



Global Precision Agri-Food Research Initiatives

Precision Agri-Food Scoping Study and Assessment RFP **3**



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Presentation Outline

- Study Objectives, Definitions
- Canada, Ontario Key Player in Agriculture R&D
- Global Precision Agriculture Initiatives in Industry & Academia
- Key Big Data Players for R&D
- Opportunities for Ontario
- Collaborations
- Funding Considerations
- Conclusions
- Recommendations



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Authors

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- International consultant
- Masters and PhD in remote sensing of Ontario livestock and cropping systems
- Former Director General of the Canada Centre for Remote Sensing (2002-2005)

Dennis Nazarenko – Project Manager and Technical Research

- Senior consultant focused on emerging technologies and their commercial adoption

Peter Kallai – Project Oversight and Results Analysis

- Expertise in strategic program development for emerging technologies

About KEYSTEP

- 20 years in emerging tech with over 200 studies in various Canadian sectors for leading R&D organizations, universities, industry groups and companies.
- Dozens of projects relevant here in agri-food, spatial data, biotech, big data and ICT infrastructure
- Major public R&D program financing success included \$2-\$20 million/year.

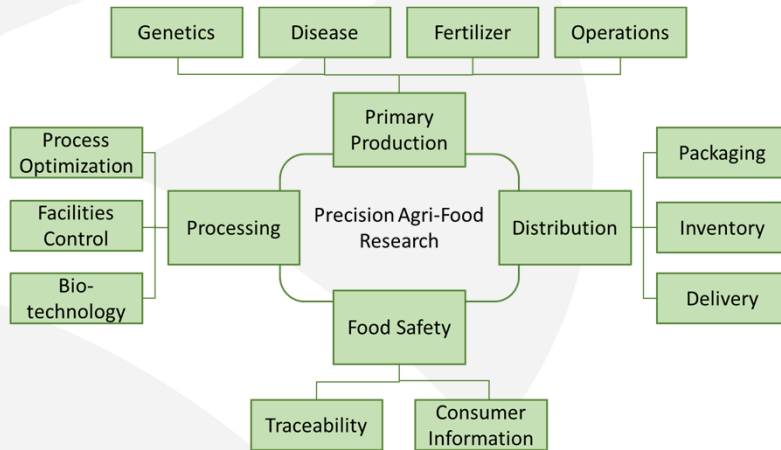


Study Objectives

1. Global trends in research in precision agri-food relevant to Ontario.
2. The research foci and interest of players in precision agri-food that may be relevant to Ontario.
3. Canadian (outside of Ontario) and global initiatives of relevance.
4. Nature of precision agri-food initiatives including goals, objectives and programmatic structure
5. Associated data collection and management.
6. Collaborative mechanisms used in research organizations.
7. Research gaps in Ontario relative to global initiatives with respect to big data approaches.



Defining Precision Agri-Food



Methodology – Survey of Key Institutional and Commercial Initiatives



Methodology – Consideration for Initiative Evaluation

Precision Agri-Food

- Precision Livestock
- Precision Plant
- Precision Agri-food Supply Chain

Tech Assessment

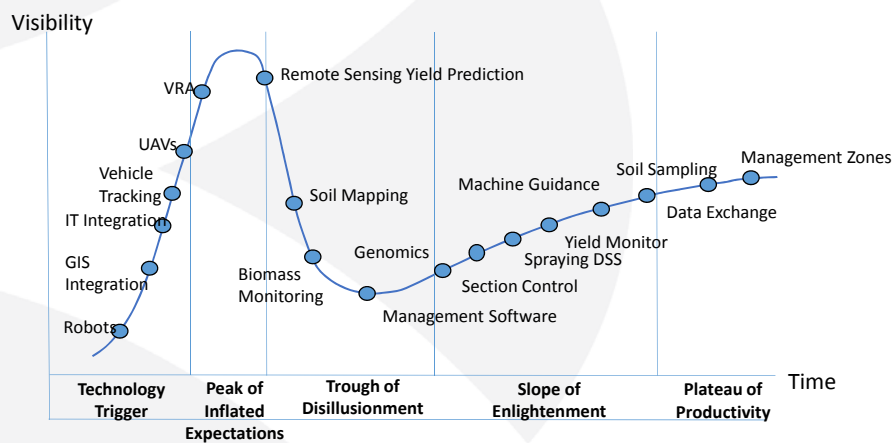
- Big Data Capabilities
- Emerging Technologies
- Data Environment

Programmatic Element

- Focus
- Founding
- Collaboration



Emerging Technology - Precision Agriculture

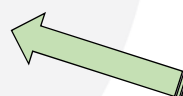


After, van der Wal, 2012



R&D Priorities in Agriculture

	Crops	Horticulture	Livestock	Biofuels	Biodiversity
Productivity	•	•	•	•	•
Environmental Sustainability	•	•	•	•	•
Food Quality	•	•	•		
Security	•	•	•		
Traceability	•	•	•		



Technology



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Big Data - Key Players

Data Collection

- Farmers
- Researchers
- Equipment Manufacturers
- Seed, Chemical Companies and Applicators
- Multi-Use Technology Providers

Data Management

- Producers
- Data Collectors
- Independent Agriculture Data Banks
- Data Cooperatives

Data Users

- Farmers and Ranchers
- Researchers
- Food processors, Retailers
- Industry Groups
- Environmental Interests

“Big Data in US Agriculture”. Megan Davis.
Congressional Research Service Report, 2016



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Global Research Leadership

Examples

Universities

Wageningen University and Research Center
University of California-Davis
Cornell University
 China Agricultural University
 Universidade de São Paulo
 Ghent University
 Harvard University
 University of Florida
 Aarhus University
 University Hohenheim
University of Massachusetts-Amherst
University of Guelph
 University of Wisconsin-Madison
 KU Leuven
 University of Copenhagen
 University of Minnesota-Twin Cities
 Zhejiang University
 Rutgers University-New Jersey
 University of Illinois-Urbana-Champaign
 University of British Columbia

Agriculture and Agri-Food Canada
 Institut nationale de la recherche agronomique
 US Department of Agriculture
 International Rice Research Institute
 Big Data Europe
 EU Future Internet PPP

Government Labs, Institutes

Input, equipment Companies

DuPont-Pioneer
 Cargill
 Monsanto
 John Deere
 AGCO

Food Processing, Retail

Weston-Loblaw/McCain
 Maple Leaf Foods

Not for profit, cooperatives

Group InVivo
 Grower Information Services Cooperative
 Iowa Soybean Association Network

InfoTech

Farmers Edge
 Ag Leader

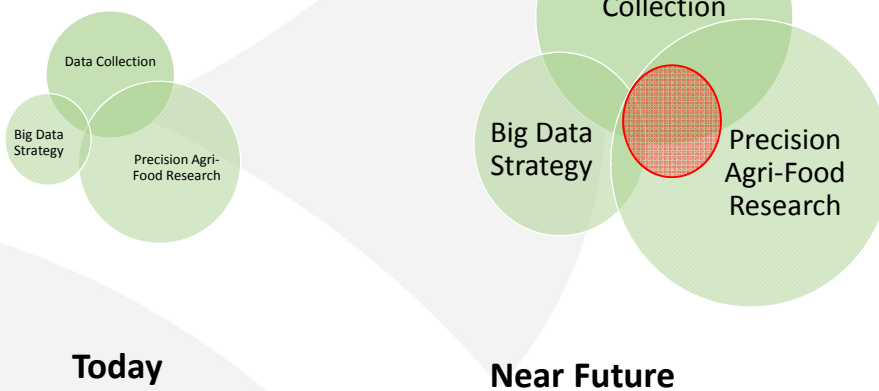
Industry

<http://www.usnews.com/education/best-global-universities/agricultural-sciences>

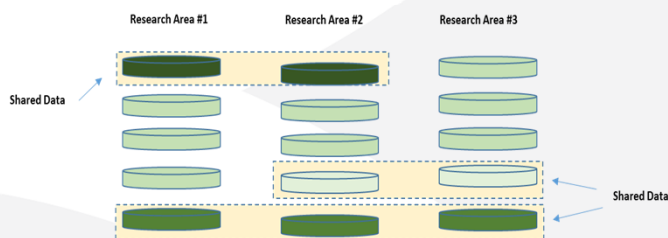
KEYSTEP Growth & Finance, 2016



Big Data & Prec. Agri-food



Data Environment Today



Data is siloed
Data volume is increasing
Sources are diverse
Connectors are incomplete

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Big Data Approach



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Leading Research Initiatives

	Wageningen	Cornell	UC Davis
Overview	<ul style="list-style-type: none"> Leadership in precision agriculture Big Data approaches to research 	<ul style="list-style-type: none"> Third in US News assessment of leading agriculture universities College of Agriculture and Life Science (CALS) includes 15 academic departments and two schools 	<ul style="list-style-type: none"> Agriculture Sustainability Institute (ASI) and Russell Ranch Sustainable Agriculture Facility provide leadership in sustainable precision agriculture research
Selected Research Areas	<ul style="list-style-type: none"> Food production, safety, security, integrity Food related public health Green cities Embedded systems (ie, greenhouses, smart homes) 	<ul style="list-style-type: none"> Food productivity and sustainability Food contamination 	<ul style="list-style-type: none"> UC Davis Genomic Centre – plant and animal genomics Data collection and integration methodologies Irrigation water consumption and management
Initiatives	<ul style="list-style-type: none"> Precision Farming 2.0 Big Data Europe 	<ul style="list-style-type: none"> Computational Agriculture Initiative (2003 – current) 	<ul style="list-style-type: none"> UC Davis Innovation Institute for Food and Health



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Leading Research Initiatives

	Wageningen	Cornell	UC Davis
Infrastructure	<ul style="list-style-type: none"> Centre for Advanced Technology in the Agro and Food Sector <ul style="list-style-type: none"> High performance computing Project support 	<ul style="list-style-type: none"> Cornell Centre for Advanced Computing <ul style="list-style-type: none"> Internal high performance computing infrastructure Project support 	<ul style="list-style-type: none"> BioInformatics Core Facility <ul style="list-style-type: none"> data analysis, research computing facilities Hosts Galaxy (web-based platform for data intensive genomics and biomedical research)
Collaboration	<ul style="list-style-type: none"> Universities, government agencies, Dutch industry, European Union Open to international collaboration 	<ul style="list-style-type: none"> USDA, Large agriculture industry, state farm groups SME – technology spinoff from Computational Agriculture Initiative <ul style="list-style-type: none"> \$2.2 million venture capital funding 	<ul style="list-style-type: none"> Other UC campuses, other academic institutions Collaborations with industry <ul style="list-style-type: none"> Mars Corporation – creation of UC Davis Innovation Institute for Food and Health
Resources (examples)	<ul style="list-style-type: none"> Strategic res. - 100% gov't Applied res. - 50/50% gov't/ind. EU proj/prog –75/25% EU/univ. 	<ul style="list-style-type: none"> Funding sources - US Gov't 40%, Endowment fund 32%, NY State 10%, Foundations 10%, Private 7% 	<ul style="list-style-type: none"> Mars - \$40 million UC Davis - \$20 million (10-year period)



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Global Initiatives – Academic

- **Big Data for Precision Agri-food is here.**
- Most efforts are at a project level
- A few institutions have defined big data strategies - Wageningen University and Research Centre, UC Davis
- Internal HPC and bioinformatics groups are becoming important
 - Projects typically rely on internal systems for data management and analytics
 - Potential barrier to scaling or collaborative research
- For most institutions, there is no systematic attention to the data environment



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Global Initiatives – Industry

- Large multi-national agriculture supplier/input companies
 - Equipment manufacturers are investing in advanced data collection systems
 - Seed, nutrient and herbicide companies are leveraging big data for product innovation
- Agri-food industry
 - Focus on farm product improvement, new product development, food quality and waste reduction is generating new and more data
- Data management innovators
 - A new generation of data savvy companies are forming to collect, manage and analyze big data
 - Focus is typically on productivity improvements, but also supporting reporting (i.e., food traceability)
- Grower/Producer Associations
 - Organizations are forming or modernizing to address and/or leverage big data
 - Concerns over data ownership and privacy



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Global Initiatives - Government

- Government groups are active in programs and projects.
- AAFC
 - Participation in Group on Earth Observations Global Agricultural Monitoring (GEOGLAM)
 - Provide secretariat for Joint Experiment for Crop Assessment and Monitoring (JECAM)
- INRA
 - Global Alliance on Food Security Research - Wheat Initiative (GAFSR)
 - Global Research Alliance on Agricultural Greenhouse Gases (GRA)



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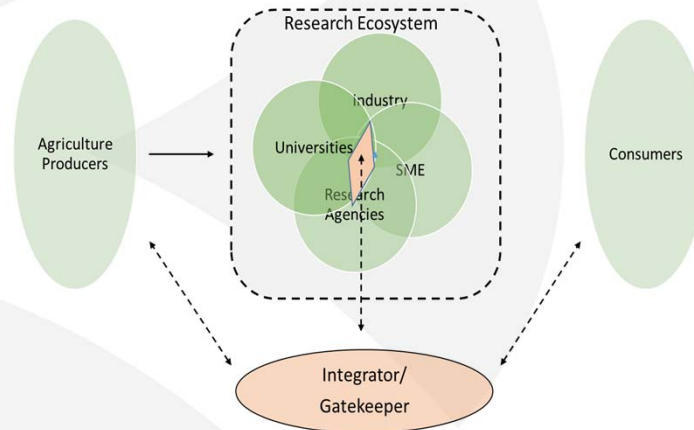
Analysis – Ontario Relevance

- Big Data applications are still in early days in Ontario
 - Ontario is providing leadership in precision agri-food research that can leverage Big Data approaches
- Many areas of research can leverage Big Data
 - Faster learning on real farm operations as opposed research stations
- Systematic approaches to Big Data research in agri-food is very limited
 - Few examples of integrated approaches
 - Little evidence of systematic approaches to data collection, management and leveraging across research areas
- Leading global initiatives are generally open to collaboration



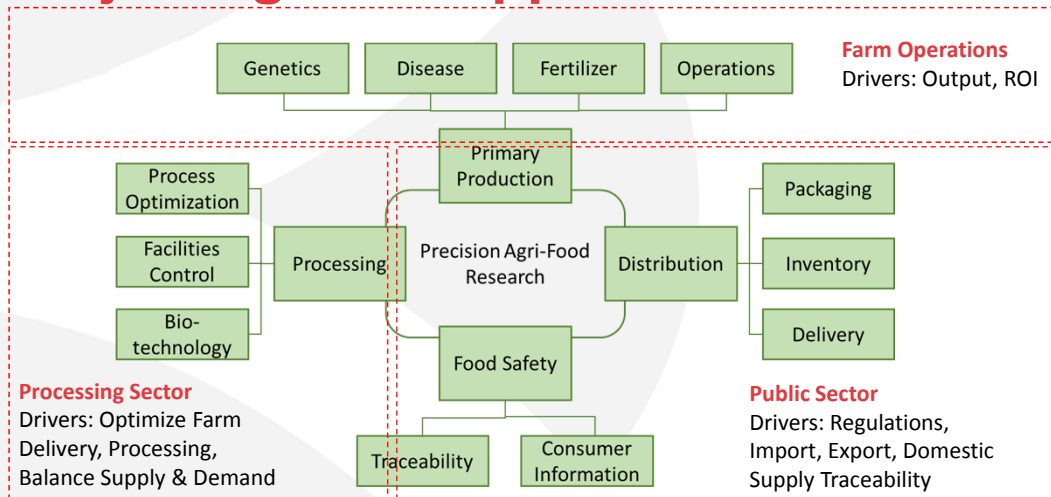
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A Unique Opportunity for Ontario



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Major Big Data Opportunities



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Extensive Collaborations, Roles

- Universities/Applied Research Institutes
 - Research program/project definition
 - Develop high level information system plans to meet research needs
 - Lead data governance structure development
 - Build internal and external partnerships for the projects and programs
 - Propose funding and find business model
 - Measure program effectiveness at the farm (increased output and ROI)
- Government
 - Funding
 - Research support
- Private Sector
 - Provide access to data (e.g. farm data, equipment based data)
 - Participate and co-fund projects
 - Commercialize projects results
- Farms and Food Processors
 - Participate in project
 - Provide access to farms, data, needs definition, etc.

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Funding Considerations

- Core funding + program funding + project funding
- Funding structure (as described by Wageningen University):
 - Strategic research - 100% government funded
 - National applied research (PPP) - 50% gov't and 50% industry (25% cash, 25% in-kind), with funds going to relevant institutes to cover R&D costs
 - Service projects - 100% funded by industry
 - EU and international projects/programs
 - Projects, programs - 50% funded by EU and 50% by Global Companies (EU Program Supporters)
 - University portion - 75% funded by EU, 25% local university
- Funding envelopes must be multi-year (5+ years)
- Funding levels must be sufficient to sustain programs with 150-200 researchers



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Overall Conclusions

- Precision Agri-food is not new, global R&D focus is Precision Agri-food 2.0 (now) leading to 3.0
- Big Data is an important element of Prec. Agri-food 2.0, will be major part of 3.0
- No clear global leader yet, but Wageningen, UC Davis and Cornell have leading projects and programs and organizing to scale up their Big Data expertise
- No major **integrated** effort for Prec. Agri-food and Big Data in Canada yet, mostly dispersed projects and efforts
- Ontario has an opportunity to create and lead such an **integrated** effort
- Governments have clear roles to play to fund integrated efforts, scale it and apply it to assist in meeting regulations



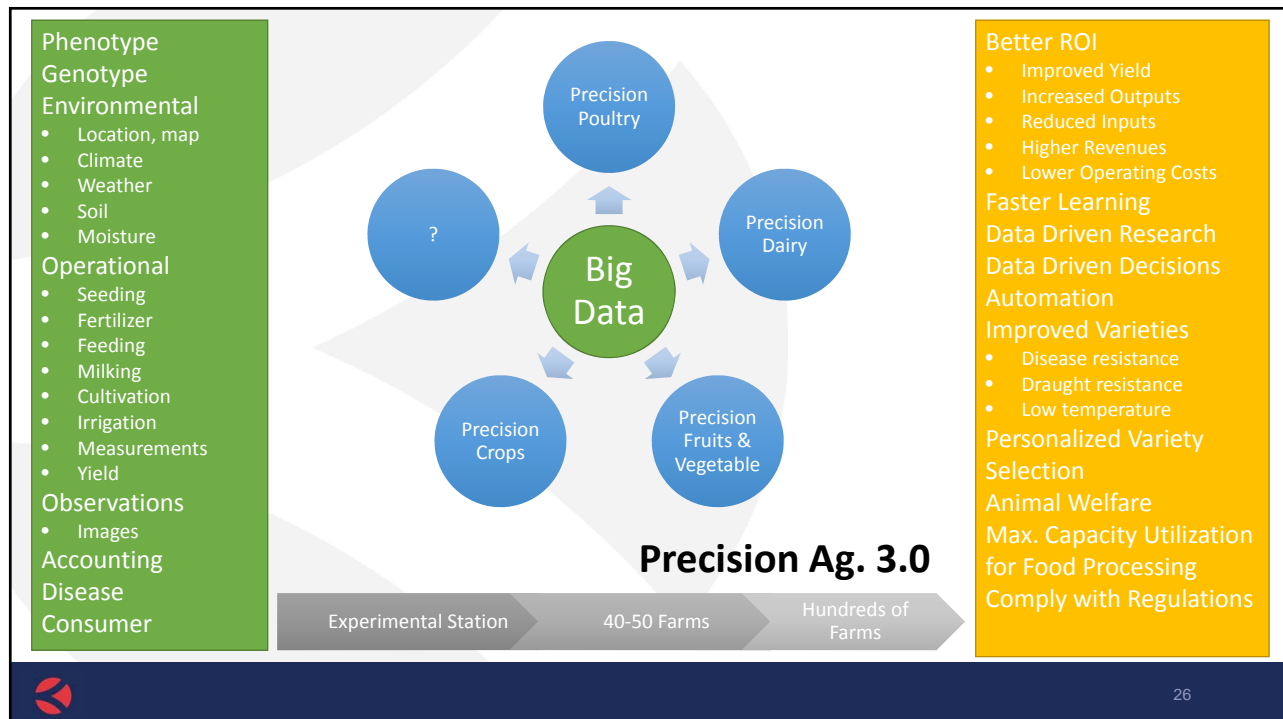
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Recommendations

- Ontario to play a key role as a Big Data Precision Agri-food research integrator
- A Big Data precision agri-food research initiative should:
 - Focus on Canadian needs (both short-term and long-term needs)
 - Need identification should be sector based, and
 - Have an emphasis on applied research
- Government needs to fund infrastructure and strategic long-term research needs
- International collaboration will require Ontario to bring its own funding
- Explore partnership opportunities with leading academic and international initiatives
- Program definition must include both scientific priorities as well as socio-economic resources



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Acknowledgements



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RESEARCH & INNOVATION CENTRE



Thank you to these organizations and their researchers and staff for input and advice.



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Acknowledgements

This project was funded in part through *Growing Forward 2 (GF2)*, a federal-provincial-territorial initiative. The Agricultural Adaptation Council assists in the delivery of GF2 in Ontario.



Canada

