

CSA PUBLIC POLICY CENTRE

Building Smart, Sustainable Agriculture in Canada

Through Better Data Governance and Stewardship

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CSA Public Policy Centre

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Contents

1.0 Introduction: Why Ag Data Matters Now 6

2.0 Data-driven Decision Making in On-farm Agriculture 7

- 2.1 What Is Ag Data? 7
- 2.2 The Ag Data Ecosystem: From Field to Cloud to Decisions 7
- 2.3 Ag Data in Action: Farm-level Optimization and Efficiency 8
- 2.4 Ag Data in Action: Big Data and Predictive Analytics 9
- 2.5 Ag Data in Action: Traceability and Certification 9
- 2.6 Ag Data in Action: Carbon Markets and Ecosystem Services 10

3.0 Challenges and Risks: Obstacles to Effective Ag Data Stewardship 12

- 3.1 Data Ownership, Access, and Consent 12
- 3.2 Data Privacy and Cybersecurity Risks 13
- 3.3. Data Portability and Interoperability 15
- 3.4 Adoption Capacity: Uneven Uptake Across Canada 16
- 3.5 Managing Risks, Unlocking Rewards 16

4.0 Learning from Peer Jurisdictions: International Models for Ag Data Governance 17

- 4.1 United States 17
- 4.2 Europe 17
- 4.3 Australia 18

5.0 Ways Forward: Shaping a Trusted Ag Data Future for Canada 19

- 5.1 The Opportunity: From Passive Taker to Global Leader 19

6.0 Conclusion: A Strategic Pivot for Canada 23



> **Canada's agriculture sector is a cornerstone of the national economy, contributing approximately 8% of GDP and placing Canada among the world's top eight exporters of agri-food and seafood products.[3]**

1.0 Introduction: Why Ag Data Matters Now

Canada's agriculture sector is a cornerstone of the national economy, contributing approximately 8% of GDP and placing Canada among the world's top eight exporters of agri-food and seafood products.[1] Maintaining and growing Canada's competitive advantage depends on how well the sector harnesses data, digital tools, and new technologies to boost productivity, improve profitability, and strengthen its position in global markets.

At the same time, agriculture plays a big role in Canada's climate and environmental ambitions. While some farming practices generate greenhouse gas emissions, pollute waterways, or contribute to biodiversity loss, agriculture is also uniquely positioned to be part of the solution—sequestering carbon in soils, enhancing biodiversity, and building resilient ecosystems that help Canadians adapt to a changing climate. Data-driven tools and decision-making can also play a key role in advancing sustainability in agricultural production.

This dual reality places Canada's farmers at the heart of one of the biggest shifts the sector has ever seen: the rise of big data and digital tools to make every decision more precise and more sustainable. From soil moisture sensors and drone imaging to satellite data and artificial intelligence (AI)-powered predictive models, the flow of agricultural data, or *ag data*, is transforming how agricultural products are grown, processed, and brought to market.

Yet for many farmers,[2] this digital promise remains out of reach or underused. Rural internet gaps, unclear data ownership rights, privacy concerns, limited interoperability between equipment and platforms, cybersecurity threats, and skills/capacity gaps all pose real barriers to fully unlocking ag data's potential. Many of these barriers are products of a leadership gap: Canada lacks a coherent national framework that defines who owns and controls agricultural data, how it can be shared and protected, and what supports are needed to ensure farmers can leverage it with confidence.

Meanwhile, global peers—from the United States to the European Union and Australia—are advancing national strategies, voluntary codes, and cross-industry data standards that position their farmers to thrive in an increasingly data-driven food economy.

This policy brief provides a perspective on the fast-evolving agricultural data landscape in Canada. It describes how data is generated and used on the farm and along the value chain, identifies challenges and gaps that constrain its potential, highlights promising international models, and outlines policy directions for Canada to build a trusted, clear framework for ag data governance and stewardship. In doing so, the brief aims to spark discussion among policymakers and industry leaders about practical pathways forward. It highlights immediate actions and collaborations that can help Canada strengthen its ag sector's competitiveness and sustainability in the digital era.

2.0 Data-driven Decision Making in On-farm Agriculture

2.1 What Is Ag Data?

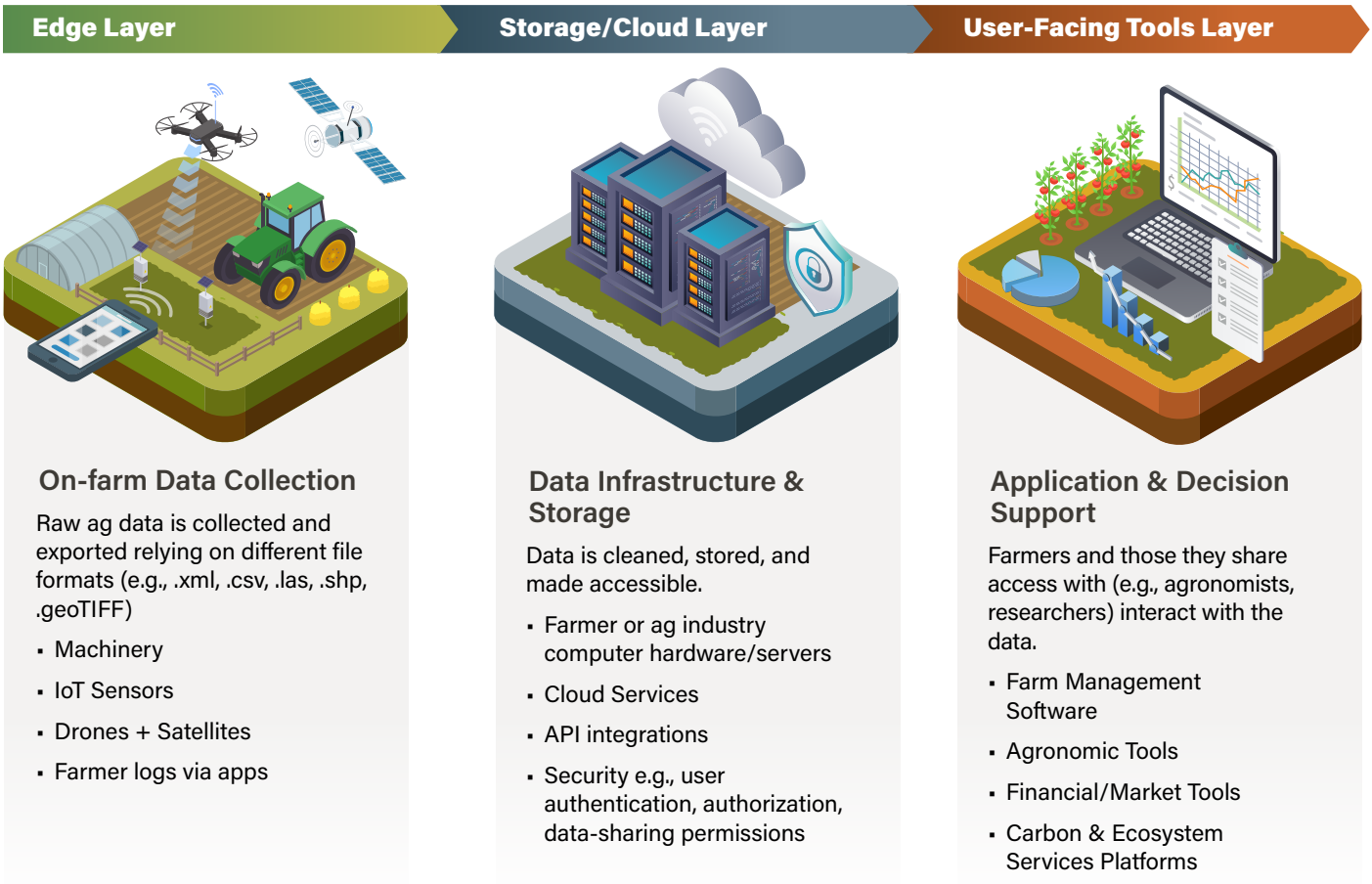
For the purposes of this brief, *ag data* refers broadly to information generated through primary agricultural activities—planting, harvesting, livestock management, application of fertilizer and other treatments, and soil testing—and its collection, storage, analysis, and use by producers and other stakeholders. While farmers have always gathered information to guide their decisions, today's digital technologies have expanded the scale, speed, and sophistication with which this data is collected and potentially turned into actionable insights.

Modern farm operations can rely on an interconnected system of sensors, machinery, software, and cloud-based services to generate and process ag data. While producers are the primary collectors and originators of this information, ag data is increasingly valuable across the entire supply chain: from agribusinesses and input suppliers to regulatory and certifying bodies, commodity traders, financial and insurance companies, researchers, and policymakers.

2.2 The Ag Data Ecosystem: From Field to Cloud to Decisions

At its core, the ag data ecosystem can be visualized in three key layers:

Figure 1: Ag data ecosystem



Edge Layer: On-farm Data Collection: This is where raw data is generated. Technologies range from sensors mounted on tractors and combines (to track yield data) to Internet of Things (IoT) devices (soil probes and barn monitoring cameras) to drones and satellite imagery (to capture detailed field conditions). Farmers may also input information manually through mobile apps—logging planting dates, treatment applications, and harvest records. These diverse data sources generate information in multiple file formats (.xml, .csv, .las, .shp, or geoTIFF) that must then be stored, cleaned, and organized for analysis.

Storage/Cloud Layer: Data Infrastructure and Security: Raw data is uploaded to local servers or to cloud platforms that provide the processing power and storage capacity needed to manage large datasets. Cloud services enable farmers and their advisors to access data on demand, run complex analyses, and combine different data types. This layer also includes application programming interfaces (APIs) that ensure different file formats can be integrated for use and security protocols that protect sensitive information through user authentication, authorization controls, and data encryption.



Ag Data Applied in the Bioeconomy

The bioeconomy encompasses renewable biological resources like crops, forests, livestock, and organic waste that produce food, energy, materials, and other bio-based products. Farming contributes to Canada's bioeconomy through activities like bioenergy production (e.g., manure biodigesters), sustainable biomass harvesting (e.g., crop residues for biofuels), and value-added bioproducts (e.g., bioplastics or biochar). New standards and regulations better enable the potential of the bioeconomy. By developing and integrating ag data standards with the bioeconomy's needs—traceability, certification, environmental monitoring, life-cycle analysis, and other emerging metrics—farming can support the scalability, transparency, and trust at the agri-food–bioeconomy nexus.[5]

User-facing Tools Layer: Applications and Decision Support: Farmers and others use processed data through software platforms that turn it into usable insights. These include farm management information systems, agronomic advisory tools, financial and market analysis applications, and emerging platforms for carbon and ecosystem services. By aggregating data and presenting it in user-friendly dashboards or mobile interfaces, these tools support day-to-day decision-making on the farm and strategic planning for the season ahead.

2.3 Ag Data in Action: Farm-level Optimization and Efficiency

Yield monitors on combines first appeared in the 1990s, heralding an early wave of more sophisticated data-capture and data-driven insights in agriculture—often encapsulated under the term *precision agriculture*. Since then, the precision capabilities have continued to evolve with real-time data and increasingly automated functions as well as AI-enhanced insights under the umbrella term *smart* farm technologies.

In practice, this looks like modern tractors, seeders, and sprayers equipped with GPS-guided variable rate technology that enables farmers (or the machines themselves) to adjust seeding densities or input application in real time based on sub-field variability. Soil probes, drone-mounted cameras, and in-field weather stations provide further layers of granular, site-specific data.

The value of this hardware is unlocked through complementary software platforms that help farmers extract, organize, combine, and analyze data. These digital platforms—referred to as *agriculture technology platforms* (ATPs) in this brief[3]—are now an important and growing segment of the agri-food industry. They range from in-house tools offered by large equipment manufacturers and input suppliers to independent ag tech start-ups serving smaller operators or niche crops.

Access to granular data, mediated by ATPs, enhances farmers' ability to fine-tune every element of production to local conditions, thereby boosting productivity, conserving inputs, and improving environmental outcomes. For example, by knowing exactly where soil nutrient levels are lower, a farmer can target fertilizer applications to where they are needed most, reducing waste and runoff. In livestock operations, sensors and digital records can monitor animal health, reproductive status, and milk quality in real time, enabling early interventions that improve herd welfare and farm profitability.

Reliable high-speed internet is a key enabler for these advances. While connectivity has improved in many rural regions, gaps remain that constrain farmers' ability to fully benefit from digital tools.[4] Farmers' own skills navigating hardware and software tools also shape successful adoption. (Refer to 2.4 Ag Data in Action: Big Data and Predictive Analytics).

2.4 Ag Data in Action: Big Data and Predictive Analytics

On-farm data collection alone is typically not big data. True big data arises when individual datasets from hundreds or thousands of farms are aggregated and combined with other large data sources such as historical weather patterns, market trends, or satellite-based climate observations.

When analyzed with data science and AI tools, these massive datasets can generate predictive insights that help farmers make more informed decisions despite uncertain conditions. For example, predictive analytics can optimize planting and harvest dates, forecast yields based on real-time weather conditions, or identify emerging disease or pest threats before they cause significant losses.

Even among advanced agricultural economies, the integration of AI-enabled predictive systems is still in the early phases of development and application. Some of the most robust demonstrations of big data applications have come from controlled environments like greenhouse or vertical farming where fewer uncontrollable variables make predictions more reliable. Nonetheless, open-field farming is catching up as AI models become more sophisticated and data sources become more diverse and more reliable.

For agribusiness, big ag data can mean big business when predictive analytics inform targeted marketing to producers or serve as a new source of market intelligence for companies deciding which product or service innovations to prioritize for development.[6]

The private sector is leading much of this innovation, but public examples exist. Holos, an open-source tool developed by Agriculture and Agri-Food Canada (AAFC), helps producers estimate greenhouse gas emissions and soil carbon changes from different management practices, supporting more climate-smart decisions at the farm level.[7]



As big data continues to transform agricultural innovation, the extent to which producers understand its value, engage with it, and help shape its application will determine how quickly—and how successfully—this transformation takes hold.

2.5 Ag Data in Action: Traceability and Certification

Beyond optimizing production, ag data plays a critical role in enabling effective regulation and modern markets for agri-food.

Traceability, the ability to track an agri-food product from source to consumer, is vital for food safety,[8] quality assurance, and building confidence among increasingly discerning domestic and international consumers that they are buying sustainably and/or humanely produced food. Digital technologies make traceability systems more robust and efficient. Blockchain, for example, can create immutable digital records that follow a product through the supply chain, reducing fraud, and ensuring that claims like *organic* have integrity rather than be suspected to be empty greenwashing.[9]

Certification systems work hand-in-hand with traceability, providing integrity to claims—about sustainability, for example—for agri-food products from crops to livestock. Such certification programs uphold standards defined by verifiable data.[10] Automated data collection by sensors and monitoring equipment can

reduce the need for costly, manual on-site audits, making certifications more accessible to smaller producers and enhancing consumer trust. Recent collaborations, such as efforts to apply blockchain technology to canola traceability,[11] illustrate how digital solutions are starting to address long-standing challenges in verifying sustainability claims.



Ag Data Applied in Agri-food Regenerative Commitments

In the absence of formal certification, farm-level data can still be verified for other claims. *Regenerative agriculture* refers to a sustainable farming system characterized by a set of principles distinct from organic or agroecology farming systems. At this time, regenerative agriculture does not have a commonly recognized set of standards or certification. Though a recent CSA report on regenerative agriculture in Canada considers the advantages and potential paths to developing standards in Canada.[12] Regenerative agriculture encompasses many diverse principles and practices within its scope. Its application and outcomes are often dependent on local factors like farm and crop type, and the metrics to evaluate success have not been agreed upon. Nonetheless, both the potential for the generation of data and the anticipated need for data management are large. Several agri-food companies active in Canada have made commitments focused on advancing regenerative agriculture within their supply sheds (i.e., regions where they source ingredients) as part of their public sustainability plans and reporting. As a result, farmers and agri-food companies work together to generate verified farm-level data about practices and/or outcomes common to regenerative agriculture systems.[13] Many of these agri-food companies incentivize farmer adoption with payments based on verified agriculture data—particularly during the 3–5 year transition period when practice change introduces more risk into farm management.

2.6 Ag Data in Action: Carbon Markets and Ecosystem Services

Well-structured data is also the foundation of emerging markets that pay farmers for delivering ecosystem services such as carbon sequestration. Measurement, reporting, and verification (MRV) systems are needed to credibly document these environmental benefits and issue tradable credits.

Yet in practice, current agriculture MRV protocols both internationally and within Canada are patchy and inconsistent, limiting farmers' ability to participate in carbon markets.[14, 15] A recent RBC analysis found that while sustainable practices should earn farmers $8–$13 per acre in carbon credits, weak measurement and verification means they often receive a fraction of that potential value.[16]

Strengthening MRV systems so that they balance data collection burden with cost, time, and accuracy is important. Data collection burden and cost could be mitigated if MRV systems take advantage of data already being collected by farmers. However, such data must be comparable—a challenge explored in greater detail in this brief's "Ag Data Applied in Assessing Soil Health."

Robust MRV systems, in short, scaffold on robust, recognized standards of metrics, sampling approaches, and verification techniques, which are currently proliferating and uneven. Only with a consistent foundation will producers capture more value for their environmental stewardship—whether through ecosystem service markets, tax credits, or new insurance regimes—supporting both farm incomes and national climate goals.

> **"Well-structured data is also the foundation of emerging markets that pay farmers for delivering ecosystem services such as carbon sequestration."**



Ag Data Applied in Assessing Soil Health

MRV issues frequently intersect with challenges related to soil health in Canada. While healthy soils are the foundation of productive, climate-resilient agriculture, measuring soil health is far from straightforward. Canada currently uses a patchwork of approaches to assessing soil health. Different labs and institutions use varied sampling protocols, indicators, and reporting formats, making results difficult to compare across regions and timescales—thereby undermining confidence in the results of different land management techniques.[17, 18] Cross-provincial differences in soil testing further complicate matters.[19]

New technologies that measure and monitor soil health by drawing on remote sensing, mobile spectroscopy, machine learning, and advanced lab techniques are creating unprecedented capacity to monitor soils at resolution and at scale compared to conventional techniques.[20] If soil indicators and data comparability can be made uniform, these next-generation tools could help players in Canadian agriculture benchmark soil performance, inform sustainable land management and on-farm decisions, and support MRV needs.

To realize soil health data's potential, Canada will need to focus on harmonizing soil health indicator selection, methods for sampling, analytical methods, and reporting. This priority is echoed in the recommendations of the Senate of Canada's 2023 report *Critical Ground: Why Soil Health is Essential to Canada's Economic, Environmental, Human and Social Health*.[21, 22] A forthcoming report from the CSA Group looks to inform a common and consistent approach to soil health testing, interpretation, and reporting of test results, as well as soil data/metadata management. This common approach could help researchers, farmers, policymakers, and industry groups align on what good soil management really means through measurable, comparable data.

Ag Data Applied in Policymaking on Biodigesters

Biodigesters convert manure and crop waste into renewable methane. Farms typically gain a return on their investment by reducing their energy costs or generating income by selling excess gas. Biodigesters also divert methane emissions from the atmosphere, yet farmers are not rewarded for this outcome. Due to high upfront costs, biodigesters are generally more feasible for larger operations though some smaller farms have managed to make them financially viable. Standardized farm-level data on biodigester costs and benefits—especially for smaller farms—would clarify expected returns under different conditions. As well, better data from ag inputs and farm costs would help policymakers design effective climate policies and market incentives that appropriately incentivize farmers' adoption of biodigesters. These could work in concert with the new edition of the Code for Biogas Generation and Utilization (CSA/ANSI B149.6:25), which supports the engineering of safer and more efficient design for the deployment of biogas production systems.[23]

This section painted a picture of how technology is shaping the future of farming, which is increasingly defined by data—collected, analyzed, and applied in real time to improve decision-making, productivity, environmental performance, and resilience. From precision planting and variable-rate fertilization to automated livestock monitoring and supply chain traceability, nearly every type of farm and production system is being reshaped by these innovations. Farmers who leverage these innovations capture gains in productivity, resilience, and profitability, but presently, adoption is uneven and Canada's agriculture sector is lagging. The next section probes some of the key challenges and risks, particularly if ag data governance and stewardship is delayed or remains uncertain.

3.0 Challenges and Risks: Obstacles to Effective Ag Data Stewardship

The potential for data to transform Canadian agriculture is immense, and adoption is underway. However, fully realizing this potential will depend on how well the sector addresses four critical and interrelated challenges: data ownership, access, and consent; data privacy and security risks; data portability and interoperability; and adoption and capacity gaps. Each carries risks that, if left unresolved, could limit innovation, erode trust, and place Canadian producers at a disadvantage relative to global competitors.

3.1 Data Ownership, Access, and Consent

One of the most significant and complex issues related to ag data is the lack of clarity around who truly owns agricultural data and what that ownership means in practice.[24] Many Canadian producers firmly believe they own data such as yield maps, soil test results, or machine telematics generated through their farming operations. But the reality is more complicated.[25] A Toolkit for Ethical Data Governance in Agriculture notes that data ownership is best defined as "possession of and responsibility for data"—noting that under this definition "ownership of data does not necessarily guarantee control over how it is or can be used and by whom."[26] There is also no legal definition of agricultural data.[27, 28]

> **The vast majority of producers rely on ATPs—often provided by equipment manufacturers, input suppliers, financial institutions, independent ag tech firms, or industry associations—to collect, process, and analyze their data.**



3.1.1 Ambiguity in Contracts and Business Models

The vast majority of producers rely on ATPs—often provided by equipment manufacturers, input suppliers, financial institutions, independent ag tech firms, or industry associations—to collect, process, and analyze their data. While the raw data originates on-farm, ATPs' terms of service often grant the platform wide rights to access, aggregate, anonymize, and even share or sell that data to third parties. Algorithms, analytics tools, and visualizations built on top of farm data are generally treated as proprietary intellectual property belonging to the ATP.

In practice, producers frequently sign contracts that they do not fully read or understand. Service agreements are rarely written in plain language, and many farmers lack access to legal or technical advice to interpret them.[29] This typically leaves producers with limited bargaining power in negotiating fair terms for how their data will be used, shared, or monetized.[30]

3.1.2 From Ownership to Sovereignty

Under Canadian law, raw data cannot be copyrighted, patented, or trademarked.[31] Instead, *ownership* tends to rest with whoever controls access, storage, and use—in this case, often the ATP.[32] This has led to growing interest in the broader principle of data sovereignty: the idea that producers should retain meaningful control over how data about them or their operations is used and by whom.[33] In agriculture, this extends to ensuring that producers benefit fairly from the value that aggregated data generates for other players across the supply chain.



3.1.3 Special Considerations for Indigenous Data

For Indigenous communities, data sovereignty takes on additional dimensions. The CARE principles—Collective Benefit, Authority to Control, Responsibility, and Ethics—developed by the Global Indigenous Data Alliance,[34] highlight the unique responsibilities involved when agricultural projects collect data about Indigenous peoples, lands, territories, and traditional knowledge. These principles emphasize that Indigenous communities must maintain authority over their data, ensuring its use aligns with self-determination and collective benefit.

3.1.4 Risk of Price or Service Discrimination

Without clearer frameworks, producers fear that their data may be used in ways they did not anticipate and/or undermine their autonomy. One recurring concern is price discrimination: the potential for companies to use detailed farm data to segment producers into higher- and lower-value categories, charging more to farms that appear more profitable or have fewer alternative options. While evidence of this practice in agriculture is limited today, its technical feasibility and the precedent from other industries make it a credible risk. This lack of trust in how data may be used or monetized can deter farmers from adopting digital tools in the first place.

> **“Without clearer frameworks, producers fear that their data may be used in ways they did not anticipate and/or undermine their autonomy.**

3.1.5 Risk of Foreign Interference

Finally, there are issues with data residency as a notable volume of Canadian ag data likely transits and/or is stored on servers located in the US and run by large US-based cloud service providers. This introduces an additional layer of legal uncertainty and risk if laws other than Canadian ones apply to Canadian ag data.[35] Furthermore, future changes in foreign government policy, new trade disputes, or geopolitical tensions could affect how Canadian producers access or control their own data held abroad—thereby compromising national and Indigenous data sovereignty.

3.2 Data Privacy and Cybersecurity Risks

Closely related to ownership, access, and consent are the intertwined issues tied to forms of data protection: privacy and cybersecurity.

3.2.1 When is Ag Data Personal?

While some ag data may clearly overlap with personal information protected by federal laws like the *Personal Information Protection and Electronic Documents Act* (PIPEDA), many farm-level datasets—like machine telematics, field yield data, or livestock logs—fall into a grey zone. Such ag data generated during farmers’ work could be held to be job-related and thus not strictly fall under the traditional notion of privacy according to past judicial decisions.[36] On the other hand, detailed ag data that captures field-level agronomic information (e.g. soil characteristics), farm operation data (e.g. specific crop inputs selected), and machine data (e.g. frequency of spraying), may qualify as personal data when they are attributed to an identifiable individual, revealing a farmer’s practices and preferences.

> **Digital agriculture's promise depends on a constant data flow across devices, platforms, and storage systems.**

Even de-identified or anonymized data may not be enough to ensure privacy if it can be used—alone or in combination—to identify an individual, under PIPEDA (and/or other provincial legislation and policies).[37] At present, the link between the ag data and the individual farmer is likely to be subject to a case-by-case evaluation of whether it falls under the scope of PIPEDA or provincial legislation and policies.[38] These ambiguities add a layer of complexity that many producers and ATPs are not fully prepared to manage and speak to the need for specific policies and regulations tailored to the agricultural context.

3.2.2 Growing Cybersecurity Vulnerabilities

Digital agriculture's promise depends on a constant data flow across devices, platforms, and storage systems. This makes the sector vulnerable to cyber threats ranging from ransomware and phishing attacks to foreign actors seeking to steal valuable intellectual property or disrupt critical infrastructure.[39]

Recent surveys reveal a worrying gap in risk perception and preparedness. While many farmers believe they are unlikely targets, research suggests otherwise. Small and medium-sized farms, which lack dedicated IT staff or robust security plans, are increasingly attractive targets for cybercrime. A 2024 non-representative survey found that 82% of farmers believed they had never experienced a cyberattack, despite nearly half of their suppliers reporting attempted or successful breaches.[40, 41] Larger agri-food companies are not immune: major agri-food processors in Canada have already faced significant cyber incidents with cascading impacts throughout the food system.[42] As Canada lacks a standard for cyber incident reporting across the agricultural sector, accurately monitoring and tracking these threats is a challenge.[43]

3.2.3 Potential Impacts

The consequences of a successful cyberattack could be highly disruptive. For example, a compromised temperature-controlled livestock barn could threaten animal welfare.[44] A ransomware attack could lock farmers out of critical operational data at peak planting or harvest times. Disruptions to cloud-based ATPs could affect thousands of producers at once. Yet nearly 80% of Canadian farms lack a formal cybersecurity plan, according to a 2024 non-representative survey of producers.[45] As precision agriculture grows more connected, the risks will only intensify—requiring clear standards, accessible guidance, and trusted, sector-specific supports. A forthcoming CSA report on cybersecurity along the food value chain will explore in greater detail the nature of this challenge.



3.3. Data Portability and Interoperability

Another major barrier to realizing the full value of ag data is the difficulty of moving and integrating data across different systems, machines, and platforms.

3.3.1 Portability: Keeping Data Usable Across Platforms

Data portability enables producers to export their data—yield maps, soil test results, input records—from one ATP or piece of equipment and import it into another without losing accuracy or detail. Yet proprietary file formats, closed ecosystems, and lack of standardization can make data export a cumbersome, costly process. In practice, many farmers feel locked in to particular brands or platforms, even if alternatives might better serve their needs.[46]

3.3.2 Interoperability: Systems That Talk to Each Other

Interoperability goes further: different systems should be able to exchange and use information seamlessly. On the farm, this could mean a John Deere tractor easily communicating with a New Holland seeder, or a sensor on one brand of sprayer sharing data with independent farm management software. Under C-294, *An Act to Amend the Copyright Act (interoperability)*, enacted in 2024, companies and individuals can circumvent the digital lock on software for the purpose of making devices (like tractors or combines) interoperable with other equipment or software.[47] This regulatory update is a boon for the agriculture industry, especially Canada's multi-billion dollar shortline (custom) manufacturing sector that creates specialized attachments for many types of farming equipment.[48]

At the storage and analytics level, interoperability ensures that diverse datasets can be combined, analyzed, and compared securely and accurately. The FAIR principles—making data Findable, Accessible, Interoperable, and Reusable—are widely recognized by the scientific community and are increasingly referenced in agriculture as a benchmark for good data stewardship.[49] Agri-food Data Canada, housed at the University of Guelph, is responding to the challenge of the huge variety of data types that makes data sharing and data reuse difficult in Canada's agri-food research ecosystem. Through training, tools, and protocols they are building more infrastructure to ensure past, new, and future research data is FAIR.[50] Realizing FAIR principles in practice requires technical standards, trusted governance frameworks, and business models that align incentives for open data sharing while respecting proprietary interests.

3.3.2.1 Risks of Poor Interoperability

When interoperability is limited, producers lose flexibility and bargaining power. Incumbent ATPs can entrench market power, stifling competition and innovation.[51] Proprietary "walled gardens" raise costs for farmers, forcing them to navigate duplicative systems or pay to manually reformat and re-enter data.

For Indigenous communities, tensions can also arise between the FAIR principles' push for open access and the CARE principles' emphasis on Indigenous data sovereignty and restricted reuse where appropriate.[52]

Figure 2: Portability and interoperability



> **"Data stewardship frameworks must be credible, trusted, and tailored to the realities of Canadian agriculture."**

3.4 Adoption Capacity: Uneven Uptake Across Canada

Finally, even where digital tools and standards exist, producers' capacity to adopt them remains a real limiting factor. Recent Statistics Canada surveys suggest that producers are increasingly aware of and interested in digital agriculture tools. Some interpret the data optimistically: that Canadian farmers are "well on their way" to adopting precision technologies. Others, however, see a piecemeal approach with "pockets of excellence" alongside significant gaps, particularly among small and medium-sized operations.[53]

Barriers are numerous:

- ***Costs*:** Investing in new machinery, sensors, and software can be expensive, with uncertain returns on investment for individual farms.
- ***Skills and Literacy*:** Many producers need training and technical support to fully use and troubleshoot complex digital tools.
- ***Time and Capacity*:** Setting up, maintaining, and effectively using ATPs and associated hardware technology is a new demand on time for farmers; this can be outsourced but creates a new, ongoing expense.
- ***Connectivity*:** Reliable, high-speed internet remains unavailable in many rural areas in Canada, limiting real-time data transmission and cloud-based analytics.
- ***Trust and Relevance*:** Some farmers would like more certainty about the timeline and scope of return on investment when adopting digital and data tools on their farms—particularly for small and mid-sized farms that often are more sensitive to risk compared to larger operations.

3.4.1 Risks of Falling Behind

If adoption lags, Canada's agricultural sector could lose competitive ground. Faster adoption of data-driven agricultural technologies in countries like the US, Brazil, and Australia positions their producers to shape next-generation ag tech innovations, secure "green premiums" in global markets, and leverage carbon or ecosystem service markets more effectively.

Low adoption also limits the potential for big data solutions. If too few producers contribute their data to collective platforms or research collaborations, Canada misses out on accelerating innovations in related domains like plant and livestock breeding, pest and disease management, and other innovations that depend on large, diverse datasets.[54]

3.5 Managing Risks, Unlocking Rewards

Together, these challenges do not spell doom for Canada's efforts to improve agricultural productivity, sustainability, and resilience, but they do signal an urgent need for clear policy responses to digital agriculture's risks and rewards. Data stewardship frameworks must be credible, trusted, and tailored to the realities of Canadian agriculture. They must address producers' concerns about data ownership, privacy, and control; raise the bar for cybersecurity; make data sharing simple and secure; and support farmers with the skills and infrastructure they need to succeed. In the next sections, this brief turns to lessons from peer jurisdictions and practical policy pathways that Canada can pursue to meet these challenges.

4.0 Learning from Peer Jurisdictions: International Models for Ag Data Governance

While the scale, policy culture, and agricultural systems differ from Canada's, lessons from the United States, the European Union, and Australia highlight the value of clear principles, voluntary frameworks, and more ambitious policy coordination to ensure farmers retain trust and can benefit from digital support in agriculture.

4.1 United States

The US agri-food sector has long been a leader in digital agriculture adoption, owing not only to its scale and early growth of data-driven platforms but also to its attractiveness as a market in which multinational firms choose to invest and grow. As a result, data governance has been a priority—albeit mostly approached through voluntary, industry-led mechanisms.

Ag Data Transparent (ADT) is among the most notable initiatives. Originally developed under the American Farm Bureau Federation, ADT is now an independent nonprofit that audits ag tech providers' terms of service against a set of clear principles for collecting, using, storing, and transferring farmers' data. ATPs that meet these principles can display the ADT certification,[55] signaling to producers that the company's data practices align with transparency and fairness goals. In 2025, ADT announced it will build on the success of its "seal" to create a similar principles-based certification for agricultural carbon market programs seeking farmer participation.

ADT's principles encourage clear communication around critical issues like portability and third-party data sharing. For Canadian farmers who work with ATPs active in both countries, ADT's reach extends indirectly into the Canadian market.[56] However, its voluntary nature means it does not guarantee compliance or address producer concerns such as data sovereignty or competitive dynamics that can arise when dominant firms hold large, aggregated datasets.

Other innovative efforts push beyond transparency. OPENTeam (Open Technology Ecosystem for Agricultural Management) brings together a network of producers, researchers, and tech developers to foster a more open, community-driven approach. Initiatives like the Agriculturalist's Bill of Rights and the Data Fiduciary Oath of Care for Agricultural Professionals articulate stronger farmer rights and responsibilities for those handling ag data.[57]

The US is also home to both longstanding (i.e., over 100 years in operation) and emergent ag data cooperatives. By pooling data under farmer-led governance structures, cooperatives can help producers retain collective control over how their data is accessed and used, negotiate fairer terms with ag tech providers, and share in the value that aggregated data generates for research, sustainability verification, or market innovation.[58]

4.2 Europe

The European Union offers a contrasting approach that combines strong, binding legal frameworks with sector-specific voluntary codes.

The landmark *General Data Protection Regulation* (GDPR), adopted in 2018, sets some of the world's most stringent standards for personal data protection, shaping how all sectors, including agriculture, must handle personal and sensitive data. Although much ag data falls outside personal data definitions, overlaps do exist, and the GDPR sets a high bar for consent, processing, and re-identification risks.

Recognizing gaps specific to agriculture, the EU's agri-food stakeholders developed the EU Code of Conduct on Agricultural Data Sharing by Contractual Agreement (EUCC). Launched the same year as the GDPR, the voluntary code provides practical guidance on fair contracts, ownership, portability, and control for ag data specifically. By aligning with the GDPR, the EUCC clarifies how broader privacy principles intersect with on-farm realities.[59]

In 2024, the EU introduced the *Data Act*, a cross-sector, horizontal regulation aimed at unlocking the value of non-personal data by setting clearer legal requirements for data sharing and reuse, especially for connected

devices and industrial data. While not ag-specific, the *Data Act* reinforces the EU's ambition to create a more trusted, harmonized approach to data governance.

Building on this regulatory foundation, the EU launched the Common European Agricultural Data Space (CEADS) in 2025. This initiative aims to create a secure, trusted, and interoperable environment where both public and private agricultural data can be shared responsibly. CEADS is designed to foster innovation and competitiveness while ensuring that farmers and other stakeholders retain sovereignty over their data.

While Europe's layered approach has strengths—particularly in building trust and encouraging cross-border collaboration—it also requires trade-offs. Early research suggests that robust privacy protections may, in some cases, limit entrepreneurial data use or complicate small producers' access to digital tools.[60] Balancing these competing policy goals remains an ongoing challenge.

4.3 Australia

Australia offers a practical example of a national government and farm sector working together to raise the bar on data governance. In 2022, the Australian government launched the Digital Foundations for Agriculture Strategy, which advances one of four national priorities for its agri-food sector.[61] The strategy sets out a vision for Australia to be not only an adopter but also a developer and exporter of digital agriculture solutions.

A core focus area is data and governance, calling for clear rules of engagement and frameworks for sharing data across farm systems and along the value chain. The strategy funds the creation of a National Centre for Digital Agriculture, though this is still in its formative stages.

Australia's approach builds on its Farm Data Code, developed by the National Farmers' Federation with government support.[62] The code goes beyond transparency to establish minimum standards for how farm data should be collected, stored, and used. For example, it explicitly affirms that farmers have the right to have their identifying data deleted from ATPs, a clear step toward strengthening data sovereignty.

The strategy is complemented by the Australian Agriculture Data Exchange (AADX), an industry-led platform and community that provides standardized data-sharing infrastructure and governance frameworks. The AADX also explores models to compensate farmers for sharing their data, an idea still in early development but potentially instructive for other jurisdictions seeking to build trust and incentivize adoption.[63]



The International Standards Organization and Ag Data

Globally, the International Standards Organization (ISO) has begun laying foundations for harmonized approaches to ag data. In 2023, ISO launched a new Technical Committee (ISO/TC 347) focused on data standards across agriculture and food systems. Rather than prescribing standards for data capture, this initiative focuses on improving data sharing, ensuring semantic consistency (common terminology, vocabularies, and frameworks), and tackling interoperability challenges that arise as farms adopt increasingly complex digital systems.[64]

Areas under ISO consideration include uniform terminology and semantic resources for ag data; sustainability models, metrics, and life-cycle data for agri-food systems; livestock and greenhouse/controlled environment farming data management; and value-chain traceability, including feed, fibre, and energy crops.[65]

Over 25 countries, including Canada, are participating. While the ISO process is still in development, it provides a credible, globally coordinated forum for countries like Canada to shape standards that align with domestic interests while enabling cross-border data flows critical for trade and innovation.

5.0 Ways Forward: Shaping a Trusted Ag Data Future for Canada

Agricultural data will continue to expand in scope, scale, and value whether Canada acts to guide its governance or not. For farmers, policymakers, and agri-businesses alike, the question is how to ensure that this data-driven transformation works for Canadian producers, not just for those who collect, analyze, or profit from the data the farmers generate.

As the preceding sections have shown, Canada's current approach is piecemeal. There are several factors contributing to the relatively hands-off approach by government. While data, digitalization, and technology adoption are mentioned in key policy documents like the Guelph Statement,[66] which outlines a vision for Canadian agriculture to 2028, in practice, ag data is among a very large set of focus areas. Simply put, the breadth and number of priorities that characterize agricultural policy frameworks make true priority-setting a challenge in a sector that is already complex and growing more so amidst climate change, global trade uncertainty, and the pace of technological innovation.[67] Moreover, business risk management (BRM) programs and their related cost-sharing tend to dominate the federal–provincial–territorial negotiations at the expense of other non-BRM programming and spending.[68] Finally, governments' specialized expertise and capacity related to data and related digitization—policymaking that covers regulation, adoption, and risk assessments—may tend to reside outside agricultural government departments, in departments such as Innovation, Science and Economic Development at the federal level that are focused on digitization more broadly across industries.

Meanwhile, on the ground, many producers are adopting digital tools, and some industry groups are driving voluntary data standards. The sector is facing a vacuum of leadership around a clear, coordinated national framework that sets out who owns and controls agricultural data, how it can be used and stored safely, or how producers are supported to take up ag data tools with confidence.

By contrast, other jurisdictions show that early action—whether through voluntary codes like Ag Data Transparent in the US, robust regulatory frameworks like the EU's GDPR and *Data Act,* or national strategies like



Australia's—can build trust and keep pace with a rapidly changing digital landscape. As these examples illustrate, countries can actively develop and invest in national (or in the case of Europe, EU-focused) ag data governance even while international standardization (i.e., through ISO forums) is unfolding. In short, they are not mutually exclusive or sequential steps—countries with significant agriculture industries like Canada have taken steps to establish both a robust ag governance framework at the national (or regional) level, as well as international standards supporting data consistency, clarity, and interoperability.

5.1 The Opportunity: From Passive Taker to Global Leader

Canadian agriculture needs a strong Canada-wide approach to ag data in order to position Canada as a credible partner and standard-shaper in global agri-food markets. Otherwise, Canada risks remaining a *taker*: passively importing digital platforms, proprietary software, and standards shaped by larger markets and companies.[69] This dynamic can weaken Canadian farmers' leverage, reduce competition, and limit the Canadian ag sector's influence over how new tools and datasets evolve. Data sovereignty concerns also point to potential economic security risks.

A more deliberate shift Canada to being an ag data leader—actively shaping data rules, supporting homegrown ag tech innovators, and ensuring that data stewardship frameworks work for Canadian producers, including diverse farm scales and Indigenous communities engaged in agriculture. Doing so means striking the right balance: acting boldly enough to address urgent risks like privacy, cybersecurity, and interoperability, while avoiding unnecessarily restrictive policies that could wall off Canadian agriculture from valuable global innovations and markets.

This brief homes in on three core recommendations that should inform what happens next for ag data in Canada.



Recommendation 1:
Making Ag Data a Clear Priority

The Government of Canada, working with provincial and territorial governments, should ensure that ag data governance has a place among Canada's leading agriculture policy priorities. The upcoming renewal of the Sustainable Canadian Agricultural Partnership,[70] which expires in 2028, offers a natural window to elevate digital agriculture as a core pillar—including a roadmap for standards development, a commitment to data extension services, and coordinated funding to help the sector further unlock the value of ag data.[71] Ag data can also be foundational to governments' effectiveness and efficiency at tracking sustainability progress—tracking that the federal government is falling short at achieving, according to the Auditor General.[72]

Since AAFC's Open Science Action Plan 2021–2022 to 2025–2026 already calls for "phased-in implementation of findable, accessible, interoperable and reusable (FAIR) data principles" within the department, AAFC could, with its provincial/territorial counterparts, seek to extend FAIR data principles to apply to all federally and provincially supported ag research and programs, with guidance for when CARE principles apply.[73] Where provincial/territorial governments and partners have already launched ag data initiatives, time-limited pilots, or seeded new networks such as the Pan-Canadian Smart Farm Network and their demonstration farms members—these should be better connected, scaled, and made visible as part of a coherent Canada-wide vision for ag data.[74]

There are many opportunities to ensure Canada's approaches to ag data governance and stewardship align with key national strategies such as Public Safety Canada's National Cyber Security Strategy.[75] As well, the agriculture sector's perspective and needs can shape key new strategies such as the updated national AI strategy led by Innovation, Science and Economic Development.[76] This way, a whole-of-government approach can be leveraged, which is important given the many facets to ag data governance.

Recommendation 2:
Focus on the Fundamentals—A Framework for Canadian Ag Data Standards

Whether under the aegis of a national ag data strategy or as a stepping stone to national strategy development, Canada must start making headway on its own framework for ag data standards. Such a framework would outline foundational requirements for how ag data is collected, stored, shared, and secured. This will take collaboration across governments, businesses, industry associations, research institutions, nonprofits with ag programs, and, of course, farmers themselves—but the potential benefits for Canada are significant:

- ***Reduced Friction for Producers*:** Improving portability and interoperability will help ag data move between platforms, help smaller ATPs compete, and clarify responsibilities when it comes to consent, privacy, and cybersecurity.
- ***Supported Innovation via Technology Adoption*:** Digital agriculture technologies are important tools for Canadian farmers looking to improve their farm businesses. Robust and purpose-built Canadian data governance tools will build trust between producers and technology providers, which in turn drives successful technology adoption.
- ***Increased and Codified Knowledge*:** While helping to position digital and data-driven technology as a key resource for modern farming practices, standards will also raise awareness and knowledge of data governance among farmers, companies involved with generating and analyzing ag data, and other organizations across the agri-food value chain.
- ***Economic Growth through Enhanced Digitalization across the Agriculture Sector*:** Fostering a secure data-sharing environment would enable farmers to make data-driven decisions that enhance productivity and resilience and help the ag industry realize the full potential of traceability and certification for market creation and access.

Governments, not least the Government of Canada, have a critical role to play as agenda-setters, conveners, and enablers to start this work. Pan-Canadian engagement is key given how diverse Canada's farm sector is and how uneven digital adoption remains across regions and farm sizes. Since governments are themselves stakeholders in ag data, they can look to neutral third parties with extensive track records of multi-stakeholder engagement, such as CSA Group, to design and deliver the framework and standards development process. A successful, pan-Canadian, multi-stakeholder process will ease the adoption of the standards—though public policy and regulation will play a role in balancing mandates and incentives around standard use.

The AAFC can look to recent insights and lessons learned from the extensive inter-governmental and multi-stakeholder efforts working on the potential of health data, for example, the creation of the Pan-Canadian Health Data Charter[77] and the related Shared Pan-Canadian Interoperability Roadmap,[78] which work together to guide collective action toward a shared vision for health data in Canada.

Recommendation 3: Building Capacity and Confidence—A New Generation of Data Extension Services and Support

Standards are necessary but insufficient on their own to make Canada an ag data leader. Producers must be equipped with the knowledge, skills, and support they need to participate fully and confidently in digital agriculture. In Canada, some demonstration farms and producer-led digital literacy initiatives already exist but remain scattered and small in scale.[79] The BC On-farm Technology Adoption Program provides up to $100,000 to help farmers purchase and deploy new technologies like precision ag or AI-based tools.[80] Farm Credit Canada has recently launched Root AI, a generative AI/chatbot tool built specifically for the Canadian agricultural sector and trained to support many farm financing, sustainability, and agronomy queries.[81] These initiatives require not only greater investment—they need to ladder up to a new generation of data extension services.

Next-generation agricultural data extension services will move beyond the old model of one-way information delivery from experts to farmers. A new approach to data extension services could be akin to a networked innovation system that blends the public mission of data extension services with the agility of private and civic actors—research institutions, agri-tech firms, cooperatives, financial services, and farmer organizations—working together to deliver innovation-as-a-service models. Innovation-as-a-Service (IaaS) is already gaining traction in agriculture, lowering the cost and risk of adopting fast-evolving digital technologies.[82] By turning data analytics, automation, and agronomic insights into subscription-based or pay-per-use services, farmers can access continual technology upgrades and expert support without the heavy upfront investment required to buy hardware outright. This is especially important for small and medium-sized farming operations, which often face the greatest barriers to adoption (including time) but stand to gain significantly if trust and usability improve.

Next-gen data extension service innovation hubs would have the expertise to act as brokers and curators, vetting new technologies, matching tools to local farm needs, and helping producers adopt ag tech solutions with less risk and cost—potentially paired with shared regional, digital infrastructure (e.g., IoT networks of weather monitors, soil monitors, or ATP subscriptions for analytics). These hubs could also support the generation, pooling, and strategic use of agricultural data by helping farmers access and interpret insights—helping to ensure collected ag data gets leveraged. With their consent, insights from farmers' use of emerging technologies could feed directly into technology product improvement. Such data could also underpin outcomes- or performance-based contracts where technology service providers are paid based on achieving targets (e.g., yield uplift, cost savings). Many next-generation extension features are present in the non-profit Wabash Heartland Innovation Network at work in Indiana, for example.

Another stream within this approach may support nascent data cooperatives in Canada.[83, 84] Such cooperatives could be important sandboxes for different approaches to data management and generate insights into what works best for different needs more quickly.



6.0 Conclusion: A Strategic Pivot for Canada

Data is the new backbone of a more productive, resilient, and sustainable Canadian agri-food system. Agricultural data will continue to grow as a strategic asset with intentional focus by governments, farmers, and other stakeholders. If governance is left entirely to market forces or non-Canadian incumbents, Canada and Canadian farmers risk seeing the benefits accrue elsewhere, while farmers shoulder most of the cost, uncertainty, and risk.

The path forward is clear. Canada must shift from being a passive taker to an active shaper of how ag data is stewarded, standardized, and shared across Canada. This will require:

- Credible, trusted ag data frameworks created for Canadian agriculture that protect producers' control over their own data and build confidence in the digital tools they choose—as well as improve Canada's market conditions for Canadian-built and owned ATPs;
- Shaping global standards like the ISO process to ensure Canada's perspectives and experiences are reflected in the rules that increasingly govern agri-food trade and sustainability claims;
- Innovative and practical support models that de-risk on-farm digitization and accelerate returns for farmers, so that digital transformation works for them and not just for those who profit from their data; and
- A strong, united strategy for smart and digital agriculture.

This moment is an opportunity. Canada must get the foundations right: robust standards, clearer contracts, stronger cyber protections, and new approaches to supporting adoption. This will position Canada's farmers and agri-food businesses to thrive in the next era of smart, sustainable agriculture.

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