PLANNING AN OPEN ONTARIO AGRI-FOOD DATA PLATFORM

Precision Agri-Food Scoping Study

The following are the findings of project for the development of Ontario's first comprehensive open Agri-Food data collaboration and innovation platform led by Ontario Agri-Food Technologies (OAFT). The study was supported by a steering committee whose member organizations included the University of Guelph, the University of Waterloo, Niagara College, Vineland Research and Innovation Centre (VRIC), Grain Farmers of Ontario (GFO), Ontario Fruit and Vegetable Growers (OFVGA), Livestock Research Innovation Corporation (LRIC), Ontario Federation of Agriculture (OFA), Bioindustrial Innovation Canada (BIC), Farm Credit Canada (FCC) and Golden Horseshoe Food and Farming Alliance (GHFFA).

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The opinions and views expressed in this report are the sole responsibility of the consulting firm Precision Strategic Solutions and are not necessarily held or endorsed by Ontario Agri-Food Technologies and its partners; The Ontario Ministry of Agriculture, Food and Rural Affairs; Agriculture and Agri-Food Canada; and/or the Agricultural Adaptation Council.

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Table of Contents

1 EXECUTIVE SUMMARY

This report details the results from Phase Three of a series of government-industry funded projects related to enabling precision agricultural principles to be put into practice in Ontario.

In June of 2016, the first phase of a comprehensive Precision Agri-Food Scoping and Assessment Study was completed with the objective to assess the readiness of stakeholders in the Ontario Agri-Food industry to advance the development and implementation of Precision Agri-Food Technologies (PAT) by driving research, development, and innovation towards commercial opportunities. Phase Two, completed in March of 2017, focused on three main activities:

i) A deeper assessment of the organization, programs, infrastructure, and information and communication technologies (ICT)/data-related activities of global leaders in precision agriculture identified in Phase One;

ii) The identification and initiation of joint industry/government/research pilot projects within the field of precision agriculture that will each add incremental value (e.g., direction, infrastructure, insight) to a platform which broadly supports and benefits the agri-food sector as a whole; and

iii) Further development of the concept and strategic funding plan of Ontario Precision Agri-Food (OPAF) as a "facilitation organization and infrastructure" for furthering Ontario and Canada's Precision Agri-Food strategy.

The activities and findings of Phase One and Two provided the foundation for Phase Three, the development of a comprehensive, Ontario open Agri-Food data collaboration and innovation platform. The long-term goals, with participation from industry stakeholders, were to build the functional components (e.g., reporting, analytics and visualization tools), to integrate existing data assets with emerging data assets (e.g., farm, input suppliers, service providers, government, academia, private enterprise and open-data repositories) and enable the implementation of industry-wide analytics capabilities to drive the next generation of decision support system capability. The proposed platform would allow for 'living' data; where data is not connected once, but integrated across time and space, where reporting and analysis will pull from the most recent, near real-time data. Ultimately, the platform would provide an infrastructure for enhanced research by enabling access to an unprecedented quantity and variety of data from a variety of industry resources. All participating stakeholders would be able to access data according to the restrictions of the data owners. Clearly, the platform would not only be a collaboration platform, but an innovation platform where data will drive new insights and questions.

Phase Three was the implementation and test drive of the envisioned platform which focused on five main objectives as outlined below:

1. Evaluate and 'Test drive' an ICT platform by implementing up to three pilot projects;
2. Detailed scoping of further applications;
3. Development of tools, templates, best management practices, governance structures and risk mitigation strategies required for of an organization to lead data driven Agri-Food collaboration;
4. Outreach to academia, government and industry to identify further applications and opportunities for collaborations and partnerships; and
5. Secure platform sustainability through continued industry participation.

Key outcomes of the Phase Three activities include:

- The identification and execution of five pilot projects across two commodity groups and nine participating stakeholders;
- The vision of Canadian Precision Agri-Food (CPAF), a Canada-wide common infrastructure evolved from the OPAF vision: of developing a platform for secure data collaboration amongst all members of the Agri-Food value chain, addressing issues of data standards, data interoperability, data security, seamless sharing of data and information between stakeholders in complex environments, and providing an ecosystem for open innovation;
- The Canadian instantiation of an Internet of Things (IoT) collaboration platform built on an open source development environment, FIWARE, and hosted on a secure, scalable, flexible, Canadian cloud infrastructure;
- Development of a Governance, Risk Management and Compliance (GRC) Framework;
- A workshop held to identify suitable terms of incorporation for the establishment of CPAF/OPAF as a Not for Profit Corporation; and
- Strengthening existing relationships and collaborations with global leaders in agri-food initiatives; particularly the Internet of Food and Farm 2020 (IoF2020), the Ag Data Coalition (ADC) and the Ag Data Transparency (ADT) initiative.

From a developer perspective, the test drive of FIWARE and the OPAF cloud was highly successful. The developers commented on how FIWARE performed tasks succinctly as a data broker, providing smooth and verifiable exchange. The quirks (e.g., data retrieval and provisioning) encountered were easily addressed and did not prevent productive development work; and emphasized the need for a flexible OPAF platform that uses best-in-class and first-in-class technologies, built on top the solid FIWARE foundation. All in all, the FIWARE test drive and instantiation scored highly in areas of efficiency, data standards, data retrieval, learning resources and documentation as well as community resources and engagement. The OPAF hosting environment met and exceeded all expectations in terms of onboarding, customer service and security.

A number of 'next steps' and opportunities were identified throughout this report. All pilot projects engaged on during Phase Three have the potential for direct benefit to industry if implemented full-scale. These pilots together with identified future opportunities will provide a strong foundation for the continuance of projects leveraging the OPAF platform. The envisioned CPAF collaboration ecosystem (evolved from the OPAF vision) will enable intelligent agribusiness risk management, providing the means for Ontario and Canadian Agri-Food to move beyond reactive to predictive and proactive, provide data in near-real-time for risk mitigation (e.g. disease and pest surveillance) and industry benchmarks. CPAF can provide leadership in regards to education and standards concerning cybersecurity, data ownership and privacy, as well as address issues of data entry fatigue – a significant barrier to industry initiative participation.

The Ontario Precision Agri-Food (OPAF) initiative referred to in this report is collectively defined by the activities and outcomes of Phase One, Two and Three projects. CPAF is a vision of a Canada-wide common infrastructure that has evolved from the OPAF vision: of developing a platform for secure data collaboration amongst all members of the Canadian Agri-Food value chain; addressing issues of data standards, data interoperability and data security; seamless sharing of data and information between stakeholders in complex environments; providing an ecosystem for open innovation. CPAF has the potential to be a global leader in sustainable agriculture through the power of data.

2 REASON FOR STUDY

Agriculture in Ontario - indeed, in Canada - is on the cusp of a dramatic revolution in large part due to the emergence of Precision Agri-Food technologies and the Internet of Things (IoT). We are about to witness the digitization of agriculture and with this there will be explosive growth in the volumes of electronic data being collected, along with an unprecedented demand for tools to manage and analyze this data to extract maximum value. Canadian farmers are under incredible pressure, tasked to meet societal demands and farm in an environmentally sustainable manner while remaining economically viable. It is in this context we understand the unequivocal importance of Precision Agri-Food.

IoT is a network of interconnected physical devices capable of connecting to the internet. Through IoT we are experiencing a fundamental paradigm shift in the concept of Precision Agriculture to the use of information and communication technologies (ICT) for improved fine-scale control of plants, animals, and the variability of natural and physical resources, with the goal of optimizing economic, social, and environmental farm performance. Moving beyond the concept of Precision Agriculture is Smart Farming, a framework in which decisions are made using data in real-time. In a Smart Farming system, decision support systems result in actionable outcomes by using all available data (e.g., data generated by sensors, devices or residing in external data repositories) enhanced by situational awareness (e.g., human expertise or resident industry knowledge).

In June of 2016, the first phase of a comprehensive Precision Agri-Food Scoping and Assessment Study was completed with the objective to assess the readiness of stakeholders in the Ontario Agri-Food industry to advance the development and implementation of Precision Agri-Food Technologies (PAT), by driving research, development, and innovation towards commercial opportunities.

Operational Precision Agri-Food implementations are nascent in Ontario, largely due to the lack of integration between devices and siloed data in disparate repositories. The adoption of Precision Agri-Food management strategies is currently limited to innovative farmers, or early adopters; the bottlenecks preventing more widespread adoption are the lack of ease of use, difficulties regarding integration, farmers' resistance to change/adopt, farmers' fear of security breaches, lack of evidence to prove the short-term return on investment, lack of reliable and trusted service providers, and affordability. The complexities of Precision Agri-Food require advanced ICT platforms to address the issues of data standards, data interoperability, and data security to allow for the seamless sharing of data and information across the entire value chain. Precision Agri-Food is expected to be a powerful driver that will "transform farming and food into smart webs of connected objects that are context-sensitive and can be identified, sensed and controlled remotely". [1]

Phase One identified opportunities for Ontario to take a leading role in developing the strategy, vision, and necessary infrastructure to facilitate and accelerate the validation, adoption, and innovation of PAT. Further, our global scan of PAT initiatives identified that very little emphasis is being placed on the requirement for a big data facilitator/integrator function. Consequently, there exists considerable opportunity to address this function in a comprehensive manner, for all commodity groups in Ontario and Canada.

Phase One, identified the need to test drive a simple open source collaboration platform and FIWARE, was selected as a starting point. This platform was developed through projects supported by the European Commission and is the founding project for the Internet of Food & Farm 2020 (IOF2020) initiative currently underway. FIWARE allows for flexibility, where all partners can interact, and does not require building customized interfaces between all possible participant interactions. Further, Phase Two

[1] Verdouw, C.N., Wolfert, J., Beulens, A.J.M, Raialland, A. (2015). Virtualization of food supply chains with the internet of things. Journal of Food Engineering, 176: 128-136.

continued to explore the opportunity to become global partners in IOF2020, to allow for a common network and technology base that will enable transactions with European markets, provide for shared learning experiences and identify overlapping business and software ecosystems for Agri-Food IoT solutions with a common network and technology base with European markets.

Phase Three is the natural evolution of the work completed in Phase One and Two, in the development of a comprehensive Canadian open Agri-Food data collaboration and innovation platform. A collaboration platform, led by and within the context of Canadian agriculture, will help address the unease within global agriculture communities concerning the lock-down of agricultural data by commercial entities; "we need to ensure that data itself flows freely, but that the rewards for its use are properly realized by the industry, with minimal potential for leakage".[2] Stakeholders across Ontario and Canada, collect and use a variety of data to evaluate and monitor production and performance, as well as inform critical management decisions. The data exists in siloed repositories in disparate formats; on the farms (farm management systems, sensors and devices), in some well-administrated data repositories (producer associations, academic and government) and small business operations including service providers. The alignment of all commodity groups in Ontario and Canada towards a shared collaboration platform will significantly reduce redundancy, increase functionality and leverage all available resources.

Phase Three focused on the instantiation and testing of the collaboration platform through the development and deployment of pilot projects. This report outlines the findings of Phase Three, the development of comprehensive open Agri-Food data collaboration and innovation platform. The report follows the inherent structure of the identified objectives.

[2] Grain Central. (January 20, 2017). Who should control ag data? Last accessed January 27, 2017 at http://www.graincentral.com/news/agribusiness/who-should-control-ag-data/.

3 THE TEST DRIVE

A number of information technology (IT) tools were assessed on their ability to provide the required functionality for the OPAF platform. In all respects, FIWARE, the base technology for the EU initiative the Internet of Food & Farm 2020 (IoF2020), was the clear choice. FIWARE:

- Is flexible (i.e. open source);
- Uses state-of-the-art base technology for authentication & security;
- Membership provides access to FIWARE Mundus - community, marketplace for reduction in time-to-market for the launch of new services and technologies;
- Provides easy integration with other tools and platforms;
- Uses available validated technologies;
- Utilizes Generic Enablers Repository – open source reusable components;
- Works off a distributed network to prevent full scale outages; and
- Is Internet of Things (IoT) ready.

The OPAF team was confident in the ability of FIWARE to meet all the requirements Ontario and Canada will require of a flexible, open source collaboration and innovation platform.

3.1 The FIWARE Community

Three members of the project team attended the FIWARE Summit in Utrecht, Netherland in May of 2017, and two members attended a FIWARE workshop hosted by the Edmonton Research Park in June of 2017. As a result, the team was able to develop an intimate knowledge of the FIWARE ecosystem, community and available resources.

Key findings and outcomes include:

- Contacts with FIWARE Mundus community (outreach/partnerships/support for global FIWARE activities, outside the EU);
- Access to community of agri-food experts using FIWARE now and in the future for business applications;
- Access to and partnerships with companies and projects using FIWARE to power innovative solutions in smart Agri-Food, manufacturing, heath and cities;
- Identification of potential partners in Canada who are considering the use of FIWARE as a key component of innovations hubs for small and medium enterprise (SME) and mid-market enterprise (MME)

The OPAF initiative became an official member of the FIWARE Foundation at the Summit held in Utrecht, Netherlands. The FIWARE community consists of projects and individuals who are committed to contribute to further development of the FIWARE platform and the continued sustainability of the FIWARE ecosystem.

3.2 The OPAF Platform

The collaboration platform has been built on an open source development environment, FIWARE, and is hosted on a secure, scalable, flexible, Canadian cloud infrastructure.

OPAF has made great progress with the FIWARE environment and thus far our team of developers are very impressed with the capabilities of the software/platform. FIWARE has proven to be a very high-quality tool that allows our initial work to progress smoothly, efficiently, and securely. Furthermore, the OPAF instantiation has three layers of top quality security; first in FIWARE with state of the art authentication and security; second, with our Canadian hosting company, who is required by law to meet security standards for Canadian financial and health sectors. The hosting environment is strictly Canadian. Thirdly, with the building of OPAF's / CPAF's Governance, Risk Management and Compliance (GRC) framework. The GRC Framework in development moves beyond the framework prepared by the National Institute of Standards and Technology (NIST). OPAF takes security very seriously, providing out of the gate alignment with leading IT security and governance practices.

3.3 The Pilots

During the tenure of Phase Three, the OPAF project team identified and engaged with industry on five pilot projects involving nine participating stakeholders. The pilot projects were selected on a number of criteria that included the ability to test drive the OPAF platform; importantly, however, the projects that were chosen were so such that if successfully implemented, would provide direct benefit to industry today.

3.3.1 Mobile DHI

This pilot involves integration of data from Canadian Dairy Herd Improvement (CDHI) and Dairy Farmers of Ontario (DFO) to broaden the functionality of Mobile DHI. Mobile DHI was first developed by CDHI to give Canadian dairy producers fingertip access to important CDHI information concerning their herd, cows and heifers. The Mobile DHI-OPAF pilot project partners included dairy producers, Canada Dairy Herd Improvement (CDHI, CanWest DHI and Valacta), Dairy at Guelph (the University of Guelph is a leader of Canada's dairy research) and a mobile application development. By working together, the Mobile DHI-OPAF team developed and implemented a new Bulk Tank Module, integrating CDHI data with bulk tank test results. Ontario producers enrolled in the project were able to closely monitor milk parameters such as somatic cell count (SCC) at the cow and bulk tank level. SCC is an important indicator of udder health and milk quality.

A number of producers and veterinarians enrolled in the pilot project were surveyed and interviewed in order to assess the app in terms of functionality, perceived value and suggestions for future development. A number of observations and pertinent comments include:

- Some producers have begun experimenting with the application in order to make routine management decisions;
- A number of producers commented on the usefulness of having centralized cow test and bulk tank information using the app;
- The app provided a means to be less reliant on paper records;

- One producer in particular noted how useful the app was in eliminating the need to run back into the house when he sought specific cow or bulk tank information;
- Most producers indicated they check their bulk tank data several times per week and the app facilitated more connectivity and monitoring;
- Veterinarians saw the app as an excellent way to stay current on herd performance and health when "on-the-go";
- In one particular case, a veterinarian and producer in the barn noted a sudden increase in bulk tank SCC and with the app were able to identify the appropriate cows to sample for milk culture; and
- All veterinarians interviewed responded positively regarding the potential to use the app as a benchmarking too for their herds and would recommend the app to their colleagues.

By far, producers recognized real value in bringing together multiple sources of information in one place; specifically, CDHI and bulk tank information.

> "It's just the next logical step."

The success of this pilot is evidenced by the plan to scale the project, giving all dairy producers enrolled in CDHI access to the Bulk Tank Module, starting in January of 2018, improving both cow and herd management.

3.3.2 Automated Milking Systems – Robotics

In Canada, approximately 9% of all dairy cows are milked by robotic systems (automated milking systems, AMS), DeLaval and Lely being the two primary robotic systems used in Canada today. Robotic milking systems generate high volumes of data for every cow, at every milking. Integrating robot data with existing data will provide limitless opportunities to strengthen our dairy industry. For example, CDHI provides their clients with 24-hour milk, fat and protein yields; key metrics used by our dairy producers to manage their herds. The 24-hour milk and component yields are also used for genetic improvement programs (e.g., Canadian Dairy Network - CDN). However, accurate estimates of 24-hour yields requires data from CDHI test results and the robot.

The OPAF pilot project supported by CanWest DHI and Valacta involved using the OPAF platform as the connector between the CDHI database and robotic data. The Robotic OPAF project partners include CDHI (CanWest DHI and Valacta), CG Wellington, Lely and the OPAF project team.

The OPAF team was able to pull robotic data from five dairy producers with herds milked by the DeLaval automated milking system residing with CG Wellington. As a result, an analysis was completed to determine the feasibility of matching AMS milk records to CDHI cow test day records. This is a critical first step in providing the Canadian dairy industry with accurate 24-hour yield estimates for fat and protein. The OPAF team will continue to investigate the most efficient method for DeLaval data access and integration.

The proposed OPAF-CDHI-Lely project required access to the newly implemented Lely Cloud. To date, the application for API access was approved; however, the Lely Cloud will not be ready until the spring of 2018. Nevertheless, a number of first steps were achieved and the OPAF team anticipates continuation of this project upon readiness of the Lely Cloud.

> "The collaborative nature of the Canadian dairy industry and our reputation for embracing innovative technologies will ensure our position as global dairy leaders. Automation, digitization, technology and machine learning are the drivers that define our dairy farms today. More than ever we need to be collaborative both philosophically and digitally; OPAF provides the environment to do so."
>
> -Neil Petreny
> General Manager
> CanWest DHI

3.3.3 OBHECC

The Ontario Broiler Hatching Egg & Chick Commission (OBHECC) represents the interests of broiler breeder growers, broiler hatching egg producers and broiler hatcheries involved in the supply of day-old chicks to the Ontario broiler industry.

OBHECC – Premises Identification

The Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) administrates the Provincial Premises Registry (PPR) that provides premises identification numbers (PID) and standardized geolocation information that uniquely identifies a legal land parcel. In order for OBHECC to register and/or obtain the PIDs of their producers (by permission), data is exchanged with the PPR Portal, via a series of spreadsheet exchanges. To date, the OBHECC-OPAF pilot project has identified the permissions, legal agreements, data attributes and processes required for automated data exchange (eliminating the need for manual data entry) using the OPAF platform. This pilot will be of interest to all livestock commodities as the integration of premise information is of utmost importance when it comes to disease surveillance, especially in times of disease outbreaks.

OBHECC-Hatcheries

OBHECC works closely with broiler hatcheries where data is frequently exchanged. The OBHECC-OPAF hatchery pilot is developing a system for the automatic exchange (push and pull) of data using the OPAF platform with the objective to eliminate redundant data entry (currently accomplished by manual entry of data up to four times). At this stage, the execution roadmap is in development and in the process of identification and standardization of hatchery data attributes. This project highlights areas of optimization made possible with the OPAF platform.

The Ontario broiler industry consists of a number of well-managed and administrated data assets and repositories. Although some information and data are exchanged in the value chain, the potential to derive value from the data (whether from industry wide benchmarks, risk management or predictive analytics) is considerable. However, there remains issues concerning data integration and information sharing up and down the value chain, as well as issues concerning data standards, privacy, security and trust. These challenges are limiting the ability to realize substantial value from the data. The OPAF team

is currently working with OBHECC and industry partners to enable these realizable opportunities in the Ontario broiler industry.

In the words of one Canadian poultry expert:

> "One of the greatest assets in the poultry industry is the amount and scope of data that is routinely collected in electronic format on a daily basis. To effectively utilize this data, it has to be integrated, capable of being shared, appropriately analyzed and reported in a format that is useful to both the providers of the data and the industry at large. This is especially important in benchmarking, establishing normal limits and in disease surveillance and investigation. OPAF is able to provide a platform where the data flow between sectors (in this case a hatchery and the board regulator) can be optimize and automated, as well as provide a database where good statistical analysis, compiling of additional related information and various reporting functions can be completed. Knowledge is the key to success in agriculture as in other businesses for continuous improvement and accurate forecasting. Being able to handle big datasets efficiently and effectively is required to gain that knowledge. This collaborative project with OPAF highlights the potential of a good connected system and the experience gained will be integral designing and implementing truly useful data management critical to the future success of the poultry industry."
>
> - Dr. Rachel M. Ouckama, DVM Diplomate ACPV
> General Manger, Maple Lodge Hatcheries Ltd

3.4 Test Drive – Developer Perspective

The following paragraphs summarize the test drive of FIWARE from a developer perspective; specifically, the ability of FIWARE to provide the required functionality for the OPAF platform.

FIWARE states in a few words that what they do is make and share open source technology for smart solutions. This is an overview of the said technology; about its strengths, weaknesses and future. We found FIWARE to be very useful given it is open source. In fact, FIWARE has been adopted by many users (e.g., SMEs and MMEs) because of the peer-review of open sourced technology.

Installation in the cloud was easy and simple as installation packages were provided. There are a number of forums which speak to FIWARE installations; however, the following paragraphs speak specifically to the OPAF installation. For the OPAF installation and setup, there existed plenty of relevant documentation which helped tweak settings for optimum performance.

Concerning our use of FIWARE we have mixed emotions, mainly because we understand that software in general cannot be a one size fits all. We have likened FIWARE to a mail routing center -- think Canada Post. On the positive side we have found it is very efficient for routing mail to various destinations; FIWARE was built specifically for these tasks. Furthermore, FIWARE has built in guarantees (e.g., similar to a verification signature) for "mail" delivery. FIWARE did give us liberty to exercise various programming languages to accomplish the task of data routing, allowing us to maximize development applications.

FIWARE was created to provide for flexibility and broad horizons in order to accommodate large team development work; therefore, FIWARE solutions are not locked to any one specific technology. With FIWARE, modern data standards are enforced from the root allowing FIWARE to connect with various software; allowing for expanded interactivity of its data exchange. As developers, we had confidence in using FIWARE as additional modules created in-house could seamlessly hook into the ecosystem.

Notwithstanding the power and flexibility of FIWARE, it is not without some challenges. For example, in some areas of data retrieval and manipulation FIWARE did not provide for the most optimal implementation. The FIWARE ecosystem has a built-in fixed format for data retrieval and in the case of the CDHI Mobile pilot project, employment of additional functionality to pull the data points and allow usage by clients was required. At times FIWARE was problematic, especially when changes to specification was required on our end. This was evident in terms of data return where added functionality was required to retrieve all data points. However, these nuances were minor in nature and were not considered a major stumbling block.

Overall, we believe FIWARE performed tasks succinctly as a data broker, providing smooth and verifiable exchange. The quirks (e.g., data retrieval and provisioning) we encountered were easily addressed, although bothersome. Importantly, these inconveniences did not prevent productive development work; but emphasized the need for a flexible OPAF platform that uses best-in-class and first-in-class technologies, built on top the solid FIWARE foundation.

The developers for the OPAF platform provided a fully scored report card concerning a number of features of the OPAF instantiation can be found in Appendix A. Key report card findings in regards to the FIWARE instantiation and test drive include:

- Scores highly in regards to efficiency, where
    - Data is guaranteed for critical and non-critical domains,
    - Rivals other closed-source (paid for) systems, and
    - Provides integrity of data across multiple instances (e.g., globally distributed);

- Scores high in regards to data standards, where
    - Major data formats are supported,
    - Utilities for data verification are provided,
    - Ecosystem is future proofed, and
    - Open-source Open Data framework “CKAN” is used (e.g., offers a platform and marketplace for Open Data;

- Scores moderate in regards to data retrieval, where
    - In-house modules are required for full data retrieval;

- Scores high in regards to learning resources and documentation; where
    - Documentation library was vast and easy to navigate,
    - GitHub repository for sample projects and building blocks was provided, and
    - Online training courses, seminars, SlideShare posts, video tutorials and technical blogs were provided; and

- Scores high in regards to community, with
    - An excellent social media and community presence,
    - FIWARE Lab (a non-commercial sandbox environnement)
    - Venues for developer and entrepreneur interactions, and
    - Supported activities such as boot camps, hackathons and workshops.

Overall, FIWARE was deemed to be a solid technology that helps developers forge relationships with the "Future". The FIWARE mission is:

> … to build an open sustainable ecosystem around public, royalty-free and implementation-driven software platform standards that will ease the development of new Smart Applications in multiple sectors.[3]

FIWARE surpasses this goal. In addition, the OPAF hosting environment met and exceeded all expectations in terms of onboarding, customer service and security.

In the words of one software developer:

> "We have found FIWARE to be invaluable in our current pilots for many of the reasons it touts: data management and analysis at a large scale, verified security standards and IoT capability among many others. Throughout our pilot, FIWARE has made software development a thrill because of its composite design. We were able to focus on the main tasks and allow FIWARE to take care of the software "glue" between our components -- ultimately leading to high quality design and efficiency. FIWARE presented a smooth platform for us in the case of our Bulk Tank pilot; 24/7 stability, lighting fast execution and unrivaled security to say the least. As Microsoft's CEO Satya Nadella states "Everything is going to be connected to the cloud and data and all of this will be mediated by software". If data is the vernacular of today, then FIWARE is the vehicle to drive data to its various destinations with security, progress and ease, agnostic of said destination."
>
> -Joel Sotomayor
> JRS VirtualStudio Inc

3.5 Future Projects and Opportunities

In addition to the scale up of Phase Three pilot projects, a number of pipeline projects have been identified and are in first stages of scoping. Project areas include soil health as well as plant and animal health.

Projects and ideas explored include:

- Initial scoping exercises with the Association of Chicken Processors (AOCP);
- Mapping environmental metrics for sustainable agriculture in Ontario;
- Advancing the Ontario Agriculture Soil Health Strategy;
- Benchmarking agricultural practices within Ontario watersheds;
- The development of intelligent solutions for the optimization of dairy farm operations;
- Connecting stakeholders participating in the emerging bioeconomy; and

[3] https://www.fiware.org/about-us/

- Smart logistics to address supply chain concerns.

On June 29, 2017 a workshop for the Grain and Oilseeds sector was held at Grain Farmers of Ontario (GFO). Participants represented a wide swath of the supply chain including producers, industry representatives and GFO staff members. The workshop identified four significant challenges;

i) Data handling (scale, privacy, etc.),

ii) Data to support market access (social license),

iii) Crop input analysis (pest management, nutrients); and

iv) Soil information (soil health and emerging new data).

As a result of the discussions it was decided to begin scoping an early warning system for western bean cutworm (WBC), *Striacosta albicosta*, by capturing and integrating relevant data in real time. The project would enable application to other pests and diseases. A full report of from the workshop can be found in Appendix D.

3.6 Summary

All pilot projects engaged on during Phase Three have the potential for direct benefit to industry if functionality is expanded, optimized and implemented at full scale. The Mobile DHI project is anticipated to scale up with the Bulk Tank Module in January of 2018. The pilot projects involving automated milking systems in the dairy industry provided the critical first step in providing the Canadian dairy industry with accurate 24-hour yield estimates for fat and protein. The OPAF platform has the potential to be a key component for the integration of robotic milk data with Canadian milk recording data. The opportunity to work with OBHECC, whether to optimize data and information exchange with other stakeholders in the broiler chain, or the development of trusted and confident relationships with industry partners including the Association of Ontario Chicken Processors (AOCP) will provide a strong foundation for the continuance of projects leveraging the OPAF platform.

The building of trusted and confident relationships for collaborative projects requiring the sharing of data requires a great deal of time and requires open and transparent communication. These relationships must be established before any project can be scoped and legal agreements readied.

Lastly, the implementation of Phase Three pilot projects and test drive of the OPAF platform provided the team with a clearer understanding of future organizational structures, capacity requirements and the required funding to support the organization/platform over the short and long term.

In the words of one Canadian Agri-Food expert:

> "We are at an exciting and important place in animal agriculture as we deal with global concerns about feeding a growing population while also improving our environmental and antimicrobial stewardship. Accessing, understanding, sharing and using the growing number of data sources that we have available is paramount to accomplishing this. OPAF, as a platform, offers exciting opportunities to move us forward much more quickly and efficiently."
>
> - Dr. David Kelton, DVM, PhD
> DFO Research Chair in Dairy Cattle Health
> University of Guelph

4 GOVERNANCE AND OPERATIONALIZATION

4.1 Governance

The OPAF team reviewed a number of agriculture-related, non-profit, publicly-available governance structures. In October 2017, the OPAF team and Steering Committee engaged in a governance workshop in order to identify the critical structure required for OPAF to operate as a standalone not-for-profit organization. Topics under discussion included:

- Benefits of registering as a federal non-profit organization;
- Governance versus operation board;
- Membership structure;
- Liability; and
- Funding as an independent non-profit organization.

There were a number of major discussion points; one related to the timing of incorporation, another to defining the strategic vision. A third discussion point concerned the delineation between Canada Precision Agri-Food (CPAF) and the provincial counter parts (the XPAFs; OPAF for Ontario, for example), defined by business objectives and services provided. It was agreed that a small committee would convene to discuss issues of strategic focus and timing of incorporation. It was generally agreed to move the projects and initiatives forward under 'CPAF'; and until decided, the CPAF initiative would continue to operate under the auspices of Ontario Agri-Food Technologies (OAFT).

Organizationally, the delineation between CPAF and the provincial counter parts (the XPAFs) will need to be defined by business objectives and services provided. Currently, it is envisioned such that CPAF membership will provide clients with a number of core services, and provincial counterparts will focus on provincial Agri-Food priorities. A few points concerning the role of CPAF and the provincial counterparts under consideration are provided below.

CPAF:

- Developing and maintaining the collaboration platform;
- Maintaining equal access to the platform and to resource-sharing between all partners, nationally and globally;
- Applications – e.g., farm audit application services;
- Access to processes and documentation required for service level agreements, data share agreements and non-disclosure agreements;
- Education and standards concerning cybersecurity, data ownership and privacy; and
- Innovation – enablement of multi-partner innovation projects bringing Agri-Food technologies at TLR 3+ (technology readiness levels as defined within the Strategic Innovation Fund Program Guide[4]) to commercialization.

[4] https://www.canada.ca/en/innovation-science-economic-development/programs/strategic-innovation-fund/innovation-funding/application-toolkit/program-guide.html#annex-a

XPAFs:

- Addressing issues of data entry fatigue – a known barrier to initiative participation (e.g., among certified crop advisors, veterinarians and disease surveillance programs);
- Focus on provincial Agri-Food priorities;
- Focus on optimization of Agri-Food operations, including producers and industry partners; and
- Business relations development.

In general, CPAF is the vision of a Canada-wide common infrastructure that has evolved from the OPAF vision: of developing a platform for secure data collaboration amongst all members of the Agri-Food value chain; addressing issues of data standards, data interoperability and data security; seamless sharing of data and information between stakeholders in complex environments; and providing an ecosystem for open innovation.

4.2 Cybersecurity IT Security and Governance

As mentioned, the OPAF team takes security very seriously, and provides out of the gate alignment with leading IT security and governance practices. The OPAF team, in partnership with an IT securities expert, drafted the first version of CPAF's cybersecurity IT Security and Governance Policy or the Governance, Risk management and Compliance (GRC) Framework. The CPAF GRC Framework in development moves beyond the framework prepared by the National Institute of Standards and Technology (NIST). The GRC Framework identifies policies and procedures to protect, detect, respond to and recover from external security risks and threats. By completion of the project, the cloud instantiation of the OPAF platform consisted of three security layers: FIWARE, with state of the art authentication and security; the Canadian hosting environment, required by law to meet security standards for Canadian financial and health sectors; as well as the CPAF GRC Framework.

The CPAF GRC Framework is comprised by the following policies:

1.1 ITSC Charter

1.2 CoBIT Management Guidelines and Control Objective

1.3 ISO/IEC 27001:2005 ISMS

1.4 NIST Cyber Security Framework

1.5 PIPEDA Legislation

1.6 CPAF Information Governance Policy

1.7 CPAF Asset Management Policy

1.8 CPAF Business Objective Policy

1.9 CPAF Risk Management Policy

1.10 CPAF Access Control Policy

1.11 CPAF Awareness & Training Policy

1.12 CPAF Data Security Policy

1.13 CPAF Incident Management Policy

1.14 CPAF Business Continuity Management Policy

1.15 CPAF Service Assurance Policy

1.16 CPAF Acceptable Use Policy

1.17 CPAF Communication Policy

1.18 CPAF Environmental Controls Policy

1.19 CPAF Systems Development Life Cycle Policy

The CPAF GRC Framework is considered to be a living document with strict guidelines concerning ongoing reviews and assessments.

4.3 Operationalization

The alignment of all stakeholders in Ontario towards a data management strategy and common collaboration platform will significantly reduce redundancy, increase functionality and leverage all available resources. Significant consideration must be given to data sharing agreements, rights to access and security of private farm or industry data. In scoping out the pilot projects and mapping implementation, the OPAF team were able to identify processes important when scoping further projects. Documentation the team developed include:

- Formalized Non-Disclosure agreements;
- Project Participation agreements; and
- Formalized Data Sharing agreements.

Through the implementation of the Phase Three pilot projects, the OPAF team was able to validate the importance of the Pilot Project Criteria developed in Phase One and Two (Appendix B) as well as formalize a process for the scoping of future projects. OPAF proposes a multi-stage approach, beginning with stakeholder engagement, then proceeding to execution, implementing short-term projects to achieve long-term objectives. Each stage provides opportunity for assessment in order to remain aligned with industry, research and government objectives. Further details on the engagement and execution process can be found in Appendix C. Other processes that need to be considered include detailed communication plans, project management tools and relevant assessments (e.g., business analysis) at critical points of project development to ensure success.

A number of re-usable projects and components were identified during Phase Three. In particular, the ability to integrate PPR data with data repositories existing within agri-industry (with producer permission) will be of interest to all agricultural commodities as the integration of premise information is of utmost importance when it comes to disease and pest surveillance, especially in times of outbreaks. The OPAF platform in its entirety is sustainable; the cloud and FIWARE instantiation, FIWARE components and in-house modules can be used for scale up of existing pilots as well as execution on future projects.

The implementation of pilot projects and continued scoping of pipeline projects provides opportunity to operationalize the steps required for successful innovative projects, beginning with stakeholder engagement and progressing to execution of a well-defined implementation roadmap.

5 OUTREACH

5.1 Activities

The OPAF team attended and presented at a number of industry events, including two presentations at an industry workshop in June, attendance at the FIWARE Summit in Utrecht, Netherlands and the Edmonton Research and Innovation FIWARE workshop. Other events attended by the OPAF team included North American Carbon World, Coalition Offset Solutions, Genome Alberta, Geoinformatics Conference, Poultry Industry Council (PIC) Research Day, PIC Poultry Health Research Network (PHRN) Day, PIC Poultry Health Day, Ontario Cap and Trade Forum, Spring Dialogue Days, Ontario Climate Consortium Symposium and Food & Beverage Ontario; all events provided network opportunities for the OPAF initiative. A full list of activities can be found in Appendix E.

5.2 Collaborations and Partnerships

The OPAF initiative shares many of the objectives and values of global leaders in agri-food initiatives; particularly the Internet of Food and Farm 2020 (IoF2020), the Ag Data Coalition (ADC) and the Ag Data Transparency (ADT) initiative.

In future, CPAF/OPAF will continue to build effective international partnerships to enable Canada to take its place as a world leader in the Agri-Food IoT ecosystem.

5.2.1 Internet of Food and Farm 2020

The Internet of Food and Farm 2020 (IoF2020) is a 30-million-euro initiative – a pan-European vision for the collaborative development of Agri-Food applications launched in January of 2017. IOF2020 key areas of focus include:

- Innovation action;
- Bringing together and integrating the supply and demand side of IoT technologies in Agri-Food;
- Building a symbiotic ecosystem of technology providers and players; and
- Providing leadership, adoption, validation, security, privacy, standards, quality of life, innovation, opportunities, for a secure and sustainable European IoT ecosystem beyond IoF2020.

IoF2020 is governed by a board of directors and is the culmination of the: Smart AgriFood (2011-2013, 5M €), FIspace (2013-2015, 13.5M €) and FIWARE Accelerators (2014-2016, 17M €) projects. Over the next five years IoF2020 will implement a series of large-scale agri-food IoT pilots consisting of 55 trials and 19 use cases in:

i) Arable Farming[5],

ii) Dairy[6],

iii) Fruits[7],

iv) Vegetables[8], and

v) Meat[9].

[5] [55] https://www.iof2020.eu/trials/arable
[6] https://www.iof2020.eu/trials/dairy
[7] https://www.iof2020.eu/trials/fruits
[8] https://www.iof2020.eu/trials/vegetables
[9] https://www.iof2020.eu/trials/meat

A collaboration agreement between CPAF and IoF2020 is currently in development and has identified a number of areas for collaboration including:

- Participation in workshops/webinars (topic specific);
- Joint events;
- Joint workshops pertaining to use case commonalities;
- Access to Catalogue of Re-Usable components;
- Sharing ecosystem and networks;
- Cooperation and coordination in standardization activities; and
- Periodic meetings.

Since the launch of IoF2020, numerous technology companies, technology service providers and agri-food initiatives have made requests for cooperative engagement, from Sweden, Canada (OPAF), New Zealand, Australia, Portugal, Greece, Netherlands (Agro Field Labs in Smart Industry) and DataBio (with partners across the EU). These projects, with exception of DataBio (a Horizon 2020 project supported by the EU Commission) are funded at the national or regional scale are in various stages of development and implementation.

5.2.2 Ag Data Coalition

The Agriculture Data Coalition (ADC) is a non-profit organization whose mission is to help farmers better control and manage their electronic data and promote innovation and progress in the agricultural marketplace by the creation of a neutral, independent, farmer-centric data repository where farmers can securely store and control their data (collected every day in the fields by their tractors, harvesters, aerial imaging and other devices). Farmers can share their data to trusted third parties — whether researchers, crop insurance agents, government officials, farm managers or input providers.

In September of 2017, members of the OPAF team attended and presented at the ADC Board of Director's meeting. Both organizations recognized the potential for collaborations. In future, CPAF will continue collaborative discussions with ADC, whose experience will be instrumental in building out the farm cloud data storage, a key component of the envisioned CPAF platform (Appendix F).

5.2.3 Ag Data Transparency

In the United States, a consortium of farm industry groups, commodity organizations and agricultural technology providers (ATPs) have developed the Ag Data Core Principles – defining standards and best practices for agriculture data ownership, consent and privacy – and the Ag Data Transparency (ADT) initiative, who provide a process through which ATPs submit their data contracts for independent review to determine compliance with the Ag Data Core Principles. In June of 2017, the OPAF team presented at a joint workshop with the Ontario Farm Data Privacy and Security project, whose main objectives were:

1. Exploring the opportunity for collaboration with the ADT project in order to understand and expand upon their evaluation process; and

2. Delivering recommendations for a Canadian instantiation of the ADT project, either stand-alone or in partnership with ADT project.

CPAF will continue to work collaboratively with ADT, where OPAF team members are participating on the Board of Directors and encouraging the adoption of the ADT initiative in Canada.

6 NEXT STEPS

In all events and activities participated by OPAF team members (Appendix E), networking for the purposes of future development was undertaken. Activities included conversations and in-person meetings with potential partners such as Farm Credit Canada, CENGN, and Earnscliffe Strategy Group. Continued conversations with major agriculture commodity groups were also undertaken. As well, CPAF will continue to engage with global initiatives such as the Ag Data Transparency initiative and the Ag Data Coalition.

The OPAF team has begun to work closely with a number of departments within Agriculture and Agri-Food Canada (AAFC). In terms of risk, the CPAF has the ability to be an enabler for intelligent agribusiness risk management. Applications of the platform either by CPAF, participating organizations or independent entrepreneurs could include:

- Experiential data sharing (producer, business and social data), reducing insurance claim size and frequency;
- The ability to move beyond reactive to predictive and proactive where examples include greater efficiency for input use to maximize ROI or minimize loss (e.g., pesticides, fertilizers, antibiotics); and
- Disease surveillance systems in near real time (e.g., insects and crop pests, disease surveillance in dairy, benchmarking in broilers) as a natural consequence of a collaborative data and information ecosystem.

CPAF can also provide a forum for collaboration and leadership in regards to:

- Evolving social Innovation models – protecting Canadian farms with anticipated shift in the re-distribution of business costs, benefits and risks and new business models (sensor vs sensor related services); and
- Trade impacts – protection of Canada's reputation (e.g., monitoring, benchmarking/measuring and reporting of agri-environmental metrics) and protection against the use of Canadian agri data existing in repositories outside Canada.

A number of opportunities and 'next steps' were identified throughout this report. All pilot projects engaged on during Phase Three have the potential for direct benefit to industry if implemented at full-scale. These pilots together with identified future opportunities will provide a strong foundation for the continuance of projects leveraging the OPAF platform. The vision of Canadian Precision Agri-Food (CPAF) and the provincial counterparts were discussed in Governance (4.1). It is incumbent on CPAF to seek out and strengthen partnerships with provincial, national and global leaders in Agri-Food who share the vision of CPAF

We feel strongly that operating as an independent third-party organization will be critical for acceptance of the services CPAF can offer. CPAF can provide:

- Security and privacy for all participants, including no obligations to the Freedom of Information Act (FOIA) or FOIA requests;
- 24/7 support services aligned to support business requirements; and
- Support for transactional business data environments.

We see the CPAF initiative as the foundational groundwork for a Canadian Agri-Food Collaboration Ecosystem serving industry, government and academia. A collaboration ecosystem that can enable intelligent agribusiness risk management, provide a means for Ontario and Canadian Agri-Food to move beyond reactive to predictive and proactive, and provide data in near-real-time for risk mitigation (e.g. disease and pest surveillance) and industry benchmarks. CPAF will deliver leadership in education and

standards concerning cybersecurity, data ownership and privacy, as well as address issues of data entry fatigue – a significant barrier to industry initiative participation.

The ICT collaboration platform envisioned, developed and tested throughout the OPAF initiatives will continue to evolve. This platform – the **Digital Canadian Agri-Food Environment** (Digital CAFE) – will provide secure data collaboration amongst all members of the Agri-Food value chain; addressing issues of data standards, data interoperability and data security; seamless sharing of data and information between stakeholders in complex environments; and providing an ecosystem for open innovation.

CPAF has the potential to position Canada as a global leader in sustainable agriculture through the power of data.

> "There's no room for complacency in the fast-moving digital world."
> -Neelie Kroes
> EU Commissioner for Digital Agenda

7 AUTHORS

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Appendix A DEVELOPER REPORT CARD

Below is a report card on the OPAF FIWARE test drive and instantiation as well as the cloud hosting environment.

FIWARE INSTANTIATION AND TEST DRIVE	
Feature	**Score**
Efficiency	**9/10** - Quickly provides access to many standards - Data moves blazingly quick - Data has guarantees, this works for critical and non-critical domains - Rivals many other closed-source (paid for) systems - Integrity of data across multiple instances in the world (e.g., globally distributed)
Data Standards	**10/10** - Major data formats supported - Various utilities built in to verify sent data - Futureproofing built into the ecosystem - Security focused - FIWARE uses the open-source Open Data framework "CKAN" to offer a platform and marketplace for Open Data.
Data Retrieval	**7/10** - Data is difficult to retrieve for certain queries - The querying language is limited, causing additional strain on the developer to add overlays to the retrieval process - Retrieval may not always return the amount you specified by the query so you need to continuously query until the amount is found. This causes "book-keeping" to be done on the developer's side
Learning Resources and Documentation	**10/10** - The documentation catalog was vast and easy to navigate - FIWARE had an excellent GitHub repository that made it easy to find sample projects and building blocks - Online training courses are available - Web and Online seminars available - SlideShare posts - Video Tutorials - Technical Blogs

Community	**10/10** - FIWARE has excellent social media and community involvement initiatives - FIWARE Lab provides a non-commercial sandbox environment for testing applications and technology - Venues for developer and entrepreneur interaction and discovery (e.g., how various stakeholders are using FIWARE for solutions and commercialization) - FIWARE supports hackathons, boot camps, and workshops to continually engage and grow the FIWARE developer community
Overall Mark	**9/10** - FIWARE is an amazing technology that helps developers forge relationships with the "Future" - FIWARE mission is: "to build an open sustainable ecosystem around public, royalty-free and implementation-driven software platform standards that will ease the development of new Smart Applications in multiple sectors" and FIWARE not only achieves this goal but also surpasses them - It has excellent resources for setting up an instance - Can scale quickly with key focus on security

LONG VIEW SYSTEMS – CLOUD HOSTING ENVIRONMENT	
Set Up	**10/10** - Long View Systems (cloud hosting environment) provided an effortless set up process - In terms of onboarding, a welcome package with critical information including key contacts was provided
Customer Service	**9/10** - The customer service provided by Long View Systems was unparalleled - We had excellent response times in terms of queries - Most response times were under 24 hours via telephone and email - Responses were also provided outside normal business hours
Security	**10/10** - The Long View team was excellent - Meetings were set up with their firewall team - Key processes were outlined - all ports required provisioning by the firewall team to ensure security of any OPAF requests for external ports - A "heart beat" monitoring service was provided which monitored our servers and notified us of any suspicious or abnormal network activity
Overall Mark	**9.5/10** - The Long View experience was simply "amazing". They were security focused, always available via phone or email with excellent response times - Long View's 24-7 365 monitoring service kept intruders away and kept us informed of unusual network activity. - The monitoring system was proactive; we were alerted any time any unusual activity occurred on the OPAF servers. - Overall, we had a very positive experience dealing with Long View and they come highly recommended.

Appendix B PILOT PROJECT CRITERIA

1. **Project Description**

   a) **Challenge:** Define the challenge and the participants/stakeholders. Pilot projects need to address a specific challenge or answer a specific question of interest to the industry, government or academic researchers. These must be data driven projects.

   b) **Value:** How will this solution bring value to the industry and/or the participants and what value can the industry and each participant expect?

   [For example: Does this project have the potential to improve farm management practices? Will it improve disease surveillance? Will it answer an important question concerning environmental sustainability? Will it assist in the optimization of transport? …]

   c) **Outcome:** Describe the outcome of this pilot project and how that would address the challenge. Identify the stakeholders that will require information/communication from the system/outcome. If the implementation of the pilot is time sensitive, please indicate the required time frame.

   [For example: Will the outcome result in industry benchmarks or report that need to be accessed by numerous participants? Will the outcome result in improved algorithms for on-farm decision support? Will the solution need to be reported in real-time? …]

2. **Project Participants**

   a) **Direct:** Please identify all stakeholders in the Agri-Food supply chain network who would participate in building out the pilot project.

   [For example: Producers, associations, service providers, researchers. …]

   b) **Supporting Experts:** Who are the potential experts and/or researchers required to find optimal solutions?

3. **Data Characteristics**

   a) **Data Sources:** How and where is the data generated and in what format does it exist? Is there any known manner in which data can be linked?

   [For example, the data could be generated using on-farm sensor technology and exist in an electronic format or on-farm data may only exist in the form of handwritten report. Is there historic data? Will the data be collected in real-time? Are there variables collected across the data repositories that can link the data together such as premises identification?]

   b) **Data Aggregation:** Are there currently any third party services that collect, store, aggregate and/or communicate the data?

4. **Potential Funding Sources**
    a) **Funding Sources:** Identify potential funding sources for the project

    b) **Support:** Will there be committed support from industry and research participants?

    c) **Income Generation:** Do you foresee any revenue generating opportunities from a successful implementation?

5. **Comments:** Please provide any additional comments below.

Appendix C PROJECT ENGAGEMENT AND EXECUTION PROCESS

Engagement

OPAF will work in partnership with a committee of industry experts to complete a scoping and assessment study in order to identify priority areas, key stakeholders, collaborative projects, and data assets. The assessment will identify gaps in knowledge, models, tools and data requirements.

The following outlines engagement process:

1. Map the industry
    - Identify the stakeholders - industry, government and research
    - Identify specific stakeholders within the value chain for first point of contact
    - Identify relevant scale; local, regional, provincial, national or global

2. Identify objectives
    - Short and long term
    - Construct preliminary roadmap for execution

3. Current state mapping
    - Identify existing resources
        - Projects, tools, models, metrics and data
        - Data requirements, format and ownership
    - Identify gaps

4. Build Collaboration Model
    - Communication with all relevant stakeholders
    - Ensure value to all participants
    - Develop trusted relationships/agreements to enable data sharing for all stakeholders; industry, government and research
    - Use of data share agreements to ensure access respects ownership and proceeds in a secure and confidential manner
    - Coordination of resources
    - Eliminate redundancy in data space
        - Entry
        - Storage
    - Standardized tools, models, metrics and data (as required)

5. Create Implementation Roadmap

Execution

1. Execute against implementation roadmap through a structured, controlled pilot with clearly defined and measurable success criteria

2. Evaluate results of pilot with project stakeholders

3. Scale pilot to a production implementation
    a. Add functionality
    b. Add participants
    c. Increase scope

Appendix D OPAF AND GFO - WORKSHOP

Below is the distributed full report on the OPAF-GFO workshop

Ontario Precision Agri-Food and Grain Farmers of Ontario Consultation

This report provides an overview of the Ontario Precision Agri-Food Technologies (OPAF) concept, along with details concerning a proof of concept project for the Ontario grain and oil seed sector developed at a June 29, 2017 workshop, in partnership with Grain Farmers of Ontario (GFO) and other industry leaders.

The OPAF initiative is led by twelve partner organizations (Ontario Agri-Food Technologies, Livestock Research Innovation Corporation, Ontario Federation of Agriculture, Niagara College, Vineland Research and Innovation Centre, Grain Farmers of Ontario, University of Guelph, University of Waterloo, Ontario Fruit and Vegetable Growers' Association, Ontario Agri Business Association, Bioindustrial Innovation Canada and Golden Horseshoe Food and Farming Alliance.

OPAF Project Overview

Ontario Precision Agri-Food (OPAF) is undertaking the development of a comprehensive Open Agri-Food Data Collaboration and Innovation Platform for Ontario. A Scoping and Assessment study pertaining to the use and adoption of Precision Agri-Food in Ontario was completed in the spring of 2016[10]. In particular, the User Needs Assessment identified the need for more industry collaboration, to be able to ask business-relevant questions of data generated in agriculture and how to use the data to create meaningful information and actionable insights.

Agriculture is experiencing a revolution in large part due to the emergence of Precision Agri-Food technologies and the Internet of Things (IoT) which are driving the digitization of agriculture, explosive growth in volumes of electronic data and unprecedented demand for tools to manage, analyze and extract maximum value. Canadian farmers are under incredible pressure, tasked to meet societal demands, farm in an environmentally sustainable manner while remaining economically viable and a Precision Agri-Food approach is key to addressing these. Ontario can lead the development of an open, collaborative vision, strategy and implementation within the emerging Precision Agri-Food sector on behalf of Canada.

Precision Agri-Food brings a fundamental paradigm shift to agriculture using information and communication technologies (ICT) for improved fine-scale control of plants, animals, natural and physical resource variability to optimize economic, social, and environmental farm performance. Decisions can be made using all available data in real-time, enhanced by situational awareness.

Operational Precision Agri-Food implementations are nascent in Ontario, largely due to the lack of integration between devices and siloed data in disparate repositories. The adoption of Precision Agri-Food management strategies is currently limited to innovative farmers (early adopters); the bottlenecks preventing more widespread adoption are the lack of ease of use, integration and affordability.[11] The complexities of Precision Agri-Food require advanced ICT platforms to address the issues of data standards, data interoperability and data security to allow for the seamless sharing of data and

[10] Hand, K.J., Carpenter, J., Roche, S., Wilton, B., (2016). User Needs Assessment Final Report: Precision Agri-Food Scoping Study. Last accessed on January 27, 2017 at https://www.opaf.ca/reports/.

[11] Aubert, B.A., Schroeder, A., Grimaudo, J. (2012). IT as an enabler of sustainable farming: an empirical analysis of farmers' adoption decision of precision agriculture technology. Decis. Supp. Syst., 54: 510-520.

information across the entire value chain[12]. Precision Agri-Food is expected to be a powerful driver "that will transform farming and food into smart webs of connected objects that are context-sensitive and can be identified, sensed and controlled remotely"[13].

The longer-term objective of this project is to build the functional components (e.g., reporting, analytics and visualization tools) of a data collaboration platform for the Ontario and Canadian agri-food industry that will be able to integrate existing data assets with emerging data assets (e.g., farm, input suppliers, service providers, government, private enterprise and open data repositories).

The platform is a nexus, enabling the movement of information; the platform is not a database nor a data collection tool. *In the shorter term, the OPAF proposal aims to accomplish two main objectives: first to 'test drive' a highly sophisticated and costly open source software tool (FIWARE – see below) using an Ontario based pilot and second to continue to build a pipeline of good projects where multiple stakeholders can benefit from advanced data-sharing technology.*

Research

The proposed platform allows for 'living' data; where data is not connected once, but integrated across time and space, where reporting and analysis will pull from the most recent, near real-time data. Living data is the tool that will provide the research community with high dimensional Big Data, enabling the implementation of industry-wide prescriptive analytics capabilities (by employing such techniques as machine learning) to drive the next generation of decision support system capability to address issues such as sustainability and site specific farm management. Ultimately, the platform provides an infrastructure for research specific to the characteristics and needs of Canadian farms, by enabling access to unprecedented amounts and variety of data from a variety of industry (and other) resources. All participating stakeholders will be able to access data according to the restrictions of the data owners. Clearly this platform would not only be a collaboration platform, but an innovation platform as data integration will drive new insights and questions.

CPAF

Importantly, the solution will be developed from an organizational perspective, building and maintaining stakeholder relationships and identifying business requirements, iteratively building a long-term solution through specific, well-defined requirements-driven trials and pilots. The User Needs Assessment identified an existing open source collaboration platform, FIWARE, developed through agri-food use cases in the EU as a potential technology to build to test drive the pilot projects. This platform, built over several years (with approximately 70 M€ dedicated specifically to agri-food use cases), was sponsored by the EU Commission and is one of the base technologies being used for the Internet of Food & Farm 2020 (IOF2020) initiative currently underway. The collaboration platform allows for flexibility, where all partners can interact and does not require building customized interfaces between all possible participant interactions.

Currently, collaborative efforts are underway with organizations across Canada as well as national commodity sector associations, which will accelerate the evolution of OPAF to CPAF, Canada Precision Agri-Food. Collaboration is the fundamental core of CPAF from both an ICT and organizational perspective; across all agriculture sectors, whether on a provincial, national or global scale.

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[12] Vermesan, O. and Freiss, P. Digitising the Industry: Internet of Things Connecting the Physical, Digital and Virtual Worlds. (2016). Last accessed January 27, 2017 at https://ec.europa.eu/digital-single-market/en/news/digitising-industry-internet-things-connecting-physical-digital-and-virtual-worlds.

[13] Verdouw, C.N., Wolfert, J., Beulens, A.J.M, Raialland, A. (2015). Virtualization of food supply chains with the internet of things. Journal of Food Engineering, 176: 128-136.

Grain Farmers of Ontario

The Grain Farmers of Ontario (GFO) was formed in 2010 as the amalgamation of three predecessor organizations: the Ontario Corn Producers' Association, Ontario Soybean Growers, and the Ontario Wheat Producers' Marketing Board, it is the largest farm commodity group in Ontario. Barley and oat growers voted in favour of representation which became effective in July 2015. GFO represents 28,000 farmer-members whose crops cover 6 million acres of farm land across Ontario. GFO is best described by their mission statement

> …Our mission is to develop and promote an innovative and successful business environment which will allow our farmer-members the opportunity for profitable growth.[14]

GFO strategic goals focus on steady growth through market expansion, research and innovation to enhance farmer returns, providing for economic, environmental and societal sustainability, public outreach, policy development, and advocacy.

OPAF & GFO

A number of needs, concerns, challenges and opportunities were identified in the field crop sector as part of the User Needs Assessment[15]. In further explorations, OPAF identified four broad themes of sector challenges; data handling (scale, privacy, etc.), data to support market access (social license), crop input analysis (pest management, nutrients) and soil information (soil health and emerging new data):

- Smart logistics to address supply chain concerns
- Maintain or expand market access through proof of on-farm sustainability practices without compromising farm scale
- Market access through proof of on-farm practices that have resulted in enhanced product quality
- With aggregated nutrient application data shared with academic audiences, there is opportunity for improved models regarding prediction and economic impact and therefore more informed government policy (application scripts are already being done for farmers through the current commercial tools/models available)
    - Complex models to explore reduction of phosphorus levels in the Great Lakes require data from numerous and varied sources including as soils, watershed, weather, agricultural and urban activities
- Support of real time surveillance systems for pest and disease by integration of all relevant data streams
    - Where are the current outbreaks of soybean pests and/or disease to allow earlier planning?
    - New ways to explore solutions to dealing with *Fusarium graminearum* using integrated data sources
- Complex models to explore soil health requiring varied and numerous data attributes
- Support policies for the establishment of rural broadband by demonstrating economic value
- Leadership regarding the use, security and ownership of on-farm data
- Integration of open-data specific to the needs of crop farmers; for example, LiDAR and Landsat satellite images

[14] The 2016 Grain Farmers of Ontario Annual Report, accessed at http://gfo.ca/Annual-Report

[15] Hand, K.J., Carpenter, J., Roche, S., Wilton, B., (2016). User Needs Assessment Final Report: Precision Agri-Food Scoping Study. Last accessed on January 27, 2017 at https://www.opaf.ca/reports/.

OPAF & GFO Project Consultation

To further understand the needs and challenges within the Ontario grain and oilseed sector and to explore more fully data driven solutions to address these needs and challenges, on June 29, 2017, OPAF and GFO organized a consultative workshop with key sector stakeholders. The objective of the workshop was to define a series of tangible project ideas realizable using the proposed data collaboration platform. During the workshop, a series of high-level questions guided the conversations, allowing for a deeper dive into projects of interest and corresponding project challenges and specifics. The agenda for the workshop can be found in Appendix 1. The following presents details of the workshop.

Attendees

- Karen Hand – OPAF
- Jane Carpenter – OPAF
- Josh Cowan – GFO
- Mark Brock – GFO / row crop farmer
- Mike Strang – row crop farmer
- Dale Cowan - AGRIS Co-operative Ltd
- Tony Balkwill – NithField Advanced Agronomy
- Crosby Devitt – GFO
- Greg Kitching – Premier Equipment

Project ideas, concerns and opportunities

During the group brainstorming session, several project ideas, along with key concerns and opportunities were discussed. Key points are listed below:

- Projects as avenues of value for producers: in terms of management, monetary or as a way of providing convenience / efficiency
- There needs to be improved access to public open data, whether government data or research data (Australia was used as an example of an efficient system for the access to open data)
- All participants in a project needs to realize value
- Considerations in regards to farm data; how clean is the data, is there a potential for the data to be used against the farmer, is another party profiting from the farmer's data, what is the comfort level of producers in regards to data sharing and aggregation
- OPAF may provide an opportunity for the grain sector to be proactive in terms of data integration / use of supply chain data
- Pilot projects although specific, test drive the idea and viability of larger-scale projects and connectivity
- Producers are uncomfortable with an academic or government based institute storing or managing their data, but believe researchers require access to data
- There is a need for data sharing in order to build disease alert systems, where everyone takes ownership and responsibility
    - OPAF could be in the centre and provide the means to draw real-time maps that give the breadth of the outbreak while maintaining anonymity – if there is disease in the area you know there is disease in the area, no one's privacy is compromised but producers can be proactive

    - Without connectivity we don't have a real picture of what's actually going on, where data off the farm needs to be viewed in the context of the situation and conditions under which the data was generated
    - Would being notified of disease in the area help the producer? – yes, taking proactive management decisions and putting systems into place to mitigate any potential losses
- Currently, decisions regarding pest and disease outbreaks are largely reactive and not proactive
- Conversation concerning business partnership with Agricolus, a European business application powered by FIWARE using complex spatial modeling to predict disease outbreaks based on weather data at various levels of granularity
- Accurate weather prediction models would be extremely valuable to producers
- Thought and considerations need to be given to businesses who have made substantial investments in weather stations and building of a weather network, the sharing of weather data needs to provide value, either monetary or for customer relations
- The cost of sensor technology is decreasing and will reach the point where buying off the shelf sensor technology for the farm will become affordable, how will this data be collected? Shared?
- If we do move forward with a project idea, what are the timelines? What happens if OPAF is not funded past the current project deadline (October 31, 2017)?

The following provides a summary of key points in the group discussion:

- Will the data ever be used against the farmer?
- The role of OPAF in building a data ecosystem
- Potential project ideas included; weather predictions, proof of sustainability, disease surveillance, data collection/aggregation to address social issues such as the use of neonicotinoids, collection of research and government and data into one repository, easily accessible

Potential Pilot Projects

Two potential pilot projects were identified:

1. Collection and integration of data to address proof of sustainability

Key discussion points included:

- Defining sustainability requirements is program dependent
- Field programs such as Field Print are already in place
- SAI – uses a benchmarking approach, where sustainability is ranked (e.g., bronze, silver and gold)
- There is also the Sustainable Farm and Food Initiative (SFFI)
- Should there be one standard adopted across Canada? Does there exist global standards for large corporations?
- The ability to apply a level of standard on any given province wide product would provide good value; for example, "Ontario corn is silver"
- Is there use case to use FIWARE for SAI?

2. Collection and integration of data in real time for pest/disease surveillance

It was decided to pilot the project with a specific pest identified in order to demonstrate value. The pilot project would be built as generically as possible to allow application to other pests and

> diseases, once more of the supply chain becomes connected and engaged. This is of utmost importance, given the potential for elimination by genetic modification for any one pest.

Ontario Grain and Oilseed Pilot Project

The following project scope was based on discussions concerning the implementation of a pilot project for the purposes of disease surveillance with specifics pertaining to surveillance of western bean cutworm.

Project Description

Challenge:

The objective of this pilot project is to enable an early warning system for western bean cutworm (WBC), *Striacosta albicosta* by capturing and integrating relevant data in real time.

> …The western bean cutworm (WBC) is a pest of corn (field, sweet and seed) as well as dry beans (with the exception of soybeans) and to a lesser extent tomatoes and nightshades. Unlike other cutworms, this pest prefers to feed on the fruit of the plant, i.e. corn ears and bean pods.[16]

According to the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA), Ontario Crop IPM website[7], moths emerge in late June, early July having overwintered in other regions. Once adult moths lay their eggs, hatching occurs within a week. Egg masses on one plant can impact other plants in the vicinity as the larvae are mobile. In corn, it is estimated that an infestation of one larvae per year can result in 3.7 bu/ac loss in corn.

The pilot project will focus on 10 to 20 producers within a defined region. The primary region of interest being Bothwell, Ontario, located on the north-eastern limits of Chatham-Kent, recognized as a particular hotspot of activity historically for WBC. A secondary region of interest may also be identified for the pilot project.

Value

Discussion within the group believe that current response to pest outbreaks is largely reactionary. Therefore, an early detection system would allow for proactive measure to be taken by producers in affected regions; thereby enabling farmers to make informed decisions concerning the application and timing of pesticide application.

Companies may provide intrinsic value to producers by having product available at critical times in the necessary quantities.

The accumulation of pest data across the supply chain would also provide tremendous value, the ability to track outbreaks, severity and interactions over time, integrated with weather data and management systems would allow for complex modeling in order to gain a greater understanding of best management practices to optimize pest control and elimination and the economic impact of WBC.

Outcome

The specific outcome of this project will be the successful implementation of a use case for a WBC early warning system using a variety of source data that would allow for personalized alerts based on geographic data and pest movement. Once full scale, collection of key parameters would allow for

[16] http://www.omafra.gov.on.ca/IPM/english/sweet-corn/insects/western-bean-cutworm.html#advanced

development of prediction models answering questions concerning issues such as seasonality, prevalence, effective control and elimination.

It is important to note, the system needs to be built as generically as possible, and therefore widely applicable as an early warning system for other disease and/or pests.

Project Participants

A few project participants were identified in the workshop. These participants will be approached in the near future to determine interest in engagement, including but not limited to Tracey Baute, Entomologist-Field Crops, Ridgetown, University of Guelph and Albert Tenuta, Pathologist-Field Crops, Ridgetown, University of Guelph as well as Chuck Baresich at Haggerty Creek Ltd.

Data Sources

It is important to note; a number of pest surveillance systems are in operation today. It would be important to understand the current systems (e.g., OMAFRA) and their possible role in building the alert system; for example, consolidating bases of information in order to ensure concurrent updates.

Other data for consideration may include product on the ground as well as weather. Further data source will be identified through expert contacts such as those identified above.

Comments and Next Steps

A number of key issues were addressed:

- How do you capture the outcome of a treatment?
  - Someone logging into an app for a prompt – did you treat? (y/n); very simple – producers won't answer a survey because they don't have the time but will answer a simple y/n question if prompted
  - Value: capturing an 'image' of a disease regarding spread, treatment, treatment reactivity, etc.
- Concern in regards to sharing data could be quickly mitigated by demonstration of value
- A working group is required to
  - lead the direction of the project, narrowing the scope, decide key data attributes
  - Would like to see a whole-value-chain approach: would like something that at the end of the day, membership can say "yes, I see the value in sharing my data"
  - Key contact for identifying participating producers
- Starting with a specific example, but using it to build an entire platform by demonstrating value
- Detailed scoping of the pilot project could begin in September with roll out of proof of concept to shortly follow

Appendix 1

Grain Farmers of Ontario - Workshop Agenda

679 Southgate Drive, Guelph
June 29th, 2017

Goals of Today

To work with key individuals from across the grain and oilseed sector to identify and develop realizable projects, pushing the envelope of what is currently possible, using the Ontario Precision Agri-Food (OPAF) Information and Communication Technology (ICT) framework; a data collaboration platform that will be able to integrate existing data with emerging data (e.g., farm, input suppliers, service providers, government, private enterprise and open data repositories).

Agenda

8:30 – 9:00am: Arrive and Coffee

9:00am – 9:15am: Welcome and introductions

9:15am – 9:35am: Introducing the OPAF framework

9:35am – 10:30am: Brainstorming pilot projects for the Grain and Oilseed sector

10:30am – 10:45am: Coffee break

10:45am – 10:55am: Prioritizing pilot projects

10:55am – 12:30pm: Details of the pilot project characteristics

12:30pm: Lunch and closing remarks

Appendix E INDUSTRY ACTIVITES AND EVENTS

Date	Event	OPAF Presentation
10-Apr-17	Multi Ontario Ministerial Meetings in Toronto	Yes
20-Apr-17	North American Carbon World	
20-Apr-17	Growth Summit II, Agriculture and Digital Adoption Breakfast Sessions	
21-Apr-17	Ontario Livestock Poultry Council Meeting	
26-Apr-17	Ontario Cap and Trade Forum	
02-May-17	Spring Dialogue Days 2017	
04-May-16	Coalition on Offset Solutions	
05-May-17	Bio-economy Event	
05-May-17	Circular Economy Workshop - University of Guelph	
10-May-17	Poultry Industry Council (PIC) Research Day	
11-May-17	Ontario Climate Consortium Symposium 2017	
15-May-17	Discovery Conference	
16-May-17	Big Data, Changing Climate and Agriculture - University of Guelph	
17-May-17	Lely Workshop - Listowel	
24-May-17	Poultry Industry Council (PIC) PHRN Day	
25-May-17	Genome Alberta	
29-May-17	FIWARE Summit - Utrecht, Netherlands	Yes
4-Jun-17	FIWARE Edmonton Research Park FIWARE Workshop	Yes
15-Jun-17	Poultry Industry Council (PIC) - Poultry Health Day	
23-Jun-17	Ag Data Transparency (ADT) Workshop	Yes
29-Jun-17	Food & Beverage Ontario AGM	

29-Jun-17	GFO workshop	Yes
7-Aug-17	Geoinformatics Conference-Fairfax Virginia	
11-Sep-17	OMAFRA ADM (Soil Health, Plant and Animal Health)	Yes
13-Sep-17	Plant Heath Strategy Committee Meeting	Yes
22-Sep-17	Board Meeting - Ag Data Coalition	Yes
26-Sep-17	Agriculture and Agri-Food Canada / Agriculture et Agroalimentaire Canada	Yes
17-Oct-17	Canadian Poultry Research Council (CPRC) - Smart Poultry Workshop	
31-Oct-17	AOCP Board Meeting	Yes

Appendix F CPAF BASIC ARCHITECTURE