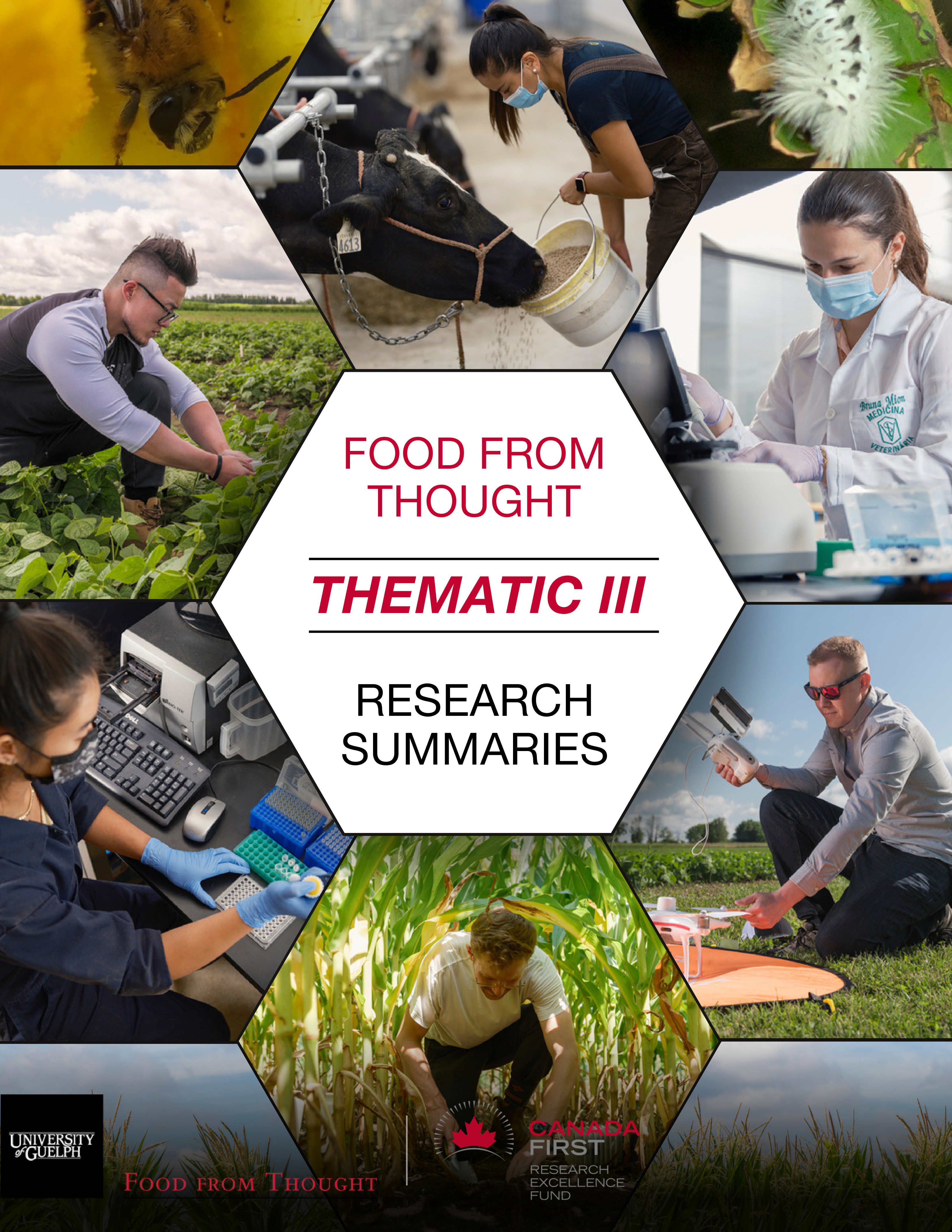

FOOD FROM THOUGHT

THEMATIC III

RESEARCH SUMMARIES

UNIVERSITY of GUELPH

FOOD FROM THOUGHT

CANADA FIRST RESEARCH EXCELLENCE FUND

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About Food from Thought

Sustainability in agriculture requires new strategies to feed a growing population without compromising the planet's health. This depends upon an improved understanding of the complex interplay between farming practices, and the environment.

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. The goal of the program is to increase the sustainability and productivity of global food production by leveraging the power of leading-edge data science, agri-food research, and biodiversity science. Food from Thought will position Canada as a global leader in the development of innovative solutions that improve both the sustainability and productivity of food systems at global, landscape, and micro-levels.

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.

The Food from Thought research program includes leading-edge projects in the areas of data strategy, livestock, crop sciences, pathogens and food safety, biodiversity, ecosystem services, digital ag and integrated food systems research.

Introduction

With this booklet, we are pleased to present the research projects funded in Food from Thought's third Thematic Research Funding Call. In these pages, you'll find summaries of the newly funded research projects, outlining the complex problems to be addressed, how these projects will address the issues, why the research matters, who's involved, and the expected impact of the research. These projects build on five years of innovative solutions improving the sustainability and productivity of agricultural production at the global, landscape and micro-scales.

The purpose for presenting this work now, as these projects are just getting off the ground, is rooted in a key principle of knowledge mobilization – engaging stakeholders and research users early in the research process. Creating opportunities for other researchers and research users to learn about the research before it happens enables greater cross-collaboration and integration, setting the stage for more significant research impact and moving us toward our collective goal of agricultural systems for a healthy planet.

With a duty to act on feedback received through Food from Thought's midterm review, the priorities for this round of funding were a little different than before. These projects focus primarily on the integration of research conducted to date, as well as the data strategy for Food from Thought and supporting the development of Agri-food Data Canada, a data ecosystem supporting agri-food sustainability. A few transformational and catalytic projects also promise to be game-changers within a relatively short time frame. This call encouraged greater inclusion of early career researchers and, as in all our work, emphasized indigenization, equity, diversity, and inclusion. We are excited to share the outcomes of this work with you as these cutting-edge research projects unfold.

To learn more:

- Visit the www.foodfromthought.ca for project details and updates.
- Subscribe to our monthly e-newsletter, The Feed.
- Read our annual impact reports, available on our website.
- Join our events or connect with us at conferences.

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Researchers & Projects

Researchers & Projects

Bioinformatics Strategies for Prediction of Biodiversity and Ecosystem Services

This research will create real-time biomonitoring and decision-making tools to measure and protect ecosystem services that are impacted by agricultural production.

Principal Investigator:
Dr. Sarah Adamowicz

Thematic Areas:
Ecosystem Services

Collaborators & Students:
Dr. Elizabeth Mandeville
Dr. Khurram Nadeem
Dr. Nicole Ricker
Dr. Ayesha Ali
Dr. Dirk Steinke
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Dr. Karl Cottenie
Dr. Robert Hanner
Dr. Zeny Feng
Dr. Stefan Kremer
Jacqueline May
Matthew Orton
Jessica Castellanos Labarcena
Helga Sonnenberg

What challenge(s) does the project address?
Biological diversity provides services required for food production, including nutrient cycling, clean water, food webs underlying commercial and Indigenous fisheries, pollination, natural pest control, and resilience to invasive species. However, biodiversity and ecosystem services face severe threats, including habitat loss, invasive species, pollution, and overharvesting.

How will this research address the challenge(s)?
Protection of ecosystem services requires new approaches for real-time biomonitoring and decision-making tools. This research program uses an integrative research approach that will challenge conventional wisdom in the field and yield new biomonitoring insights.

Why does this research matter?
Historically, the ability to track biodiversity promptly and manage agro-ecosystems has been limited. Real-time decision making, capturing the impacts of agricultural production on biodiversity is required to evaluate the impacts of agricultural management practices.

What are the (new) methods (techniques, technologies, etc.) that the project team will use during the research?
Using statistical learning and machine learning methods, this project will create and test new models to predict ecosystem services, health status, and biodiversity using metagenomic data (DNA sequence reads from whole communities of organisms, including insects and microbes).

What impact will the project have on agriculture?
This work will result in new bioinformatics tools for obtaining rapid information for decision-making, such as ecosystem health and the presence of invasive species, including insects and associated species in agricultural fields. The result will enable rapid biomonitoring and changes in agro-ecosystem management.

The Canadian Bee Gut Project

Principal Investigator:
Dr. Emma Allen-Vercoe

Thematic Areas:
Data Strategy and Crops

Collaborators & Students:
Dr. Graham Thompson
Dr. Brendan Daisley
Andrew Pitek
Anna Chernyshova
Amira Bouchema
Elizabeth Mallory

Honeybee populations in Canada are in decline, jeopardizing food security and increasing food inequity by escalating the costs of produce items. This research focuses on a novel approach to understanding the role of health and disease-associated microbial communities found in honeybees to allow for improved microbiome management in apiculture.

What challenge(s) does the project address?
Microbial imbalances in honeybees increase susceptibility to pathogens and agrochemicals, driving unsustainable colony loss rates within apicultural. There is a lack of solutions to address honeybee microbiome imbalances since missing microbes are often unknown.

How will this research address the challenge(s)?
This research will focus on the underlying microbial ecology of plant and animal-associated microbial communities at the systems level to ensure sustainable honeybee populations in Canada.

Why does this research matter?
Honeybee pollination is crucial to the success of many agricultural crops and is estimated to contribute $4.0 to $5.5 billion a year to the Canadian economy. However, for over a decade, the beekeeping industry in Canada has been experiencing unstainable colony losses and this issue has been unresolvable via traditional management strategies.

What are the (new) methods (techniques, technologies, etc.) that the project team will use during the research?
A crowd-sourcing approach will be leveraged to obtain nation-wide microbiome samples from managed honeybee colonies across Canada. High-throughput DNA sequencing will be used to systematically profile gut-associated microbial communities and determine linkages with honeybee health. Ultimately, an open-source big data analysis portal will be established from this work which will act as a catalytic reference point from which to grow, thereby enabling a more unified investigation of the underlying microbial factors affecting sustainability of the beekeeping industry in Canada.

What impact will the project have on agriculture?
This research will help to address the longstanding and complex issue of unsustainable colony loss in the Canadian beekeeping industry by understanding the novel microbial determinants of health and disease.

Combining Deep Learning and the Theory of Tipping Points to Better Predict Droughts

Principal Investigator:
Dr. Madhur Anand

Thematic Areas:
Crops, Ecosystem Services and Livestock

Collaborators & Students:
Dr. Rozita Dara
Dr. Chris Bauch
Dr. Daniel Dylewsky

This research will provide an early warning system for drought, enabling farmers and policymakers to react and decrease the severity of the effects of drought.

What challenge(s) does the project address?

Droughts can cause catastrophic disruptions to human livelihood and ecosystem services, which has stimulated research into developing advanced warning systems for droughts.

How will this research address the challenge(s)?

Using tipping point theory in a deep learning model enables a purely data-driven approach to the problem of detecting early warning signs of drought, using the data made available by recent advances in remote sensing technology.

Why does this research matter?

Droughts impact ecosystems, agriculture, and human livelihood in a rapidly warming world, but predicting them in any concrete sense remain a challenge. If droughts can be anticipated, resources can be better allocated to adapt to or prevent their occurrence.

What are the (new) methods (techniques, technologies, etc.) that the project team will use during the research?

This research will develop a deep learning model to anticipate the abrupt onset of droughts by harnessing the mathematical theory of tipping points. Combined with large data sets and the integration of available climate data, the deep learning model will have the ability to learn and be validated using real and simulated drought scenarios.

What impact will the project have on agriculture?

This research will provide an early warning system for agricultural and environmental sciences and present an opportunity for environmental monitoring extending beyond droughts to apply to any natural phenomena that exhibit a tipping point.

Big Data Analytics (BDA) Using Artificial Intelligence (AI) to Reduce Food Safety Risks in Canada

Principal Investigator:
Dr. Manick Annamalai

Thematic Areas:
Data Strategy, Pathogens and Food Safety

Collaborators & Students:
Dr. Kevin Keener
Dr. Maria Corradini
Dr. Carly Huitema
Dr. Raja Ragupathy
Dr. KSMS Raghavarao
Dr. Nabil Magbool Jan
Arun Kumar
Sundhar Alagumalai

This research focuses on increasing food safety along the Canadian food supply chain by creating tools to detect and trace food safety risks.

What challenge(s) does the project address?
Around 1 in 8 Canadians are affected by a foodborne illness every year, resulting in various levels of hospitalization, and 200-400 food recalls annually, causing significant economic and health impacts.

How will this research address the challenge(s)?
The Canadian government has recently made data and reports (even up to the past 50 years) available to the public. The research team will create tools to detect and trace food safety risks to decrease foodborne illnesses and recalls in Canada using this data.

Why does this research matter?
Consumers are facing information fatigue. The increased number of food recalls could overload consumers, which increases the likelihood of lowering attention and the risk of missing critical information about recalls.

What are the (new) methods (techniques, technologies, etc.) that the project team will use during the research?
This research will use big data, machine learning algorithms, artificial intelligence, and data from past foodborne outbreaks and food recalls. Researchers will study the information through descriptive analytics (what happened), diagnostic analytics (why did it happen), predictive analytics (what will happen), and prescriptive analytics (how to prevent).

What impact will the project have on agriculture?
The developed models will be used to implement a Smart Safety Surveillance System in Canada for rapid and accurate traceability to reduce food safety risks, implemented in the Canadian food supply chain.

Scaling-up Precision Agronomic Management Practices for Enhancing Ontario's Grain Production

Principal Investigator:
Dr. Asim Biswas

Thematic Areas:
Crops and Digital Agriculture

Collaborators & Students:
Dr. Solmaz Fathololoumi
Dr. Hitesh Kumar Bhogilal Vasava
Dr. Adam Gillespie
Dr. Aaron Berg
Dr. Prasad Daggupati
Dr. Joshua Nasielski
Dr. John Sulik
Caleb Niemeyer
Tony Bulkwill
Cameron Ogilvie
Daniel Saurette

This research will develop precise and ideal agronomic management strategies that are economical and ecological to address yield limiting factors in Ontario grain production. These strategies will increase profitability and sustainability to make the Ontario grain industry competitive.

What challenge(s) does the project address?

The rapid development of information technologies, including smart farming (e.g., precision agriculture) have emerged to optimize resources and minimize environmental impacts, but scaling up the technology remains a major challenge in enhancing Ontario's grain production.

How will this research address the challenge(s)?

This research aims to integrate fine resolution spatial and time-based soil and crop characteristics with satellite imagery using artificial intelligence to enable farmers to scale precision agricultural management to the farm and regional level.

Why does this research matter?

The wide-scale adoption of precision agriculture technologies is challenged due to the sensor technology providing field-specific information that helps develop precision agronomic decisions. Integrating satellite imagery with the field-specific sensor information allows for precision agriculture validation and scaling, enabling farmers to scale up precision agricultural management, decreasing input use while increasing Ontario's grain yield.

What are the (new) methods (techniques, technologies, etc.) that the project team will use during the research?

Artificial intelligence techniques will be used to compare and integrate information from multi-platform, multi-sensor, multi-scale, and multi-resolution data to measure, model, and map changes at the field, farm, and regional scale.

What impact will the project have on agriculture?

Better information helps better management decision-making, and this project will develop a series of information layers across the province. This information will not only provide required data for large-scale decision making and modeling, it will improve small-scale precision field management leading to cost and input saving and environmental health improvement.

Ecological and Evolutionary Impact of Agricultural Stressors

This research focuses on how ecosystems and individual species respond to the impacts of agriculture, improving our understanding of how to safeguard biodiversity in river ecosystems affected by agricultural production.

Principal Investigator:
Dr. Melania Critescu

Thematic Areas:
Ecosystem Services and Biodiversity

Collaborators & Students:
Dr. Gregor Fussmann
Dr. Andy Gozalez
Dr. Graham Bell
Dr. Rowan Barrett
Dr. Kevin McCann
Dr. John Fryxell
Dr. Andrew MacDougall
Dr. Paul Hebert
Dr. Sarah Adamowicz
Dr. Dirk Steinke
Dr. Takahiro Maruki
Robert Hechler
Christopher Hempel
Julien Beaulieu
Wendy Gamero Morgado
Kaushar Kagzi
Elizabeth Weller
Michelle Gross
Patricia Humer

What challenge(s) does the project address?

Ecosystems and individual species downstream from agriculture are impacted by individual management decisions on a farm, reacting with a physiological stress response. Understanding how particular species and ecosystem responds to stress is currently not well understood.

How will this research address the challenge(s)?

This research will develop, test, and apply genomics tools to assess river ecosystem health and link the responses to impacts and stressors in agricultural watersheds.

Why does this research matter?

Agriculture impacts its surrounding environment. This research will enable the assessment of impacts from agriculture and the trade-offs on ecosystems downstream of agriculture to support evidence-based decision-making focusing on biodiversity.

What are the (new) methods (techniques, technologies, etc.) that the project team will use during the research?

The use of environmental RNA as a biomarker for species identification and function, an area largely unexplored, enable researchers to reconstruct the footprint of biodiversity of functional information on complex communities of organisms in river ecosystems.

What impact will the project have on agriculture?

The development of environmental RNA biomarkers will provide a foundation for broad, sensitive, and non-invasive environmental health assessment, enabling policymakers to better the impacts of agriculture on biodiversity in ecosystems affected by agriculture.

Microbes to Microeconomics: Integration of Datasets for Sustainable Agriculture

Principal Investigator:
Dr. Kari Dunfield

Thematic Areas:
Crops

Collaborators & Students:
Dr. Tongzhe Li
Dr. Claudia Wagner-Riddle
Dr. Alfons Weersink
Dr. Adam Gillespie
Dr. Mica Tosi
Dr. Kira Borden
Andrew Hector
Olivia Blumenthal
Evan Mayer
Heather White

This research will assess regenerative agricultural practices, evaluating the environmental and economic synergies to ensure the adoption of practices that decrease greenhouse gas emissions from agriculture.

What challenge(s) does the project address?

Research has identified the value of soils and soil biota for supporting global food production and agriculture-based climate change solutions. Protecting soil health and soil biodiversity is essential to the stewardship of ecosystem services provided by soils, such as soil fertility (for food, fibre, and fuel production), water quality, resistance to erosion, and reduced greenhouse gas emissions.

How will this research address the challenge(s)?

By integrating interdisciplinary datasets, from soil microbes to microeconomics, this research will quantify and evaluate the ecosystem services provided by climate-smart and regenerative agriculture practices in Ontario.

Why does this research matter?

Soils are recognized worldwide to be critical in the fight against climate change and food security. However, soils are also at risk due to soil erosion, nutrient depletion, loss of carbon, and declining soil biodiversity. Protecting soil resources is a defining issue of our time, but solutions are complex and require an integrated cross-disciplinary approach.

What are the (new) methods (techniques, technologies, etc.) that the project team will use during the research?

The innovation of this project is the integration of diverse datasets for soil health, soil carbon, soil biodiversity, and greenhouse gases which will enable the evaluation of diverse the ecosystem services provided by agriculture practices. In addition, behavioural and experimental economics methods will be used to better understand agricultural producers' adoption of soil management practices.

What impact will the project have on agriculture?

This project will develop metrics and tools to determine cost-effective practices for GHG reduction to develop appropriate policy strategies, minimizing the risk of adopting new techniques and supporting decisions at the farm level.

A One Health Approach to Regenerative Grazing

Principal Investigator:
Dr. Kari Dunfield

Thematic Areas:
Crops

Collaborators & Students:
Dr. Heather Murphy
Dr. Nicole Ricker
Dr. Claire Jardine
Dr. Charlotte Winder
Dr. Dasiel Obregon Alvarez
Sarah Fox
Heather White
Henry Ngo
Ilya Law

This project will examine the benefits of regenerative grazing and pasture management strategies for beef producers, improving animal health and farm sustainability in Ontario.

What challenge(s) does the project address?

Limited research has been conducted to evaluate the benefits of regenerative grazing of livestock. Studies have been largely limited to environmental impact in terms of carbon footprint, economic implications, nutrient cycling, and soil health, ignoring animal, human, and ecosystem health.

How will this research address the challenge(s)?

This project will use a One Health approach to assessing the ecosystem services provided by regenerative grazing (is a principle-driven agricultural practice of building soil health by managing livestock on perennial and annual forages)) and will quantify the animal, environmental, and human health benefits

Why does this research matter?

Sustainability goals often include both animal and soil health and have a goal of minimizing antimicrobial resistance. However, on-farm, field-based studies quantifying these impacts are lacking, particularly under Ontario environmental conditions.

What are the (new) methods (techniques, technologies, etc.) that the project team will use during the research?

This research will study four beef cattle farms (two conventional, two regenerative) over a two-year period. Farming practices such as antibiotics, feeding management, rotation practices, and manure application will be monitored, along with soil health and biodiversity, pathogens, and animal health.

What impact will the project have on agriculture?

Livestock farmers are working to improve animal welfare and become more sustainable while also limiting the use of antibiotics. Alternative or regenerative grazing strategies could address these challenges while not sacrificing production efficiencies.

Closing the Digital Decision-making Loop in Precision Cattle Management

This research has the potential to improve animal welfare, farm productivity, and environmental sustainability by targeting individual animal needs rather than the herd as a group.

Principal Investigator:
Dr. Jennifer Ellis

Thematic Areas:
Data Strategy, Livestock and Digital Agriculture

Collaborators & Students:
Dr. Trevor DeVries
Dr. John Cant
Dr. Katie Wood
Dr. Vern Osborne
Dr. Dan Tulpan
Dr. Jan Dijkstra
Dr. David Innes
Jihao You
Carolina Reyes
Patty Kedzierski
Maureen Sahar

What challenge(s) does the project address?

Meeting the projected 70% increase in global demand for livestock products by 2050 without increasing the environmental footprint will require a 50% increase in the efficiency of livestock farming. Farm animals are typically managed in groups where the target is an ‘average’ animal. This limits our ability to precision feed and manage individuals.

How will this research address the challenge(s)?

This proposal aims to develop novel digital technologies for livestock management that will be high impact, catalytic and transformational, focusing on integrating existing bio-monitoring systems and laboratory data to develop the tools to optimize precision feeding.

Why does this research matter?

Precision feeding in livestock production enables farmers to meet individual animal needs instead of those of a group and has the potential to increase whole-farm feed conversion efficiencies up to 26% or up to half of the desired 50% increase.

What are the (new) methods (techniques, technologies, etc.) that the project team will use during the research?

This research will apply machine learning, artificial intelligence, and mechanical models to optimize herd and individual animal health and production while minimizing greenhouse gas emissions.

What impact will the project have on agriculture?

The precision feeding tools to be developed in this research will improve feed efficiency, animal health and longevity, environmental sustainability, and farm profitability in Canada’s commercial dairy and beef farms.

Integrating Data to Model Food Production and Ecosystem Services at Multiple Scales

Principal Investigator:
Dr. Evan Fraser

Thematic Areas:
Data Strategy and
Integrated Food Systems

Collaborators & Students:
Dr. Karina Benessaiah
Dr. Joey Bernhardt
Dr. Helen Booker
Dr. Maria Corradini
Dr. Larry Goodridge
Dr. Krishna KC
Dr. Kevin McCann
Dr. Dirk Steinke

This research will explore how different agricultural management practices affect four key ecosystem services: soil carbon sequestration, nutrient runoff, biodiversity conservation, and the accumulation of naturally produced toxins.

What challenge(s) does the project address?

Agriculture is the world's most significant driver of habitat loss and contributes approximately one-third of the world's greenhouse gas emissions. However, agriculture can also be a solution to these same problems at the local level. When carefully managed, soils absorb carbon and farms can produce food and help increase biodiversity.

How will this research address the challenge(s)?

This project will compile farm and field level data that measure biodiversity, carbon, nutrients, water and globally available land use cover databases. This project will also examine the presence and proliferation of natural toxins to create models, predict, and theorize the links between agricultural management and ecosystem services.

Why does this research matter?

There is a gap between observing the problems caused by agriculture at the global level and understanding how individual management at the farm or field scale may drive solutions.

What are the (new) methods (techniques, technologies, etc.) that the project team will use during the research?

The aggregated databases will provide a resource to explore the theory, test relationships, and model scenarios on how land management (including governance models and incentive structures) impacts carbon, biodiversity, water quality, and mycotoxin production and prevalence.

What impact will the project have on agriculture?

This research will impact provincial and national policymaking and provide rigorous scientific evidence as the basis of the policy addressing ecosystem services.

Oceans of Biodiversity - Energy Flow and Food Resources in the Twilight Zone

This research will seek to understand the potential for sustainable fisheries in the ocean's mesopelagic zone (the layer of water between 200 and 1,000 metres), also known as the “Twilight Zone” because of the very limited penetration of sunlight at these depths. The study will examine the mesopelagic food web, determine mesopelagic fish biomass, and assess the role of the mesopelagic ecosystem in climate regulation.

Principal Investigator:
Dr. Kim Juniper

Thematic Areas:
Ecosystem Services and Biodiversity

Collaborators & Students:
Dr. Catherine Stevens
Dr. John Dower
Dr. Diana Varela
Emily Fricska
Monique Boulanger

Fisheries and Oceans Canada partners/collaborators:
Dr. Stéphane Gauthier
Dr. Akash Sastri
Marie Robert
Moira Galbraith

What challenge(s) does the project address?

The ocean’s mesopelagic zone, extending from depths of 200 to 1000 m, is massive. It is home to large and primarily unexploited fish stocks, a resource that could represent an important future source of protein. However, very little is known about the life histories, behaviours, and diets of the animals found in the mesopelagic zone, information that is crucial to evaluating the impacts of commercial exploitation on mesopelagic ecosystem services.

How will this research address the challenge(s)?

The researchers will study organisms from multiple trophic levels or food web compartments to obtain a comprehensive, holistic view of the function and relationships within the mesopelagic community, and the size of mesopelagic fish stocks.

Why does this research matter?

This project will increase our understanding of the mesopelagic zone, including its food web, its role in climate regulation, and the potential use of mesopelagic resources by humans. The biochemical/nutritional properties of most of the local mesopelagic species haven’t been investigated; such data are important in assessing human digestibility. This knowledge is essential to ensure sustainable fishing is maintained in this region of the ocean, should such exploitation become widespread.

What are the (new) methods (techniques, technologies, etc.) that the project team will use during the research?

This research will use acoustic data, biochemical analysis, and DNA barcoding to characterize the mesopelagic community’s abundance, biomass, diversity, and food web relationships in the NE Pacific Ocean. These data will be complemented by analyzing the composition of organisms at the base of the food web (i.e., microbes, phytoplankton, zooplankton).

What impact will the project have on agriculture?

The results of this project will improve the understanding of the mesopelagic zone, enabling more sustainable fishing balanced with the ecosystem services and the ocean's capacity to serve as a climate buffer.

Multidisciplinary Approaches to a Prediction Model for Gilt Fertility

Principal Investigator:
Dr. Julang Li

Thematic Areas:
Data Strategy and Livestock

Collaborators & Students:
Dr. Dan Tulpan
Dr. Mohsen Jafarikia
Dr. Yashu Song
Brian Sullivan
Lauren Fletcher

This project will enable farmers to select highly fertile pigs through the use of novel biomarkers, decreasing the size of the Canadian breeding herd and decreasing the swine industry's environmental impact.

What challenge(s) does the project address?

Selecting fertile pigs is a challenge the pork industry faces as fertility is not an easily selected trait. This challenge results in the breeding herd being 40% larger than required, increasing costs to producers and expanding the environmental impact of production.

How will this research address the challenge(s)?

This project will combine known biological markers of fertility and expand and verify novel biological markers to develop and confirm a new model to enable farmers to select highly fertile female pigs.

Why does this research matter?

Providing pig producers with the ability to identify highly productive pigs based on biomarkers will allow them to select animals with higher fertility, increasing efficiency and reducing the environmental impact of pig production in Canada.

What are the (new) methods (techniques, technologies, etc.) that the project team will use during the research?

The machine learning approach will be used to integrate the metabolic data, vaginal microbiome and miRNA data to establish and validate the model to improve fertility selection in the swine industry.

What impact will the project have on agriculture?

This project will increase the ability of farmers to select pigs to maintain current pork production in Canada, decreasing the number of pigs in the breeding herd by potentially 40%, increasing profitability, and decreasing the environmental impact of the swine industry.

A Natural Capital Program for Farm Ecosystem Services

Principal Investigator:
Dr. Andrew MacDougall

Thematic Areas:
Data Strategy, Ecosystem Services, Integrated Food Systems, Biodiversity

Collaborators & Students:
Dr. Genevieve Ali
Dr. Asim Biswas
Dr. Neil Rooney
Dr. Andrew Young
Dr. Ryan Prosser
Dr. Kevin McCann
Dr. John Fryxell
Dr. Hafiz Maherali
Dr. Amy Newman
Dr. Bob Hanner
Dr. Joey Bernhardt
Dr. Lana Levison
Dr. Dirk Steinke
Dr. Jeremy DeWaard
Katherine Balpataky, ALUS Canada

This research will measure the value of land retirement and ecosystem services by creating a scientifically validated natural capital investment platform for corporations and citizens to support sustainability initiatives by Canadian farmers.

What challenge(s) does the project address?
Agricultural land retirement programs globally have struggled to retain retired lands due to the growing pressure to produce food, and rising input costs, leading millions of acres of retired marginal farmland to move back into production.

How will this research address the challenge(s)?
This research will measure the value of the ecosystem services gained from land retirement. These values will be integrated with the Alternative Land Use Services' (ALUS) New Acre Project, which leverages corporate and citizen-based investment to provide an annual fund to participating farmers for land management costs.

Why does this research matter?
Ecological value is critical because the environmental impact of food production is rising. Agriculture now contributes up to 25% of all GHG emissions globally. Retired lands can play a crucial in role in reducing or even preventing impact. Economic value is critical because it prevents retired lands from moving back to cropping.

What are the (new) methods (techniques, technologies, etc.) that the project team will use during the research?
This research uses a big-data synthesis to create a science-based accounting, capturing the value of ecosystem services and biodiversity on retired agricultural land. This synthesis provides a natural capital valuation integrated with ALUS's New Acre Project that directly pays farmers to grow ecosystem services and biodiversity.

What impact will the project have on agriculture?
The use of big-data allows for the complex drivers of ecosystem services to be combined in a real-world setting, upgrading the design of marginal-land restoration within regenerative agriculture, and allowing the "ecological engineering" of permanent-cover planted areas that maximize ecosystem service. The partnership with ALUS Canada, the fastest-growing farmer-led stewardship program in Canada, enables farmers to maintain their retired lands.

Improving Livestock for Climate Resilience

This research will investigate how to identify livestock with enhanced health and adaptation to climate change to breed more resilient livestock in Canada.

Principal Investigator:
Dr. Bonnie Mallard

Thematic Areas:
Data Strategy, Livestock

Collaborators & Students:
Dr. Niel Karrow
Dr. Angela Canovas
Dr. Dan Tulpan
Dr. Christine Baes
Dr. Victoria Asselstine
Dr. Lauri Wagter-Lesperance
Shannon Cartwright
Kristen Lamers
Danielle Naylor
Nicole Moran
Carissa White
Olivia Willoughby
Samla Cunha

What challenge(s) does the project address?
Climate change affects livestock's health and welfare, and a projected increase in the intensity of climatic variability, including heat wave severity and duration, compounds these problems.

How will this research address the challenge(s)?
This research will explore animals' physiological responses to climatic stress and identify the biological and genetic traits associated with climate change resilience and the impact of climate change on reproductive health.

Why does this research matter?
One strategy to secure the sustainable production of livestock in Canada is to identify and develop resilient genetic resources capable of maintaining a high standard of health and welfare in changing climate conditions.

What are the (new) methods (techniques, technologies, etc.) that the project team will use during the research?
The project team will validate and identify the resilience traits at a cellular level between the microbiome and immune system to investigate mechanisms of enhanced health under variable climatic conditions and identify their genetic background.

What impact will the project have on agriculture?
Understanding the genetic traits associated with climate resilience and health traits identified in this research is an essential step toward the long-term goal of implementing breeding programs. The livestock will be more environmentally sustainable and will increase animal welfare.

RNA Interference Strategies for Disrupting Chitin Biosynthesis and Controlling Fungal Pathogens of Crops

Principal Investigator:
Dr. Gopinadhan Paliyath

Thematic Areas:
Crops

Collaborators & Students:
Dr. Francois Tardif
Dr. Shirin Seifbargheii
Priya Padmanabhan
Vighnesh Sukhu
Malavika Nair
Jason Deveau
Sean Thompson
Brooke Thompson

This research has the potential to decrease the use of pesticides and fungicides in agriculture and increase the resilience and environmental sustainability of agricultural management practices in crop production.

What challenge(s) does the project address?

Across the world, over 6 million tonnes of fungicides and pesticides are being used annually in agriculture applications alone. Climate change-associated increases in rainfall and temperature will increase pathogen and pest infestation while simultaneously requiring increasing levels of agrochemical use.

How will this research address the challenge(s)?

Recent advances in understanding the molecular regulation of pathogen resistance, with precision control of these organisms by RNA interference, provide an alternative to fungicides and agricultural pesticides.

Why does this research matter?

Bringing this technology to scale agriculture is challenged by the lack of appropriate carriers for the delivery of inhibitory RNA.

What are the (new) methods (techniques, technologies, etc.) that the project team will use during the research?

This project will evaluate and optimize spray formulations containing inhibitory RNA targeting fungal cells.

What impact will the project have on agriculture?

The results of this research will accelerate the scaled application of inhibitory RNA as a fungicide and pesticide in agricultural management, decreasing the dependency of agriculture on traditional agrochemicals associated with pollutants that impact animal and human health and ecosystem services.

Coordinating Antimicrobial Resistance Reporting in the Agri-Food Canada Database

Principal Investigator:
Dr. Nicole Ricker

Thematic Areas:
Data Strategy, Pathogens and Food Safety

Collaborators & Students:
Dr. Dan Tulpan
Dr. Zvonimir Poljak
Dr. Andrew McArthur
Dr. Durda Slavic

This research will create a data management system for tracking antimicrobial resistance across Canada, allowing for better mitigation strategies to be deployed in livestock production.

What challenge(s) does the project address?

Antimicrobial resistance is one of the most significant human health concerns of this generation, and there is no clear solution that will result in a concrete end to the issue. In addition, the methods used to track antimicrobial resistance, even in Canada, differ and are challenging to compare.

How will this research address the challenge(s)?

Tracking and maintaining long-term surveillance data on antimicrobial resistance is required to identify the impact of changing policies and mitigation strategies.

Why does this research matter?

Antimicrobial resistance is tracked by nine agencies in Canada that use different tracking methods preventing researchers from monitoring antimicrobial resistance and comparing the agencies' data.

What are the (new) methods (techniques, technologies, etc.) that the project team will use during the research?

This research will create a data management ecosystem focusing on FAIR principles: findable, accessible, interoperable, and reusable, establishing long-term data stability and comparability without sacrificing individual confidentiality.

What impact will the project have on agriculture?

This project will harmonize the tracking of antimicrobial resistance across Canada, enabling the analysis of policy interventions and shaping future policy directions through evidence-based decision-making.

Large Scale AMR Surveillance in a One Health Context Using DARTE-QM

Principal Investigator:
Dr. Nicole Ricker

Thematic Areas:
Pathogens and Food Safety

Collaborators & Students:
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Dr. Brandon Lillie
Dr. Heather Murphy
Dr. Adina Howe
Dr. Zvonimir Poljak
Dr. Andrew McArthur
Dr. Michael Mulvey
Dr. Richard Reid-Smith
Dr. Anne Deckert
Dr. Claire Jardine
Dr. Kari Dunfield
Gabhan Chalmers
Jutta Hammermueller

This research will create a novel standardized method for testing and tracking antimicrobial resistance across Canada, allowing for better mitigation strategies to be deployed in livestock production and food safety across Canadian supply chains.

What challenge(s) does the project address?

Antimicrobial resistance is one of this generation's most significant human health concerns. The continued emergence of resistance threatens to interfere with our ability to treat and prevent human infectious diseases. In addition, the methods used to track antimicrobial resistance, even in Canada, differ and are challenging to compare.

How will this research address the challenge(s)?

Combating antimicrobial resistance requires a One Health approach, combining efforts at limiting resistance emergence and spread within humans, animals, and the environment. Improved surveillance will help industry and governments form evidence-based policies and develop mitigation strategies to control the emergence and spread of resistance.

Why does this research matter?

Antimicrobial resistance is tracked by nine agencies in Canada that use different tracking methods, meaning there is no nationally standardized method for monitoring antimicrobial resistance in Canada. In addition, livestock industries also lack strategies to evaluate the level of risk or measure the success of mitigation strategies.

What are the (new) methods (techniques, technologies, etc.) that the project team will use during the research?

This research will use a targeted amplicon method that maintains the broad scope of metagenomics while reducing the costs substantially to allow for large-scale adoption and implementation to create a systematic approach to antimicrobial resistance in Canada.

What impact will the project have on agriculture?

This project will create a standardized platform for antimicrobial resistance surveillance that benefits Canadian livestock industries by providing systematic, comparable data to inform policy decisions that ensure human, animal, and environmental health and sustainability.

A Hybrid Cloud Ecosystem for Management, Analysis, and Storage of Large Scale Agri-food Datasets: A Food from Thought Legacy

Principal Investigator:
Dr. Scott Ryan

Thematic Areas:
Data Strategy and Crops

Collaborators & Students:
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Jeff Gross
Dyanne Brewer
Jairo Melo
Elie El-Zammar

This research will establish an accessible and adaptable database to enable the movement, sharing, discovery, and analysis of agri-food research data.

What challenge(s) does the project address?
Storing, managing, and ensuring data is accessible is a challenge faced by researchers globally. Large funding grants, such as Food from Thought, result in vast volumes of novel and high-value data that needs to be accessible to researchers beyond the life of the grant.

How will this research address the challenge(s)?
This project aims to create a Food from Thought legacy platform that stores, manages, mobilizes, and analyzes large agri-food datasets. The cloud-based platform will catalogue data, making it readable by both people and computers.

Why does this research matter?
Improved data management will create strong research outcomes that inform practices and policies for agri-food systems nationally and globally and boost the efficiency, safety, resilience, and diversity of agri-food systems.

What are the (new) methods (techniques, technologies, etc.) that the project team will use during the research?
This project will use FAIR (Findable, Accessible, Interoperable, and Reusable) principles to create a modular database ecosystem that can grow and adapt as new data forms are integrated. A web-based user interface for data viewing, navigation, and management ensures usability.

What impact will the project have on agriculture?
The creation of an accessible database will represent a Food from Thought legacy for the long-term support of agri-food projects. The use of machine learning for metadata analysis will generate new hypotheses that will help achieve sustainable agri-food initiatives.

Building a Surveillance and Monitoring Tool for Avian Influenza Outbreaks in Canada

Principal Investigator:
Dr. Shayan Sharif

Thematic Areas:
Pathogens and Food Safety

Collaborators & Students:
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Dr. Lauren Grant
Dr. Zvonimir Poljak
Fatemeh Haghighi

This research will create a near real-time decision-making system to allow the early detection of an avian influenza outbreak, enhancing the ability of farmers and policymakers to respond and prevent threats to animal health and food security.

What challenge(s) does the project address?
Time plays a key role in avian influenza disease management and control. However, disease data access and use can be very time-consuming and costly. Given the rapid decision-making required to respond to an avian flu outbreak, epidemiologists do not have the time to develop models of the outbreak to make the best recommendations for controlling the outbreak.

How will this research address the challenge(s)?
The project's main goal is to develop a multi-pronged system to detect and provide an early warning of avian flu outbreaks that can be used under real-world circumstances in Canada.

Why does this research matter?
This system will allow for near real-time analysis to detect an outbreak in a region and predict and evaluate risk factors for an outbreak, allowing for continual improvement of the analysis based on new information. The approach can be expanded to other animal infectious disease outbreaks, allowing for early detection and addressing threats to animal health in the future.

What are the (new) methods (techniques, technologies, etc.) that the project team will use during the research?
The researchers will use machine learning to detect hidden patterns that indicate the risk of avian flu, focusing on spatial analysis and social media and news analysis.

What impact will the project have on agriculture?
The estimated losses due to an avian flu outbreak in British Columbia (BC) in 2004 were around $380 million CAD. More recent (2022) outbreaks in Ontario and all other provinces in Canada (except for PEI) have also caused considerable losses. Aside from the great impact of avian flu outbreaks on animal health, some of these viruses impact public health. Early detection and real-time predictive analysis will decrease the spread and severity of future outbreaks in the Canadian poultry industry, increasing animal well-being and human health.

Development of Targeted Solutions for Boar Taint

Principal Investigator:
Dr. Jim Squires

Thematic Areas:
Livestock

Collaborators & Students:
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This research has the potential to increase animal welfare by tailoring management practices to individual animals and developing a breeding program to eliminate the need for interventions.

What challenge(s) does the project address?

Boar taint is an off-odour and off-flavour that develops in heated pork products from male pigs. Male pigs are typically castrated to prevent the occurrence of boar taint. However, castration has become scrutinized due to the welfare concerns associated with the procedure. It also reduces the production efficiency of the animal and has a negative environmental impact as surgical castrates consume more feed and produce more waste. Therefore, the swine industry is interested in solving the boar taint problem without surgical castration.

How will this research address the challenge(s)?

Previous research has identified several dietary management strategies that are effective at preventing boar taint but not in all animals. This is because the physiological systems that influence boar taint development vary significantly between animals. Genetic markers have been identified that reflect this individual variability, which are associated with high and low levels of boar taint. This project will use these markers to define genotypes associated with favourable treatment outcomes for each dietary treatment. This will allow management interventions to be tailored to individual animals based on their genotypic potential to respond favourably to treatment.

Why does this research matter?

The development of individual treatments for boar taint has the potential to eliminate the need for castration, which will increase animal welfare across the swine industry and could improve profitability and reduce the environmental impact of swine production.

What are the (new) methods (techniques, technologies, etc.) that the project team will use during the research?

This project will apply a precision medicine approach to solving boar taint. This involves identifying the boar taint phenotype, or treatment outcome, in response to each dietary treatment. Treatment outcomes will then be compared to the genotype of each animal to identify genetic profiles associated with favourable treatment outcomes, enabling the scaling of individualized solutions to boar taint in the swine industry.

What impact will the project have on agriculture?

The individual management interventions on swine farms will increase animal welfare by eliminating the need for castration. This project will also allow for the genetic marker set to be validated for the ultimate goal of developing a breeding program that enables swine farms in Canada to raise pigs that are genetically selected for low boar taint.

Development of an N management Decision Support System

Principal Investigator:
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Thematic Areas:
Crops

Collaborators & Students:
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Dr. Bill Deen
Dr. Josh Nasielski
Chad Anderson
Ben Rosser
Dale Cowan
Tony Balkwill
Greg Hannam

This research will update the nitrogen decision support system in corn production to account for differences between fields and the impacts of climate change.

What challenge(s) does the project address?

Existing corn nitrogen (N) decision support systems do not account for the interaction of weather and N across the growing season. Current decision support systems fail to reliably forecast crop responses to N within the farming season and in a farmers fields.

How will this research address the challenge(s)?

This project will evaluate state of the art machine learning and crop process models for predicting within-field variation of delta-yield, while accounting for in-season weather effects.

Why does this research matter?

Nitrogen is a synthetic fertilizer. Creating an up-to-date decision support system to ensure that N is applied in the right place, at the right rate, and at the right time will reduce environmental impacts and improve farm profitability.

What are the (new) methods (techniques, technologies, etc.) that the project team will use during the research?

The researchers will use a large data set including corn N response, satellite remote sensing, weather, soil, and crop management across soil types, cropping systems, and weather patterns to predict crop yield using artificial intelligence models such as long term short memory and machine learning models such as random forest. The modeling framework also includes a process-based crop growth model that allows for weather and management simulations, providing decision support system functionality.

What impact will the project have on agriculture?

The adoption of the updated decision support system will increase nitrogen use efficiency in corn production and enable farmers to respond to weather variability, maximizing yield while reducing the environmental impact of crop farming.

Oceans of Biodiversity – Sub-project Synthesis and Research Integration

Principal Investigator:
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Thematic Areas:
Biodiversity

Collaborators & Students:
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Sheryl Murdock
Shea Wyatt
Rebecca Crawford

Species interactions are the foundation of functioning ecosystems. Identifying important links among species, and between species and their environment is vital to our ability to predict ecosystem responses to climate change and inform more effective conservation and management strategies.

What challenge(s) does the project address?

Identifying the links among species of microorganism forming the base of oceanic food webs is hampered by their small size. Our research will provide information on how climate change may affect these species and the marine ecosystem in which they live.

How will this research address the challenge(s)?

To address the size limitation, we have used genetic techniques to generate large DNA datasets. This approach allows us to integrate information on species diversity and distribution with environmental and productivity measurements to better understand the connections between microorganism, ecosystems, and the environment.

Why does this research matter?

Understanding the links among species and their roles in oceanic ecosystems can improve models that predict how marine systems and their food production respond to changing environmental conditions, enabling better conservation and management.

What are the (new) methods (techniques, technologies, etc.) that the project team will use during the research?

This research will use DNA sequence data and statistical methods to establish the strength of relationships between biological groups, productivity, and environmental variables.

What impact will the project have on agriculture?

Marine primary production is the base of oceanic food webs providing food for marine ecosystems. This is comparable to agricultural food products that provide food resources for terrestrial animals and humans. Our results on the impacts of climate change and species interactions on marine primary production can be extrapolated to terrestrial systems with similar dynamics.

A WebGIS Platform for Identifying Agri-Environmental Hot Spots in the Lake Erie Basin at a Field Scale

Principal Investigator:
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Thematic Areas:
Data Strategy
and Ecosystem Services

Collaborators & Students:
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This project will develop modeling and WebGIS platform of the Lake Erie Basin to support the targeting of agri-environmental programs in higher pollution risk locations to improve water quality.

What challenge(s) does the project address?

Most agri-environmental risk assessment uses models of a large scale that are suitable for regional analysis. There is a gap in modelling at the site and field scales for supporting stakeholders to make location-specific conservation decisions.

How will this research address the challenge(s)?

This research will establish, calibrate, and validate the modelling of major watersheds in the Lake Erie Basin, focusing on producing field scale agri-environmental risk results that can be communicated and accessed by stakeholders through a WebGIS-based platform.

Why does this research matter?

Identifying priority locations with higher agricultural pollution risk and targeting conservation measures in those locations would effectively decrease agricultural pollution to water bodies and increase program spending efficiency.

What are the (new) methods (techniques, technologies, etc.) that the project team will use during the research?

The Integrated Modelling for Watershed Evaluation of Beneficial Management Practices model has a cell-based structure, which enables agri-environmental risk assessment at site, field, farm, watershed, and river basin scales.

What impact will the project have on agriculture?

This modelling and WebGIS platform can be used to support the spatial targeting of agri-environmental programs in the Lake Erie Basin to effectively mitigate pollution to water bodies for achieving environmental targets.

NOTES

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