Agri-Food Product Identity Verification and Governance

DIACC Special Interest Group Insights

Table of Contents

About the DIACC

Created as a result of the federal government's Task Force for the Payments System Review, the [Digital ID & Authentication Council of Canada](#) (DIACC) is a non-profit coalition of public and private sector leaders who are committed to developing a Canadian digital identification and authentication framework that will secure Canada's full and secure participation in the global digital economy.

About DIACC Special Interest Groups

A DIACC Special Interest Group (SIG) provides a mechanism in which to engage our community in discussion around a specific interest. They enable more opportunities to connect subject matter experts from around the world and to broaden the conversations outside of our DIACC membership.

A DIACC SIG does not create intellectual property but rather contemplates a specified question to make a recommendation to DIACC regarding the next steps that should be considered for incorporation into the DIACC strategy and roadmap.

About the Author

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Additional contributions were made by organizations that participated in this Special Interest Group (SIG) including the University of Washington, Scott David, Digital Technology Supercluster, Evgueni Loukipoudis, and Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA), Magdy ElDakiky.

Executive Summary

The Canadian agri-food system is vulnerable to many threats that endanger food production and distribution. Issues such as climate events, labour disruptions, complex and long distance supply chains, public health emergencies, and food safety are only some factors that impact food production and distribution. The complexity of this system is further exacerbated by the sheer number of actors that interact over vast spaces to produce, process, transfer, and market agri-food products without well-structured protocols, processes, policies and standards. During the COVID-19 emergency, the Canadian food system and global food system, in general, have shown to be vulnerable to unforeseen disturbance.

The need for a more resilient agri-food system has been recognized by the Canadian government and the private sector. Strengthening resilience in this brittle system requires a holistic approach that should include the integration of new technologies and new policies with various actors and protocols in the value chain. Technologies such as the Internet of Things (IoT), sensing solutions, data acquisition and processing platforms, and artificial intelligence solutions can create an environment in which risks and threats in the food system can be more effectively measured and mitigation strategies can be evaluated. Although the use of digital technologies can offer many advantages to the current fragmented agri-food system, their adoption has not been widespread. Many factors have contributed to limited adoption of digital technologies including access to high quality data, ability to integrate different systems and actors (interoperability), policies and legal agreements to facilitate governance, and strategies and tools that enable validation and verification of identities (ID) and credentials.

The ability to effectively validate and govern digital identities (IDs) of food products, actors, machines (e.g., farm tractors, IoT devices, animals), and other entities the food system has many benefits. Food traceability, disease outbreak risk management, cybersecurity threat detection, promoting Canada's food product brand, improving market competitiveness, and the ability to build tools to empower commons and improve inclusivity in this complex digital ecosystem are only some of the advantages of establishing best practices, standards, and technology solutions for ID verification and governance. This report aims to review the benefits of digital ID and credential verification solutions in the food system followed by a "Call to Action" for policy-makers, researchers, non-profit organizations, technology providers, and other food system actors to collaborate and establish best practices and develop technology solutions.

Introduction

A sustainable and resilient agri-food system is foundational to a healthy economy and community. The COVID-19 emergency, for instance, has shed light on vulnerabilities in the food system in Canada and around the globe and has emphasized the need for enhanced risk management and resilience. Food insecurity, increasing food prices, the growing number of people facing acute hunger, SME's (e.g. small farm holders) inability to survive/grow, labor shortage, and supply chain interruption are only some of the issues that threaten the food system during uncertainties and crises.

The role of digital technologies in transforming Canada's agri-food system to achieve this vision is undeniable. Digital technologies can help enhance food production, safety, and sustainability. They can accelerate and improve the work of various actors across the supply chain of producers, processors, packagers, distributors, and retailers. Small businesses and farmers can benefit from digital technologies to increase their revenue and boost crop and livestock product output. The government of Canada can improve the agri-food related policies, such as the ones in the distribution of subsidy programs among farmers, management of inventories and food storages, and risk assessment and mitigation at the time of foodborne outbreaks. New digital tools can operationalize an integrated systems approach to complex agri-food problems by accounting for and enabling the management of increasingly diverse sets of actors, social and political realities, and trade conditions.

The Canadian agri-food sector has been slow in adopting digital technologies. This is partially due to the fact that investments in these technologies have not been perceived as rewarding as expected in some agri-food sectors. A number of factors have contributed to the perception and reality of unmet expectations to date. Among these issues, availability of (or access to) high quality data and integration methods (i.e. interoperability) have been a major limiting factor. Limited availability of funding and support for digitization in the agri-food sector, lack of regulations that support adoption, and finally farmers' hesitation to use digital technologies and lack of trust in these technologies are other contributing factors.

The net effect of these multiple uncertainties results in the central reason for the slow adoption: the lack of explicit quantifiable Return of Investment (ROI) for the farmers and other actors and a compelling business case to invest in and adopt digital technology. Development of business cases for additional investment are challenging, since not all actors have the same interests and agendas in respect to digitalization, and due to the various ways in which information and identity risks present themselves across the agri-food Sector, it is difficult to convene collaborative networks to address shared issues, since it is not always easy to agree on a starting point that will serve the economic interest to all parties.

The good news is that as the world becomes more digitized, the agri-food Sector stakeholders will start to experience new forms of familiar information threats and also entirely new information threats

that will serve to bring agri-food Sector parties together to solve these shared challenges more efficiently. Yesterday's grange systems and agricultural "cooperatives" of various sorts enabled farmers to cooperate in the governance of certain shared risks from agricultural activities and pool resources for mutual benefit. Future digital "Granges" will enable similar shared risk and benefits for the harvests of data that are now produced by agri-food stakeholders in digital contexts.

To make the most of agri-food data, data provenance, interoperability, and governance (e.g. data access, security, quality, and privacy) should be enabled from farm to fork and among fragmented systems/actors. One of the core components to enable these requirements is the ability to verify and validate agri-food entities' digital IDs. By entities, here, we refer to food products, locations, technologies (e.g. machine, sensors), stakeholders, packages, and any other items in the supply chain. There are currently shortages of frameworks and strategies for verification of digital IDs that can facilitate data access, integration, and governance in the decentralized and complex systems such as agri-food.

This report is intended to draw attention to the shortage of digital ID best practices in the agri-food system and the need for these solutions in this sector. This report focuses on the role of digital IDs and verifiable credentials as integral components of agri-food technologies.

The Need for Digital Verifiable Credentials

The growing sophistication and complexity of the agri-food system as well as interactions among its diverse actors (Fig. 1) have increased the need for tools that facilitate interactions among different actors, platforms, and processes in the supply chain. The current agri-food system, however, is fragmented with limited ability to validate interactions, claims, and identity in the value chain. This impacts the growth of the agri-food market and global trade. It also imposes several health, technology, and economic related risks including intensifying cyber attacks on agri-food critical infrastructure, increasing food fraud, and hindering our ability to trace the origin of food or environmental crises.
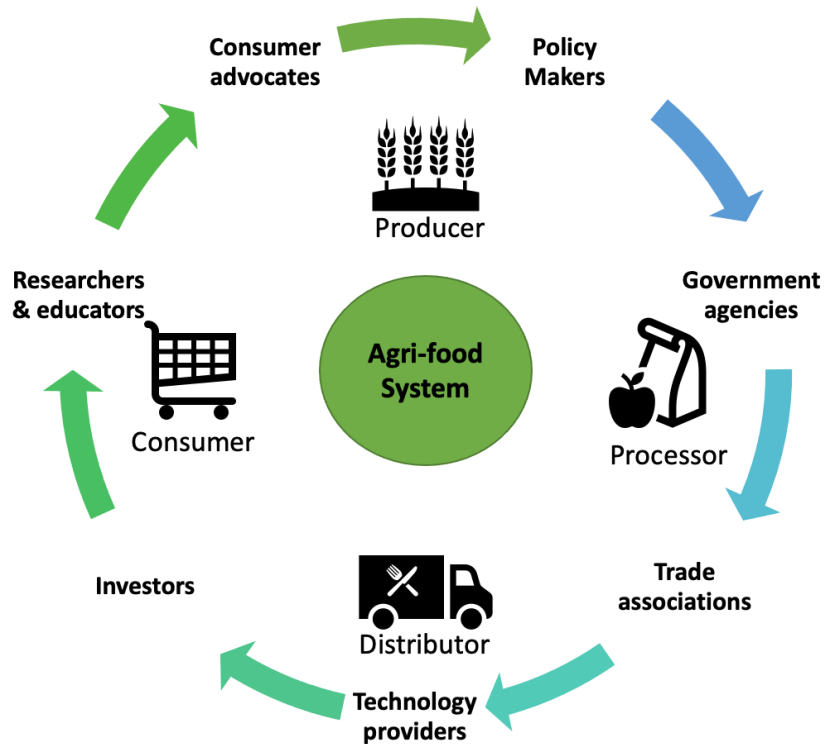
Figure 1: A Generic agri-food Ecosystem

Decentralized food systems and complex interactions between entities and actors reduce government agencies and public health's ability to detect food fraud. Experts have estimated that food fraud costs between 10-40 billion dollars a year and constitutes 1% of the global food trade. Lack of visibility in food supply can increase the risks of food-born illnesses such as salmonella and listeria. This fragmented ecosystem also reduces the ability to track the origin of ingredients and the condition under which food products are processed. For instance, to fake the amount of protein in baby formula and milk products, they were mixed with nitrogen that contained plastic resin. There is also an increasing need to optimize the use of natural resources and facilitate sustainable trade. Without traceability, agri-food companies and actors such as farmers cannot take control of their carbon footprints and governments will not be able evaluate the social, environmental, and economic impact of food and agriculture production. Another growing threat on the food system is cyberattacks. Cyberattacks on agri-food critical infrastructure can threaten food security. A recent case in point was a hacking group, BlackMatter, that carried out a cyber attack on NEW Cooperative, an agriculture supply chain, and locked up its computer systems. BlackMatter demanded a $5.9 million ransom and threatened to publish a terabyte of the cooperative's data. The company was forced to take their computer network offline to isolate the incursion.

Creating an environment for risk monitoring and mitigation and enabling end-to-end traceability require new technology solutions that enable all entities in the value chain to verify identities. This can be achieved by establishing standards and effectively governing verifiable credentials in the agri-food system. Standardized identity management strategies will be fundamental to the success of solutions that trace and verify transactions, products, and processes. Use of verifiable credentials enables various actors in the value chain to verify identity of people, third parties, products, packages, locations, documents, machines (e.g., IoT devices), and other entities more effectively. They also authorize verification of claims and transactions. Digital identity and verifiable credentials will establish an innovative platform for agri-food systems to be part of a larger digital, standardized, and interoperable ecosystem.
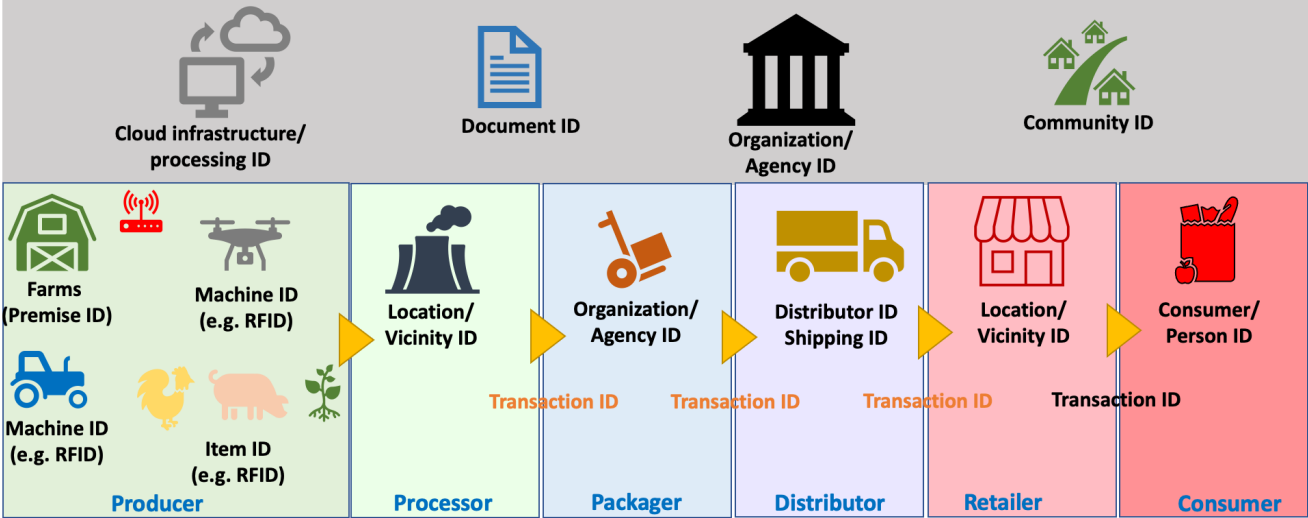
Digital Identifiers in Agri-food System

The term "Digital Identity (ID)" is most often used to indicate a digital reference to an individual human being. The Digital Identity & Authentication Council of Canada's (DIACC) Pan-Canadian Trust Framework (PCTF) defines Digital Identity as "a type of digital representation that uniquely identifies a Subject within a context, and that a User presents/uses exclusively to represent the Subject when they access online services". Digital IDs are most often used in reference to individuals. Such IDs can be used to help verify the identity of a person, authenticate their credentials, or authorize them to take an action. In the context of this report, digital ID can be used to describe the digital evidence of an organization, or thing (and such "things" can be tangible (like a combine) or intangible, like a corn futures contract or a co-op membership) in addition to a person ID. As interactions in the agri-food sector continue to be digitized, stakeholders are increasing their reliance on the variety of digital identities available. A brief survey of current applications of digital identity in the agri-food system reveals its ubiquity and familiarity, including the communication of identity attributes such as serial numbers, location numbers, shipping serial numbers, transaction numbers, machine IDs, and item numbers that can be used to identify items, sensors (Internet of Things), locations, and the actors in the system (Fig. 2).

There are a number of factors that affect the usefulness of digital identities. Of course, like any other communication, digital identities must be understood to be effective and must be standardized to some degree to be broadly understood. DIACC can support standardization efforts with its Pan-Canadian Trust Framework that is designed to meet current and future Canadian digital identity ecosystem innovation needs by verifying trust of services and networks. Thus, in a sector such as agriculture which has many different sorts of stakeholder populations performing a variety of distributed and centralized tasks that must be able to work together, an effective digital ID management in agri-food systems should also be decentralized and interoperable. Digital IDs also must be unique so that they can be applied to distinguish among entities and composable so that they can be created simply as needed by stakeholders for a given agri-food system function.

Digital identities must also be persistent, because it is also important to build technological capabilities that can track the entire lifecycle of products (i.e., food, feed, machines, tools) in the value chain and the actions over time of stakeholders (i.e., farmers, buyers, truckers, brokers, etc.). In such cases where digital identities are maintained, and yet modified, through time the related technologies will need to have the capacity to uniquely identify an item or entity (e.g., food or farmer) in each stage, and to be able to trace the history of their agri-food system related actions backward and to project them forward in order to gain insights about the interactions in order to de-risk them and leverage them to the maximum extent possible.

Figure 2: Sample "Things" that need a Digital ID in Agri-Food System

Benefits of Digital IDs: By enhancing our ability to audit and investigate the conditions under which food products are grown and processed, sustainability requirements can be better monitored and enabled. Equitable access to data and products through appropriate digital ID governance and verification will also contribute to satisfying sustainability targets. Lastly, an effective digital ID verification and governance system will enhance confidentiality, governance of tools and technologies (e.g., artificial intelligence) access control, and security of critical agri-food infrastructure.

Use-Case-1: Traceability as a Premium

Some food items get much of their value from the way they have been produced. Consider wine or beer as examples. As a consumer, when we drink from the bottle of wine, we are not just consuming wine, but we are consuming the entire experience of how that bottle of wine was produced. Monitoring every step from where, when, and how the grapes were picked, how they were blended, pressed, fermented, then went through their second fermentation, how they were aged, are all possible today in great detail using digital technology. We do not need to rely on a few sentences on

the label of the bottle. Instead we have a digital ID of every activity that occurred before every bottle landed on our tables. Digital technology allows us to identify the vineyard on the map, take a virtual tour of the location, learn about its history, its sustainability practices, connect with the winemakers, learn about what food they pair this wine with, and share your experience with other consumers. As wine drinkers, we are buying the experience and you are willing to pay a premium for it. This is valid not only for wine. The same technologies can be applied for all food products with which food quality can be monitored and controlled.

Use-Case-2: Rewarding Sustainable Farming

Food waste, environmental sustainability, and an inclusive green economy focused on nutrition, health, diversity, and equity can all be improved through well-structured and established traceability and verification systems. The core need is the ability to identify farms and link sustainability indicators to individual farms. This can be further improved by the ability to perform root cause analysis and to identify the source of emission. For instance, we can consider the use of these technologies to keep a record of emission profiles of farms to promote and reward sustainable practices. Farmers can monitor their own emission footprint and optimize it if they can link metrics and sustainability indicators to their farms and farm tools/activities. Government can identify and reward the best farm practices that contribute to sustainable farming.

Current Challenges of Digital IDs in Agri-food System

Despite many benefits offered by digital ID technologies in agri-food systems, use of these technologies is still in its infancy. Effective use of these technologies requires an understanding of how these technologies work and how they can be integrated into the decentralized and distributed agri-food system for the greater societal good and stakeholders benefits. Opportunities that are offered by digital IDs have not been fully explored in the agri-food system.

There are currently limited standards and best practices for agri-food ID governance and verification. The data ecosystem is fragmented and, in-turn, digital IDs are also fragmented in terms of format and consistency. We do not have a comprehensive understanding and knowledge of the legal, social, and ethical implications of digital IDs and technologies that enable verification of credentials. Our understanding of governance requirements in the complex agri-food structures is limited. Finally, we do not have an in-depth understanding of legal, process and stakeholders cross-functional interactions and requirements.

The slow trend in adopting digital IDs perpetuates several threats and vulnerabilities to agri-food systems. It will increase fragmentation in the ecosystem and among agri-food partners, technologies, and data collected by different devices and partners. Lack of adoption of standardized ID management and governance practices will also limit the ability to exchange and share data, the ability to build interoperability among agri-food tools and platforms to enable food recall, validation of food product authenticity, and food transparency and provenance more effectively.

These limitations will hamper our ability to create an ecosystem that is more inclusive and fair that can balance power by providing equitable access and control to data and digital solutions to all actors in the value chain. They will also create hurdles to improve transparency and build trust among different agri-food actors. Inability to uniquely identify food products, documents, devices, tools, and all other items in the value chain is a major threat to the agri-food system in a world where all sectors are moving rapidly toward digitalization.

Enabling Digital ID Verification and Governance in Agri-Food System

Similar to other technology solutions, Digital IDs need to be properly governed to ensure effective use and reduce potential risks. For instance, verification mechanisms should be implemented through standardized protocols, policies and technical solutions to verify identities and facilitate a trusted ecosystem among agri-food actors and services. Digital certificates and verifiable credentials are examples of such solutions.

Digital ID verification and governance solutions should be interoperable to enable integration with heterogeneous systems and to be usable in different contexts. They should be secure and tamper-proof to protect from unauthorized access and attacks.They should be extendable and usable in decentralized and distributed environments. Standardized policies, legal frameworks, and protocols enhance security and robustness of these solutions. Solutions such as meta-data, ontologies, tracking systems, digital platforms such as blockchain, and artificial intelligence can create an environment to facilitate governance, secure verification, and audit procedures and to ensure digital trust among agri-food stakeholders.

Recommendations

Capturing the intended business, economic, social value of digital ID cannot be achieved automatically and cannot be guaranteed without substantial collaboration and coordination among various stakeholders including researchers, policy-makers, standardization bodies, and agri-food system actors. It is also vital to investigate and establish best practices through addressing barriers, global conversation, and experimentation and benchmarking. If the identification systems are poorly understood and implemented or are misused, the risks of adoption of these technologies are much higher than their benefits. Some risks include data privacy and protection, human rights and democracy, exclusion and descrimination, and mismanagement of resources. These risks can significantly hinder economic growth and can affect disadvantaged communities.

Here, we make a call to action for various stakeholders including researchers, policy-makers, privacy and public organizations, investors, insurances, standardization bodies (e.g., DIACC), and technocrats to collaborate, share resources and lessons learned, in order to establish and implement a robust, interoperable, secure, and trustable digital ID system for agriculture and food sectors.

Build a National Agri-food Digital ID Verification and Governance Roadmap

There is a need in the agri-food system to adopt technologies such as digital IDs management and governance tools and protocols, digital certificate verification tools/software for uniquely identifying food products, equipment, and value chain participants throughout the entire supply chain. A private-public partnership between the industry, academia, and government institutions will be instrumental in promoting and facilitating the use of digital IDs, governance, and verification systems in agri-food.

- Standards, frameworks and best practices (e.g., PCTF) are useful tools to generate and govern digital ID in the agri-food system. Government institutions (e.g., ministries), academia (e.g., researchers at University of Guelph) and non-profit organizations (e.g., DIACC) can facilitate innovation platforms to communicate the benefits, reduce uncertainty, and encourage adoption of digital ID in the agri-food system.
- Whereas standards tightly define methodologies to determine conformance, frameworks (e.g., PCTF) define a baseline of requirements and auditable criteria that are used to verify trust and assurance of multiple solutions within an ecosystem. Trust and assurance marks can be issued to solutions and services based on third-party audits performed against a common framework. Trustmarks can be issued both to agri-food systems organizations and to the

digital IDs they issue. Trustmarks are tools that enable participants with verifiable trust regarding information in a broad, diverse, and global ecosystem.

- Industries and government organizations can provide funding to run pilots and proof-of-concept projects to better understand the social, legal, ethical, and business implications of digital ID and digital certificates in the agri-food system.
- Researchers and technology providers (e.g., academia and industry) can collaborate on designing and developing technology solutions for digital ID verification and governance in the agri-food sector; technologies to enhance validation and verification of digital certificates.
- Academia and non-profit organizations can provide opportunities for education and thought leadership through workshops, programs, and networking opportunities.
- Government institutions, academia, and non-profit organizations can work together to build a roadmap for the adoption of digital ID verification and governance best practices and establishment of these technologies in the agri-food system similar to what has already been done in other domains (e.g., Small Modular Reactors).

Conclusion

The need for technologies and best practices that can establish digital ID and credential verification in the agri-food system is evident. Threats and vulnerabilities that may arise from the lack of adoption of these technologies and practices as well as potential benefits and use cases have been identified. This report encourages key stakeholders and various players in the agri-food system to collaborate and enhance adoption and establishment of digital ID verification and governance practices for a greater social good and a sustainable agri-food system.