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Digital Technologies and the Big Data Revolution in the Canadian Agricultural Sector: Opportunities, Challenges, and Alternatives

SSHRC Knowledge Synthesis Grant Report

Author(s): **Murray Fulton**, *CCSC Research Fellow and Professor, Johnson Shoyama Graduate School of Public Policy*
Marc-Andre Pigeon, *CCSC Director and Assisant Professor, Johnson Shoyama Graduate School of Public Policy*
Bill Oemichen, *CCSC Research Fellow and PhD student, Johnson Shoyama Graduate School of Public Policy*
Yang Yang, *Assisant Professor, Johnson Shoyama Graduate School of Public Policy*

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JOHNSON SHOYAMA
Canadian Centre for the Study of Co-operatives
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ABSTRACT

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Canadian Centre for the Study of Co-operatives
101 Diefenbaker Place
University of Saskatchewan
Saskatoon SK Canada S7N 5B8
Phone: (306) 966–8509 / Fax: (306) 966–8517

E-mail: coop.studies@usask.ca
Website: http://www.usaskstudies.coop

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EXECUTIVE SUMMARY

Primary production agriculture is changing rapidly due to major developments in digital "smart" technologies. Smart farming is based on deploying remote sensing devices in agricultural equipment such as tractors, planters, crop sprayers, and combines in the grain and oilseed industries and in robotic milkers and ear tags in the dairy, beef, swine, and poultry industries. We review industry publications, the business press, and the academic literature to examine the response in Canada and elsewhere by farmers, agri-business firms, agricultural organizations, and governments to the emergence of digital technologies. Based on this review, we provide recommendations on what players in Canadian agriculture could be doing.

Smart devices in farm implements and other on-farm machinery create and provide a wide variety of what is referred to as "small data." While small data has some value on its own, the real value emerges with the creation of "big data." Big data is created when an agricultural technology provider (ATP) combines the data of many farmers with data from other sources (e.g., weather). This data can then be analyzed with proprietary algorithms to provide recommendations—e.g., the seed, fertilizer, and chemical combinations to use on different land units—that can improve yields, environmental outcomes and/or economic return.

While data aggregation provides value, it also creates a set of problems and challenges, including concerns around privacy, security, data ownership, competition and market power, and the transformation of work, which together are manifested in a lack of trust. A recent survey of Canadian farmers by Farm Credit Canada indicated that 65-70 percent of respondents believe information technology can increase efficiency, lower costs, increase yields, and improve management and decision-making. At the same time, nearly a quarter of respondents had become less comfortable sharing data with outside organizations over the last two years.

One of the responses to farmers' lack of trust in ATPs has been the creation of voluntary codes of conduct by agri-business and farm organizations, as has been done in the United States, New Zealand, and Australia. To facilitate trust-building between farmers and agribusiness, voluntary codes are typically combined with an accreditation process and the use of a logo. Voluntary codes of conduct have not been developed in Canada.

Although the introduction in Canada of voluntary codes of conduct is likely a necessary first step to address the lack of trust that farmers have in ATPs, it is unlikely that this move is sufficient to fully realize the benefits of big ag data. Other measures will also be required.

One measure that is being pursued in Canada is data portability. Data portability, and a host of related rights, are at the centre of the federal government's *Digital Charter Implementation Act*, 2020, also known as Bill C-11, which is currently before Parliament. This legislation has not yet been passed; it will also not apply to farmers in their role as farm business owners.

In addition, it is not at all clear that increasing data portability will fundamentally address the market power and competition problems created by big ag data. Market power problems are likely to remain an issue because of the large sunk costs associated with big ag data service provision. While provisions for interoperability could potentially address market power issues, there is little indication of policy support for this measure.

One policy alternative that has not received attention is the creation of ag data co-operatives. Farmers have, since the late 1800s, used co-operatives as a way of creating competition in input

and output markets and in the process creating greater trust in the system. The co-ops (including credit unions) that have been created in the intervening period provide a range of goods and services to farmers, including farm inputs (e.g., fuel and fertilizer), financial services, and processing and marketing services (e.g., fruits, dairy, hogs, poultry).

The governance structure in an ATP co-op—one in which farmers own the ag data service provider with which they do business—would act to ensure that farmers' data are not exploited. In addition to providing farmers with the full benefit of the data they own, an ag data co-operative would provide farmers with the trust needed to adopt big ag data.

The creation of ag data co-operatives will require the involvement of a wide group of actors, including researchers, co-op developers, farm leaders, existing farm organizations and businesses, and federal and provincial policymakers. Co-op proponents will need to be attuned to the technological issues around big ag data and they will need to pay attention to a social and legislative environment in which the approach to data sovereignty, security and privacy are changing rapidly.

1.0 INTRODUCTION

Primary production agriculture is changing rapidly due to rapid advancements in, and deployment of, biotechnology and digital "smart" technologies (including cloud computing). While digital agriculture or smart farming—which is often referred to as big ag data—offers the potential for greater productivity and improved environmental stewardship, it also creates concerns around privacy, market power, and the transformation of agricultural work (Coble et al., 2018; Klerkx et al., 2019). The impact of big data on agriculture is covered in a number of literature reviews (Wolf & Buttel, 1996; Coble et al., 2018; Sykuta, 2016; Klerkx et al., 2019).

The purpose of this synthesis report is to present the opportunities that big ag data provide, to discuss the challenges that exist in the adoption of big ag data and how they have been addressed to date, and to sketch out some of the ways that government and the agricultural industry, particularly farmers, could respond in the future. An underlying premise of this report is that big ag data will be transformational—the changes that it creates will be systemic and will affect all aspects of the agriculture and food system, including the nature of farm work in primary agriculture.

Since the full nature of the changes that will take place are unknown, there is considerable uncertainty about what will happen and how the different players in the agricultural system, including government, will respond. At the same time, there is potential for the actions of different groups to affect the outcome in fundamental ways.

As the report makes clear, Canada lags other countries in its response to big ag data issues. While agri-business and farm organizations in the United States, New Zealand, and Australia have introduced voluntary codes of conduct, no such measures have been developed in Canada. Farmers have also not responded collectively on the business front by forming ag data co-operatives. Finally, while the federal government has introduced legislation focused on consumer privacy and digital rights (Digital Charter Implementation Act, 2020, 2021), this legislation has not yet been passed; it will also not apply to farmers in their role as farm business owners.

This lack of response has the potential to result in a lack of trust by farmers in big ag data, which in turn could limit its uptake and use. Conversely, a lack of response could lock in the advantage of those that understand the transformational nature of digital agriculture and secure first-mover advantage. Nevertheless, it is unlikely that the full benefits of big ag data will be realized and/or widely shared unless all the actors (and particularly farmers) involved in the Canadian agricultural industry step up and play a greater role than they have to date.

The remainder of the report is structured as follows. Chapter II outlines the role of agriculture and the agri-food industry in Canada, while Chapter III describes smart agriculture and big data. Chapter IV examines the introduction of voluntary codes of conduct by numerous countries around the world and the effect they have had on farmers' trust in big ag data. Data portability, which is currently being introduced in Europe and Canada, is examined in Chapter V. While data portability may be able to deal with some of the data privacy issues arising around big data, it will not address the market power and competition issues at the heart of the farmers' concerns. The report concludes in Chapter VI with an examination of the role ag data co-operatives could play in addressing competition issues and in generating trust.

2.0 CANADIAN AGRICULTURE

Agriculture is a major industry In Canada. In 2018, the agriculture and agri-food sector (this includes primary agriculture, the agricultural inputs sector and the food processing, wholesaling, retailing and food services sectors) generated $Cdn 143 billion in gross income or 7.4% of Canada's gross domestic product (GDP). Canada's food and beverage processing industry is Canada's largest manufacturing industry, with approximately 17 percent of both manufacturing GDP and employment. Food and beverage processing is concentrated in Ontario and Quebec and consists primarily of meat (25%), dairy (13%), beverage (10%), and grain and oil seed processing (10%) (Agriculture and Agri-Food Canada, 2018).

The primary agriculture sector, or farm production sector, is key to the larger agri-food industry, providing the demand for agricultural inputs and supplying the agricultural output that is then processed, consumed, and exported. Realized net farm income in 2020 was $Cdn 9.5 billion (this excludes cannabis) (Statistics Canada, 2021)[1], with an average net operating income per farm of $Cdn 95,000 (average net worth per farm

1 Realized net income is the difference between a farmer's cash receipts and operating expenses, minus depreciation, plus income in kind (Statistics Canada, 2021).

of $Cdn 3.4 million) and an average farm family income of more than $Cdn 194,000 (Agriculture and Agri-Food Canada, 2021).

In 2018, Canada had 194,432 farms covering 64.2 million hectares of land (roughly 7% of Canada's land mass). Primary production agriculture is concentrated in southern Ontario and Quebec, the Prairie Provinces (Manitoba, Saskatchewan, and Alberta) and in the lower mainland of British Columbia (Agriculture and Agri-Food Canada, 2018).

3.0 SMART AGRICULTURE AND BIG DATA

3.1 Smart Devices and Big Agricultural Data

3.11 The Benefits of Smart Devices

Smart farming promises advancements in agricultural productivity, reduced environmental impact, greater food security, and enhanced long-term sustainability (Kamilaris et al., 2017). Smart farming is based on deploying remote sensing devices in agricultural equipment such as tractors, planters, crop sprayers, and combines in the grain and oilseed industries and in robotic milkers and ear tags in the dairy, beef, swine, and poultry industries. The smart sensing devices transfer data from the implement/animal to computers that then use artificial intelligence and machine learning to provide real time guidance and controls back to the implement and/or operator. This process is intended to "enable more precise and timely allocation of on-farm resources" (Toregas & Santos, 2019).

Multiple types of smart devices are being deployed in agriculture (Kosior, 2019). For example, smart sensors in tractors and planters determine the most efficient and effective seeding, fertilizer, pesticide, and herbicide application rates (Toregas & Santos, 2019). Rather than broadly applying expensive and environmentally unfriendly herbicides and pesticides, smart devices enable targeted application in much smaller, and typically more effective, amounts (Toregas & Santos, 2019).

Drones help determine crop growth rates and condition, pesticide infestations, and crop nutrition needs. Ear tags in cattle and swine determine livestock physical health (Whelan, 2021), while robotic milkers determine when a cow is ready to be milked and how much milk is being produced (Pfankuch, 2021).

Labour savings provide an additional reason for smart technology adoption (Fretty, 2021). Robotic milkers eliminate much of the need for farm labour to milk cows. In addition, sensors in tractors, planters, cultivators, and combines are beginning to eliminate the need for someone with high degrees of expertise to operate these implements while sitting in the vehicle's cab (Toregas & Santos, 2019). As the director of automation and autonomy at John Deere says:

> In order to get the best outcome, it's not just a matter of taking more time to complete one job after the other. Whether it's preparing the soil, planting the seed, protecting or harvesting a crop, farmers have numerous activities occurring in parallel, and unfortunately labor is not always available. If skilled labor is not available, it can have a significant impact on the overall outcome of a crop. We believe autonomy can alleviate that problem significantly by making equipment robotic and autonomous in decoupling it [from] labor availability (Fretty, 2021).

Big ag data allows farm owners to hire fewer and lower-cost workers and to focus on farm management rather than supplying the physical labour needed to operate and monitor the machines (Toregas & Santos, 2019).

Smart sensors in irrigators determine the rate and timing of water application to crops based on soil and crop conditions, thereby eliminating the waste associated with imprecise application (Toregas & Santos, 2019). More effective water use is particularly important in the fruit and vegetable industries and in a world of climate change where increasingly lengthy heat waves and extensive droughts are becoming more common. Farmers also use smart cultivators to combat weeds that rob the crops of nutrition and water.

3.12 Data Aggregation — The Creation of Big Data

Smart devices in farm implements and other on-farm machinery create and provide a wide variety of what is referred to as "small data." The broad categories of the data collected by smart devices include: (1) weather and climate information, (2) land use data, (3) animal and animal production data, (4) crop and crop production data, (5) soil information, and (6) weed information (Kamilaris et al., 2017; Coble et al., 2018).

While small data has some value on its own, the real value emerges with the creation of "big data" through data aggregation. The ability of small data from a single farm to provide insights into more desirable seed and fertilizer use is limited due to its narrow geographic range; simply put, most farms are not large enough to produce the variation necessary to determine what works and what does not (Sykuta, 2016). Unless historical data are available (the effectiveness of which is reduced because of the major technological changes occurring in agriculture), there is insufficient variation on most farms.

Big data is created when an agricultural technology provider (ATP) combines the data of many farmers with data from other sources. This aggregated data can then be analyzed with proprietary algorithms to provide recommendations—e.g., the seed, fertilizer, and chemical combinations to use on different land units—that can improve yields, environmental outcomes and/or economic return. The techniques used to analyze and interpret the data include artificial intelligence, machine learning, statistical analysis, map analytics, GIS geospatial tools, computer vision analysis, image processing, and reflectance and surface temperature calculations (Kamilaris et al., 2017). Examples of ATPs include the Climate FieldView platform, owned and operated by The Climate Corporation, a subsidiary of Bayer Crop Science, the Winfield United system, owned by Land O'Lakes, and Farm Business Network (FBN).

The underlying technology for big ag data is provided by some of the world's largest technology companies. Bayer, for instance, has partnered with Amazon Web Services (AWS) to develop and aggregate agricultural data through the Internet of Things (IoT) (Amazon Web Services, 2021). Google Ventures is one of FBN's main investors (Agence France-Presse, 2015). A more in-depth description of these cases is provided in the Appendix.

The connection between the small data collected on a farmer's equipment and the big data compiled by ATPs is complex. In some cases, the sensors that collect small data will be built into the farm machinery (e.g., a combine), while it other cases the sensors are purchased separately and then installed on the machinery; in both instances, special equipment is often needed to retrieve the data from the sensors. The data that is collected may be automatically transferred to the equipment supplier—this is particularly the case for machine performance information such as hours worked or activities undertaken. Alternatively, farmers may have to explicitly indicate that they want access to the data for their own use and/or that they agree to have the data transferred to the supplier in return for a set of services. Determining the options that are available, as well as using the equipment and the software, can be time consuming and confusing. In many instances, farmers are not aware of what they are agreeing to when the sign End-User License Agreements or enter into contracts with ATPs (Bloomberg, 2017).

3.13 The Challenges of Big Data

While data aggregation provides value, it also creates a set of problems and challenges, including concerns around privacy, security, data ownership, competition and market power, and the transformation of work, which together are manifested in a lack of trust. A 2019 survey of more than 2,000 Canadian farmers by Farm Credit Canada indicated that 65-70 percent of respondents believe information technology can increase efficiency, lower costs, increase yields, and improve management and decision-making. At the same time, nearly a quarter of respondents had become less comfortable sharing data with outside organizations over the last two years (58 percent indicated their comfort level remained constant) (Farm Credit Canada, 2019). The rest of this section examines the factors that farmers have identified as being of concern; the issue of trust is examined in Chapter IV.

The privacy and security issues that farmers face over the use of their data are similar to those that consumers face over the use of their personal data, namely, "Is my data secure?" and "Will it be used without my knowledge?" (Sykuta, 2016). Farmers' concerns focus on ensuring the privacy of both personal data and business data that could be valuable to other people (Sykuta, 2016). Farmers are worried that their equipment—e.g., tractors or combines—could be hacked and made inoperable unless a ransom payment is made (Rotz et al., 2019).

Equipment manufacturers are dealing with the security threat through greater control over machinery repair—i.e., they often allow only authorized technicians to work on the machinery. While this practice reduces the opportunity for security breaches, it means farmers are no longer able to repair their own machines. Farmers are worried about the elimination of the right-to-repair and a corresponding increased dependence on the service provided by equipment dealers and manufacturers (Rotz et al., 2019).[2]

Concerns also exist around data ownership and how data might be used. A recent high-profile example was when the partnership between Bayer's Climate FieldView and Tillable, a software platform that seeks to make the land rental market work better by linking landowners and renters, was discontinued because of fears that Tillable was suggesting

2 The Federal Trade Commission in the United States voted unanimously in July 2021 to enforce the right-to-repair. The right-to-repair movement is directed at a wide range of equipment and devices from farm machinery to cell phones to automobiles to medical equipment. Right-to-repair supporters often argue that users should have access to the data on the equipment/devices (Bloomberg, 2017; Goode, 2021).

offers based on data from FieldView (Janzen, 2020).

Attempts have been made to clarify the data ownership question in the United States and the European Union. In the United States, national farmer organizations and trade groups negotiated the "Privacy and Security Principles for Farm Data" with leading ATPs in 2014 (Sykuta, 2016). The principles indicate that farmers retain ownership of the data generated on their farm; however, the information and recommendations generated by the ATP from the farm data (e.g., cropping or input recommendations) is the property of the ATP (Sykuta, 2016).

The clarification of data ownership does not address the concentration and market power concerns that arise around data aggregation. As a result of the large economies of scale and scope, the agricultural data aggregation industry is likely to be highly concentrated (Fulton, 1997; Fulton & Giannakas, 2001). Entry of new firms can be controlled by the incumbent ATPs who have access to the cross-sectional (i.e., across farm) data that is needed to make effective agronomic recommendations; without this data, entry becomes difficult (Sykuta, 2016). In addition, competition among the small number of firms is limited due to relatively large switching costs that effectively lock farmers into the system they have chosen (Sykuta, 2016; Lam & Liu, 2020).

The high degree of concentration and limited competition raises concerns that ATPs will use their market power to price discriminate—i.e., to price their recommended services and input bundles in such a manner that they capture much of the potential farmer profit generated by these services/bundles (Sykuta, 2016). There is also a general concern that the contracts offered by the ATPs are not transparent and thus do not provide for informed consent on behalf of the farmer. Coupled with potential antitrust concerns, the increasing foreign ownership of agricultural data by Bayer and others is raising substantial concerns inside and outside of the U.S. government (Carbonell, 2016; Lianos & Katalevsky, 2017).

Finally, there is a concern that the practices of the ATPs could fundamentally change the nature of farming, with farmers increasingly reliant on ATPs as they make their farm management decisions. More generally, the view is expressed that new technologies, such as big data, fundamentally alter the structure of work and society (Bronson, 2018).

3.14 Response to Big Data Challenges

The above problems have not gone unnoticed by farmers; indeed, there is strong evidence that farmers care about who benefits from the use of the aggregated data, that trust is a key farmer concern, and that farmers are skeptical about the value of big data (Jakku et al., 2019). The lack of transparency around issues such as data ownership, portability, privacy, and liability has resulted in farmers being reluctant to share their farm data (Wiseman et al., 2019), thus reducing the potential for this technology to improve economic livelihoods and reduce environmental costs.

To alleviate these concerns and create confidence in big data, agricultural technology providers, along with farm organizations and in some cases government, have moved to create voluntary codes of practice for the use and sharing of agricultural data. At a more general level, the European Union has intervened directly with the introduction of data portability rights under the general data protection regulation (GDPR). In addition to data portability (the ability for farmers to request their data in a form that can be transferred to another ATP), discussion is occurring around policies related to data interoperability (the ability for the user of one service to access features of another service), and greater oversight of the standard contracts of adhesion used by the ATPs.

The ability of the proposed solutions to address the problems appears to be limited — data portability does not address the barriers to entry that exist in the industry and farmers may be reluctant to switch ATPs because of the need to adopt different production systems (Graef, 2015), while efforts to create interoperability are far more difficult in the big data area than in telecommunications where they have been fruitfully used (Graef, 2015).

The provision of greater oversight of the standard contracts of adhesion used by the ATPs would appear to be useful. The contracts could also be made less exploitative if the data aggregation activity were designed and/or undertaken by farmers through co-operatives or some other form of collective action (Graef, 2015). Co-operatives have long been used in the agricultural sector to increase competition and limit market power (Fulton & Giannakas, 2013). In addition to reducing the incentive for exploitive behaviour, they are less susceptible to barriers to entry (Sexton & Sexton, 1987).

Other solutions that have been suggested to deal with market power include open-sourced data and government funding of data analytic tools (Carbonell, 2016); these databases and tools would be useful for new players, including co-operatives, wishing to enter the industry. Access to databases and tools may be particularly important in terms of the service offered to groups with less aggregate buying power (e.g., smaller farmers and organic farmers). The groups developing the big data technology favour particular players, namely large-scale crop farmers, and disadvantage other groups such as organic farmers (Wolf & Buttel, 1996; Bronson, 2018, 2019).

4.0 VOLUNTARY DATA AGREEMENTS

Since 2014, the most significant response to the big ag data question has been the development and adoption of voluntary codes of practice for the use and sharing of agricultural data. This response has typically involved the major agricultural technology providers and farm organizations, with government sometimes playing a facilitating role. The next section presents an overview of the initiatives in four countries/regions: the United States, New Zealand, Australia, and the European Union. This overview is followed by a discussion of the implications of these agreements.

4.1 Voluntary Data Examples

4.11 Privacy and Security Principles for Farm Data: United States

In 2014, The American Farm Bureau Federation (AFBF), one of the largest U.S. non-governmental farm organizations, working together with many farmer-led groups and ag-technology providers, established the *Privacy and Security Principles for Farm Data* (also known as the *Core Principles*) (American Farm Bureau Federation, 2021). The core principles address 13 critical issues of data use and security in precision agriculture technologies, including: (1) education; (2) ownership; (3) collection, access and control; (4) notice; (5) transparency and consistency; (6) choice; (7) portability; (8) terms and definitions; (9) disclosure, use and sale limitation; (10) data retention and availability; (11) contract termination; (12) unlawful or anti-competitive activities; and (13) liability & security safeguards.

The voluntary Core Principles lay the foundation for the Ag Data Transparent certification program, which verifies companies' compliance with the guidelines and provides a seal of approval. The certification program is administered by the Ag Data Transparency Evaluator, Inc., a non-profit organization formed in 2016 by AFBF, together with interested farmer-led groups and ag-technology providers.

The companies participating in the certification program submit their agricultural data contracts and answer eleven questions about how they collect, store, use, and share farmers' ag data. The contracts and answers are then reviewed and verified by a third-party administrator (the law firm of Janzen Agricultural Law LLC, with Attorney Todd Janzen as the administrator of the project). The companies and data products that are consistent with the Core Principles are awarded the Ag Data Transparent seal.

As of January 2021, 37 companies have agreed to follow the Core Principles, including seed companies, farm equipment manufacturers, ag-tech startups, farm co-operatives, and agronomic advisors. Of these 37, 26 companies have been recognized as Ag Data Transparent and approved to use the trademark.

The goal of the certification process is to inform farmers about whether an ATP or its products comply with the Core Principles for ag data ownership, consent, and disclosure. Organizations that choose to comply with the Core Principles and to use the seal of compliance pay fees according to their firm size and age.

4.12 Farm Data Code of Practice: New Zealand

The Farm Data Code of Practice was established in 2014 in consultation with around 60 New Zealand rural organizations and 200 industry professionals and farmers to promote the effective sharing of agricultural data within New Zealand's agricultural sector (Farm Data Accreditation Limited, 2015). The code is now owned and managed by Farm Data Accreditation Ltd (FDAL), an independent company governed by seven industry organizations. The development of the code was originally funded by New Zealand dairy farmers (DairyNZ) and the Ministry for Primary Industries (a New Zealand government agency).

The Code of Practice sets voluntary guidelines for organizations to follow when collecting, storing, and sharing farmers' primary production data. It outlines the disclosure and practice requirements for accredited organizations, such as the rights that the parties have to the data, rules and processes for data sharing, data security and storage guidelines, and terms and conditions for data access.

To demonstrate compliance, organizations must complete a compliance checklist that was developed based on the Farm Data Code of Practice and provide the relevant evidence. Self-auditing is accompanied by a self-declaration that confirms the compliance and is signed by the organization's designated authority. The compliance checklist, evidence, and declaration are returned to FDAL for review and assessment. Compliant organizations are authorized to use the Farm Data Code of Practice trademark. Participating organizations pay fees to FDAL to get accredited and to use the trademark. As of June 2021, five organizations were accredited and approved to use the trademark.

4.13 Farm Data Code: Australia

The National Farmers' Federation (NFF) published Australia's Farm Data Code in 2020. The Code, which establishes the principles for the collection and use of farm data, was developed and adopted by the NFF in consultation with key industry stakeholders such as farmers, researchers, and agricultural technology providers. It focuses on seven key areas: (1) transparent, clear and honest collection, use and sharing of farm data; (2) fair and equitable use of farm data; (3) ability to control and access farm data; (4) documentation and record keeping; (5) portability of farm data; (6) keeping farm data secure; and (7) compliance with national and international laws (National Farmers' Federation, 2020).

Although the Farm Data Code is a voluntary initiative, all relevant entities that manage data relating to farmers and farming businesses are encouraged to comply with the principles. The introduction of the Farm Data Code was partly driven by the changing data landscape in Australia, including proposed government legislation on data availability and use, and the Consumer Data Right that was being rolled out across industry sectors starting with banking, energy, and telecommunications (The Treasury, Australian Government, 2019). The Code is subject to two six-month reviews, followed by a continuing biennial review cycle to ensure its timeliness and relevance. The working group of the code is currently exploring certification or accreditation models that may help increase the code's uptake and impact (National Farmers' Federation, 2020).

4.14 Code of Conduct on Agricultural Data Sharing: The European Union

Launched in 2018, the European Union (EU) code of conduct on agricultural data sharing sets out the general principles for agricultural data collection and sharing within the EU agri-food sector. The code of conduct focuses on five key principles of data rights: (1) data ownership; (2) data access, control and portability; (3) data protection and transparency; (4) privacy and security; and (5) liability and intellectual property rights (Copa-Cogeca et al., 2018). The code was developed collaboratively by eleven major organizations representing the EU agri-food sector, including farmers, agricultural co-operatives, and representatives of various industries like fertilizer producers, animal breeders, seed producers, animal feed manufacturers, and the machinery industry.

Compliance with this code of conduct is voluntary, although all parties involved in the use of agricultural data are encouraged to conform. Additionally, the code focuses on non-personal ag data. Data that is "linked to a person who is identifiable through a contract, land register, coordinates, etc.," is considered personal data; such data falls under the General Data Protection Regulation (Copa-Cogeca et al., 2018).

4.2 Voluntary Data Agreement Considerations

Voluntary agreements have been introduced in large part to deal with the lack of trust that farmers express around agricultural data. The increased value of agricultural data (at both the individual and aggregated levels), lack of legislative and regulatory frameworks, and complexity and inconsistency in contractual agreements all contribute to a tension between farmers and agribusiness around data issues and a reluctance by farmers to share data (Sanderson et al., 2018). The unwillingness to share data, whether it takes the form of a reluctance to purchase new equipment outfitted with smart sensors or a reluctance to purchase/use ATP services, hampers the realization of the potential benefits of data-driven agricultural solutions.

This section examines the issue of farmers' trust in agricultural data and the evidence that exists about the extent and nature of the trust/distrust.

4.21 Trust Among Farmers

At the heart of the voluntary ag-data codes released in the United States, New Zealand, Australia, and the European Union is a focus on mitigating concerns and building trust between farmers and agribusiness via an emphasis on the key data issues: consent, disclosure, and transparency (Sanderson et al., 2018). For instance, one of the key objectives of the Australian Farm Data Code is to "… build trust and confidence in the way farm data is collected, used and shared so that, where appropriate, farm data can be utilized in ways that bring benefits to Australian agriculture" (National Farmers' Federation, 2020). Similarly, the New Zealand Farm Data

Code of Practice was developed to "give primary producers confidence that data pertaining to their farming operations is secure and being handled in an appropriate manner" (Farm Data Accreditation Limited, 2015).

The emerging data codes aim to generate a greater level of transparency, simplicity, and trust in contractual agreements between farmers and agribusiness. Farmers are not always fully informed about the potential benefits and risks of sharing their ag data due to the low awareness and/or the complexity of the issue. The guiding principles aim to increase awareness among farmers about the importance and value of their ag data and encourage them to review the conditions and terms when signing a contractual agreement with service providers. Also, compliance with a voluntary code signals an agribusiness's awareness and commitment to address farmers' data concerns and its willingness to adopt "good" data management practices. The hope is that the service providers who demonstrate their commitment to farmers' data security, in turn, are more likely to be recognized and chosen by the farmers.

To facilitate the trust-building between farmers and agribusiness, voluntary codes are often associated with an accreditation process and the use of a logo. For example, the U.S. Core Principles require participating agribusinesses to submit their data contracts and answers to eleven questions to a review process; businesses that meet the criteria are allowed to use the Ag Data Transparent seal. Similarly, the New Zealand Code of Practice entails a self-auditing and declaration process, and the award of a trademark for complying companies. Accreditation models are also being considered by the Australian Farm Data Code. The use of accreditation and trademark acts as a heuristic that farmers can use in their data decisions. This heuristic converts "details about ag-data practices into something tangible, understandable and useable" (Sanderson et al., 2018); the goal is to build confidence and trust among farmers that their ag data are secure and handled with efficiency and integrity.

4.22 Farmers' Trust in Big Ag Data

Precision agriculture and access to ag data represent an opportunity to improve productivity, profitability, resource efficiency, animal welfare, environmental practices, and even provide tools to combat climate change (Copa-Cogeca et al., 2018). Benefits also seem promising to farmers who will "benefit from a highly innovative technology sector that delivers applications that are simple to use and access, which source the information they need without impedance and deliver value" (Farm Data Accreditation Limited, 2015). A few studies, however, reveal concerns and reluctance among farmers over sharing data related to their farms and operations.

The American Farm Bureau Federation surveyed about 400 farmers in 2016, 77% of whom expressed concerns about entities that can access their farming data (American Farm Bureau Federation, 2016). The U.S. Department of Agriculture's National Institute of Food and Agriculture (NIFA) conducted input analysis with over 1,000 industry stakeholders from academia, professional organizations, practitioners, and producers. Twelve overarching topics concerning ag data were identified as the most important to stakeholders. The most dominant topic centered around "data infrastructure and management," followed by the "use of data and how consumers, producers, the environment, and other entities are affected by data," and "creation, collection, provenance, and characteristics of data". Other important data issues include "training, programs, student, and knowledge needs around data," "federal agencies, principles, and protocols associated with data," "privacy, security, confidentiality, and quality data issues," and "data sharing, repositories, and analysis" (USDA-NIFA, 2017).

Farmers worldwide have much in common when it comes to their concerns about ag data collection, sharing, and use. A survey of 1,000 Australian farmers across 17 agricultural sectors (e.g., grains, fisheries, livestock, and dairy) identified a lack of trust among farmers in how their farm data is collected and handled (Wiseman et al., 2019). Three out of four respondents reported knowing little about the terms and conditions relating to data collection in their agreement with technology and service providers. The majority of respondents also reported little or no trust in service providers maintaining the privacy of their farm data (56%) and not sharing with third parties (62%). These low levels of understanding of contractual agreements and trust in service providers had a direct impact on farmers' reluctance to share their on-farm data.

Wiseman et al. (2019) highlighted five key areas of concerns in the legal rights and regulatory framework that give rise to the mistrust, including a lack of clarity and transparency of data terms and conditions, questions of ownership and sharing of data, privacy concerns, inequality of bargaining power, and a lack of benefit-sharing between farmers (i.e., data contributors) and third-party advisers/agribusiness (i.e., the data aggregators).

4.23 Voluntary Policies Versus Government Regulation

As Sanderson et al. (2018) outlines, the existing codes of practice share many similar features: (1) they are voluntary and self-regulatory without being legislatively mandated; (2) they are principle-based guidelines that are focused on good ag-data practice outcomes rather than exact process or actions to achieve them; (3) they have a communicative function between data originators and aggregators that ag data are managed in ways that cohere with certain principles, a function that is often facilitated by an accreditation process and the use of logos; (4) the goal is to change the attitude and behaviour of farmers and agribusiness, and thus encourage a more effective sharing of data within the agricultural sector.

Voluntary codes are not without challenges. The principle-based codes offer a normative framework rather than detailed, prescriptive rules. Thus, agribusinesses have flexibility in identifying the most efficient way to achieve these benchmarks. However, rather than relying on the goodwill of agribusinesses, credible accreditation, monitoring, and enforcement by an independent, third-party auditing bodies are deemed necessary to assure compliance (Sanderson et al., 2018).

The success of ag data codes depends on the uptake from farmers, agribusiness, and industry; however, a higher rate of adoption does not necessarily mean that the codes are having a greater impact or are more effective. Little research has been conducted to assess the impact, effectiveness, and value of ag data codes. Many crucial questions remain largely unanswered. For example, since the introduction of voluntary codes, has awareness increased among farmers and agribusiness about the importance of ag data? Has a more trusting relationship been established between farmers and agribusiness? Have there been any behavioural changes—e.g., have service providers improved their data practices? Have farmers become more willing to share ag data and select compliant/accredited service providers? Have farmers gained a better understanding of what data are being collected?

An ideal scheme to govern ag data is likely to require a mix of social, legal, institutional, and regulatory settings that involve a broad range of interested stakeholders. The development and implementation of voluntary codes involve multiple stakeholders such as farmer groups and industry-led organizations; this involvement is needed to ensure that the codes are informed by experts and that they have the support of both farmers and agribusiness (Sanderson et al., 2018). Government also plays a role in the development of voluntary codes. For instance, the development of the New Zealand Farm Data Code of Practice was originally funded by both industry-led groups (DairyNZ) and the government (Ministry for Primary Industries).

The self-regulatory and voluntary codes also aim to fill the regulatory gap in government legislation around agricultural data. For instance, the EU Code of Conduct serves to complement the General Data Protection Regulation that governs "personal data" but not the non-personal ag data such as on-farm agronomic and machine information.

Conventionally, self-regulation and government legislation ("command and control") are considered as mutually exclusive policy alternatives that sit at two polar extremes. However, as argued by Sinclair (1997), there may exist a much richer range of policy options that fall somewhere in between and a combination of self-regulation and government legislation can provide a more desirable regulatory outcome. The balanced or hybrid approach (of both voluntary, market-driven and compulsory, state-driven regulation) can be especially effective for regulating agricultural data given the highly competitive nature of the agriculture sector (Sinclair, 1997).

5.0 PUBLIC POLICY OPTIONS: DATA PORTABILITY

While voluntary codes could represent a viable path forward for Canadian farmers, these efforts could be pre-empted—and at a minimum are likely to be shaped—by the evolving policy context. This section explores some of the policy options that exist for big agricultural data around data portability. Data portability has received a great deal of attention in other countries and is often looked at as a way of addressing the challenges raised by big data.

5.1 Data Portability

Policymakers in several countries, including Canada, are actively creating or about to create data portability rights like those that have been in force in the European Union since May 2018 under the general data protection regulation (GDPR). Under the EU provisions, consumers can demand the transfer of their data from one platform or business to another. Formally, the right reads as follows:

> Data subject shall have the right to receive the personal data concerning him or her, which he or she has provided to a controller, in a structured, commonly used and machine-readable format and have the right to transmit those data to another controller without hindrance from the controller to which the data have been provided (Radley-Gardner et al., 2016).

For policymakers, data portability promises to reduce lock-in by lowering switching costs in areas as diverse as banking (where users must both cancel and recreate recurring transfers), software platforms (where users must relearn and re-customize their settings), and arrangements with a variety of other service providers ranging from utilities, cable TV providers, grocery stores and more (where again, reconfiguration is often required). If extended to the relationship between producers and suppliers, data portability rights could empower producers to "port" their data from one supplier to another. One option for a supplier is a producer-owned data co-operative; this policy option will be discussed in the next chapter.

5.2 The Canadian Policy Context

The question of data portability, and a host of related rights, are at the centre of the federal government's "Digital Charter," which is currently before Parliament in the form of the *Digital Charter Implementation Act*, 2020 (DCIA), also known as Bill C-11 (Digital Charter Implementation Act, 2020, 2021). The act consists of two parts, the Consumer Privacy Protection Act (CPPA) and the Personal Information and the Data Protection Tribunal Act (PIDPTA).

The DCIA has a heavy emphasis on ensuring data privacy rights and a secondary focus on the potential pro-competition effects arising from data portability. While the act supplants and codifies important principles of the Personal Information Protection and Electronics Documents Act (PIPEDA), the introduction of a data portability clause (section 72) is a classic case of using "framework legislation." It sets out broad policy objectives but leaves the important implementation details to regulation and guidance documents (Charland et al., 2020; Fasken, 2020b). Of particular importance, these non-legislative mechanisms will set out which sectors fall under the scope of the data portability requirements.

Data portability is only one part of—and usually framed as of secondary importance to—the broader suite of data charter measures implemented in the European Union and being contemplated in Canada, with privacy objectives being the over-arching objective. Among other things, and building on PIPEDA, the DCIA also requires firms to appoint a person or persons responsible for questions tied to data privacy matters, develop codes of conduct and procedures to ensure proper consent, mechanisms to answer customer queries, de-personalize data, erase data, ensure alignment with DCIA provisions by any firm with which they share (depersonalized) data and much more. Further, Canada contemplates severe penalties of up to $25 million or 5% of global revenue for non-compliance with the DCIA's privacy provisions.

The federal government's legislative and future regulatory efforts on these matters appear to have been (and will continue to be) informed by the actions of other jurisdictions, including most notably the European Union's pioneering GDPR (Fasken, 2020a). Policymakers will also be paying attention to concurrent discussions around applying many of the aforementioned rights to banking through so-called "open banking" initiatives.

5.3 Data Portability and Competition

There is a small but growing literature that explores the implications of adopting data portability policies like those in the GDPR. While the literature generally takes for granted and demonstrates how data portability can enhance consumer welfare and support entry and competition, it also offers some cautions, pointing to potentially conflicting effects that could complicate policy responses in this area.

Under this standard approach, data portability is an attempt to reduce switching costs. As Klemperer (1987) shows, markets in which consumers must incur a cost to switch from one supplier to another are likely to be less competitive. Thus, if switching costs can be lowered, competition can be increased.

Lam and Liu (2020) develop an economic model to explore the implications of two effects they say arise from data portability. They call the first, more well understood and direct effect, *switching facilitation*. This effect makes it easier for consumers to move their information, thus reducing the lock-in effect modeled by Klemperer and that currently characterizes many consumer-business relationships.

The switching effect plays a dominant role in Wolhfarth's (2019) game theoretic model, which shows how these switching effects always harm incumbents and advantage entrants given a set of assumptions, one of the most crucial being that consumers bear a cost (disutility) when they share information. This same assumption leads Wolhfarth to a counterintuitive result, namely that data portability can reduce consumer well-being because it empowers entrants to collect more data than consumers might otherwise want to share.

Lam and Liu (2020) point to a second, less familiar and more indirect effect, that they call the *demand expansion* effect. This effect says that if data are easier to port, then it is also easier for customers to share more information with their existing service providers (in the case of big ag data, the service providers would be ATPs). If incumbents anticipate the potential switching impact of data portability rights, they can be expected to invest heavily in providing the kind of value-added data analysis—and aggregation services—that deepens their existing relationship with clients. Under certain circumstances, Lam and Liu show how this *demand expansion* effect can outweigh the *switch facilitating* effect, entrenching an incumbent's relationships and forestalling new entry. The authors conclude that policymakers should consider broadening the scope of data portability to include these value-added type services—so not just the individual's proprietary data but also add-ons are covered—to minimize potential anti-competitive outcomes. Wohlfarth (2019) arrives at a similar conclusion despite his very different model.

These economic analyses build on earlier policy analysis from legal scholars who were the first to point out these and other types of effects. Swire and Lagos (2013) for example note that the requirement to deliver data "without hindrance" in the GDPR is likely to act as a regulatory barrier because of high implementation costs tied to meeting what they call "the export-import" or "EIM" requirements. The EIM requirements are commonly understood today as building to the specifications of an application programming interface (API).

There is also earlier economic analysis that suggests that reducing switching costs through data portability may not result in less competition. An idea closely related to switching costs is contestability. Contestable markets are ones in which firms can enter and exit at very low cost. Although contestable markets may be highly concentrated with only two or three major firms, they can still offer competitive pricing. Competition is provided by the ability to freely enter and exit; this ability means that prices will be kept at or near average cost. However, contestability only holds if consumers can switch easily to an entrant and if there are no sunk costs (Baumol et al., 1992).

Sunk costs act as barriers to entry—firms will not enter a market if they know that doing so requires them to make investments that cannot be recouped should they decide to exit (Sutton, 1991). Sunk costs can take several different forms. Some sunk costs, such as regulatory costs, are exogenous—i.e., they must be incurred regardless. Other sunk costs, such as those related to advertising and R&D, are endogenous—i.e., they are decided upon by the firm as part of its strategic activity. Since higher sunk costs reduce competition, one of the takeaways from Sutton's analysis is that firms may explicitly invest in sunk costs to limit entry and hence competition. As well, firms may find government regulations beneficial since more regulation means higher sunk costs and less competition.

Big agricultural data appears to be subject to both endogenous sunk costs and exogenous sunk costs. Endogenous sunk costs include the costs associated with proprietary software and algorithm development, data collection, advertising and consumer branding, and the creation of voluntary codes of practice. Exogenous sunk costs arise from government requirements around data portability (e.g., EIM requirements), as well as from the need to meet regulatory requirements around consent, customer queries, de-personalized data, and non-compliance penalties.

Given the importance of sunk costs in the big ag data area, it is likely that voluntary and regulatory attempts to introduce greater competition will not be successful—as with virtually all high-tech areas, competition is expected to be low. While part of the reason is that the economics of high-tech industries do not allow for competition, it is also the case that the large firms that have emerged have significant political influence. This political influence allows firms to erect barriers to entry and to thereby retain their economic position (Zingales, 2017).

While often touted as a pro-competition measure, the data portability provisions remain nested within and subordinate to policy objectives around privacy. Further, it is argued, the data portability provisions were (and are) developed largely with the goal of limiting the network effects of social media companies like Facebook or Google rather than promoting true competition objectives per se (Swire & Lagos, 2013).

5.4 Interoperability

Data portability is only one element of a larger pro-competition concept called interoperability, which is the ability for the user of one good or service to access features of another good or service. In the physical realm, vehicles generally have "interoperability" standards, where owners can choose to use parts made by third parties instead of the original equipment manufacturers (OEM). In digital space, operating environments are sometimes "interoperable": Apple users for example can open Microsoft Word documents in Pages and Linux users can do the same in Writer from the Office Libre suite.

As Cyphers & Doctorow (2021) note, interoperability encompasses a number of rights or powers beyond data portability, including what they call "back-end interoperability," which allow users to interact "fluidly" with users on other services, and the "right to delegate," which is the power of third-party software to interact with a user's existing services.[3] In their preferred version of interoperability, which Cyphers and Doctorow call "Competitive Compatibility" or ComCom (formerly known as "adversarial interoperability"), the law would provide for the legal right to exercise these powers without the consent of service providers. A competitor to Facebook, for example, could build a platform where its users could access their Facebook content without having to sign into Facebook, much like Facebook users were able to do when competitor MySpace was the (fleetingly) dominant social media platform.

In a ComCom world, the potentially anti-competitive consequences of data portability flagged by the academic research appear less formidable. There are no enforced (high cost) data standards for example. Incumbent investment in new services, while welcomed, are unlikely to forestall new entrants, who can develop niche markets and services that appeal to segments of an incumbent's users that invariably will be neglected, all without sacrificing the benefits of the incumbent's network effects. The entrants' sunk costs in this scenario represent less of a barrier to entry than they would be otherwise. For a variety of reasons — many of which are linked to the power of the firms occupying the data sector — this approach to locking in competition in the platform-based digital world does not appear to be on the policy agenda (Doctorow, 2021).

6.0 PUBLIC POLICY OPTIONS: DATA CO-OPERATIVES

The discussion in the previous chapter indicates that while voluntary agreements and data portability may be beneficial in addressing privacy concerns, they are unlikely to be a panacea to concerns about competitive pricing and non-exploitative data use. An alternative (and potential complement) to both voluntary agreements and data portability is the creation of data co-operatives.

Co-operatives have a long history in agriculture, dating back to the late 1800s. One of the key reasons for the creation of agricultural co-operatives is their ability to enhance competition in agricultural input and output markets and to increase the trust that farmers have in the system (Sexton & Iskow, 1988; Fulton & Giannakas, 2013). The co-ops (including credit unions) that have been created in the intervening period provide a range of goods and services to farmers, including farm inputs (e.g., fuel and fertilizer), financial services, and processing and marketing services (e.g., fruits, dairy, hogs, poultry).

Co-operatives encourage competitive behaviour because of their ownership structure. Since farmers own and control the firm with which they do business (i.e., the co-operative), they have less of an incentive to act in an exploitative fashion. Instead, they are more likely to provide better service and to charge prices that are more in line with costs.

While co-operatives can be beneficial in terms of making markets work better, they are difficult to create. Part of the reason is that co-operatives are a form of collective action; thus, their formation requires the original members to overcome social dilemmas such as free rider problems (Giannakas et al., 2016). As well, the original members are often unable to capture fully the benefits of co-op formation, some of which accrue to future members, thus limiting their incentive to create the co-op (Fulton & Giannakas, 2012). Nevertheless, despite these challenges, co-operatives continue to be formed, often with the support of co-op development agencies.[4] Governments can also play an important role if their involvement is balanced between indifference (and even hostility) and undue control (Fairbairn, 2000).

3 While Cyphers and Doctorow do not so say explicitly, these three features align closely with the power to modify, repair and reverse engineer technology both physical (e.g., devices) and digital (e.g., re-implement APIs).

4 An example of a co-operative development agency in Canada that is working in agriculture is Co-operatives First. See https://cooperativesfirst.com/.

An agricultural data co-operative would take the form of an ATP described earlier. However, instead of being owned by a technology company like Bayer or John Deere, a data co-operative would be owned by farmers. An example of an ag data co-op is Grower's Information Service Cooperative (GiSC) headquartered in Lubbock Texas. As GiSC's website says, "we enable our member producers to have access to the most premier weather and data analytic platforms in the industry. Allowing our member producers to aggregate and benchmark their operational data with other member producers to make better on farm decisions year after year" (*Grower's Information Services Coop*, 2021).

The creation of ag data co-operatives will require the involvement of a wide group of actors, including researchers, co-op developers, farm leaders, existing farm organizations and businesses, and federal and provincial policymakers. Co-op proponents will need to be attuned to the technological issues around big ag data and they will need to pay attention to a social and legislative environment in which the approach to data sovereignty, security and privacy are changing rapidly. The next sections discuss some of the issues that will arise around property rights.

6.1 Property Rights Considerations

Consideration of agricultural data co-operatives raises a set of issues about the control and ownership that farmers would wish to claim through their co-op. To understand the issues, it is necessary to delve into ag data property rights.

Table I outlines five different ag data property rights that ATPs could potentially possess: the right to access the data; the right to withdraw the data; the right to manage the data; the right to exclude others from using the data; and the right to alienate the data. The ATPs that are currently operating are typically Full Owners.

The ATPs with Full Ownership over farm data will (and already do) wield considerable power to sell access to the data, protect it from creditors and/or layer a range of derived financial products on top of this ownership. As Pistor (2019) notes, this layering of derived financial products is an essential feature of modern capitalism and ownership claims. It is also a key contributor to what has become known as the "financialization" process, itself a factor driving income inequality (Pistor, 2019; Zalewski & Whalen, 2010).

Table 1: Farm Data Property Rights and Data Rights Bundles

Data Rights Bundles					
	Full Owner	Proprietor	Authorized Claimant	Authorized User	Authorized Entrant
Access	X	X	X	X	X
Withdrawal	X	X	X	X	
Management	X	X	X		
Exclusion	X	X			
Alienation	X				

According to Pistor (2019), this financialization process ultimately rests on the state's willingness to endorse, through legislative or related means of enforcement, private efforts to extend the power of ownership claims by assigning *priority rights* over an asset, extending the *durability* of ownership and priority claims over the asset through time, creating a *universal right* to priority and durability within a jurisdiction and across jurisdictions, and finally, ensuring the *convertibility* of the asset into state money.

Based on these attributes, ATPS, perhaps encouraged by a Wall Street/Bay Street firm, could create novel financial products whose returns depended on treating data as an asset class. These assets would generate a return based on the willingness and ability of farmers to pay for the insights generated from the data. Through careful crafting of the legal code, the owners of these new financial products would enjoy universality, durable priority rights and convertibility—they could buy and sell the rights to the returns generated by the data as they see fit, ultimately exerting control over the data itself. In this scenario, farmers could be cut out of the benefits of their data for as long as those rights were endorsed by the state.

Of course, these ownership claims do not exist in a vacuum. As Pistor (2019) notes, while the claims may arise from the activities of private actors, they become truly entrenched when the actors are able to validate these private activities in the form of public policy. Specifically, "states are not neutral when it comes to whose interest in an asset shall be given priority" (Pistor, 2019, p. 23). While there is indeed good reason to expect those who presently claim ownership over Canadian farm data to seek endorsement of their claims through some form of state action, the very fact that they will likely feel the need to seek this support creates opportunities for different configurations of property rights including configurations that may be closer in spirit to the co-operative form than those of investor-owned firms.

The formation of an agricultural data co-operative provides farmer-members with the opportunity to define their property rights to data. Although it might seem intuitive that farmers should allow their co-op to become a Full Owner, this might in fact not be the best strategy. Instead, it might be advantageous if farmers were to think about their co-op being a "Proprietor" rather than a "Full Owner." The farmer-members might also wish to go further and press for legislation that would limit all ATPs to the Proprietor role.

As shown in Table 1, the distinction between Full Owner and Proprietor rests on the right of alienation, which is the right of the property right holder—e.g., the ATP—to sell the bundle of other rights. Full Owners have these rights; Proprietors do not. With Full Ownership rights, ATPs would be able to sell their collective data or monetize the returns generated from analysis of the data. They could then seek to entrench these restrictions legislatively. However, if the property rights are restricted to Proprietor, then the ability to monetize the returns is limited. The benefits of data aggregation are focused solely on the benefits that accrue to farmers from this aggregation and not on the benefits that can be obtained by selling this data to other users.

6.2 Implications for Co-operatives

The small but burgeoning field of research into data portability and to a lesser extent, interoperability, has several implications for our investigation into the potential formation of farmer-owned and controlled data co-operatives.

6.21 The Scope of Canada's Digital Charter

The literature on data portability is generally premised on the European's GDPR. Canada's digital charter is yet to become law. Assuming it clears that hurdle, a great deal remains to be resolved through regulation and possibly guidance, efforts that could take years to unwind, creating at a minimum an uncertain environment for any effort to develop a farmer-led data co-operative.

6.22 Digital Charters and Competition Impact

The literature suggests that the implementation of data portability rights does not guarantee more competition premised on easy switching. As the work by Liam and Liu (2020) suggests, data portability could entrench the power of incumbents who invest heavily in value-added services to discourage entry. Data portability could also weaken competition—and the potential for new entrants like farmer data co-operatives—in another way, by mandating that they too must share their member-data upon request by members. In other words, data portability can cut both ways, making it easier for farmer-members of a data co-operative to express any dissatisfaction with their data co-operative through exit rather than voice (Hirschman, 1974). The fact that data portability rights are, for the EU and Canada, embedded in a larger "citizen-rights" perspective centred around data privacy also points to large compliance costs for new entrants that may represent a significant barrier to entry for a prospective farmer data co-operative.

6.23 Digital Charters and Co-operatives

The literature on data portability, and indeed the underlying policy rationale behind data portability provisions, centres on the relationship between the citizen and the corporation. The underlying assumption is that the citizen-cum-consumer seeks to maximize his or her utility (measured in terms of consumption benefits but also in terms of gains from privacy and data control) in their engagement with corporations while corporations seek to maximize their profitability in their engagement with consumers. No one has, to our knowledge, considered the implications of these legislative frameworks from the perspective of a citizen who owns, controls, and uses a co-operative that is structured to be responsive to member needs rather than profit maximization.

By way of contrast, policymakers have in some domains, at least, recognized that the nature of the relationship between a co-operative and its member/owners can be very different than that of an investor-owned firm's relationship with its customer. In Saskatchewan, for example, the government has supported the credit union system's efforts to develop their own consumer code of conduct and complaint handling procedure rather than have one imposed by the province. In other jurisdictions like Wisconsin, co-operatives are exempt from market conduct regulation altogether with the understanding that the member as owner has a fundamentally different relationship with their co-operative than that same individual's relationship with a privately-owned firm or an investor-owned corporation. For example, Wisconsin Statutes Section 551.201(8) fully exempts Wisconsin's nearly 860 co-operative businesses from state securities regulation.

6.24 Digital Charters and Corporate Persons

As Meese et al. (2019) underline, the European Union's approach to digital rights is centered, as above, around the right of individuals in the European Union as citizens, with their consumer behaviour being only a derivative concept. This contrasts with the approach taken by Australia, which focuses the relationship on the individual as consumer and, correspondingly, stretches the bounds of data rights to corporate persons. In so doing, the Australian implementation of data portability seems premised, at least on the surface, on the belief that data portability could be a powerful tool to encourage not only individuals but also businesses to engage in switching.

6.25 Maximalist Interoperability

While the maximalist version of interoperability seems to offer some promise of a more purely competitive environment, there is little to no evidence that it has policy traction currently.

6.26 Government Regulation

While the legislative process around Bill C-11 will almost certainly exert some influence over the potential for and shape of any future agricultural data co-operatives in Canada, our review of the literature and the current policy process, especially as it regards data portability rights, shows that it is less clear what exactly that influence could look like. Not only does the federal legislation leave a great deal of work to forthcoming regulations that could be years in the making, but it also appears that that the federal government has not given much if any consideration to extending data portability rights to corporate persons, including incorporated farm operations.

Meanwhile, the budding economic and legal literature around data portability rights suggests that even if these rights are formalized in legislation/regulation or guidance, the potential implications for data co-operatives could range from making it easier for them to come into existence all the way to limiting their options for emergence by locking-in the advantages of incumbents. At a minimum, however, the shift towards enshrining some sort of data portability right is likely to create greater familiarity and perhaps even a cultural expectation that data should not be captive to "walled gardens" (Lessig, 1999).

Instead of waiting for these uncertain processes to play out but knowing that they will eventually, the Canadian farming sector could work with input providers to devise voluntary codes of conduct around data sharing like those discussed earlier in the United States, Europe, Australia, and New Zealand. Furthermore, as a growing literature on the design of regulatory policy suggests (Ayres & Braithwaite, 1992; Sinclair, 1997; Braithwaite, 2006; Gunningham et al., 2002; Sarker, 2013), the choice could be framed less in terms of *either* hard "command and control" regulation or pure laissez-faire "self-regulation," as tradition would dictate, but rather on a continuum, with the evolving policy context playing a decisive role in motivating and framing how voluntary codes come into being.

Even if much of the academic literature struggles with the complexity of practice, policymakers do not always fall into simple dualistic thinking. There is abundant evidence of governments, federal and provincial, sanctioning, enabling and sometimes cajoling industry to adopt voluntary codes over a range of areas depending on where jurisdictional power lies. The federal government for example has supported a broad range of voluntary codes for its federally-regulated banks, including ones over the provision of banking services to seniors, low-income individuals, credit card fees and more (Canadian Bankers Association, 2021). At the provincial level, several provinces support "self-regulation" by credit unions over their market conduct practices (see for example, Credit Union Deposit Guarantee Corporation of Saskatchewan (2019)). Voluntary codes of conduct are not uncommon in the agricultural sector either. The National Farm Animal Care Council (2021) has more than a dozen codes for the care and handling of different types of farm animals listed on its website.

Meanwhile, the federal government has actively encouraged the development of voluntary codes, going so far as to develop a "guide" in the late 1990s on how to create a voluntary code (Industry Canada, 1998). Similarly, the federal government has long supported the Standards Council, which describes itself as a not-for-profit, registered charity, non-agent federal Crown corporation. Its mission is to help industry, government and other stakeholders build standards, sometimes mandatory and grounded in legislation or regulation, other times purely voluntary. Under the heading "agriculture," the Standards Council's database (Standards Council of Canada, 2021) shows 3,080 related standards (in English and French) across a wide range of related activities such as acoustic standards for farm tractors (CAN/CSA-M5131-97 (R2006) to standards around matching of tractor wheels and rear-mounted implements (ISO 7424:1982).

As the academic literature makes clear, however, the creation of voluntary codes or standards rarely happens in a vacuum but rather hinges often on the broader policy context and some kind of threat, real or implied, of government action (Sinclair, 1997). The looming implementation of a legislated and regulatory data portability right could be that real or implied threat, creating the conditions necessary for the sector to come together and negotiate a code of practices or standard around farm data that addresses the interests of operators and input providers. If this were to take place, this code or standard could provide a necessary condition for the creation of data co-operatives.

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APPENDIX

Amazon, Google and Big Ag Data

Large technology companies, such as Amazon Web Services (AWS) and Google, are revolutionizing agricultural data collection and aggregation by developing and applying machine learning, artificial intelligence, predictive intelligence, and cloud computing to agricultural data. AWS and Google are two of the world's three cloud companies (Richter, 2021).

Amazon Web Services (AWS)

AWS has partnered with Bayer Crop Science (Bayer) to develop and aggregate agricultural data through the Internet of Things (IoT) (Amazon Web Services, 2021). German-owned Bayer is the world's second largest agricultural chemical and seed company and is one of Canada's largest suppliers of seed and agricultural chemicals (Chakravarty, 2019). Bayer became the most prominent player in big ag data after the 2016 merger of Bayer and Monsanto, giving the combined company an estimated 52% of the world's agricultural data (Carbonell, 2016; McDonnell, 2014). Data collected by Bayer includes: (1) farmland productivity; (2) seed productivity in certain soils and crop conditions; (3) pesticide and fertilizer efficacy; and harvest data.

Monsanto purchased Climate Corp in 2013. Climate Corp was co-founded by two former Google employees and its 2013 purchase represented Monsanto's first big move into ag data (Upbin, 2013). Now known as "The Climate Corporation", the Bayer subsidiary markets Climate FieldView, which is described as, "[A]n integrated digital agriculture tool that provides farmers with a comprehensive, connected suite of digital tools, providing farmers a deeper understanding of their fields so they can make more informed operating decisions to optimize yields, maximize efficiency and reduce risk (Crunchbase, 2014)."

Bayer's Climate FieldView is marketed in more than twenty countries and collects data on more than 150 million acres of agricultural land (Bayer, 2021). Bayer promotes FieldView as follows:

> "All FieldView users have full control of their farm data. They choose if, how and when to share their agronomic information. If they feel it benefits their operations, farmers can choose to share their insights with a trusted agronomic partner to help make data-driven business

decisions" (Bayer, 2021).

FieldView is available to farmers at no additional cost if they are participating in Bayer Plus Rewards. Otherwise, the cost is $299 US for a FieldView Drive Starter Kit (Climate FieldView, 2020). The Starter Kit includes a device to collect data from farm implements. There are three tiers to the FieldView service: FieldView Prime, Plus and Pro. FieldView Prime is free, while FieldView Plus costs $US 99.00 per year; FieldView Pro costs an additional $US 1.00 per acre. Figure 1 describes FieldView's product features (Connatser, 2021).

Figure 1: Climate FieldView Product Features

Climate FieldView Product Features	**Climate FieldView Prime**	**Climate FieldView Plus**	**Climate FieldView Pro**
Basic Data Layers	+	+	+
Data Inbox	+	+	+
Field-Level Weather	+	+	+
Scouting	+	+	+
Notifications	+	+	+
Field Health		+	+
Manual Scripting		+	+
Yield Analysis		+	+
Data Connectivity		+	+
In-Cab Data Visualization		+	+
Advanced Scripting (new for 2017)			+
Nitrogen Monitoring by Zone (new for 2017)			+
*Available in select locations.			

Source: The Climate Corporation (2021)

Google

Google Ventures is partnered with Farmers Business Network (FBN) (Baron, 2015), a private company founded in 2014 and primarily financed by Google (Agence France-Presse, 2015). FBN was founded in 2014 and is headquartered in San Carlos, California. FBN is an e-commerce platform estimated to earn $60 million per year from "analysis, advice and services on crops and field work" to more than 25,000 farmer members in the United States and Canada, the latter through its FBN Canada subsidiary. FBN's mission is as follows:

> "[T]o create a future of farming that puts Farmers First by democratizing information, providing unbiased analytics and creating competition for farmers' business" (Farmers Business Network, 2014).

FBN co-founder and Vice President of Product Charles Baron describes the benefits to farmers of using FBN as follows:

> "FBN allows farmers to share and review aggregate pricing data on "inputs," as they're called in agriculture, meaning the costly seeds, fertilizers and other chemicals added to the soil to generate a healthy crop.
>
> The FBN platform also allows farmers to upload, store and analyze data coming out of the "agtech" systems increasingly used to monitor weather, crop health, soil quality and irrigation levels in the field. These systems include drones and satellites overhead, mobile apps, sensors and cameras on the ground.
>
> Being able to analyze their own crop data in one report, and compare their results with others', can also help farmers find what's working in terms of new techniques or alternative products on the market" (Kolodny, 2016).

Google is one of FBN's primary investors and has provided financial support in six of FBN's eight financing rounds. Google provided $15 million of FBN's first round of $28 million in financing in 2015 (Agence France-Presse, 2015). Google provided another $60 million in financing in March of 2017, bringing FBN's total capital raised to $194 million, with the Google investment at $75 million (Kolodny, 2016).

The entry of new players like FBN has been noticed by the incumbents. In 2020, the Canadian Competition Bureau announced it is investigating whether anticompetitive trade practices by existing firms have harmed FBN (Sarkar

& Johnson, 2020). Bayer, BASF Canada, Corteva and Cargill reportedly are the primary firms being investigated (Kelloway, 2020).

Google Ventures is also partnering with Winnipeg-based Farmers Edge (Lorenz, 2021). Farmers Edge began operations in 2005 and has been trading on the Toronto Stock Exchange since March 3, 2021 (Nicholson, 2021). According to its securities filings, Farmers Edge markets FarmCommand, a proprietary cloud-based analytics platform (Farmers Edge, 2021). FarmCommand collects data from multiple sources, including weather stations, soil moisture probes, telematics devices on farm equipment, location tracking devices, grain cart weighing devices, soil sampling, irrigation monitoring and satellite imagery. The data are collected to provide farmers with "real-time monitoring and alerts, predictive models, and outcome-based data recommendations" (Farmers Edge, 2021).

Syngenta/ChemChina

Syngenta, a major supplier of seeds, herbicides and pesticides to Canadian farmers, is also involved in agricultural data (Syngenta Canada, 2021; Tully, 2018). Syngenta was purchased by ChemChina in 2017 (Shields, 2008); as of June 1, 2021, Syngenta markets its seeds under the NK Seeds brand (Haney, 2021). ChemChina is the largest agricultural chemical and seed company in the world and is also one of the top three data owners and aggregators in the world (Richter, 2021). Syngenta provides two digital services to farmers: FarmShots and Farm Management Edge (Tully, 2018). FarmShots is software that pinpoints stressed crops through satellite and drone technology, while the Farm Management System allows farmers to track crop profit and loss (Tully, 2018). The importance of agricultural data to Syngenta is best captured by Erik Fyrwald, its CEO, who said, "ChemChina is taking the long view by substantially raising spending on R&D, and by far the biggest increases are going to groundbreaking digital technology (Tully, 2018).

JOHNSON SHOYAMA
Canadian Centre for the
Study of Co-operatives
UREGINA USASK

Diefenbaker Building, 101 Diefenbaker Place,
University of Saskatchewan
Saskatoon, Saskatchewan
S7N 5B8

Ph: 306-966-8509
Email: coop.studies@usask.ca