Agri-Environmental Decision Tools Workshop Summary Report

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1.0 INTRODUCTION

On December 17th 2019, the Ontario Federation of Agriculture (OFA) hosted a day-long workshop to bring together farmers, farm input suppliers, technology developers, government, and academia to discuss how to best make use of the existing and emerging agri-environmental decision-support tools (DSTs) for Ontario. The workshop was held in Guelph at the University of Guelph's Arboretum Conference Centre with 38 attendees from 17 different affiliations (Appendix B).

The workshop was a follow-up to a 2018 Review of Agri-Environmental Tools that established an inventory of agri-environmental tools available to Ontario farmers and a rudimentary assessment of the essential components of those tools. OFA was commissioned by OMAFRA to prepare the 2018 review and stage the workshop in December 2019. Goals of the workshop were to provide a better understanding of specific tools being used by Ontario farmers and a forum in which to discuss ways to improve the uptake and effectiveness of DSTs designed to assist the farm sector. As well, the workshop was used to discuss the feasibility and usefulness of developing an 'umbrella' platform to host multiple agri-environmental tools.

This report begins with an introduction to DSTs and an overview of the workshop. Critical issues that were identified through the workshop are then examined with respect to recent academic literature. Finally, prospects for an umbrella platform are discussed and recommendations for pathways forward are presented.

2.0 WHAT ARE DECISION SUPPORT TOOLS FOR AGRICULTURE?

For the purpose of this workshop, agri-environmental DSTs were defined as any online tool or mobile phone app that produces evidence-based information that can be used by the farmer to inform decisions aimed at both improving productivity and positive environmental outcomes.[1] These tools are designed to provide guidance for the farmer in making the most appropriate decisions for their individual farm operation. They are not intended to be a prescriptive 'one-size-fits-all' plan for farmers to follow. Often times, these tools can act as a form of validation for farmer's existing knowledge, increasing their ease of mind and confidence. Technological advances have generated greater interest in the potential value of DSTs for the agricultural industry.

Many DSTs take the form of online software or mobile phone apps.[2] The most successful DSTs are able to communicate data to farmers in a fast and clear way, often through the use of visual representation of the decision-making information.[3, 4] Seven criteria for useful DSTs were identified in the 2018 Review of Agri-Environmental Tools report[5]:

- Engage producers in tool development;
- Be accessible and easy to use;
- Include a mobile app version;
- Include high quality baseline data;
- Include locally relevant data;
- Produce high quality decision-support outputs; and,
- Incorporate financial information in the decision-making model.

[1] Ontario Federation of Agriculture (OFA). 2018. Review of Agri-Environmental Tools. Available at: https://ofa.on.ca/wp-content/uploads/2018/05/Agri-Enviromental-Decision-Support-System-Tools-Final-Report.pdf

[2] Dicks, L., Walsh, C., Sutherland, W. (2014). Organizing evidence for environmental management decisions: a '4S'hierarchy. Trends in Ecology & Evolution 29(11). http://dx.doi.org/ 10.1016/j.tree.2014.09.004

[3] Rose, D., Sutherland, W., Parker, C., Lobley, M., Winter, M., Morris, C., Twinning, S., Ffoulkes, C., Amano, T., Dicks, L. (2016). Decision support tools for agriculture: Towards effective design and delivery. Agricultural Systems 149: 165-174. http://dx.doi.org/10.1016/j.agsy.2016.09.009

[4] Rose D., Bruce T. (2018). Finding the right connection: what makes a successful decision support system? Food Energy Security. DOI: 10.1002/fes3.123

[5] Ontario Federation of Agriculture (OFA). 2018. Review of Agri-Environmental Tools. Accessed via: https://ofa.on.ca/wp-content/uploads/2018/05/Agri-Enviromental-Decision-Support-System-Tools-Final-Report.pdf

Several workshop panelists emphasized that the most effective and useful DSTs have an easy to use interface, are adaptable between devices (mobile friendly), save time, and offer customer support.[6]

In the 2018 Review of Agri-Environmental Tools report 103 DSTs were identified that are available for farmers in Ontario.[7] Examples of DSTs included apps that help determine fertilizer application rates, timing of pest control applications based on soil and weather conditions, or calculators for the formulation of livestock rations. A DST shared at the workshop was OMAFRA's Crop Nutrient Calculator that is part of their AgriSuite toolkit. This calculator gathers information from farmers about nutrient levels in their soil and assists with calculations for organic amendments and fertilizers, with the intent of helping minimize environmental impacts associated with the over-application of nutrients.

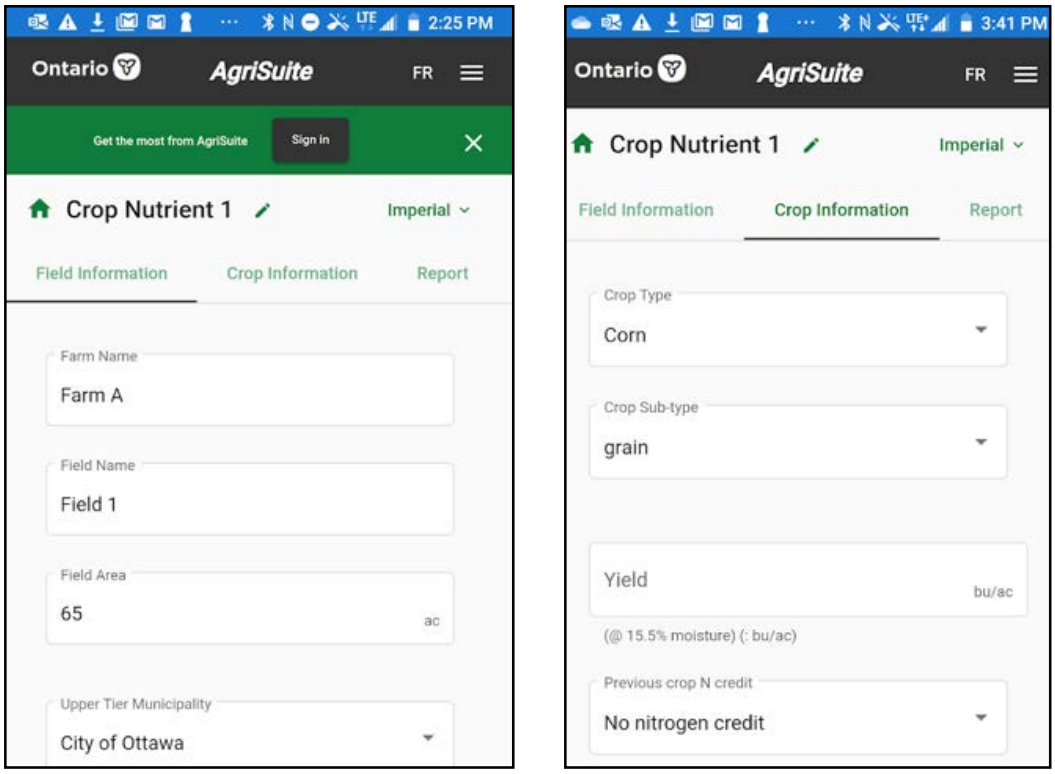

Figure 1: AgriSuite interface (Appendix E).

[6]See presentation slides from Betty Jo Almond (Appendix F) and Joe Dales (Appendix G)
[7]Ontario Federation of Agriculture (OFA). 2018. Review of Agri-Environmental Tools. Accessed via: https://ofa.on.ca/wp-content/uploads/2018/05/Agri-Enviromental-Decision-Support-System-Tools-Final-Report.pdf

3. 0 SUMMARY OF WORKSHOP DISCUSSIONS

The workshop began with an opening address from Mark Reusser (OFA Vice President) and his personal experiences with new technologies on his farm. The full agenda can be found in Appendix A.

Review of 2018 Report
Speaker: Dr. Bronwynne Wilton, *Wilton Consulting Group*
Key points:
• Tools were most commonly created for nutrient management, pest management, disease management, weather forecasting, and soil health • Report recommendations: improve development of decision-support tools; better tool assessment and validation; improve understanding among farmers; increase accessibility; and increase integration of agri-environmental assessment tools

Dr. Bronwynne Wilton presented a summary of the 2018 Agri-Environmental Support System Tools (Appendix C). The presentation reviewed results from a preliminary scan of existing decision support tools and their accessibility[8]. This presentation provided context for attendees, and was the starting point for discussions throughout the day.

Profitability Mapping
Speaker: Dr. Clarence Swanton, *University of Guelph*
Key points:
• Implications of international trade and climate change for sustainability of food supply chains • Profitability maps: build on yield maps (readily available technology) by adding data on profitability by acre • Profitability mapping can allow farmers to identify optimum crop area, optimise best management practices, provide ecosystem services at the local scale, optimise profitability, protect international markets, and reduce risk to management caused by climate change

Dr. Clarence Swanton, University of Guelph, delivered the keynote speech on profitability mapping as a form of DST (Appendix D). Dr. Swanton provided further societal context for the importance of technology for agriculture. He also focused on the roles that DSTs play in effective improvement of environmental sustainability while actually improving profitability.

[8]Ontario Federation of Agriculture (OFA). 2018. Review of Agri-Environmental Tools. Available at: https://ofa.on.ca/wp-content/uploads/2018/05/Agri-Enviromental-Decision-Support-System-Tools-Final-Report.pdf

Morning Panel – Current Trends
Panelists: Betty Jo Almond, *AgSights,* Mike Cowbrough, *OMAFRA,* Joe Dales, *RH Accelerator,* Tyler Whale, *Ontario Agri-food Technologies*
Key trends:
• The most effective DSTs fit into business processes easily, save time, are customizable, and offer good customer support • Ineffective DSTs require intense setup, are expensive, and have delays in information outputs • Need to have data usage policies that are transparent about what happens to farm-level data • Technological innovations are inevitable for agriculture and DSTs will play a big role in the near future; even with autonomous technologies (robots), farmers still need to make decisions • **Farmers are most interested in the application and utility of technologies**

The first expert panel and roundtable discussion of the day followed. Panelists included Tyler Whale of Ontario Agri-food Technologies, Betty Jo Almond of AgSights, Mike Cowbrough of Ontario Ministry of Agriculture, Food and Rural Affairs, and Joe Dales from RH Accelerator. Discussions were led by the panel on the inevitability of technological developments for decision support tools; potential barriers to adoption and ease of use; data and its importance to technological advances; and, ensuring integration and interoperability.

Current and Emerging OMAFRA Tools
Speaker: Chris Brown, OMAFRA
Key trends:
• AgriSuite (a package of free tools) is the culmination of a long history of nutrient management planning tools in Ontario • Demonstration of current calculators available through AgriSuite, including an example report for farmers and nutrient recommendations • AgriSuite available on desktop and mobile devices

The afternoon commenced with an update from Chris Brown of Ontario Ministry of Agriculture, Food and Rural Affairs on AgriSuite. AgriSuite is a tool kit, currently providing farmers with calculators for crop nutrients, organic amendments, and fertilizers. Ms. Brown also gave an overview of future tools that will be included in AgriSuite, which includes a calculator for phosphorus loss, a field management plan tool, among other tools that are being generated. OMAFRA's strategy is to release one tool at a time to allow farmers to adjust to new tools and technologies while giving an opportunity to provide feedback. Ms. Brown emphasized that these tools do not share the data they collect with government, a recurring point of tension for many attendees that will be expanded upon later in this report.

Afternoon Panel – Hot Topics
Panelists: Rob Hannam, *Synthesis Agrifood Network,* Dale Cowan, *AGRIS Cooperative,* Peter Gredig, *Agnition*
Key topics:
• Important to consider the quality of datasets that are used to build DSTs • Some farmers think about data ownership and some don't ("you put your data with people you trust") • The main question for farmers is about value, not cost – whether and how tools will save time, save money, or relieve stress • Different advisors and companies will interpret data in different ways because they are working towards particular goals • Farmers and farm advisors may benefit from a DST Selection Tool

The afternoon panel discussion was moderated by Rob Hannam, with panelists engaging in discussion about emerging topics and trends. Panelists included Dale Cowan of AGRIS Cooperative and Peter Gredig of AgNition[9]. Key ideas raised included benchmarking data as a comparison tool, ensuring data is up to date and credible, and whether or not the decision support tools serve a valid and justifiable purpose when considering the costs.

The day finished with a full group facilitated discussion. Topics of discussion included what the role is for public and private organizations, and if there is value in creating an umbrella platform or portal for decision support tools. Although no formal poll was taken, there appeared to be consensus around the need for an umbrella platform to have a champion stakeholder who is open to establishing a collaboration of government, private, and academic partnerships to ensure that the direction of the innovation is consistent.

4.0 CRITICAL ISSUES

A number of critical issues arose through discussion at the workshop, including who should be the intended end users of DST, how to interpret large amounts of data, prospects for adoption of DSTs, the value of DST for farmers, and data ownership. These issues are discussed below with the aim of offering further insights into means of improving agri-environmental DSTs for Ontario farmers.

[9]Dr. Karen Hand, University of Guelph, was scheduled to attend but had to send her regrets.

Critical Issue	Associated Ideas
DST Users *Who are the intended and actual users of DSTs?*	▪ New technologies are requiring skill development and training among farmers and farm workers ▪ Both farmers and farm advisors are users of DSTs ▪ Farmers remain as ultimate decision-makers
Data Interpretation *How is data interpreted with respect to environmental outcomes and value for farmers?*	▪ There is not a singular way to interpret data collected by DSTs ▪ Farmers' place-based, tacit knowledge remains a critical component for decision-making ▪ Farmers are interested in tools that can inform decision-making ▪ DSTs need to be thought of as learning systems
Technology Development *Who is involved in the process of DST development?*	▪ Need for an interdisciplinary approach to development of DSTs ▪ Consulting farmers can help technology developers understand the context in which DSTs will be used ▪ The quality of local data for DST models is also critical
Adoption of Technology *Why are certain tools adopted and what are the barriers to adoption of DSTs?*	▪ Interoperability with brands, tools themselves, and existing knowledge of farmers is critical ▪ Increased consultation with farmers during DST development will help designers understand farmers' needs ▪ DST failures are to be expected – DST developers must accept their failures, learn from their mistakes and improve subsequent tools
Value for Farmers *What are the tangible and intangible benefits that farmers see from DSTs?*	▪ DST benefits to farmers can be financial, convenience, or peace of mind ▪ DSTs may enable regulatory compliance (e.g. Nutrient Management Act) ▪ Farmers are willing to invest in technologies that they find useful ▪ Improvement value of DSTs is dependent on improved integration on farms ▪ DSTs can provide a valuable foundation for farmers to provide evidence of sustainable farm practices (environmental, economic, and social).
Data Security *Who owns farm data collected by DSTs and how is data protected?*	▪ Data security is an important issue for farmers ▪ Agriculture sector may not be well informed on what happens to farm-level data collected by DSTs ▪ Farmers want transparency in how their data is used ▪ Farmers place trust in people and companies who provide DSTs

4.1 DST Users

There is a need for a better understanding of who are the current and future users of DSTs. Participants at the workshop pointed out that both farmers and farm advisors are users of DSTs. The nature of DSTs and their data outputs necessitates advisors or consultants to help train farmers on the use of technologies and help with interpretation of data. This echoes a central issue raised in the recent Farmer 4.0 report, that due to new technologies we should expect a revolution in the types of skills required of farmers and farm workers.[10] The complexity of the tools and their outputs affect who is able to use DSTs effectively. It must also be acknowledged that many farmers may seek advice on an as-needed basis, while others rarely or never seek advice from consultants. Farmers will always remain as decision-makers, but technology developers need to have an appreciation that there may be multiple, different users of specific tools.

4.2 Data Interpretation

At the workshop, panelist Dale Cowan noted that every farmer and crop advisor will interpret data in different ways, depending on their experience, management style, and goals. This speaks to the importance of actionable knowledge and how specific DSTs need to fit within processes and technologies already adopted by farmers.[11] Additionally, Cowan's point was that interpretation of data generated by DSTs is as much of an art as a science, and that farmers often feel that they need to make decisions based on 'gut feel' and their place-based experience. Recent literature has also addressed the importance of farmers' situated and tacit knowledge, but also emphasised that farmers are most concerned with information that will help them make on-farm decisions.[12]

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[10] Stackhouse, J., Schrumm, A., King, C., Agopsowicz, A., Freestone, C., and Chow, D. (2019). Farmer 4.0: How the coming skills revolution can transform agriculture. RBC Thought Leadership, August 2019. Accessed via: http://rbc.com/farmer4

[11] Evans, K.J., Terhorst, A., and Kang, B.H. (2017). From data to decisions: Helping crop producers build their actionable knowledge. Critical Reviews in Plant Sciences 36(2): 71-88. https://doi.org/10.1080/07352689.2017.1336047

[12] Lundstrom, C. and Limdblom, J. (2018). Considering farmers' situated knowledge of using agricultural decision support systems (AgriDSS) to Foster farming practices: The case of CropSAT. Agricultural Systems 159: 9-20. http://dx.doi.org/10.1016/j.agsy.2017.10.004

DSTs are not solely intended as an output of options, but as learning systems to enhance farmer knowledge.[13] This necessitates creating systems that can be easily interpreted. Farmers face a steep learning curve when interpreting data with new DST software. One approach to enhance uptake of DSTs is to facilitate knowledge sharing among groups of farmers.[14]Such co-learning groups can also encourage future adoption of further technologies that are more complicated.[15]

4.3 Technology Development

There is a need for an interdisciplinary approach to DST development. Workshop participant Keith Reid suggested that DST development teams should be led by an agronomist and supported by other team members having expertise in software engineering, agricultural economics, and agricultural extension (crop scientist, animal scientist, or soil scientist). Participation from experts in social sciences such as agricultural geography or rural sociology would also make a valuable contribution. It is also important to include farmers in the development of DSTs to ensure that the tools have an effective user-centered design.[16, 17, 18] Increased user consultation could also help designers understand the context in which tools will be used to make decisions, bridging the gaps with farmers and their advisors.

The quality of DSTs is highly dependent on the quality of data that is used in their development and maintenance. Some DST data is provided by the farmer (e.g., crop yields, soil test results) but there is a heavy reliance on locally available, accurate data relating to such aspects as groundwater quality, surface water quality and weather records. Collecting these data and making them available requires public funding. Recent literature has also emphasized the importance of government support for the collection of data for DST development.[19]

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[13]Schlindwien, S., Eulenstein, F., Lana, M., Sieber, S., Boulanger, J., Guevara, E., Meira, S., Gentile, E., Bonatti, M. (2015). What Can Be Learned about the Adaptation Process of Farming Systems to Climate Dynamics Using Crop Models?. Sustainable Agriculture Research 4(4). Accessed via http://www.ccsenet.org/journal/index.php/sar/article/view/50270

[14] Eastwood, C., Chapman, D., Paine, F. (2012). Networks of practice for co-construction of agricultural decision support systems: Case studies of precision dairy farms in Australia. Agricultural Systems 108 10–18

[15] Ibid.

[16] Rose, D., Parker, C., Fodey, J., Park, C., Sutherland, W.J., Dicks, L.V. (2017). Involving stakeholders in agricultural decision support systems: Improving user-centred design. International Journal of Agricultural Management 6(3/4): 80-89. DOI: 10.5836/ijam/2017-06-80

[17] Eastwood, C.R., Chapman, D.F., and Paine, M.S. (2012). Networks of practice for co-construction of agricultural decision support systems: Case studies of precision dairy farms in Australia. Agricultural Systems 108: 10-18.

[18] Cerf, M., Jeuffroy, M., Prost, L., and Meynard J. (2012). Participatory design of agricultural decision support tools: Taking account of the use situations. Agron. Sustain. Dev. 32: 899-910. DOI 10.1007/s13593-012-0091-z

[19] Drohan, P.J., Bechmann, M., Buda, A., Djodjic, F., Doody, D., Duncan, J.M., Iho, A., Jordan, P., Kleinman, P.J., McDowell, R., Mellander, P., Thomas, I.A., and Withers, P.J.A. (2019). A global perspective on phosphorus

4.4 Adoption of Technology

As heard in the workshop, high speed, rural broadband internet continues to be an underlying issue that limits adoption rates of internet-connected DSTs. This is an issue that persists beyond Ontario, as North America continues to have gaps in terms of broadband access and cellular coverage in rural areas.[20] Tools that rely on fast upload and download speeds are inefficient given a lack of rural internet infrastructure. For instance, a farmer may adopt a DST but still underuse it in practice if they have connectivity issues that limit its performance. Interoperability is also an issue, affecting whether farmers can use certain tools with certain brands of machine, or even other DSTs that they are using.[21]

management decision support in agriculture: Lessons learned and future directions. Journal of Environmental Quality 48:1218-1233. doi:10.2134/jeq2019.03.0107

[20] Perrin, A. (2019). Digital gap between rural and nonrural America persists. Pew Research Centre. Access via: https://www.pewresearch.org/fact-tank/2019/05/31/digital-gap-between-rural-and-nonrural-america-persists/

[21] Janssen, S., Porter, C., Moore, A., Athanasiadis, I., Foster, I., Jones, J., Antle, J. (2017). Towards a new generation of agricultural system data, models and knowledge products: Information and communication technology. Agricultural Systems 155. Accessed via: https://www.sciencedirect.com/science/article/pii/S0308521X16305637

A 2016 paper broke down factors that influence the adoption and use of DSTs by farmers:[22]

Core Factors

- Performance (improvements to decision-making and productivity)
- Ease of use
- Peer recommendation
- Trust
- Cost
- Habit
- Relevance to user
- Farmer-advisor compatibility

Modifying Factors

- Age
- Scale of farming
- Farming type
- IT education

Enabling Factor

- Facilitating conditions (match/mismatch between tool with existing workflows, internet connectivity, compatibility with other machinery)

Driving Factors

- Compliance
- Level of marketing

If there is to be an increase in the overall percentage of Ontario farmers using DSTs, there is a need to appeal to both large and small operations. The Farmer 4.0 report indicates high usage (95%) of advanced technologies among farmer with sales more than $1 million, but lower usage (60%) for farmers with sales less than $1 million.[23] Since Ontario has many farms in the latter size category, it is critical to devise strategies to help DSTs appeal to those smaller operations.

Another important topic is discrepancy between the age of Ontario farmers and the age of technology users. The Farmer 4.0 report predicted that in the year 2025 one-quarter of Canada's farm operators will be 65 or older, but that farm operators over the age of 60 are considerably

[22] Rose, D., Sutherland, W., Parker, C., Lobley, M., Winter, M., Morris, C., Twinning, S., Ffoulkes, C., Amano, T., Dicks, L. (2016). Decision support tools for agriculture: Towards effective design and delivery. Agricultural Systems 149: 165-174. http://dx.doi.org/10.1016/j.agsy.2016.09.009

[23] Stackhouse, J., Schrumm, A., King, C., Agopsowicz, A., Freestone, C., and Chow, D. (2019). Farmer 4.0: How the coming skills revolution can transform agriculture. RBC Thought Leadership, August 2019. Accessed via: http://rbc.com/farmer4

less likely to adopt advanced technology than those under the age of 40.[24] Considering the growing proportion of farmers over 65 in Ontario, it is important to hold reasonable expectations on the extent of computer-assisted DST adoption.

Artificial intelligence and machine learning are expected to become more integrated into DSTs.[25] Developers must strive to demystify these concepts and explain their utility for farmers in order to gain the trust of users. While technological innovations are rapidly changing the possibilities for DSTs, implementation for farm use is sometimes flawed. Though at the outset this may deter adoption, it is crucial to understand, critique, and discuss how and why certain tools fail. This will help ensure that future tools can successfully evolve and improve from past failures.

4.5 Value for Farmers

Whether or not farmers are the end users of DSTs, these technologies ultimately must benefit farmers and farm operations. Part of the challenge of uptake of DSTs has been farmer awareness and attitudes towards new technologies.[26] Demonstrating value for farmers is critical for adoption of DSTs. For example, GPS-assisted guidance is a widely adopted technology in agriculture because of the utility that is provides (i.e., driving in straight lines). On the other hand, drones have not had the same success demonstrating their value on farms. For instance, a 2015 study at the Holland Marsh Muck Research Station found that drone aerial photography was not able to visually detect vegetative diseases with an acceptable rate of reliability.[27] Drone technology may eventually become viable for on-farm use, but there is not yet wide-spread use of these technologies on farms.

Workshop participants emphasized that value for farmers does not necessarily need to be in the form of financial benefits. Farmers may adopt DSTs if they offer peace of mind, validation or increase of knowledge, or the ability to self-evaluate performance among peers. At the same time, research has shown that farmers are willing to invest in technologies that they find

[24] Ibid.
[25] Bannerjee G., Sarker, U., Das, S., Ghosh, I. (2018). Artificial Intelligence in Agriculture: A literature Survey. International Journal of Scientific Research in Computer Science Applications and Management Studies.Volume 7, Issue 3. ISSN 2319 – 1953
[26] Rossi, V., Salinari, F., Poni, S., Caffi, T., and Bettati, T. (2014). Addressing the implementation problem in agricultural decision support systems: the example of vite.net®. Computers and Electronics in Agriculture 100: 88-99.
[27] Tayviah C., Gossen B., and Mcdonald. M. (2015). Using Aerial Infrared imagery in the Detection of Stemphylium Leaf Blight on Onion, 2015, in Muck Vegetable Cultivar Trial and Leaf Report, University of Guelph, Office of Research and Department of Plant Agriculture, Report Number 65, Muck Crops Research Station, King, Ontario

useful.[28] This suggests that there is a market for DSTs but more attention needs to be placed on matching individual Ontario farmers with appropriate tools. An important avenue to address is knowledge integration and learning among farmers and other end users.[29]

DSTs can provide a valuable foundation for farmers to be able to meet market demands for evidence of sustainable farm practices. Sustainable farm practices include not only environmental management practices but economic and social as well. Several workshop attendees made specific reference to DSTs that are aligned with the economic (feed bin monitors and auto-start power generators) and social (on-farm food safety) pillars of sustainability in addition to the environmental pillar.

This interest in tools which integrate the three pillars of sustainability (social, economic, and environmental) connects well with the emerging market requirements for 'sustainable sourcing'. Companies along the agri-food value chain, both in Canada and globally, are increasingly asking for evidence and metrics related to on-farm management practices. In fact, there are so many competing sustainability standards and tools in the agri-food system, that the Canadian Federation of Agriculture is leading an initiative aimed at stream-lining these programs and tools in an on-line platform. This platform will form the central plank of the Canadian Agri-Food Sustainability Initiative (CASI) and will act as a coordinating hub for a variety of programs and tools that farmers might be participating in or using within their farm businesses. CASI will also act as a communication tool between on-farm practices and market demands for evidence of sustainability.[30]

4.6 Data Security

Legal ownership of agricultural data is complicated[31], however, based on commentary at the workshop questions around data ownership do not appear to be at the forefront of concerns for farmers. Farmers are often most concerned with the protection of their data. The impression among workshop participants was that the agriculture sector as a whole has only a rudimentary understanding of what happens to farm data collected by DSTs. It is important to consider how data is collected, controlled, and assessed in order to ensure the transparency and fairness that

[28]Bonke, V., Fecke, W., and Michels, M. (2018). Willingness to pay for smartphones apps facilitating sustainable crop protection. Agronomy for Sustainable Development 38: 51. https://doi.org/10.1007/s13593-018-0532-4
[29]Rodela, R., Bregt, A.K., Ligtenberg, A., Perez-Soba, M., and Verweij, P. (2017). The social side of spatial decision support systems: investigating knowledge integration and learning. Environmental Science and Policy 76: 177-184. http://dx.doi.org/10.1016/j.envsci.2017.06.015
[30] Canadian Agri-Food Sustainability Initiative (CASI). 2020. Available at: https://www.agrifoodsustainability.ca/
[31]Mcintosh, M. The legal mess of farm data ownership. (2018). Available at: https://farmtario.com/machinery/the-legal-mess-of-farm-data-ownership/

farmers want.[32] A 2019 survey from Farm Credit Canada showed that while 65% of farmers surveyed believe that technology can improve management and decision-making, 71% said that data treatment was "very" or "extremely" important when selecting an agriculture technology provider.[33] This suggests that farmers are willing to share data from their farm, provided that they are made aware that it is being collected and that it is aggregated in a way that protects the confidentiality of their data. The workshop discussion reflected these concerns, as participants voiced the importance of transparent data agreements and concerns about data breaches at large companies.

Ultimately, when farmers adopt new DSTs they want to know that they can trust the companies that collect and host their farm-level data to have systems in place that protects their data from cyber-attacks.

5.0 PROSPECTS FOR AN UMBRELLA PLATFORM FOR DST

Participants at the workshop expressed interest in the potential of an umbrella platform to help compile DSTs available for Ontario farmers. The basic idea is to have a simple internet search engine to locate DSTs and have them sorted for different purposes and commodities. Several comments were made by panelists and participants about the importance of better promotion of specific technologies for farmers. At present, farmers are mostly aware of DST through word of mouth or seeing demonstrations at agriculture events. A single place for farmers to search for DSTs would be viewed as a valuable source of information. Several factors were identified by workshop participants that could complicate logistics and implementation of such a platform.

> *Continual Maintenance*
> With technology continually evolving through product updates, new versions, and new products it is imperative that any database of DST will need to be continually updated. The need for continual maintenance points to the need for funding continuity as well.[34] As products become obsolete they will need to be removed from the database, and as new products are introduced they will need to be added.

[32] Wiseman, L., Sanderson, J. & Robb, L. Rethinking Ag Data Ownership. Farm Policy J. 15, 71–77 (2018)
[33] Farm Credit Canada, 2019 "Producers embrace technology, but want control over their data, FCC Survey" Accessed via:https://www.fcc-fac.ca/en/about-fcc/media-newsroom/news-releases/2019/producers-embrace-technology-but-want-control-over-their-data.html
[34] Rose, D., Parker, C., Fodey, J., Park, C., Sutherland, W.J., Dicks, L.V. (2017). Involving stakeholders in agricultural decision support systems: Improving user-centred design. International Journal of Agricultural Management 6(3/4): 80-89. DOI: 10.5836/ijam/2017-06-80

Organizational Responsibility

A central point of discussion at the workshop revolved around who would lead and fund an umbrella platform. If it was run by a public agency, where would the funding come from? If it was run by a private organization or business, how would they make a profit to make the venture viable? If it was run by a commodity organization, would it be a service to members? Some workshop participants expressed concern that any tools included in such a portal might be considered to be the 'winners' or the best tools (whether or not there was an evaluation process). There is merit in considering the potential for one agency to host an umbrella platform and another to provide independent, objective evaluations of the DSTs using a standardized methodology.

Selection of Tools

Another topic that arose through the workshop was that farmers also need guidance in selecting tools that best suit their needs. It is not enough to simply provide an exhaustive list of DSTs – it is imperative that farmers and their advisors are given guidance on how to determine which tools might be most useful for the particular farm operation under consideration. A DST umbrella portal needs to include some means of critiquing and ranking tools for different needs. For instance, this could take the form of user evaluations and comments. There is also opportunity for an accredited agency such as the Prairie Agricultural Machinery Institute (PAMI) to provide science-based evaluations on the utility and effectiveness of individual DSTs.

The idea of an umbrella platform stems from questions about the best way to find and aggregate DSTs in ways that make it easier for farmers or crop advisors to access them. There was suggestion at the workshop that there is onus on creators of DSTs to do good marketing and promotion of their products. Internet searches, social media, and word of mouth will support the spread of DSTs that are effective and useful for farmers, but there may be real benefit in external evaluation of DSTs in order to best serve Ontario farmers.

6.0 THE PATH FORWARD

As innovation of DSTs continues, there is a need for continued knowledge transfer from academia and technology companies to farmers and their advisors. Such transfer can take the form of in-person training workshops. There is also value in conducting a comprehensive literature review in order to consolidate this research into one place. This would further knowledge transfer to farmers and their advisors by making the outcomes of research more

accessible outside of academia. For instance, a review can report on the latest research on DST effectiveness for specific commodities, means of data integration, and emerging technologies. A comprehensive literature review of trends could also offer a better understanding of how and why DSTs are and are not adopted.

The workshop illuminated several areas for further research that will directly benefit Ontario farmers:

Who are DST users?

- Understanding who the users of DSTs are is vital for development of the tools, whether they need to be tailored for use by farmers, or the consultants who relay information to farmers. OFA will continue to work with government and industry partners to better understand the demographics of those who use DSTs, and use this information to guide development of DSTs.

The feasibility of an umbrella platform

- More research needs to be done to explore the costs, structure, governance, and logistics around an umbrella platform. A feasibility study which includes exploring linkages with platforms such as CASI as a means of coordinating DSTs in a way that meets consumer demands would be beneficial to the industry.

Implications of the use and protection of data

- A plain language communication strategy is needed between developers of DSTs and producers to demystify the practices of data use and protection. With funding and collaboration with government and industry partners, OFA could develop and promote plain language resources related to DSTs.

Research on all of these topics should also be complimented with effective knowledge transfer and awareness targeted to Ontario farmers and farm consultants. This would ultimately help to strengthen the links between producers, farm advisors, DST developers, and academics.

APPENDICES

A. Workshop Agenda
B. Workshop Participants List
C. Presentation Slides from Bronwynne Wilton
D. Presentation Slides from Clarence Swanton
E. Presentation Slides from Chris Brown
F. Presentation Slides from Betty Jo Almond
G. Presentation Slides from Joe Dales
H. Workshop Speaker Biographies

Appendix A: Workshop Agenda

Agenda

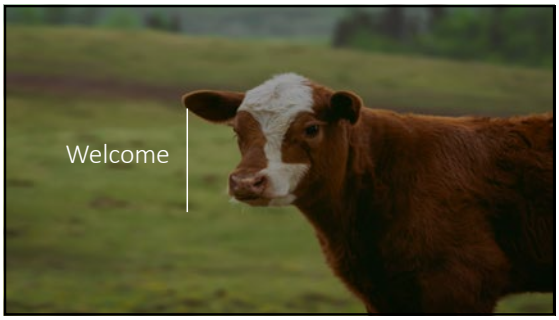
9:00	Arrival (refreshments available)
9:30	**Welcome Address**
9:45	**Review of Report on Agri-Environmental Support System Tools (2018)**
10:00	**Keynote Presentation on Profitability Mapping** Dr. Clarence Swanton (University of Guelph)
10:30	Refreshments Break
10:45	**Panel and Roundtable Discussions on Current Trends** Tyler Whale (Ontario Agri-food Technologies) Betty Jo Almond (AgSights) Mike Cowbrough (OMAFRA) Joe Dales (RH Accelerator)
12:00	Lunch Provided by University of Guelph Hospitality Services
1:00	**Update on current and emerging OMAFRA Decision-Making Tools** Chris Brown (OMAFRA)
1:30	**Panel Conversation on Hot Topics** Dale Cowan (AGRIS Cooperative) Karen Hand (University of Guelph) Peter Gredig (AgNition)
2:00	**Roundtable Discussions on Data, Privacy & Accessibility**
2:45	**Market Mingle** An opportunity to share and learn more about the latest tech and research
3:15	**Facilitated Full Group Discussion** What Do We Want the Future to Look Like?
3:45	Closing
4:00	Safe Travels Home

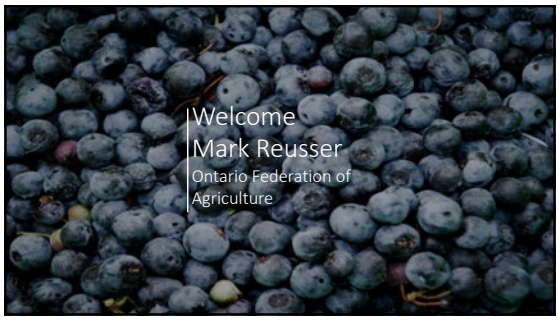
Appendix B: Workshop Participants List[35]

Name	Affiliation
Betty Jo Almond	AgSights
Marjan Asgari	University of Guelph
Andrea Bravo	Ontario Agri-food Technologies
Aaron Breimer	Certified Crop Advisors of Ontario
Chris Brown	OMAFRA
Deb Campbell	Certified Crop Advisors of Ontario
Ron Campbell	OABA
Dale Cowan	AGRIS Cooperative
Mike Cowbrough	OMAFRA
Joe Dales	RH Accelerator
Brian Dickson	OMAFRA
Peter Gredig	AgNition
Rob Hannam	Synthesis Agrifood Network
Charlotte Huitema	Junior Farmers of Ontario
Karen Jacobs	OSCIA
Charles LaLonde	CJ Agren Consulting
Todd Lewis	Ontario Sheep Farmers
Mel Luymes	Headlands Ag-Enviro Solutions
Sarah Marquis	University of Guelph
Dale McComb	OMAFRA
Kevin McKague	OMAFRA
Mike McMorris	LRIC
Les Nichols	OSCIA
Eric Nost	University of Guelph
Adrian O'Brien	University of Guelph
Keith Reid	AAFC
Mark Reusser	OFA
Clarence Swanton	University of Guelph
Tyler Whale	Ontario Agri-food Technologies
Albert Tenuta	OMAFRA
Ben Hindmarsh	OMAFRA
Nicole Reid	OMAFRA
Elaine Graham	Self Employed Consultant
Jessica Schill	BFO
Gord Wellington	OFA
Emily Duncan	University of Guelph
Danie Glanc	OFA
Nicole Rabe	OMAFRA

[35] Due to a late fall season several commodity groups had to push back some of their internal meetings, resulting in a conflict with our chosen date. This also impacted the ability of some farmers to attend the meeting. Most groups affected by the late season conflict with the meeting date did acknowledge our invitation and sent regrets.

Appendix C: Presentation Slides from Bronwynne Wilton





Today's Agenda

- Overview of the Day
- Recap of the 2018 Project
- Keynote Speaker – Dr. Clarence Swanton

-Break-

- Update on current and emerging agri-environmental Decision-Making Tools
- Panel and Roundtable Discussion

Today's Agenda

-Lunch-

- Panel Conversation
- Roundtable Discussions
- Networking Break
- Panel & Roundtable Discussions
- Next Steps

Recap of the 2018 Project

- Better understand what agri-environmental assessment tools exist and what the sector sees as essential components
- 103 tools were identified
- https://ofa.on.ca/resources/agri-environmental-decision-support-system-tools/

Findings

Tools were most commonly developed for the purposes of:

Findings

Key priority areas include:

- 4R nutrient stewardship
- Biosecurity and food safety
- Crop rotations
- Pest assessment
- Soil organic matter
- Storm water management
- Biodiversity
- Cover crops
- Greenhouse gas reduction
- Precision agriculture
- Soil pH, P, and N management
- Traceability

Findings

Seven criteria identified for tools to be useful:

✓Engage producers in tool development
✓Be accessible and easy to use
✓Include a mobile app version
✓Include high quality baseline data
✓Include locally relevant data
✓Produce high quality decision-support outputs
✓Incorporate financial information in the decision-making model

Recommendations

1. Improved development of decision-support tools	- Engage producers in tool development - Include decision-support outputs and assessment indicators - Include cost-benefit analysis
2. Tool assessment and validation	- Better assess ease of use - Evaluate tools with field tests - Develop a feedback mechanism - Certification mechanism

Recommendations

3. Improve understanding	- Engage producers with survey and workshops - Examine key tools used outside of Ontario - Ensure that outputs include next steps
4. Increase accessibility	- Convert tools from online software to mobile apps - Develop portal and/or catalogue of assessment tools

Recommendations

5. Increase integration of agri-environmental assessment tools	- Improve integration/layering of OMAFRA suite of tools - Integrate information regarding available cost-share programs - Examine how existing data can be better incorporated - Provide networking opportunities

The global marketplace is seeking validation of sustainability in agriculture

Team Canada approach needed to make Canada a global agrifood leader

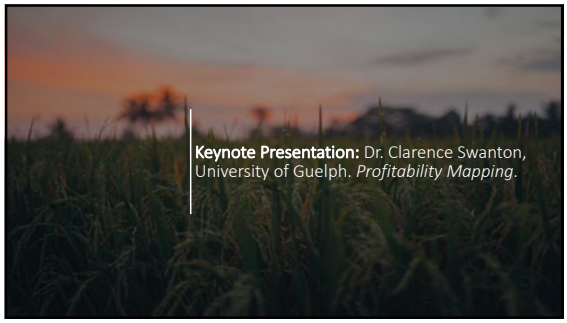
"Canada requires a **new national data strategy** to support such proprietary actions, advance pre-collaborative initiatives and satisfy public reporting"

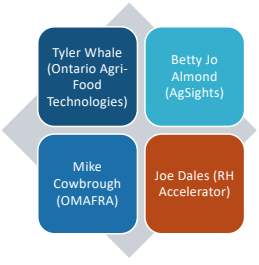
"If a no-till field in Saskatchewan stores carbon in the soil and **no one in Toronto, Amsterdam or Tokyo hears about it**, does the environmental benefit really matter?"

Canada must trumpet sustainable practices

The Canadian Agrifood Sustainability Initiative will:

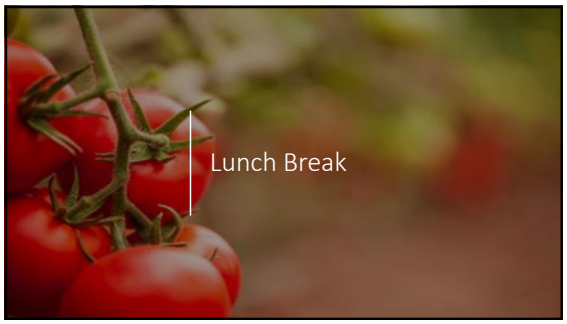
1. Develop a **national unifying sustainability assurance system** and tool which builds on the strengths of existing and emerging commodity-specific tools and programs;
2. Establish a high-quality **data sharing** portal/platform to support the national assurance system;
3. **Reduce duplication** and manage costs of assuring sustainability standards across the value chain;
4. Provide **benchmarking capacity** for topic and commodity-specific standards and tools to international standards;

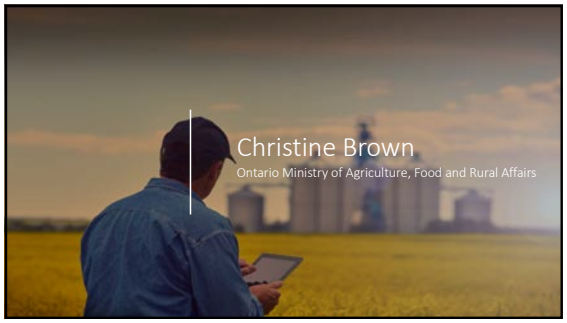


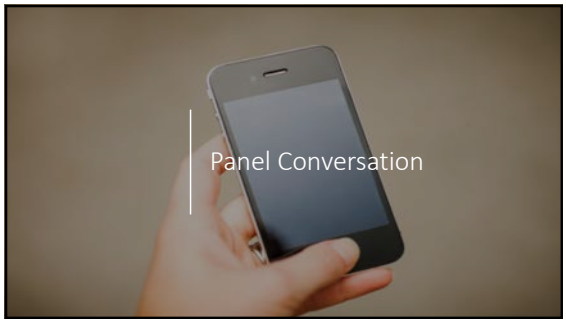


Roundtable Discussions

- What are the top 3-5 reasons farmers use agri-environmental decision support systems or tools?
- What are the top 3-5 reasons that would prevent farmers from using decision support systems or tools?
- Given the lists developed in questions 1 and 2; how would you improve current tools to a) improve uptake and b) improve functionality and effectiveness for the farmer?



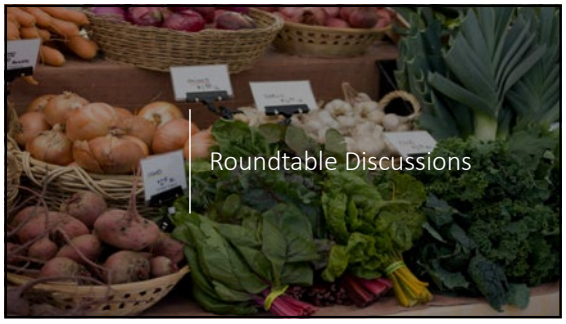




Panel

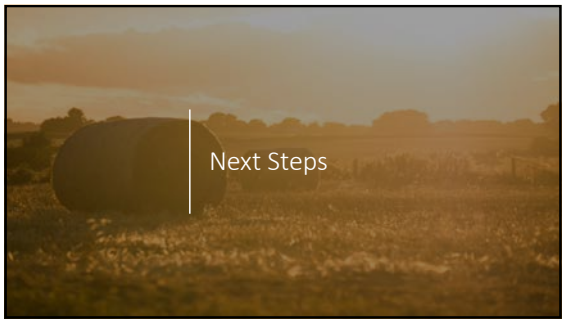
Moderated by Rob Hannam

- Dale Cowan (AGRIS Cooperative)
- Karen Hand (University of Guelph)
- Peter Gredig (AgNition)



Roundtable Discussions

- How can the different players (government/private sector/academia/etc.) work together to ensure these tools help Ontario farmers maintain and adopt best management practices?
- As a group, do you have good examples of tools that were developed with high levels of involvement from farmers or farm organizations? What works well? What doesn't work?



Roundtable Discussions

- Discuss the pros and cons of an umbrella platform for decision support systems and tools? Take in to consideration existing platforms – is there an opportunity to enhance one of these platforms to be a 'one-stop shop for tools and support systems'? Should it be restricted to environmental outcomes or inclusive of management, labour, profitability, etc ?
- As a group, develop 3-5 pros and cons of an umbrella platform for tools

Appendix D: Presentation Slides from Clarence Swanton

Precision Agriculture and Profitability Mapping

Canada First Research Excellence Fund- Food from Thought

C.J. Swanton
University of Guelph

Precision conservation meets precision agriculture: A case study from southern Ontario. 2018. Agricultural Systems 167: 176-185.

V. Capmourteres, J. Adams, A. Berg and E. Fraser, C.J. Swanton and M. Anand,

Take home messages:

Profitability mapping can serve as a management tool for farmers that will allow them to:

- Identify optimum crop area
- Optimise best management practices
- Provide ecosystem services at the local scale
- Optimise profitability
- Protect international markets
- Reduce risk to management caused by climate change

Key questions ?

- Is the future production system based on crop yield or crop nutritional value?
- How important is diversity at the soil, field and landscape level?
- Will climate change result in greater variability/risk in food production?
- Will instability in food production lead to social instability?

How stable are our farming systems?

- On farm risk to management has increased significantly because of:
  - **International trade demands- the market is changing**
  - Climate change

International Trade-the sustainable supply chain

- Why would you buy Canadian commodities?
- "Today farmers are being asked to go through sustainability schemes to verify the practices they do on the land are environmentally and socially responsible while being economically viable."
  M. Buttenham, Ontario Grain Farmer June/July 2017
- How do you maintain accountability and prepare for audits?

International Trade- Ecosystem Protection

"Companies also see sustainability as a way of connecting their consumers to farmers, pulling back the curtain and showing that the farmer is being a good environmental steward."

M. Buttenham, October 2017, Ontario Grain Farmer

Why should primary producers be interested?

How does Canadian agriculture "grow and protect its brand on the international market?"

How green is your product? What is your carbon footprint?

- On farm risk to management has increased significantly because of:
  - International trade demands- the market is changing
  - **Climate change**

Climate change is now Climate crisis!

What is the issue?

How do you flow "excess energy" through an agroecosystem ?

How do you manage this increased "risk to management" ?

On a field basis what can farmers do to manage on farm risk to management created by climate change?

- Increase organic matter, soil health
- Water control- field drainage, tiling, berms, waterways
- Crop genetics and diverse cropping systems
- Protection of ecosystem services – goods and services provided by the ecosystem processes and utilised by humans

Ecosystems Services

Nutrient flow
Pollinator habitats
Soil formation
Water quality
Food and Fiber

What is the relationship between biodiversity and ecosystem services?

Above and below ground biodiversity is critical to the maintenance of ecosystem services.

On-farm risk to management increases substantially with decreases in ecosystem services.

The earth's biodiversity is declining

- Species invasions
- Species extinctions
- Climate change
- Farming practices

→ Agro/Ecosystems under stress

Through the loss of biodiversity are we deconstructing our ecosystems under the assumption that these ecosystems have the ability to withstand such pressures without collapsing?

(Kevin McCann, Nature 2000)

Diversity –Stability Hypothesis

- Biodiversity within an ecosystem tends to be correlated positively with plant community and ecosystem stability

- Biodiversity-- species richness, strength of community interactions and functional traits

Diversity –Stability Hypothesis

- Functional diversity (range of species traits) rather than species numbers determines how the ecosystem functions

- Biodiversity is both a "variable " responding to environmental fluctuations and a critical "factor" influencing ecosystem services

The questions become:

1. How resilient are our agroecosystems?

   - the ability of a community to return to its original state following a stress or disturbance

2. Is there a threshold level of biodiversity required to protect ecosystem services?

Chisel Plowed Field

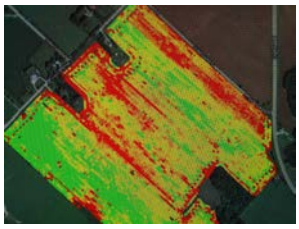
Can Precision agriculture contribute to the enhancement of biodiversity?

- General perception that ecological and environmental conservation efforts equate into a loss of profit for producers
- Can precision agriculture help to "transition" this perception to " ecological and environmental conservation will enhance profitability?"

Sustainably Intensify Production

- Hypothesis: If landscape and soil biodiversity are enhanced then agricultural productivity can be intensified while reducing the detrimental effect on ecosystem services.

Yield Maps
Technology that is readily available and understood

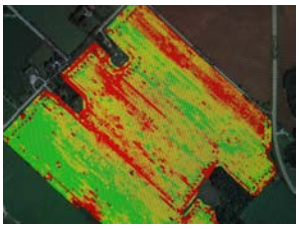


First response

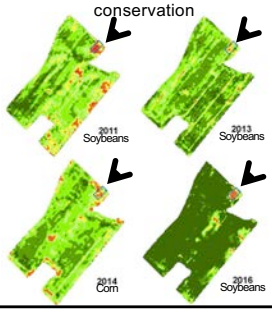
- Are there opportunities to correct or manage low yielding parts of the field?
  - Water management
  - Organic matter, soil type analysis
  - Precision adjusted planting and nutrient applications to compensate for low yields

- What if none of these approaches work?
- Can we divert these areas within a field to enhance diversity and conservation while protecting farm profitability

Yield Map transitions to Profitability Map
Technology that is readily available but may not be fully understood

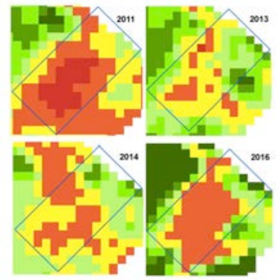


Profit mapping over time to detect potential areas for conservation



Example of 2016 farm profit mapping

Proposed area for conservation (zoomed in!)



Size: 0.6 acres

The average profit of this area, assuming no rent, is $ 27.84/acre

If paying rent, the profit goes down:
- $125 rent: $ -97.16
- $250 rent $ -222.65

Conservation scenarios and costs


Wildflowers
- Est. $800/acre
- $50/acre


Buckwheat: $50/acre


Alfalfa: $115.30/acre


Peas-Oats: $43/acre


Red clover: $25.20/acre


Untreated Oats: $36.00/acre


White clover: $42.00/acre

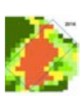

Phacelia tanacetifolia: $110.00/acre

Agricultural profit vs. conservation costs

Average profit:
- no rent ………. $ 27.84
- $125 rent……. $ -97.16
- $250 rent ……. $ -222.65

No rent:
- Two out of four years further ahead to plant economical cover crops

Agricultural profit vs. conservation costs



Average profit:
- no rent ………. $ 27.84
- $125 rent……. $ -97.16
- $250 rent ……. $ -222.65

With rent:
- If $125/acre rent then conservation with cover crops was more economical 3 out of 4 years
- If $250/acre rent then conservation with cover crops was more economical in all years

How significant is 0.6 acres?

Neighbouring farm= 0.6 acres (57 acres)

Swanton farm = 0.6 acres (106 acre farm)

Total 1.2 acres from 163 acres

In Ontario approximately 6 million acres of land growing corn, soybeans or wheat

Potential conservation set aside as a result of profitability mapping would = 44,171 acres

Barriers to Adoption

- Conservation scenarios are highly field and farm specific
- The land owner value system, rental agreements
- Need for government policy- Agricorp crop insurance

Take home messages:

Profitability mapping can serve as a management tool for farmers that will allow them to:

- Identify optimum crop area
- Optimise best management practices
- Provide ecosystem services at the local scale
- Optimise profitability
- Protect international markets
- Reduce risk to management caused by climate change

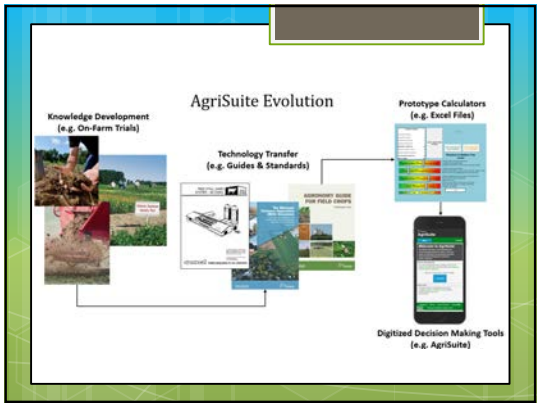
Profitability Mapping an Important Tool

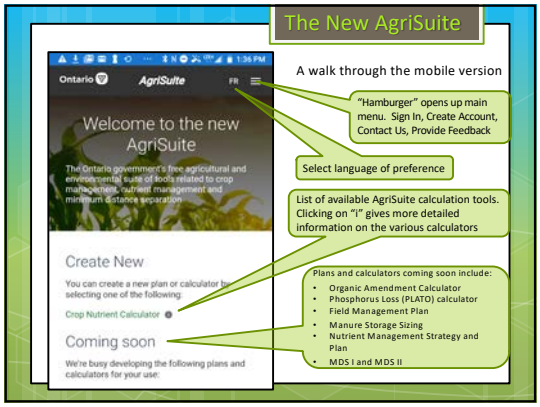
To enhance:

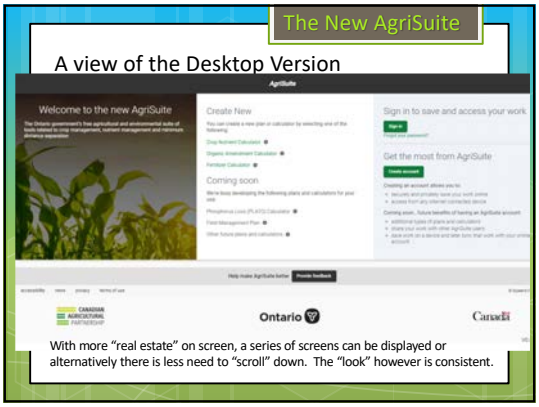
ecosystem stability through greater diversity
on farm profitability
access to international markets

Thank you

Appendix E: Presentation Slides from Chris Brown

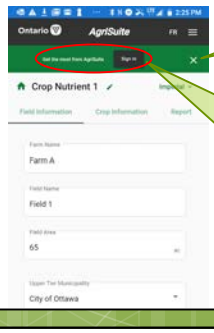






The New AgriSuite

Sign In Option (Mobile or Desktop)



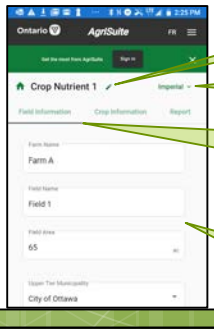
Clicking on "X" removes Sign in request

Sign in Option: Can still use calculator if don't sign in, BUT cannot save results. Signing in allows user to:
- Save calculations
- Sign in from desktop or mobile device to access same files

Will need to:
- provide email address
- Remember password

The New AgriSuite

Crop Nutrient Calculator (Field Information)



You can edit the default name of your Crop Nutrient Calculation

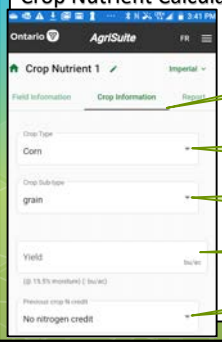
Choose the System of Units you want to work in

The **Solid Line** indicates which worksheet is displayed:
- Field Information
- Crop Information
- Report

Enter field information here such as name, location, acreage, soil test results. "Scroll Down" to reveal all required data entries.

The New AgriSuite

Crop Nutrient Calculator (Field Information)



The **Solid Line** indicates you are now on the Crop Information Input screen

Click on the "drop down" arrow to reveal a full list of potential crops. Select the crop of interest.

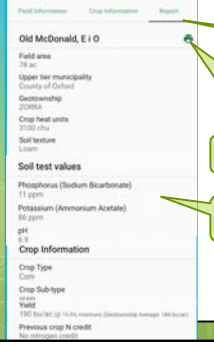
Click on the "drop down" arrow to select crop subtype (eg. grain, silage, sweet)

Enter anticipated yield goal

Drop down will list conditions that may give a nitrogen "credit" to this year's crop

The New AgriSuite

Crop Nutrient Calculator (Report Summary)

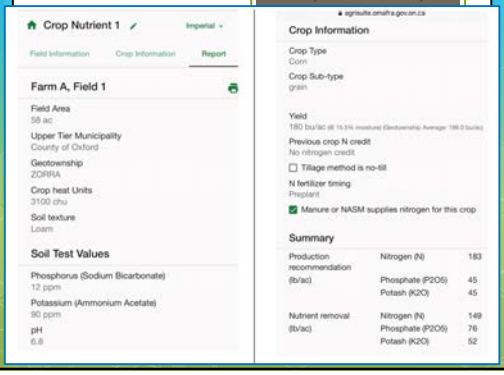


The **Solid Line** indicates now on the Report Screen.

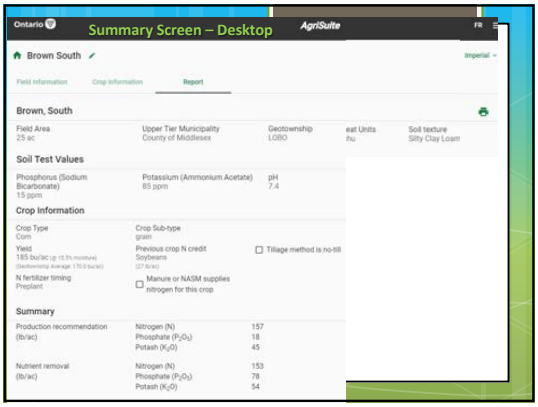
Clicking on the Printer icon allows you to send the report directly to a printer

Field, crop, and nutrient info and recommendations are summarized. Scroll down the screen to reveal all data.

Summary Screen – Smartphone

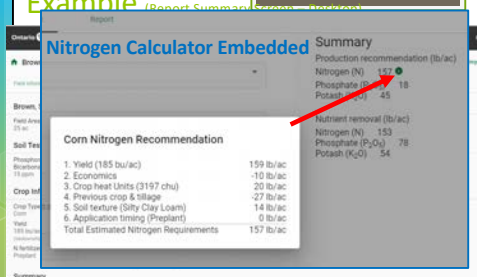


Summary Screen – Desktop

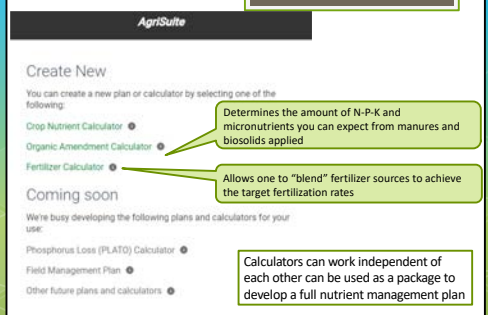


Example

Nitrogen Calculator Embedded



A Look at Future Calculators

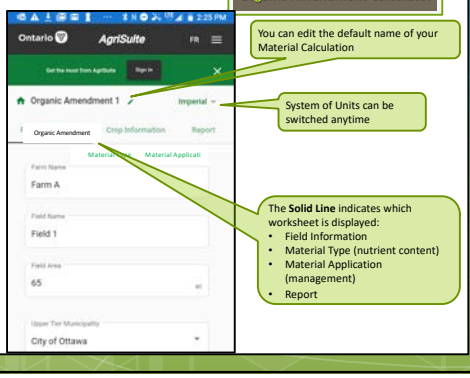


Determines the amount of N-P-K and micronutrients you can expect from manures and biosolids applied

Allows one to "blend" fertilizer sources to achieve the target fertilization rates

Calculators can work independent of each other can be used as a package to develop a full nutrient management plan

Organic Amendment Calculator

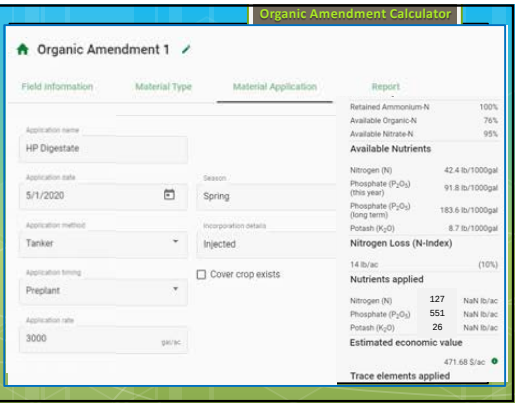


You can edit the default name of your Material Calculation

System of Units can be switched anytime

The **Solid Line** indicates which worksheet is displayed:
- Field Information
- Material Type (nutrient content)
- Material Application (management)
- Report

Organic Amendment Calculator



Use AgriSuite to:

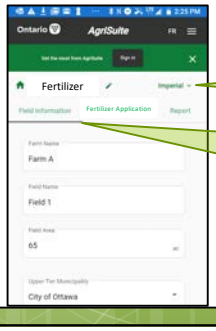
Quickly see the impact of management decisions

Spring applied Liquid Hog manure = 24 lbs/1000 gal available N

Late Summer applied Liquid Hog manure = 10 lbs/1000 gal available N

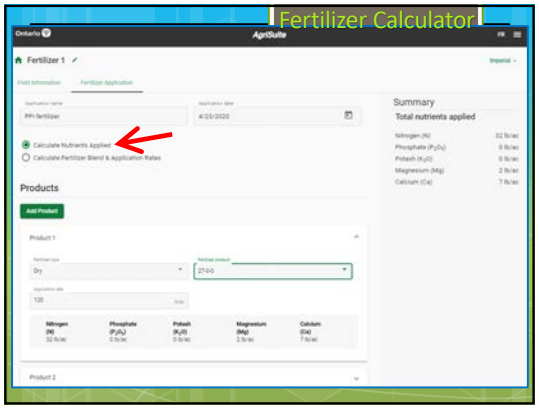
@ 5,000 gal/ac = $~ 7.50/ac

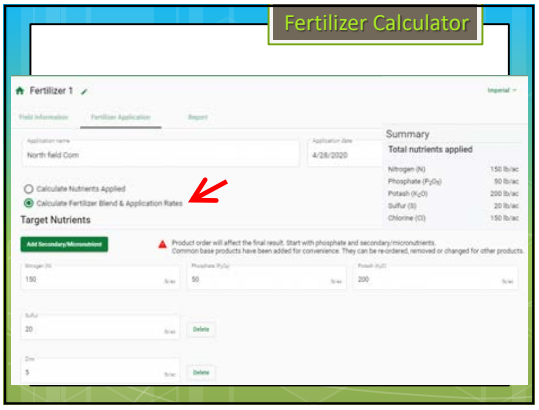
Fertilizer Calculator

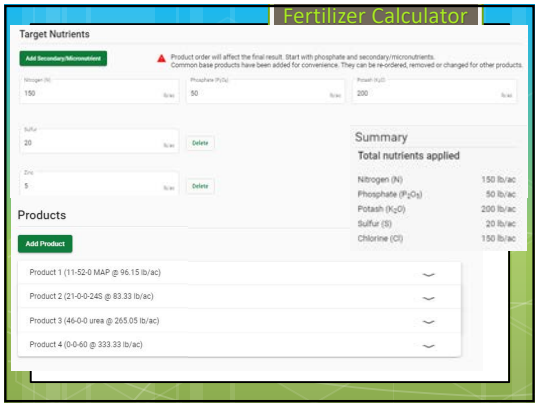


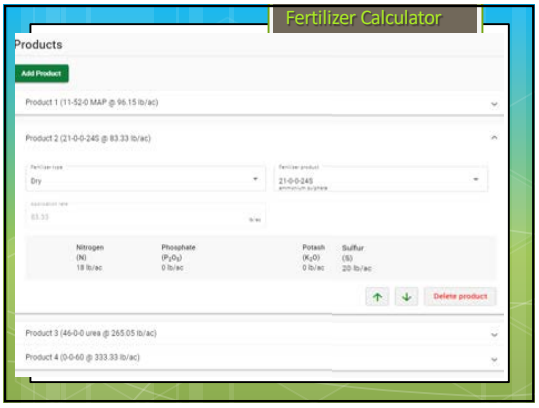
Choose the System of Units you want to work in

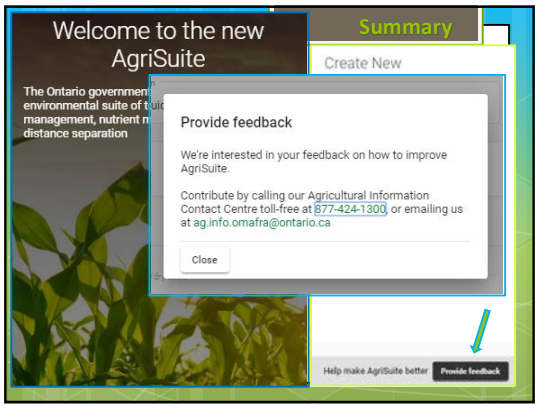
The **Solid Line** indicates which worksheet is displayed:
- Field Information
- Fertilizer Application
  - Calculate Nutrients Applied
  - Calculate Fert Blend & Appl Rates
- Report

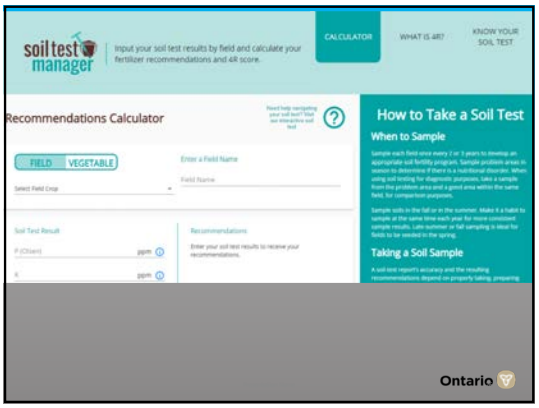

Fertilizer Calculator
Fertilizer 1
Summary
Total nutrients applied
Products
Add Product

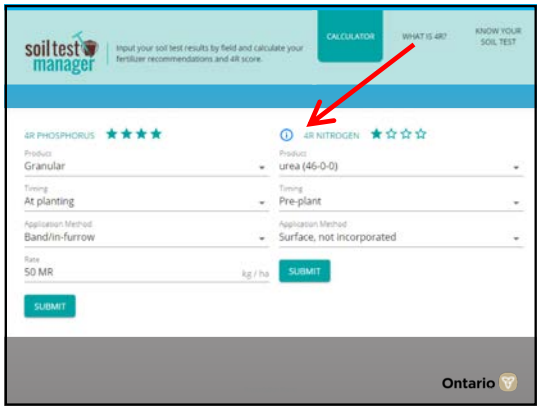

Fertilizer Calculator
Fertilizer 1
Summary
Total nutrients applied
Target Nutrients

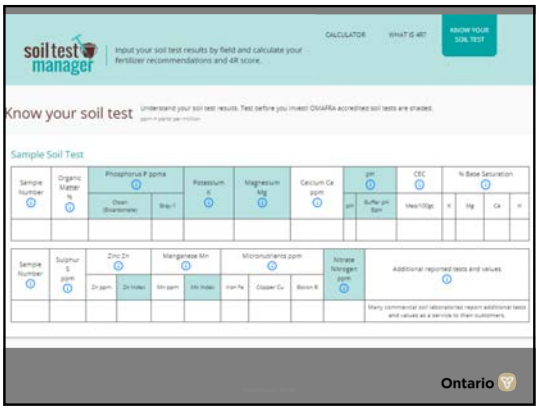

Fertilizer Calculator
Target Nutrients
Summary
Total nutrients applied
Products
Add Product

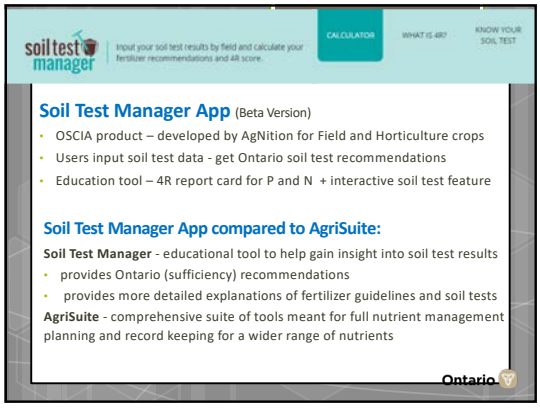

Fertilizer Calculator
Products
Add Product

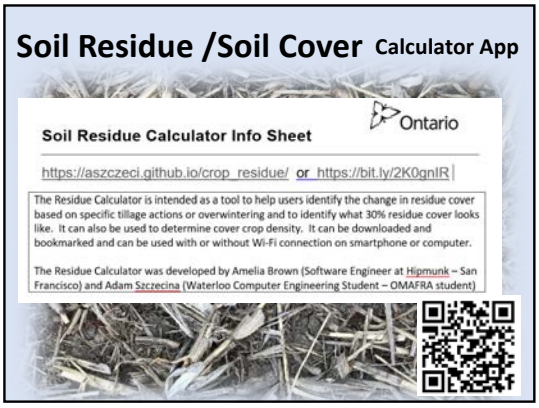

Welcome to the new AgriSuite
Summary
Create New
Provide feedback
We're interested in your feedback on how to improve AgriSuite.
Contribute by calling our Agricultural Information Contact Centre toll-free at 877-424-1300, or emailing us at ag.info.omafra@ontario.ca
Close
Help make AgriSuite better
Provide feedback

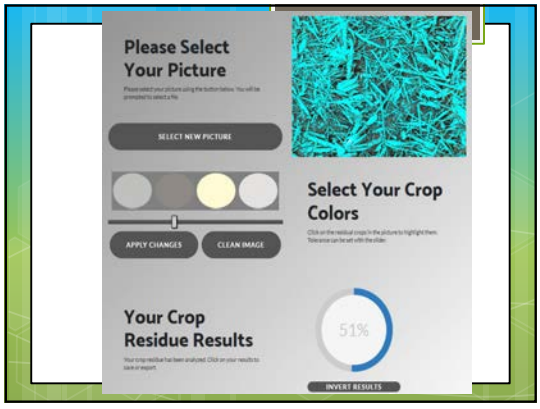

soil test manager
Recommendations Calculator
How to Take a Soil Test
When to Sample
Taking a Soil Sample
Ontario

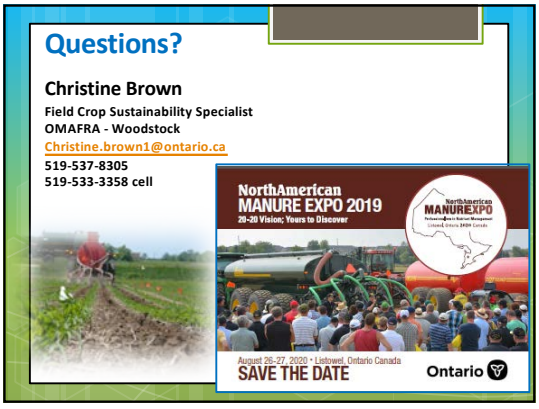

soil test manager
CALCULATOR
WHAT IS 4R?
KNOW YOUR SOIL TEST
4R PHOSPHORUS
4R NITROGEN
Granular
urea (46-0-0)
At planting
Pre-plant
Band/in-furrow
Surface, not incorporated
50 MR
SUBMIT
Ontario


soil test manager
Know your soil test
Sample Soil Test
Ontario


soil test manager
Soil Test Manager App (Beta Version)
OSCIA product – developed by AgNition for Field and Horticulture crops
Users input soil test data - get Ontario soil test recommendations
Education tool – 4R report card for P and N + interactive soil test feature
Soil Test Manager App compared to AgriSuite:
Soil Test Manager - educational tool to help gain insight into soil test results
provides Ontario (sufficiency) recommendations
provides more detailed explanations of fertilizer guidelines and soil tests
AgriSuite - comprehensive suite of tools meant for full nutrient management planning and record keeping for a wider range of nutrients
Ontario


Soil Residue /Soil Cover Calculator App
Ontario
Soil Residue Calculator Info Sheet
https://aszczeci.github.io/crop_residue/ or https://bit.ly/2K0gnIR
The Residue Calculator is intended as a tool to help users identify the change in residue cover based on specific tillage actions or overwintering and to identify what 30% residue cover looks like. It can also be used to determine cover crop density. It can be downloaded and bookmarked and can be used with or without Wi-Fi connection on smartphone or computer.
The Residue Calculator was developed by Amelia Brown (Software Engineer at Hipmunk – San Francisco) and Adam Szczecina (Waterloo Computer Engineering Student – OMAFRA student)

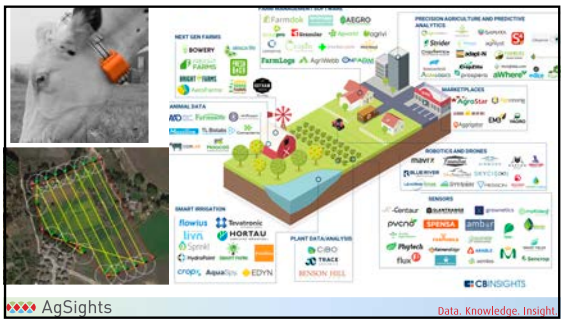

Please Select Your Picture
SELECT NEW PICTURE
Select Your Crop Colors
APPLY CHANGES
CLEAN IMAGE
Your Crop Residue Results
51%
INVERT RESULTS


Questions?
Christine Brown
Field Crop Sustainability Specialist
OMAFRA - Woodstock
Christine.brown1@ontario.ca
519-537-8305
519-533-3358 cell
NorthAmerican MANURE EXPO 2019
20-20 Vision; Yours to Discover
August 26-27, 2020 • Listowel, Ontario Canada
SAVE THE DATE
Ontario

Appendix F: Presentation Slides from Betty Jo Almond

Agri-Environmental Decision Tools

AgSights Data. Knowledge. Insight.



AgSights Data. Knowledge. Insight.

Available Tools and Use is Growing

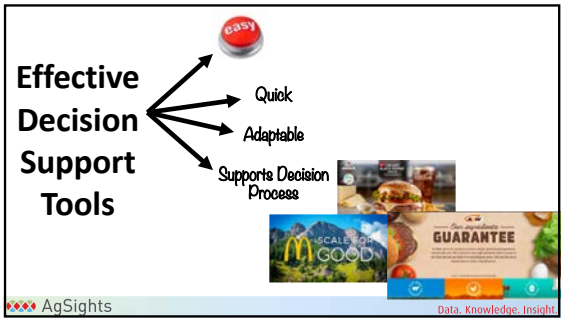
- In 2016
  - UK farmers and advisors found 395 DST's
  - DST's used to inform decisions:
    - 49% of farmers
    - All advisors
  - Software 28%, paper-based 22%, apps 10%

"Evidence-based-decision making...improve productivity and environmental outputs."

Decision support tools for agriculture: Towards effective design and delivery
Agricultural Systems, Volume 149

AgSights Data. Knowledge. Insight.

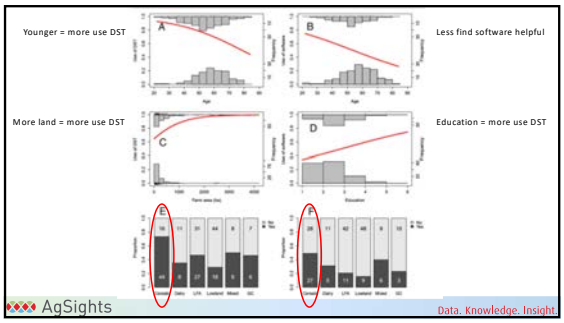
Effective Decision Support Tools



AgSights Data. Knowledge. Insight.

What Works?	What Doesn't?
Fits into your business processes easily	"Intense" setup
Save time	Expensive
Customer support	Delay in providing decision support

AgSights Data. Knowledge. Insight.



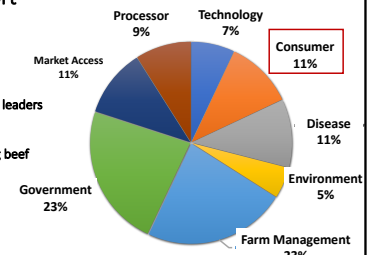
AgSights Data. Knowledge. Insight.

15 Factors influencing Adoption

1. **Performance** – does the tool perform a useful function and work well?
2. **Ease of use** – is the user interface easy to navigate?
3. **Peer recommendation** – how can we encourage peer-to-peer knowledge exchange?
4. **Trust** – is the tool evidence-based and do we have the trust of users?
5. **Cost** – is there a cost-benefit or is the initial cost too high?
6. **Habit** – does the tool match closely with existing habits of farmers?
7. **Relevance to user** – can the tool say something useful about individual farms?
8. **Farmer-adviser compatibility** – could the tool be targeted at advisers to encourage client uptake?
9. **Age** – does the tool match the skills and habits of different age groups?
10. **Scale of business** – how far is the tool applicable to all scales of farming?
11. **Farming type** – how far is the tool useful for different farming enterprises?
12. **IT education** – does the tool require good IT skills to use?
13. **Facilitating conditions** – can the tool be used effectively? i.e. is there internet access? Does it fit farmer workflows? Is there compatibility with use of existing devices?
14. **Compliance** – how can the tool help users to satisfy legislative and market requirements?
15. **Level of marketing** – how do we let users know about our tool?

AgSights Risk Report

- Interviewed animal industry leaders across Canada
- What are the big risks facing beef producers?



Data Ownership

February 2019 FCC survey:

Seventy-one per cent of farmers surveyed said data treatment is very important when selecting a technology provider.

- Ag Data Transparent becoming an industry standard
- Go360 bioTrack becomes the only beef system certified

Farm Credit Canada

AG DATA TRANSPARENT

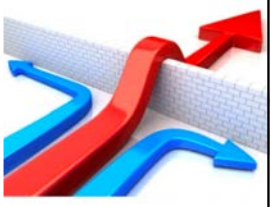
Ag Data: Challenges

Know why you are doing it
- Will drive what you collect and how

Choosing who to work with

Time and cost to collect
- Sensors must be the future

Data security (in your hands and beyond)



Data Road... Really an Information Highway

Slow / Entry lane to Fast and Active lanes

Once you have decided to get on the Information Highway

Which Lane is right for you?

Getting onto the Information Highway

"Norm! How's life in the fast lane?"

AgSights

Data. Knowledge. Insight.

"Norm! How's life in the fast lane?"

"Beats me, I can't find the onramp."

AgSights

Data. Knowledge. Insight.

Appendix G: Presentation Slides from Joe Dales

RH ACCELERATOR

ABOUT JOE DALES
INNOVATION, AGRICULTURE AND AGRI & FOOD TECH

Agriculture Background

- 35+ years in agri-business
- Education: BSc, MBA
- 1985-1999 worked in crop protection and seed industry
  - Pfizer/UAP Cynagra
  - Ciba-Geigy / Syngenta
  - American Cyanamid / BASF
  - First Line Seeds

Co-Founder

- Key role in start-up and venture capital investment raising.
- CEO & Founder etharvest.com
- Executive Role – VP of Farms.com
- Farms.com leader in ag media & HR (website & print), Agriculture and Food Job Boards & Services
- Organized the leading Canadian Precision Agriculture Conferences

Accelerator

RH Accelerator (RHA)
- Co-Founder
- Value added investor
- Consult in business accelerator for early stage, innovative companies
- Experience launching 4D products & services in Ag sector
- Consulting with Farm Credit Canada

Industry Leadership

Leadership & Governance in agriculture and agri-food industry
- Farms.com Ltd.
- AgCareers.com
- Canterra Seeds
- Western Fair Association
- A&L Laboratories
- Extensive Ag Industry Network

RH Accelerator Inc. Overview

RHA is building a systematic process and ecosystem to help early stage, innovative start up companies grow and mature creating shareholder value and great employment opportunities.

RHA is a long term, value added investment partner that leverages our business experience, networks and financial resources to increase the probability of success and accelerate the growth of our firms.

TECHNOLOGY TRENDS IN AGRICULTURE

- Robotics & Automation
- Artificial Intelligence, Machine Learning
- Augmented Reality
- Virtual Reality
- Blockchain, Bitcoin
- 3-D Printing
- Sensors
- Internet Of Things
- Ag Retail Ecommerce
- Cellular Agriculture – 5G
- Microbiome
- Smart Greenhouses
- Biotechnology and Informatics
- Food Supply Chain Management, Traceability

Agriculture is set to undergo a disruptive transformation at the hands of technology, and Canada is and can remain at the forefront of innovation

AGTECH – IMPROVING ENVIRONMENTAL MANAGEMENT

Agriculture 4.0

The application of information technology to agriculture

- Some tools are focused mainly on the farm – smart farming (e.g., precision application of nutrients)
- Analytics will optimize production.
- Others encompass the entire agri-food value chain
- Drive productivity – reduce waste, improve quality

Most Effective Ag Software Tools

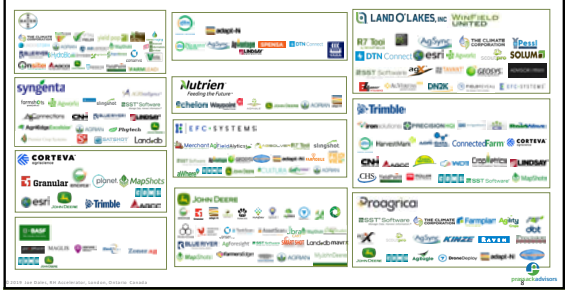
- Easy to use – Smartphone – app & mobile friendly.
- Used regularly during the year.
- Integrated – little data acquisition.
- Clear value proposition.

- High Rates of Adoption – Weather, Markets, News.
- Google, Texting, Youtube, Twitter, Chat – NewAgTalk, Agriville.com

Barriers To Tool Adoption

- Difficult to prove value – how will farmers benefit.
- Software is the easiest part of the business model.
- Farmer, agronomist education/service is critical & expensive.
- To be sustainable – requires long term continued investment and commitment. Scale required. Major Players.

DOMINANT ECOSYSTEMS 2018



AgTech Company Profile: A&L Laboratories

www.alcanada.com

COMPANY OVERVIEW

A&L is an innovative, research driven technology company focused on sustainable development. Through leading expertise, modern laboratory facilities and strong customer focus, A&L serves a wide range of industries including agriculture, environmental, food & pharma – globally.

In agriculture, A&L provides comprehensive analytical services for soil, plant tissue, feed, fertilizer and water. A&L's services also include production recommendations, remote sensing and precision agriculture capabilities. A&L Biologicals Inc. focuses on research and development of biological compounds for use in agricultural production systems. The company operates two world-class analytical laboratories serving clients throughout Canada, the U.S. and internationally.

Farmer Solutions	
Geography	Canada, plans to expand globally
Crop Focus	Most crop types
Value Captured	Ag Retail Per User Per Month Pricing; Grower Annual Pricing
Value Delivered	Ag Retail POS Management; Grower Farm Management; Ag Insurance Offers
Pricing Model	N/A
Est. # of Acres	N/A
Est. # Free Acres	N/A
Est # Customers	N/A

Recent News	Date
New VITELLU Soil Health Test Now Available from A&L Laboratories	Sept 2018
Kevin McDougall, former BASF VP US and Asia, joins A&L Laboratories	Sept 2018
A&L Laboratories announce strategic alliance with Devenir SAS and team up to expand soil testing	Feb 2019

Year Founded: 2017
Revenue (est.): N/A
Employees: 110
Headquarters: London, Ontario, Canada
Market Coverage: Global – Market Leader in Canada
Industries Served: Agriculture, Agricultural Technology, Labs – agricultural, environmental, food, pharma
Key People:
Greg Patterson, Founder and CEO
Kevin McDougall, President and COO
Acquisitions: N/A
Owners: A&L Laboratories
Capital Raised: N/A

VITELLUS

Ontario Resources

- **Farm Credit Canada** – AgExpert – Environmental Modules.
- **SoilOptix** – Field Mapping System.
- **Logiag** – Quebec EFMP system – annual.
- **Hometown.Ag** – Steve Redmond – Training & Consulting Services.
- **Farms.com & Better Farming** – National Infrastructure – private and independent company.

CONTACT US

- Joe Dales
- RH Accelerator Inc.
- Joe.Dales@RHAccelerator.com
- C 519 495-1858
- Web: www.RHAccelerator.com

- Email: David.Billson@RHAccelerator.com
- Twitter: @RHAccelerator

Appendix H: Workshop Speaker Biographies

Keynote Presentation

Clarence Swanton

- Dr. Clarence Swanton has been a Weed Scientist with the University of Guelph since 1985, serving as the Chair of the Department of Agriculture and President of the Canadian Week Science Society
- He is a fellow of the Canadian Society of Agronomy, the Canadian Weed Science Society and the Weed Science Society of America
- Dr. Swanton has received a number of awards including Outstanding Canadian in Crop Protection (2013) and the Weed Science Society of America's Outstanding Researcher Award (2002)
- Dr. Swanton's research team seeks to generate new knowledge that can be used to improve productivity and profitability of the agriculture industry while reducing its environmental footprint
- Dr. Swanton's research is highly cited globally. His team performed the original work involved in developing the integrated weed management strategies used for Ontario field crops.
- Dr. Swanton's current research explores the possibilities of precision ag, and developing a new technology that uses thermodynamics to detect stressed plants and use GPS for treatment.

Morning Panel

Betty Jo Almond

- AgSights
- Provide tools, training and support to track, monitor and improve the way you manage and market your livestock

Mike Cowbrough

- OMAFRA
- Collaborates on applied research and demonstration projects on weed management issues. Develops weed management systems for field crops

Joe Dales

- RH Accelerator
- Helping business owners, founders and the teams in early stage companies achieve their dreams

Tyler Whale

- Ontario Agri-food Technologies
- Supports commercialization, development and research of agri-tech innovation in Ontario

Update on OMAFRA Decision-making Tools

Chris Brown

- AgriSuite
- The Ontario government's free agricultural and environmental suite of tools related to crop management, nutrient management and minimum distance separation

Afternoon Panel

Dale Cowan

- AGRIS Cooperative
- Leader in precision farming technology, seed, agronomy and petroleum services

Peter Gredig

- AgNition
- Integrated Agri-digital solutions

Karen Hand

- University of Guelph, Food From Thought (Director, Research Data Strategy)
- Research on data in Canadian agri-food systems