurity

The SEED is a community project of the Guelph Community Health Centre whose goal is to eradicate food insecurity in Guelph by increasing food literacy and access to healthy food. A team of HQP scholarship recipients is participating in the Fresh Food Rx Pilot by conducting surveys and interviews with potential clients. They are also supporting the pilot in data analysis, community and policy advocacy, and future study design.

The City of Guelph Our Food Future: Creating Canada's First Circular Food Economy

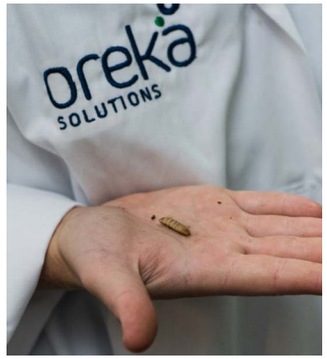
The City of Guelph/County of Wellington received a $10M grant to implement a bold vision to create Canada's first circular food economy. The HQP graduate team is developing an inventory of criteria that will help refine the definition of circular food business. Identifying and developing criteria will inform what data will need to be collected through measurement and evaluation to ensure Our Food Future is meeting its performance outcomes.

10C Nourish: Food Waste

The HQP graduate team will be part of a larger pilot study to test the feasibility, acceptability, and preliminary impact of a Food Waste Reduction Toolkit for families. This project will involve developing intervention messages (i.e. text messages) to support food waste reduction, primary data collection from families, recruitment of families, facilitating parent/child cooking nights and education sessions, data analysis, and creating a variety of knowledge mobilization tools.

10C creating space for change

HQP TRAINING THROUGH **COMMUNITY ENGAGEMENT**



Oreka Solutions: Food Waste and Food Sustainability

Oreka Solutions' mission is to harness the power of the black soldier fly to transform animal feed. The HQP graduate team will support Oreka Solutions through mapping and identifying food waste streams in the Guelph-Wellington area, and informing the creation of a management and tracing software system to track input at all levels (retail, processors, farmers, and brewers).

Semex Inc.: Sustainability through Efficiency in Livestock Production

Semex is an international company that provides high-quality semen from carefully selected elite sires for the dairy and beef industries. The HQP graduate team is conducting market research and technology development services to propose a course of action for Semex in predicting the desired genetics for each region.

Culinary Tourism Alliance: Measuring the Environmental Impact of Agri-tourism

Through a series of case studies, the HQP graduate team is examining environmental impacts of agri-tourism, including impacts due to over-tourism. This information will aid the Culinary Tourism Alliance in determining how destinations prioritize environmental sustainability and how tourists value environmentally friendly practices.

Ripple Farms: Food Innovation to Increase Sustainability

Ripple Farms is an aquaponics farm system balancing sustainability and innovation to grow high-quality crops and Toronto's freshest seafood and greens 365 days a year. The HQP graduate team is conducting a market feasibility study involving qualitative market research in order to produce convincing communications materials.

INVESTING IN HQP TO STRENGTHEN **THE FUTURE OF AGRI-FOOD**

Emily Duncan, 2017 and 2019 HQP scholar

Emily Duncan has been involved in the Food from Thought (FfT) program since it began in 2017 and has been working on FfT-related research for the past three years.

She was in the second year of her master's degree when she participated in the first Research Assistantship Program (now the HQP Program). Today, the 29-year-old from Montreal is a PhD student in the Department of Geography, Environment and Geomatics, and has received a $50,000 scholarship as part of the 2019 HQP program.

Emily's educational journey is one that exemplifies the results of investing in the next generation of researchers who will tackle our planet's most pressing agri-food issues. As the Food from Thought program has progressed, so has Emily's research and professional training, and she credits this growth to the opportunities provided by the HQP Program.

"The interdisciplinary aspect of the program is incredibly impactful. I've had the opportunity to meet and collaborate with so many graduate students outside my department who are all contributing to solving global food and agricultural challenges in unique ways," said Emily.

"These connections have influenced how I present my work because there is a need for researchers to be able to communicate effectively to others from a broad range of disciplines."

Emily's research project titled "Social Dimensions of Digital Agricultural Technologies and the Governance of Global Agri-Food Data," is focused on the collection of farm data through the use of new technologies including sensors, robotics, and big data analytics platforms. This digital transformation has the potential to increase yields and reduce the environmental impact of farming. However, there is a lack of understanding of the social consequences that digital agricultural technologies will have on the food system, such as impacts on agricultural knowledge production,

climate change adaptation, and changes in land access in rural areas.

Digital technologies are expected to have a significant role in addressing the challenge of feeding a global population that is expected to reach 10 billion people by 2050, but their transformative potential means that we need to begin paying careful attention to the social implications of their adoption. Emily's research strongly aligns with FfT goals as she aims to understand how the adoption of new technologies promotes productivity and sustainability, at both the national and international scales through research in Canada and Ghana.

As a researcher in training, Emily understands the importance of being able to share understandable and accessible information with a variety of audiences to ensure the maximum impact of her research.

"While research is often complex and theoretical, it is a crucial skill to be able to explain the outcomes to diverse stakeholders — industry, government, and academia. The program provided numerous opportunities to learn how to share research in various ways, such as through infographic development, pitch training, engaging presentation styles, and social media instruction."

Emily said she's had numerous opportunities to put into practice the knowledge that she has gained from the HQP program.

"Through various roles such as education assistant at the Arrell Food Institute and as a first-year seminar course instructor, I've worked to share the communication and knowledge mobilization skills that I gained through the HQP program. The program also provided me with important project management experience which has allowed me to confidently lead several international research collaborations related to food and agriculture."

Emily is most proud of the moments tied to the research projects that she has participated in through the HQP program which have made important scholarly and practical contributions. She plans to pursue her passions for research and teaching through an academic career and also hopes to continue to collaborate closely with industry, government, and NGOs to provide meaningful research that will contribute to a more resilient, sustainable, and equitable food system.

Her advice to the next cohort of the HQP program:

"Be open to all the new and exciting experiences that the program has to offer! Grad school is about more than just writing a thesis — take advantage of all the workshops, field trips, and networking opportunities that this program has created to build your professional development in the food and agriculture sector."

IN CONVERSATION

Name: Emily Sousa
Program: Rural Planning and Development (M.Sc.)
Faculty Adviser: Dr. Wayne Caldwell
Project Title: The Rise of Cricket Farms as 'Mini-Livestock' in Ontario

2019 HQP SCHOLAR

"The collaborative, interdisciplinary nature of the program and community engagement projects had significant impacts on my learning. I worked with a dynamic group to envision what food circularity could look like in Guelph-Wellington, to make the region Canada's first circular food economy. Working with a multitude of stakeholders towards achieving this vision emphasized the great potential for innovation, creativity, and problem-solving that can occur when a community of researchers and collaborators come together."

2019 HQP SCHOLAR

Name: Anna Welboren
Program: Animal Biosciences (PhD)
Faculty Adviser: Dr. Michael Steele
Project Title: Macronutrient Composition of Calf Milk Replacer

"The program helped me prepare for my future career by getting me out of my comfort zone. For example, for the group project, myself and two other students prepared a study to test the effectiveness and acceptability of an intervention aimed to reduce household food waste. Having to think about ways to change human behaviour, to design study material and to recruit families to participate in the study was a mind-blowing learning experience!"

INNOVATION AND COMMERCIALIZATION

Between 2017 and 2020, Food from Thought has invested $315,000 to equip researchers with the skills and tools needed to commercialize their research and develop their intellectual property into new products and processes.

Over the past four years, Food from Thought has supported 13 researchers with commercialization grants. We are pleased to highlight some of these innovative solutions, which have the potential to impact the sustainability and productivity of food systems in Canada and beyond.

A researcher prepares samples in the George van der Merwe Lab.

ENGINEERING NEXT-GENERATION SOIL AMENDMENTS FOR SUSTAINABLE FOOD SUPPLY

Dr. Rafael Santos - 2019 Commercialization Grant

The fertilizer industry is growing as populations increase, placing greater emphasis on fertilizer for crop yields. Utilizing engineered products to replace some of the main soil amendments that farmers use provides the same fertility of traditional fertilizers at more efficient levels, with improved greenhouse gas mitigation and higher crop yields. This project aims to commercialize these engineered products and test them on Ontario farms to verify the effects on nutrient uptake, crop yield and carbon sequestration capacity. This will enable a spin-off company to implement business models, secure sales and receive feedback for improvements.

BRANDING AND MARKETING STRATEGY TO LAUNCH A PLANT-BASED CHEESE IN RETAIL STORES

Dr. Art Hill - 2019 Commercialization Grant

Researchers involved in this project have developed a soy-based cheese alternative, mimicking the smooth and creamy texture of dairy cheese. It produces 30 times fewer greenhouse gas emissions and was well received at the Canadian National Exhibition. To further the reach of this product, the team is developing an evidence-based branding and marketing strategy that will enable the product to compete with similar products already on the market. Through effective branding, other plant-based products will emerge and increase the use of Ontario grains, boosting the economy and creating more jobs.

APPLICATIONS OF NOVEL STRESS TOLERANT YEASTS IN COMMERCIAL ALCOHOL FERMENTATIONS

Dr. George Van Der Merwe - 2017 Commercialization Grant

There is a growing consumer demand for a variety of craft beer production in Ontario. The yeast strain used for beer production has a large impact on the style and organoleptic properties of the final product. The project team has isolated certain yeast strains that provide improved fermentation processes. However, more research is required for widespread adoption in the distilling and bio-ethanol markets.

TURNING KNOWLEDGE INTO ACTION

Knowledge mobilization – the connection between academic research and organizations, people, and government to improve practice and inform policy – is deeply ingrained in the work of Food from Thought researchers. Through activities including engagement in research project development, presentations, conferences, and workshops, our researchers are working to mobilize their discoveries to industry stakeholders, policy-makers, government and the broader public.

The following are examples of knowledge mobilization efforts that have been funded by Food from Thought to enable researchers to maximize the reach and impact of their work:

Attendees learning about Food from Thought research projects at the Research Integration Symposium on February 21, 2020.

ACCELERATOR GUELPH WORKSHOPS AND MENTORSHIP

This new commercialization support program helps teams bring ideas to market with practical, hands-on workshops and mentorship. Using the successful model created by the Waterloo Accelerator Centre and enabled by Food from Thought funding, Accelerator Guelph guides researcher-affiliated teams to build successful, sustainable enterprises. Teams explore an invention's market feasibility, develop solid business foundations and acquire the executive leadership skills necessary to scale ideas born in research into highly valued products and services. There have been 20 workshops held annually with 15-20 participants per workshop. Accelerator Guelph builds on the University of Guelph's Research Innovation Office strengths in innovation and knowledge mobilization. This program is entirely funded by Food from Thought.

ADVANTAGE WORKSHOPS

Offered to researchers including graduate students, the Advantage Workshops are intended to give research teams the tools they need to maximize the impact of their research and to produce innovative products and tools. The workshops expose research teams to new skills that can help them envision and communicate solutions and to develop fruitful, long-term relationships with industry. Workshop topics include: Intellectual Property Essentials, Innovation Toolkit, Knowledge Mobilization (KMb) Strategy Toolkit, Advanced Collaboration Techniques, and Creating Persuasive Value Propositions. There have been 21 workshops with participation ranging from 17 to 60 individuals.

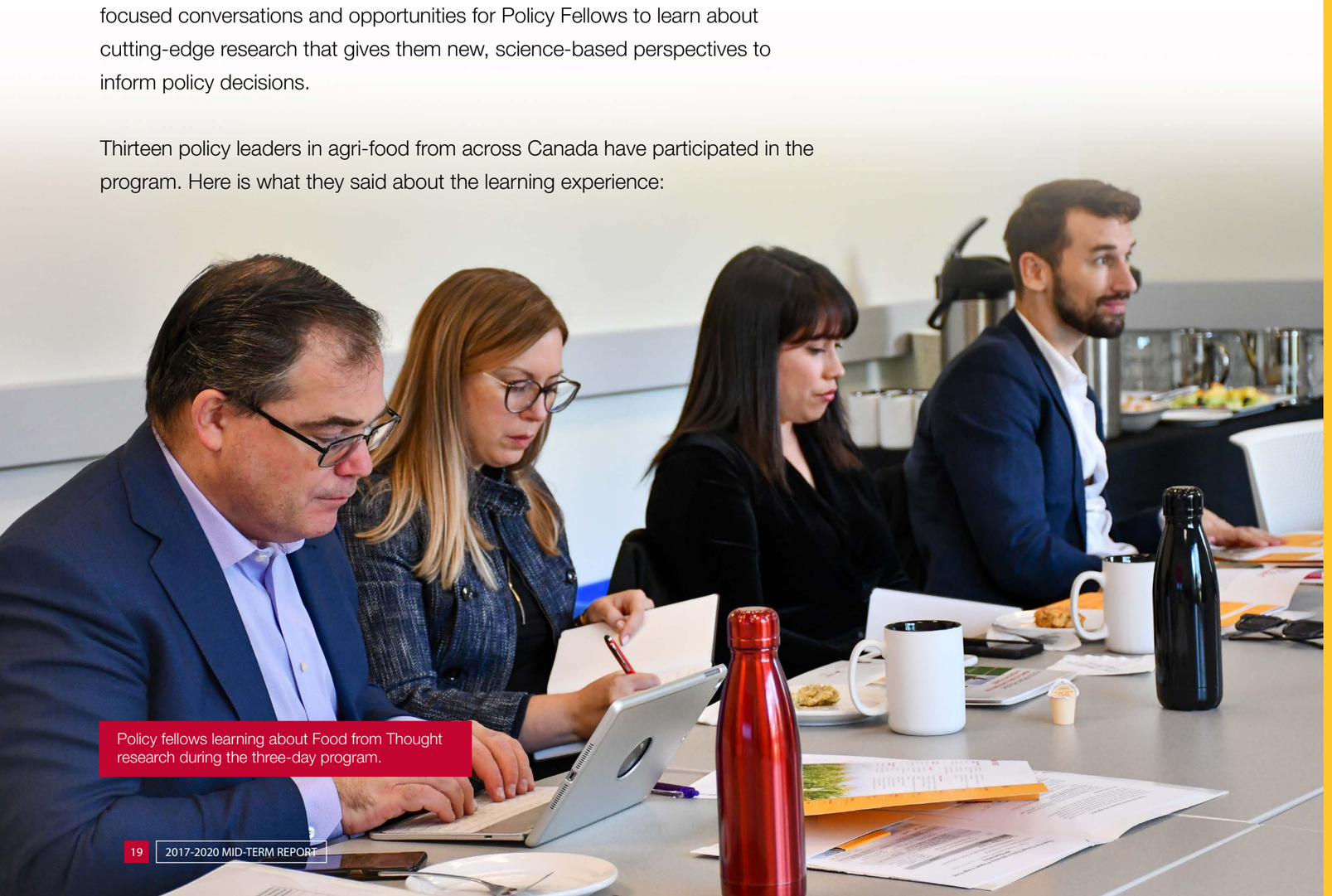
OUTREACH EVENTS

Food from Thought regularly hosts outreach events, including our Annual Meeting, Agri-Food Excellence Symposium and the Guelph Talks Food series, featuring seven researchers presenting high-energy, short-format talks about their cutting-edge research to tackle issues such as the environmental impacts of agriculture in the North. These events allow senior representatives from agri-food organizations and companies from across Canada and internationally to learn about breakthrough scientific research from University of Guelph researchers.

POLICY FELLOWSHIP

Launched in early 2018, the Policy Fellowship program, funded by Food from Thought, brings senior decision-makers from various levels of government, industry, and NGOs to the University of Guelph to participate in a three-day program. The only one of its kind in Canada, this unique experience involves focused conversations and opportunities for Policy Fellows to learn about cutting-edge research that gives them new, science-based perspectives to inform policy decisions.

Thirteen policy leaders in agri-food from across Canada have participated in the program. Here is what they said about the learning experience:



Policy fellows learning about Food from Thought research during the three-day program.

DIANA JOHNSON
Health Research Specialist,
Toronto Public Health

"The Fellowship program was an incredible opportunity to learn from experts about the latest research and trends that can inform Toronto's food policy work. Almost every meeting I had brought out a new idea… A few highlights included learning about a circular economy for food, the value of demonstration projects and the importance of understanding the nexus of urban and rural food systems. The fellowship helped me gain a broader view of food and agriculture and also granted me a unique opportunity to create new collaborations with experts from various perspectives of the food system."

HENRY GORDON-SMITH
Founder and Managing Director
Agritechture Consulting

"The experience of the fellowship was a very positive one! Networking with the other fellows, University of Guelph staff, and researchers provided unique connections that I am already leveraging to accelerate the policy impact of my work… Connections I was able to make have already led to some longer-term discussions. Agritecture looks forward to remaining connected with the Fellowship team and the University of Guelph overall."

DANIELLE COLLINS
Policy Analyst
Ontario Federation of Agriculture

"Tapping into the first-class expertise and talent at the University of Guelph has elevated my knowledge of this dynamic industry ... : Dedicating an enriching three days to discuss high-level research and policy implications has formed lasting connections and opened new doors that I could not have anticipated before beginning the program."

RESEARCH AT A GLANCE

Food from Thought Hires Leaders in Digital Agriculture Research

In 2018, Food from Thought funded the addition of six new faculty positions focused on advancing the goal of increasing the University of Guelph's capacity for data science expertise and catalyzing the development of an integrated data sharing and analytics platform.

JOHN SULIK
Precision Agriculture

ELIZABETH MANDEVILLE
Bioinformatics and Computational Biology

KHURRAM NADEEM
Computational Statistics

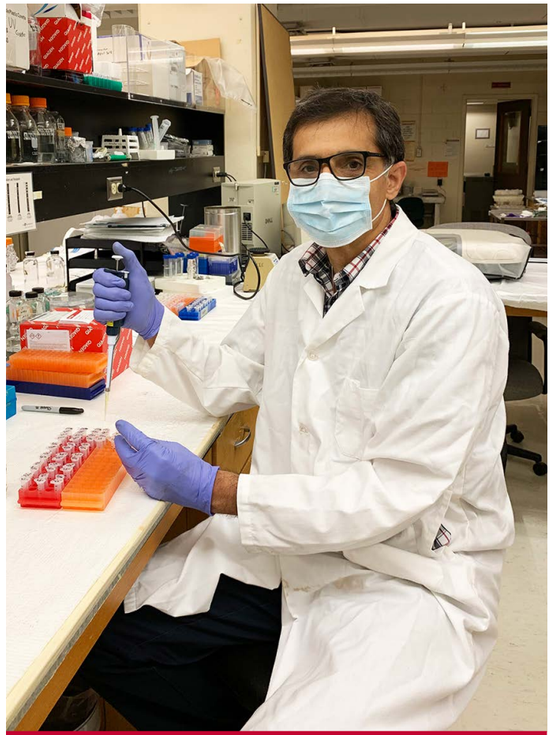
NICOLE RICKER
Pathogenomics

DAN TULPAN
Computational Biology

MIKE STEELE
Animal Physiology

DIVERSITY, EQUITY AND INCLUSION

Food from Thought is proud of our researchers' commitment to diversity, equity and inclusion. They have truly embraced the desire to cultivate research environments and teams that comprise people of different genders, races, cultures and experiences. Food from Thought researchers work to ensure that principles of diversity, equity and inclusion are embedded in their research by implementing measures that inform their collection of data, recruitment practices, and ongoing monitoring and course correction of research projects to ensure diversification. In doing so, they are producing stronger research that more accurately reflects and serves society.



Sasan Amirsadeghi (post-doctoral research associate), a molecular biologist in the Weed Research lab, works with Dr. Clarence Swanton on early physiological and molecular responses of corn and soybean to far-red light signals of weed competition.

"I am not surprised that Dr. Madhur Anand exceeds expectations on this account. She has done a superb job of ensuring that a broad range of minority members will be playing a major role in the project

- A reviewer's comments on Diversity, Equity and Inclusion in Food from Thought research

RESEARCH AT A GLANCE

Enhancing Ontario's Grain Production Using Smart Farming Techniques

Dr. Asim Biswas

Recent decades have seen higher costs associated with crop inputs, products and expertise required for adequate grain production. Current research methods combine proximal soil sensors that will account for spatial and temporal variability in the soil with UAV (unnamed aerial vehicle) sensing that will capture the variability during crop growth. The goal of this project is to improve soil health and crop yield, ensuring economic and environmental sustainability.

Dr. Asim Biswas' team set up a camera that will be used to collect time lapse images of crops over the growing season.

The Future of Corn: Improving Low Fertilizer Nitrogen

Dr. Bill Deen

Research is exploring and testing the validity of an improved low fertilizer nitrogen used in corn by examining the interaction of the fertilizer and water. Following the 2019 field research season, substantial advancements have been made in the knowledge of how to effectively conduct on-farm N response trials. Data transfer from the grower to the central database remains a significant obstacle to scaling on-farm research.

RESEARCH AT A GLANCE

Using DNA Barcoding to Create Resilient Agro-ecosystems

Dr. John Fryxell

This research project will provide a comprehensive data set on factors influencing arthropod and aquatic insect biodiversity in relation to farming practices, climate variation, physical features and landscape heterogeneity. So far, Dr. John Fryxell and his research team have sampled more than one million insects from 30 sites in southern Ontario, using DNA barcoding to identify and compare the insects. Results suggest that there is a substantial seasonal variation in biodiversity between sites.

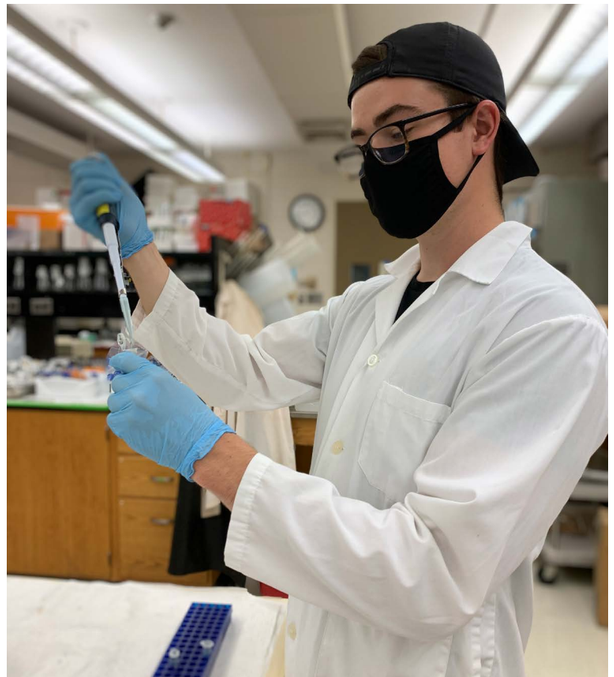
Patrick Burgess, masters student, services a malaise trap on a Lake Erie-area farm as part of this Food from Thought project.

RESEARCH AT A GLANCE

Stressed Out: Improving Stress Tolerance Among Crops

Dr. Clarence Swanton

In this research project, molecular and physiological studies are being conducted under laboratory conditions. When appropriate, results from these laboratory studies are then tested under field conditions. Most recent findings show that when weeds are present, *Arabidopsis* and corn plants are less able to protect themselves from harmful compounds due to alterations in ascorbate (vitamin C), which can result in damage and lower yield potential.



William Kramer, M.Sc. student, dilutes plant extract to prepare for nitrate assay.

Agroecology and the Search for Environmental Sustainability

Dr. Madhur Anand

Dr. Madhur Anand and her research team are currently collecting field-based data, working with existing data sets, as well as developing methodological innovations in modelling and software development. They have identified several lands set aside from profit mapping that they anticipate will increase conservation opportunities. The research will help improve monitoring and management programs at conservation authorities that will prevent further degradation of natural habitats.

RESEARCH AT A GLANCE

Improving Crop Productivity with Mixed Plant Varieties

Dr. Peter Pauls

Current concerns about feeding a growing population are coupled with increasing public interest in achieving crop production targets with environmentally sustainable agronomic practices. The overall objective of this Food from Thought research is to increase crop production and ecosystem services, simultaneously. Results have indicated multiple agronomic and ecosystem benefits from planting a variety of bean mixtures instead of monocultures. In addition, experiments have suggested that through breeding and selection, symbiotic nitrogen fixation can be improved in the presence of less fertilizer. This would be a major advance in profitability for the dry bean industry in Canada and would significantly improve the ecological footprint of the crop.

Dr. Peter Pauls observes the bean registration trial in Elora, Ont.

Utilizing Satellites for the Advancement of Agricultural Practices

Dr. Aaron Berg

Accurate and timely soil moisture information is important for crop yield predictions, weather and climate prediction, and streamflow forecasts. However, data gathered from existing satellites has been insufficient for use in precision agriculture. Dr. Aaron Berg's team seeks to develop new tools for estimating soil moisture from new, recently launched radar satellites. In addition, they are working to develop new applications that use soil moisture data. The enhanced capabilities of the RADARSAT Constellation Mission, soil maps, and topographical data will be combined to map areas for potential agricultural intensification and areas to target for conservation.

RESEARCH AT A GLANCE

Terrestrial Ecosystem Monitoring in Ontario

Dr. Andrew MacDougall

In association with ALUS, a national organization that supports the use of marginal farmland in ways that sustain a productive ecosystem, Dr. Andrew MacDougall and his team are exploring a series of environmental sustainability initiatives on high-intensity conventional farms in southern Ontario. This research, being conducted on 24 farms, is focusing on the capacity for precision conservation to meet a series of objectives centring on the production of ecosystem services. Results to date have found immediate gains derived from the renewed colonization of diverse insect populations and grassland species after only the first year of habitat restoration. It is expected that continued fieldwork, combined with intense analyses and outreach to farmers, will result in the development of national best management practices to restore low-yielding marginal crop land to areas of conservation to sustain agriculture, wildlife, and natural spaces for all Canadians.

A series of insect cages installed in a soybean field is used to test insect predator-prey dynamics.

Visit the Food from Thought website to learn more about our research themes and the innovation projects that are helping to find solutions to key challenges facing food and agriculture today.

RESEARCH INVENTORY

DIGITAL AGRICULTURE RESEARCH PROJECTS

Enhancing Ontario's grain production using smart farming techniques
Asim Biswas and **co-investigators**:
William Deen, John Sulik, Adam Gillespie, Prasad Daggupati

Accounting for soil organic carbon in profitability maps
John Lindsay and **co-investigators**:
Adam Gillespie, Madhur Anand, Eric Nost, Ahmed Laamrani, Clarence Swanton, Paul Voroney, Wanhong Yang

Livestock visualization project: Using visual and spectral images to determine calf growth and performance
Medhat Moussa and **co-investigators**:
Katherine Wood, Dan Tulpan

Utilizing data from automated calf feeders: Identifying novel ways to identify disease to improve growth and performance of dairy calves
Dave Renaud and **co-investigators**:
Charlotte Winder, Michael Steele

Expanding the value of soil health and soil ecosystem services research through development of an integrated data-sharing platform
Claudia Wagner-Riddle and **co-investigators**:
Kari Dunfield, Aaron Berg, Jon Warland

A cybersecurity monitoring and threat hunting system for protecting smart farming
Ali Dehghantanha and **co-investigators**:
Hadis Karimipour, Evan Fraser

Enhancing the impact of agri-environmental research with repeat digital imaging
Claudia Wagner-Riddle and **co-investigator**: Aaron Berg

Applying wearable sensors and machine learning to improve dairy cow health and production
Eduardo Ribeiro and **co-investigator**: Dan Tulpan

Using deep learning as an analysis and decision-support tool to assess biodiversity gain from habitat restoration in the agri-food sector
John Fryxell and **co-investigator**:
Graham Taylor

Informatics for single-specimen Ecosystems
Paul Hebert

Development of near-real time analysis and reporting tool for important livestock pathogens
Zvonimir Poljak and **co-investigator**:
Maria Spinato

Rapid assessments of farmland functional biodiversity and specific ecosystem functions
Dirk Steinke

ECOSYSTEM SERVICES RESEARCH PROJECTS

Eco-evolutionary dynamics and aquatic ecosystem services
John Fryxell and **co-investigators**:
Andreas Heyland, Teresa Crease, Robert Hanner, Wanhong Yang

Genomic indicators of agro-ecosystem services
John Fryxell and **co-investigators**:
Dirk Steinke, Robert Hanner, Elizabeth Mandeville, Paul Hebert

Terrestrial ecosystem services
Andrew MacDougall and **co-investigators**:
Jana Levison, Kari Dunfield, Hafiz Maherali, Amy Newman, Brian Husband

Food security and the maintenance of aquatic ecosystem services
Kevin McCann and **co-investigators**:
Robert Hanner, Neil Rooney, Karl Cottenie, Fred Laberge, Nicholas Bernier, Ryan Prosser, Elizabeth Mandeville, Tyler Zemlak

RESEARCH INVENTORY

CROPS RESEARCH PROJECTS

Modelling and monitoring agroecological mosaic ecosystems for optimizing human-environment sustainability
Madhur Anand

Leveraging Canada's RADARSAT Constellation Mission for advances in precision agriculture and precision conservation
Aaron Berg

Development of a protocol and pilot study for nitrogen x water on-farm research
Bill Deen and **co-investigators**: John Sulik, Joshua Nasielski

Investigating the soil microbiome to understand soil health and soil ecosystem services
Kari Dunfield

Enhancing biodiversity of the agro-ecosystem by enhancing adoption of cover crops
Elizabeth Lee and **co-investigators**: Bill Deen, Dave Hooker, Nigel Raine, Kari Dunfield

Strategies for achieving simultaneous increases in bean crop agro-ecosystem diversity and productivity
Peter Pauls

Assessing and enhancing wild pollinator biodiversity
Nigel Raine

Improved approaches for management zone creation
John Sulik and **co-investigator**: Bill Deen

Enhancement of stress tolerance to weeds and cover crops
Clarence Swanton

Financial and sustainability assessment of precision agriculture in crop production
Alfons Weersink and **co-investigator**: John Sulik

LIVESTOCK RESEARCH PROJECTS

Precision poultry management: Combined approaches for enhancing layer health and welfare in the context of sustainable high egg production
Grégoy Bédécarrats and **co-investigators**: Elijah Kiarie, Tina Widowski, Alexandra Harlander

Development of novel biomarkers for stress, boar taint and reproductive performance in pigs
Renée Bergeron and **co-investigators**: James Squires, Julang Li, Lee-Anne Huber

Breeding livestock for climate resilience
Bonnie Mallard and **co-investigators**: Angela Cánovas, Dan Tulpan, Flavio Schenkel, Niel Karrow

Precision cattle management
John Cant and **co-investigators**: Katie Wood, Trevor DeVries, Michael Steele, Vern Osborne, Eduardo de Souza Ribeiro, Dave Renaud

A comparison of key methodologies used to quantify protein quality of insect protein, black soldier fly larvae, for human and farm animals
Kate Shoveller and **co-investigators**: Lee-Anne Huber, Elijah Kiarie, Michael Rogers

Mechanisms of long-term consequences of transition cow biology on production and reproduction traits
Eduardo de Souza Ribeiro

A comprehensive assessment of slow-growing chickens: Tackling sustainability issues for chicken strains of tomorrow
Tina Widowski and **co-investigators**: Elijah Kiarie, Ira Mandell, Niel Karrow, Dan Tulpan, Shai Barbut

RESEARCH INVENTORY

PATHOGENS RESEARCH PROJECTS

Improving antimicrobial stewardship in food animals by identifying the determinants of use of antimicrobials by veterinarians and dairy farmers
Stephen LeBlanc and **co-investigators**: David Kelton, Dan Tulpan, Jan Sargeant

The use of big data to predict the emergence of food-borne outbreaks
Lawrence Goodridge and **co-investigators**: Jeff Farber, Rozita Dara, Amy Greer

Is it possible to control transmission of avian influenza virus?
Shayan Sharif and **co-investigators**: Zvonimir Poljak, Rozita Dara, Amy Greer

Control of food-borne pathogens
Lawrence Goodridge and **co-investigators**: Jeff Farber, Gisele LaPointe, Nicole Ricker

Identification of factors contributing to *Streptococcus suis* disease in pigs: Big data approach
Zvonimir Poljak and **co-investigators**: Amy Greer, Brandon Lillie, Vahab Farzan, Nicole Ricker, Robert Friendship, Davor Ojkic

BIODIVERSITY RESEARCH PROJECTS

Tracking the response of arthropod communities to changing environments (TRACE)
Paul Hebert and **co-investigators**: Dirk Steinke,Sujeevan Ratnasingham, Jeremy deWaard, Evgeny Zakharov

Centre for Biodiversity Genomics (CBG) Platform
Paul Hebert and **co-investigators**: Dirk Steinke, Sujeevan Ratnasingham, Jeremy deWaard, Evgeny Zakharov

INTEGRATED FOOD SYSTEMS RESEARCH PROJECTS

Exploring novel agricultural frontiers
Evan Fraser and **co-investigators**: Aaron Berg, Kevin McCann, Khurram Nadeem, Krishna KC

Human dimensions of the digital agricultural revolution
Evan Fraser and **co-investigators**: Dan Gillis, Rozita Dara, Alfons Weersink, Shoshanah Jacobs, Eric Nost, Rebecca Hallett, Krishna KC

Advanced yield trial for Adzuki beans at the Elora Research Station.

PARTNERS

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Canadian Research Institutions
Centre for Biodiversity Genomics
University of Guelph
University of McGill
University of Victoria

Public Sector
Agriculture and Agri-Food Canada
Canadian Food Inspection Agency
Dairy Farmers of Manitoba
Fisheries and Oceans Canada
Innovation Guelph
Ocean Networks Canada
Ontario Agri-Food Innovation Alliance
Ontario Bean Growers
Ontario Centres of Excellence
Ontario Genomics - GAAP
Public Health Agency of Canada
Pulse Science Cluster
SOSCIP
Tokyo University of Marine Science and Technology
University of Leeds
Wageningen University and Research

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Canadian Poultry Research Council
Christian Farmers Federation of Ontario
Credit Valley Conservation
Egg Farmers of Canada
Egg Farmers of Ontario
Global Animal Partnership
Grain Farmers of Ontario
Great Lakes Fishery Commission
Hensall District Co-op
Ontario Pork
Ontario Sheep Farmers
Toronto and Region Conservation Authority

Victoria Asselstine collects milk samples at the Dairy Research and Innovation Centre in Elora, Ont.

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RESEARCH EXCELLENCE FUND

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