A Proposed "Agricultural Data Commons" in Support of Food Security

Jeremiah Baarbé
Fellow, New and Emerging Researchers Group, Open African Innovation Research (Open AIR) network, University of Ottawa
https://orcid.org/0000-0002-5360-2975

Meghan Blom
Fellow, New and Emerging Researchers Group, Open African Innovation Research (Open AIR) network, University of Ottawa
https://orcid.org/0000-0001-8858-4546

Jeremy de Beer
Professor, Faculty of Law, University of Ottawa; Senior Research Associate, Intellectual Property Unit, University of Cape Town; and Co-Founder and Director, Open African Innovation Research (Open AIR) network
https://orcid.org/0000-0001-9753-3708

Abstract
This article identifies a data governance model that could help reduce dataset access inequities currently experienced by smallholder farmers in both developed-world and developing-world settings. Agricultural data is globally recognised for its importance in addressing food insecurity, with such data generated and used by a value chain of contributors, collectors, and users. Guided by the modified institutional analysis and development (IAD) framework, our study considered the features of agricultural data as a "knowledge commons" resource. The study also looked at existing data collection modalities practiced by John Deere, Plantwise and Abalobi, and at the open data distribution modalities available under the Creative Commons and the Open Data Commons licensing frameworks. The study found that an "agricultural data commons" model could give greater agency to the smallholder farmers who contribute data. A model open data licence could be used by data collectors, supported by a certification mark and a dedicated public interest organisation. These features could engender an agricultural data commons that would be advantageous to the three key stakeholders in agricultural data: data contributors, who need engagement, privacy, control, and benefit-sharing; small and medium-sized-enterprise (SME) data collectors, who need sophisticated legal tools and an ability to brand their participation in opening data; and data users, who need open access.

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Keywords
agricultural data, open data, institutional analysis and development (IAD), knowledge commons, data commons, data collection, copyright, database rights, licensing, Creative Commons, Open Data Commons, privacy, benefit-sharing, social certification, certification marks

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1. Introduction

Agricultural data is an increasingly vital resource in the advancement and innovation of farmer organisations, food production, agricultural-sector value chain development, and provision of agricultural services (Jellema, Meijninger, & Addison, 2015). Today's farmers can potentially rely on computational and precision agriculture to inform decisions. Datasets such as weather data, market price data, and agricultural input data fuel these tools, which range from simple graphs to emerging artificial intelligence networks (GODAN, 2015). Access to, and use of, such data can play a key role, particularly in developing countries, in addressing global food insecurity by "enabling better decision making, transparency and innovation" (Open Data Charter, 2016). At the same time, however, dataset ownership rights may prevent access to and use of data—a dimension distinct from, yet as important as, farmer access to education, skills, technology, infrastructure, and finances (De Beer, 2016).

Agricultural data is collected through a range of technologies at every point in the harvesting cycle, from modern, commercial operations to smallholder, sustenance farms (see, for example, Carbonell, 2016; Jellema et al., 2015). Sensors in "smart" tractors record GPS, soil, and harvest data. Drones and satellites record land use and productivity data. Weather stations provide meteorology data. Markets generate crop yield data. In developing countries, data collection is often more labour-intensive than in developed-world settings. Intermediary data collection agencies, such as Plantwise, are often involved in reaching smallholder farmers. Projects are developing mobile apps that allow smallholder farmers and fishers to track their own data and contribute to larger data pools. Using technological platforms and applications to capture data requires investment from a variety of stakeholders, and "effective data sharing depends on a strong network of trust between data providers and consumers" (Allemang & Teegarden, 2016, p. 11).

The importance of data for agriculture underscores a growing view that data has replaced oil as the world's most valuable resource (see, for example, *The Economist*, 2017). Accordingly, in complex global markets, unequal ownership of, and unequal access to, agricultural data can exacerbate power inequalities for vulnerable groups (see, for example, Davies, 2015; Ferris & Rahman, 2016, p. 2)—entrenching these inequalities in ways that threaten sustainable development and food security. Most legal rights to data are owned by data *collectors*: entities who invest in collection of data, arrangement of databases, safeguarding of confidential information, and related activities. The lack of enforceable data rights ownership by certain communities who are data *contributors*—e.g., smallholder farmers in both the developed and developing worlds—is an important economic and ethical issue. Current models for access to open data leave many stakeholders vulnerable to the whims of collectors. Meanwhile, expansion of ownership rights to protect individual or community data contributors has the potential to cause significant complications for the collector intermediaries that practise and promote open data. Accordingly, there needs to be a shift towards encouraging the growth of innovative, sustainable, and equitable data governance platforms that allow for all stakeholders involved to receive benefits (see Frischmann et al., 2014, p. 11), including not only the data contributors and collectors, but also the data *users*.

The article seeks to identify a governance model that could help reduce dataset access inequities currently experienced by smallholder farmers. We used Ostrom's (1990) institutional analysis and development (IAD) framework, as modified by Frischmann, Madison, and Strandburg (2014) and Frischmann, Madison, and Strandburg (2017), to examine features of agricultural data as a "knowledge commons" resource. We also looked at the data collection modalities practiced by John Deere, Plantwise, and Abalobi; at the Creative Commons and the Open Data Commons frameworks for open data licensing and distribution; and at the social certification practices of Fairtrade International (n.d.). Through this study, we arrived at a model for an

"agricultural data commons" fostered by a licence that could be used by data collectors to make their datasets open. We propose that governance of this agricultural data commons would be supported by a certification mark and a dedicated public interest organisation.

Given the status of data as a key global resource, the data commons we propose could apply beyond agriculture to many other sectors. However, agriculture is a particularly fitting locus for a data commons, given agriculture's role as the birthplace of the commons and as the site of certification programmes such as the Fair Trade movement. The field of agriculture also provides illustrations of data's important geopolitical dynamics.

2. The notion of an "agricultural data commons"

The IAD model, developed by Ostrom (1990) and modified by Frischmann et al. (2014) and Strandburg et al. (2017), provides a theoretical framework that can be deployed to interrogate and understand systems of data governance in relation to their potential "knowledge commons" attributes. Knowledge commons models are ones in which knowledge and information resources are shared to produce creative and innovative products (Frischmann et al., 2014, p. 5). The knowledge commons orientation, according to Frischmann et al. (2014, p. 11), builds on the "growing realization that legal facilitation of innovation and creative production cannot be confined to a simple set of property rules to incentivize individuals to innovate".

Instead of expanding or contracting ownership rights, the commons evokes the need for mutual responsibility towards data as a shared resource. A data commons views the actors who provide, collect, clean, interpret, and use data as stakeholders. A stakeholder approach acknowledges that actors are involved in *both* inputs and outputs. In the field of agricultural data, farmers contribute; governments, large private-sector firms, large non-profit entities, and small and medium-sized-enterprise (SME) intermediaries collect; and users develop new insights. Each input is necessary to produce useable data and derive benefit from it. Legal and institutional mechanisms are needed to enable a data commons, and commons mechanisms need to recognise the contributions of all stakeholders and distribute rights in ways that reinforce participation in the commons.

The Frischmann et al. (2014) modified IAD model for understanding the dynamics of a knowledge commons calls for interrogation of five aspects:

- background of the resource;
- characteristics of the pooled resource and the technologies and skills needed to create, obtain and maintain the resource;
- members and their roles;
- governance mechanisms, such as intellectual property (IP) rights; and
- benefits and costs of participating in the knowledge commons.

In the remainder of this section 2, we explore the characteristics of a potential agricultural data commons in terms of the five IAD elements just listed. We adapt the framework for the agricultural context in a way similar to the adaptation by Strandburg et al. (2017) for the medical context, including highlighting, as Strandburg et al. (2017) do, the "social dilemmas" to which the data commons could respond.

Background of the resource

The modern story of data begins in 1989 when Berners-Lee proposed a world wide web of data. The emergence of Web 2.0 platforms in 2007 led to a market for data as companies like Facebook built business models based on user-created content (O'Reilly, 2007) and, eventually, on use of customer data to drive advertising and targeting of user preferences. Most recently, artificial intelligence and the internet of things have emerged as disruptive technologies that rely on extremely large sets of linked data (Ashton, 2009; Jordan & Mitchell, 2015).

As the market for data grows, there are increased concerns around privacy. Burners-Lee (2017) recently warned that data-for-service models are vulnerable to a loss of trust among users, who are starting to seek control over their data. While large data-driven companies seek to insulate themselves from the effects of user mistrust by ensuring their services are indispensable, SMEs stand to suffer as data-sharing norms change.

Based on recognition of the value and importance of access to data, the open data movement formed, growing out of the open access and open science movements (De Beer, 2017b). Open data is data that can be accessed, used, or shared by anyone (Open Data Handbook, n.d.). By making data publicly available and accessible, open data can foster innovation, enable more efficient decision-making, and facilitate creative use of information. In turn, such use can generate new forms of public value by improving policymaking on pressing challenges facing the global community—such as, in the context of this study, growing food insecurity. A data commons comprising accessible and usable open data can foster transparency and collaboration among stakeholders, which can, in turn, foster new discoveries to help sustainably address the problems of feeding a growing population (Carolan et al., 2015). For example, open data can be used to identify and develop solutions to problems of pest infection or drought. The benefits of open data are well understood, with McKinsey valuing the global economic potential of open data at USD3 trillion a year (McKinsey, 2013).

Characteristics of the pooled resource

The nature of data can vary. It is shaped by cultural and institutional norms,and can take many forms, including: "big data", such as real-time or census data; and more qualitative data, including satellite images, pictures, texts, or maps. Data is generally technological in nature, created through the application of techniques to capture and represent characteristics of phenomena (De Mauro et al., 2016, pp. 123–125). The

term "data" is often used to refer to both discrete information about a phenomenon and sets of information compiled in databases. As a resource, data is characterised by the intersection of depletable phenomena and renewable knowledge (Manovich, 2012). The events being captured and the methods of capturing data are tangible and limited. When the events are located on farmers' fields, the resource inputs are rival, meaning that only those farmers can collect data. But once data is captured in a digital format it becomes an intangible resource and easily copied.

Data is created by persuading contributors, including communities of contributors—e.g., for the purposes of this study, communities of smallholder farmers—to provide access to phenomena of interest (De Beer, 2016, p. 11). Organisations playing the role of collectors then invest in the collecting, selecting, and aggregating of the data. By doing so they generally create ownership rights in the datasets they aggregate. The data contributors, meanwhile, tend not to have enforceable rights to the data sets developed by the collectors, generating inequality and marginalisation (De Beer, 2016, p. 14)—as the contributors become vulnerable to the whims of the collectors who own the data. In order for the data to yield benefits for contributor groups, there must be a configuration of the data governance structure that allows for equitable appropriation of, access to, and use of, the data.

Agricultural data includes information about weather patterns, soil attributes, crop yields, the occurrence and spread of diseases and pests, and supply-chain data (see Allemang & Teegarden, 2016, p. 6). Precision agriculture offers farmers the ability to use data gathered from their fields to make informed decisions. (Stakeholders can also compile data into pooled databases for uses that include policy creation, business intelligence, supply chain management, scientific research, and the development of new applications and technologies.)

The members of the commons: Contributors, collectors, users

As stated above, we start with three key categories of stakeholders—*contributors*, *collectors*, *users*—participating in communities of data production and use. In other words, these are some of the key members in any potential data commons. Manovich (2012), writing in the context of big data as a sociological and digital humanities research tool, describes a similar taxonomy of stakeholders in data communities, writing of "those who create data (both consciously and by leaving digital footprints), those who have the means to collect it, and those who have expertise to analyze it" (2012, p. 460).

Our model proposes three categories of stakeholders: data contributors provide access to the phenomena being captured; collectors gather data and make it available; and users use data to gain insights, develop applications, and make decisions. In the context of agricultural data, the contributors are often farmers. The collectors, who can be governments, private-sector firms, large non-profits, or SMEs (including social

enterprises), are typically the legal owners of the data and are responsible for opening access through licensing (De Beer, 2016, p. 14). Through their use of technology and application of intellectual property (IP) law, collectors hold proprietary ownership rights to the data collected, including the right to appropriate value from data. Even when collectors offer open access, their ownership rights allow them to choose to publish partial datasets, meaning contributors are not able to fully share in the benefits of the data they provide.

The three categories of stakeholders we have set out may not be exhaustive. For example, those who rely on agricultural products as inputs (e.g., seeds) or outputs (e.g., food) may also impact, or be impacted by, the governance of agricultural data. Whether such stakeholders should be considered members of the commons *per se* is debatable, but spillover effects and overall social value are regardless useful to consider.

Governance mechanisms

A number of (often overlapping) legal mechanisms contribute to the bundle of property rights in data (De Beer, 2016, p. 8). Possibly the most important of these rights for access to data are the exclusive rights under copyright, which include the rights to publish, copy, and circulate. A data commons must also account for other potential rights in data, including *sui generis* database rights, personal privacy rights, and rights to protection of confidential information. Also relevant to governance of data in a commons are technological systems and social norms.

Copyright protects the original expression of ideas. Applied to data, copyright can exist in original compilations of data, such as databases. Copyright protects the structure of databases and specific combinations of data. The World Trade Organisation (WTO) Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) requires its member countries to provide protections to works that are sufficiently original (WTO, 1994). The originality standard for granting copyright in a compilation of data varies from country to country, but most require some level of creative input. Within a data commons, copyright favors collectors as the members from which the database originates.

Although the data within a compilation, broadly described, may include copyrightable works (e.g., a database of satellite photos for determining land use), most agricultural data falls in the category of facts or ideas, which do not enjoy protection in and of themselves. The European Union and Mexico offer *sui generis* database rights in non-original databases that are not otherwise copyrightable. European "manufacturers" that make "substantial investments in either the obtaining, verification or presentation of the contents" enjoy a 15-year right to prohibit the reuse or extraction of substantial parts of the contents of the database (Directive 96/9/EC of the European Parliament, 1996). Mexican law provides a five-year protection for non-original databases. These

unique database rights have not gained the international traction hoped for by policymakers. In a 10-year review in 2005 of the 1996 EC Directive on databases, the EU noted that "the new instrument has had no proven impact on the production of databases" (Commission of the European Communities, 2005).

Privacy rights are not property rights, but they are an important governance mechanism that can provide stronger protection for contributors (see, for example, Lessig, 2002; Samuelson, 2000; Warren & Brandeis, 1890). Privacy rights give contributors some control over how their personally identifiable information is used. The principle of informed consent guides privacy law. Contributors must consent before collectors can gather and use identifying information. Consent often occurs when contributors, via user licences, provide access to their personal data in return for access to software or other services. There are no global instruments governing privacy rights, and laws vary greatly between jurisdictions. Privacy is a necessary part of a data commons, but privacy rights alone are not sufficient to provide for the needs of contributors in a data commons—because much valuable agricultural data is not the kind of personally identifiable data that privacy rights protect.

Protection of confidential information, i.e., trade secrets, offers some of the strongest control over data. Just because collectors own the rights to a dataset does not mean they are under an obligation to provide access to the data. Instead, databases within the control of collectors can be kept confidential, with legal consequences should the data be released. The TRIPS Agreement provides that "[n]atural and legal persons shall have the possibility of preventing information lawfully within their control from being disclosed to, acquired by, or used by others without their consent in a manner contrary to honest commercial practices" (WTO, 1994, art. 39(2)).

Data is typically made available via licensing contracts. Creative Commons and other standard open data licences are available to collectors that hold rights to data. These licences allow collectors to authorise the use of some or all of their rights, including: copyright in data; and copyright and *sui generis* rights in databases. While standard open data licences address the needs of collectors and users, these licences do not address the needs of contributors.

It is important to recognise the limitations of licensing as a governance mechanism in an agricultural data commons. While licences are very useful for transferring rights—e.g., giving someone the right to use a database—licences cannot be used to create rights (De Beer, 2016, p. 11). For example, a licence cannot create ownership rights for contributor data where copyright in the data does not exist. This confusion is sometimes seen in contracts where collectors tell contributors that the contributors "own" their data. In reality, contributors seeking to enforce ownership rights in their data would find that no ownership rights exist. However, certain clauses in a licence can be useful in an agricultural data commons, by creating enforceable norms,

between parties, that meet the needs of contributors and achieve goals similar to those of ownership.

Benefits and costs of participating

The modified IAD model draws attention to several social dilemmas, including: the potential for conflict between data collectors and contributors, coordinating the allocation of benefits from pooled data, and the need to aggregate data efficiently (Strandburg et al., 2017).

As shown above, contributors are essential to the continued existence of data as a resource. However, current data governance mechanisms risk alienating contributors by focusing data collection responsibilities and risks on contributors without sharing benefits. Discussions around agricultural data have not adequately grappled with the most contextually appropriate norms of reciprocity. For example, should an agricultural data commons operate on a give-and-take model or a pay-it-forward (i.e., users also contribute) model?

Carbonell (2016, pp. 2, 6) describes how the power divide between data contributors and collectors creates risks for farmers and results in coercive data collection tactics. As smallholder farmers come to understand these risks, they may withdraw from data collection or seek open access options that meet their needs. The relationship between contributors and collectors is typically asymmetric, and is certainly so for smallholder farmers in the Global South. This "big data divide" (Andrejevic, 2014, p. 1674) exists because collectors have the technical expertise, storage and processing facilities, and legal sophistication to obtain and use the data. A 2014 survey conducted by the American Farm Bureau Federation highlights some of the concerns farmers have with data collection:

> Fully 77.5% of farmers surveyed said they feared regulators and other government officials might gain access to their private information without their knowledge or permission. Nearly 76% of respondents said they were concerned others could use their information for commodity market speculation without their consent. (American Farm Bureau Federation, 2014)

These figures may reflect misunderstanding of the nature of privacy rights in aggregated data about unidentifiable persons. Respondents may be confusing invasions of personal privacy with control over confidential commercial information. This survey of 3,380 US farmer found that many farmers believed they owned their data—contrary to the legal reality, explained above with reference to De Beer (2016, p. 14), that collectors, not contributors, typically own agricultural data. The American Farm Bureau Federation survey reported that "more than 81 percent believe they retain ownership of their farm data", yet more than 82% were unaware of how

collectors intended to use their data. Again, the statistics may reflect misconceptions about data ownership (American Farm Bureau Federation, 2014). Nonetheless, such concerns are also felt by developing-world smallholder farmers, who are often skeptical of large multinational corporations.

Data collectors often rely on contracts of adhesion to license their activities. Contributors are required to agree to the collectors' terms, if they want to participate in the relationship or service, on a "take-it-or-leave-it" basis without room for negotiation (Goodman, 1999, p. 319; MacLean, 2017). Contracts of adhesion are common within consumer— particularly technology and software development— sectors because they create legal certainty and enable collectors to scale up their collection efforts.

Data contributors need to be engaged both in the creation of licences and in the development of data collection and management technologies. The American Farm Bureau Federation has done considerable lobbying on data privacy, including two surveys of its members (see American Farm Bureau Federation, 2014; 2016). The Federation has:

- built a consensus around Privacy and Security Principles (Basic Knowledge 101, 2014) among precision agriculture companies, including John Deere and Monsanto's Climate Corporation;
- founded the Agriculture Data Coalition (2017), a non-profit data platform "based on data owner permission"; and
- founded Ag Data Transparent (n.d.), which evaluates and certifies companies' contracts across 10 criteria of transparency, simplicity, and trust.

Although admirable, these efforts are solely focused on developed-world large-scale American industrial agriculture. There is also a need for data collectors to engage with the concerns of small-scale data contributors and smallholder farmers, in both the developed and developing worlds, who tend to be vulnerable and at great disadvantage when dealing with sophisticated firms (Ferris & Rahman, 2016, p. 9).

Privacy is widely recognised as a fundamental human right (e.g., UN Universal Declaration of Human Rights, 1948, art. 12). The rise of computational agriculture has created a number of privacy concerns that affect farmers. Because data lasts indefinitely, exposure to the risks of privacy breaches can compound over time. A majority of the large-scale industrial farmers participating in the 2014 and 2016 American Farm Bureau Federation surveys echoed these concerns. Meanwhile, smallholder farmers and indigenous communities are especially vulnerable because data breaches may reveal valuable traditional knowledge (Ferris & Rahman, 2016, p. 9).

Where personally identifiable information is concerned, the need for privacy extends beyond the need for protection of data to the ability to know and control who has access to data, to retrieve and share data, and to have data deleted on request. These control mechanisms have been widely recognised as needed by agribusinesses, a number of which have agreed to implement the mechanisms in their contracts with farmers (Basic Knowledge 101, 2014). These principles of privacy and control also form the basis of analysis used by Ag Data Transparent (n.d.).

We found, in our examination of the Abalobi experience with fishers in South Africa (see section 3 of this article), strong awareness of the need for data privacy controls. An Abalobi interviewee (personal communication, 2017) partially attributed high user satisfaction with, and retention of, Abalobi to its data privacy policies.

A healthy commons is one that motivates collective action by distributing costs and benefits across its members (Ostrom, 1990, p. 39). The American Farm Bureau Federation survey (2016) reported that "66 percent of farmers said it was extremely important or important that they share in potential financial benefits of their data" (p. 1). In the developing world, startups are building services around the need for benefit-sharing from data. US-based Farmobile (n.d.a; n.d.b) allows farmers to collect their own data for sale in a "Data Store" marketplace. The store allows farmers to sell single-use data licences to third parties. The licences' terms and conditions make compensation mechanisms and requirements clear, including the USD-per-acre compensation rate for data (Farmobile, n.d.a, p. 1). However, the Farmobile marketplace was, at the time of our research, limited to 500 corn and soybean farmers in the US, and contributors had to meet certification requirements to ensure the accuracy of their data.

Benefit-sharing is about more than just direct compensation. Potential benefits to be derived from agricultural data include: new fields of research, greater efficiencies in supply chain management, and new applications and artificial intelligence products built on the data. Many farmers and fishers already benefit from open data or shared data. Data collected by Plantwise is empowering research on the scope and spread of plant-based diseases (see Hirschfeld, 2017). Global Open Data for Agriculture and Nutrition (GODAN) reports on open data success stories in which open data is driving agricultural innovations (Compton, 2016; 2017), with examples including: SMART!, software that uses open data to help farmers across the world with fertiliser management; and eLEAF, a service that uses open satellite data to help farmers in South Africa lower water consumption and increase fruit production in orchards (Compton, 2016, pp. 8, 14). Demonstrating such benefits to potential data contributors can be a powerful motivator for data-sharing (Allemang & Teegarden, 2016, p. 7).

Although opening up access to data may appear to be in conflict with privacy, these concerns can be addressed by aggregating and anonymising data, and by showing contributors the value of opening data. Respecting principles of privacy and control, collectors who plan to open data should obtain consent via licensing, which we cover later in this article in section 4.

3. Relevant models of data collection and governance

In an agricultural data commons, the characteristics of the pooled resources would, for the reasons provided above, need to largely be determined by the decisions of the collectors of the data. Data-collecting actors are characterised by: differing business models; differing levels of legal sophistication; differing methods; differing approaches to data access; and differing relationships with their contributors and users. For our study, we examined three entities that collect and pool agricultural data and two entities that provide governance mechanisms that can be used to facilitate a data commons. We examined each entity's approach to data in terms of the five aforementioned elements of the Frischmann et al. (2014) modified IAD model: background of the resource; characteristics of the pooled resource; members and their roles; governance mechanisms, and costs and benefits of participating.

Examples of entities collecting data

The three entities engaged in collection of agricultural (or, in the case of Abalobi, fisheries) data that we looked at were:

- John Deere, a large US-based agribusiness;
- Plantwise, an NGO that works with smallholder farmers; and
- Abalobi, a social enterprise developing catch solutions for fishers in South Africa.

John Deere

John Deere collects agricultural data from farmers using its precision agriculture systems.

Background of the resource

The US-based agricultural machinery manufacturer John Deere (Deere & Company, n.d.a, n.d.b) is a pioneer and leader in the collection of agricultural data. John Deere began developing GPS-guided tractors in the mid-1990s (Liebhold, 2018; Stone et al., 2008). By 1997, it had launched its GreenStar Precision Farming System, proclaiming in a marketing brochure that "information is your new crop" (Liebhold, 2018).

Characteristics of the pooled resource

Precision agricultural data collected by John Deere is not publicly available. Instead, the data is held privately by John Deere, which collects and processes the data as a service to its customers. Customer farmers are only able to access the data gathered,

by the farm machinery and field-monitoring stations, on their farms. John Deere, meanwhile, has access to the complete pool of data from all its customer farmers. John Deere uses trade secrets and contractual mechanisms to maintain its proprietary control over this pooled data (Deere & Company, n.d.c, p. 4).

Members and their roles

Customer farmers enjoy, by contract, some control over the data generated on their farms. Depending on the services and applications they subscribe to, John Deere's customers can view their data via various tools giving them "real-time information about crop yield, moisture content, or seeding singulation and population, from the seat of their tractor" (Deere & Company, 2015, p. 11). Customers control whether third parties can access their data.

To the extent that farming communities' norms over the use and control of data differ from those of John Deere, there may be circumstances in which the differing norms affect the communities' relationship with the company. For example, on the issue of right-to-repair, John Deere has resisted the community norm of farmers repairing their own equipment—in favour of proprietary control over software and diagnostic tools (see for example Bartholomew, 2014).

John Deere's core objective in gathering this pool of data is to develop new products and services, particularly in the areas highlighted in its 2018 Annual Report: "artificial intelligence and machine learning" (Deere & Company, 2018). One of the first indications of John Deere's intentions to develop artificial intelligence was its USD305 million acquisition of Blue River, a company specialising in computer vision and machine learning (Deere & Company, 2017). John Deere's *Annual Report* for 2018 highlights the firm's expectation that artificial intelligence will reshape its industry.

Governance mechanisms

The primary governance mechanism used by John Deere for the data it collects from customers is a non-negotiable contract of adhesion. Farmers who wish to benefit from the data generated from their fields must agree to a Data Services and Subscriptions Statement (see Appendix A of this article) and contribute to John Deere's pooled data. The contract only applies to a limited number of countries, including the US, Canada, Australia, and South Africa. Contracts that apply to other countries have lower data and privacy protections (see, for example, Deere & Company, 2014).

In respect of privacy, John Deere's Data Services and Subscriptions Statement emphasises ownership and control of data, saying "YOU CONTROL YOUR DATA" (Appendix A). The Statement defines control over data as the ability to share data with others, to manage production data and some forms of machine and administrative data, to export production data, and to delete and amend data.

At the same time, the Statement is clear that John Deere is allowed to collect, and make its own use of, contributor data. It authorises John Deere to collect production data, machine data, and administrative data, and to use data to provide services, to develop and improve products, to market to consumers, and to comply with requests from government and regulatory agencies.

Costs and benefits of participating
This contract of adhesion creates the potential for a social dilemma (Strandburg et al., 2017). John Deere uses the contract to maximise their access to data as a resource. Contributors agree their data can be included in anonymised datasets, and that John Deere has proprietary ownership of this anonymised data.

Farmers, whom John Deere relies on to contribute data, are unable to access or benefit from this pooled data. This situation becomes a dilemma if farmers realise that the cost of losing access and control over their pooled data outweighs the benefits of John Deere's precision agriculture platform. Farmers in this situation, who do not wish to contribute to the pool, must stop using John Deere's data products. At scale, such a realisation would threaten John Deere's access to pooled data as resource.

Plantwise
Plantwise collects data on pests and diseases from smallholder farmers and provides them with plant health advice.

Background of the resource
Plantwise (n.d., 2017) is a global NGO founded by the Centre for Agricultural and Biosciences International (CABI), based in Oxfordshire, UK. Its stated mission is to reduce crop loss by giving plant health advice to smallholder farmers. Working in 34 countries, with a focus on the developing world, Plantwise has established 3,700 plant clinics and trained over 10,000 plant doctors to diagnose and treat crop ailments. These clinics generate data about the prevalence of pests and crop diseases.

Characteristics of the pooled resource
Plantwise collects data each time a farmer meets a plant doctor at a Plantwise clinic. When compiled, this data provides a frontline view of emerging pests and disease outbreaks. Although Plantwise's data pool is non-rivalrous—multiple people can use the data at one time—it is nationally sensitive and excludable, because information about the spread of pests and crop diseases can affect trade relations and markets and thus cannot be widely shared. Plantwise's relationship with its partner countries is based on the understanding that each country owns the data collected within their borders (Plantwise interviewee, personal communication, 2017).

Members and their roles
Farmers bring plant samples into Plantwise clinics, often located in local marketplaces. Plant doctors examine the plants and prescribe recommended treatments. During this process, the plant doctors, who are often government extension workers, collect data by filling out a diagnostic form, often completed electronically on handheld digital tablet devices (Plantwise interviewee, personal communication, 2017). After the data is recorded, it is transferred to a central processing facility where it goes through a process of harmonisation and validation to ensure accuracy, before being analysed and stored in the Plantwise Online Management System (Sluijs, Posthumus, & Katothya, 2017).

Governance mechanisms
Plantwise does not seek explicit permission from farmers to collect data, but farmers see the data collection process taking place. Plant doctors are trained to discuss issues of data privacy and ownership with farmers.

Plantwise uses institutional and technological mechanisms to govern data collection and use (Sluijs et al., 2017). Institutional mechanisms include the relationships Plantwise has developed with partner countries and the programmes it has developed to train its data collectors. Technological mechanisms include the processes Plantwise has developed to process, clean, validate, and store data as it is collected. Another technological mechanism Plantwise administers is the access controls used to permit authorised users—often local government extension agents—to access data and reports (Sluijs et al., 2017, p. 17).

Costs and benefits of participating
Government agencies use Plantwise data to develop agricultural policy and to respond to pest and disease outbreaks. Farmers see some indirect benefits from the data, as it is used to train plant doctors and fine-tune their diagnoses. The data also contributes to the publicly available Plantwise Knowledge Bank, which contains information on identifying and treating plant diseases (CABI, n.d.). Farmers using Plantwise clinics have reported improved crop yields and increased income. For example, tomato yields in Malawi were found to be 20% higher for clinic users than for non-users (Bett et al., 2018, p. 15).

However, the national security implications of the data introduce a social dilemma of resource availability: limited access may prevent users from fully exploiting the pooled data for insights and further benefits. Plantwise has explored opening the data to select partners and researchers, but to do so requires the consent of each government, which has been challenging (Plantwise interviewee, personal communication, 2017).

Abalobi

Abalobi collects data on South African small-scale fisheries while providing business management tools to fishers.

Background of the resource

Abalobi (n.d.a) is a non-profit social enterprise that provides South African fishers with a suite of applications (apps) to track, manage, and sell their catches. Abalobi's products aim to help fishers build small businesses or form fisher cooperatives. At the same time, South African science, conservation, and planning entities have expressed interest to Abalobi in the collected data on the country's small-scale fisheries (Abalobi interviewee, personal communication, 2017). The apps could provide a way to connect the scientific community with local knowledge while still respecting the rights of fishers, who tend to be skeptical of institutions (Abalobi interviewee, personal communication, 2017).

Characteristics of the pooled resource

The apps are published on an open source basis, allowing other developers to build on them. Fishers wanting to use Abalobi must first register for the service. On registering, the fishers are asked to agree to Terms of Use (see Appendix B of this article) that detail access to and use of contributor data. Once registered, the fisher receives access to the Abalobi suite of apps. These apps include the Fisher app, offering a personal logbook and weather portal that can help fishers stay safe at sea; the Monitor app, for logging catches at the landing site; the Manager and Co-op apps, providing real-time fishery data and fleet management; and the Marketplace app, connecting fishers to markets and also enabling generation of "social stories" about the products. The pooled data generated by these apps can provide the aforementioned scientific, conservation and planning entities with a range of useful data, including the size and location of catches, which might otherwise go unreported.

Members and their roles

Three groups are involved in the pooled resource. First, the fishers are the data contributors, provide fishery data while using the apps. Second, Abalobi serves as the data collector. Third, universities, research facilities, and government entities such as the South African Department of Agriculture, Forestry and Fisheries (DAFF), comprise potential users of the data.

Governance mechanisms

Abalobi asks fishers to agree to its Terms of Use before using its apps. The Terms of Use promise to treat contributor data "with the utmost of privacy" (Appendix B). While fishers must agree that Abalobi staff can access data to maintain and improve the system, fisher data is not shared with third parties without consent. At the point of sign-up, contributors are asked whether they agree to share their data with specific

third parties: the DAFF and local fisher assistants—who work for cooperatives of fishers. Contributors are able to separately choose to share their data with either of the third parties. Abalobi understands this consent to mean that its staff would have to obtain new permission to use the data for other purposes, including other forms of research (Abalobi interviewee, personal communication, 2017).

Abalobi's development was guided by its need to address a social dilemma. The organisation found that fishers generally did not trust the government to work in their interests and were skeptical of how their data might be used (Abalobi interviewee, personal communication, 2017). As a result, Abalobi designed its app to emphasise the fishers' data ownership—and securing of fishers' consent before releasing data to third parties. Fishers who use the apps can choose whether or not their data is part of the pool shared with third parties. Only Abalobi fishers who consent to data-sharing become contributors to the pooled data. Through working with the fishers in co-design of its apps, Abalobi was able to identify the need to engender trust (via transparency and informed consent) as crucial to having fishers adopt its applications and agree to share data (Abalobi interviewee, personal communication, 2017).

Costs and benefits of participating

The primary benefits of Abalobi's apps are the service and information components available to fishers. Because data-sharing is optional and fishers are understood to own their data, fishers are able to receive the benefits of using the apps regardless of whether or not they agree to share their data with third parties.

At the time of our research in 2017, Abalobi did not publish or provide open access to fisher data. According to the Terms of Use, Abalobi can publish aggregate data without seeking further permission from fishers (e.g., "total kg Snoek catch recorded in South Africa in Nov 2016"). However, Abalobi does not interpret the relevant clause in the Terms of Use as allowing it to publish open data (which it had not yet done at the time of our research) without first obtaining further permission from the fishers who use its apps.

Abalobi makes one exception to its policy of making data-sharing optional. Fishers who wish to use the Market app to sell fish must consent to sharing data with third parties, but only on the marketplace. In addition to connecting fishers to buyers, the app allows fishers to attach "social stories" to their catches by identifying where and when fish are caught (Abalobi interviewee, personal communication, 2017). Fishers are able to use these "social stories" to sell their catches at a higher price, which can help demonstrate the value of sharing data.

Examples of entities that facilitate open data governance

We also examined two entities that facilitate the governance and distribution of pooled data:

- Creative Commons; and
- Open Data Commons.

Creative Commons

Creative Commons provides a suite of licences that allow copyright owners to authorise the use of their protected works while imposing conditions on how the work is used, such as requiring attribution, limiting the distribution of derivative works, and preventing use in commercial projects (Creative Commons, n.d.a).

Background of the resource

Creative Commons offers copyright owners a way to make their works publicly available while reserving some rights (Creative Commons, n.d.a). The Creative Commons (n.d.b) organisation enables a commons by maintaining and updating six different licences that copyright owners can apply to their works (Creative Commons, n.d.c). Creative Commons is an active supporter of the open data movement and many organisations, institutions, and governments publish their works under the Creative Commons licences (Creative Commons, n.d.d).

Characteristics of the pooled resource

Copyright owners had, as of 2017, collectively published over 1.4 billion works under a Creative Commons licence (Creative Commons, 2017). Works licensed under Creative Commons are public goods in that they are both non-rivalrous and non-excludable to an extent—anyone can freely access and use the works without limiting the ability of others to use the works. The success of Creative Commons demonstrates that copyright holders receive value from sharing their works when they are able to retain rights to attribution, distribution, and commercial use (Lessig, 2004).

Members and their roles

Creative Commons depends on copyright owners choosing to make their works publicly available. In the context of agricultural data, collectors may choose to use the Creative Commons licence to make their data available to users. Many collectors, including the global private-sector agribusiness firm Syngenta (2017), use the Creative Commons licences to open their data to the public.

Governance mechanisms

Data can be licensed using version 4 of the Creative Commons licences, which have broad application, covering rights in databases and, when applicable, rights in the data itself. The version 4 licences cover rights held via both copyright and, when applicable, *sui generis* database rights. Creative Commons (n.d.e) offers six different distribution

licences, which are characterised by stackable rights. The most permissive licence, the Attribution (CC BY) licence, allows any use as long as there is attribution of the source. The least permissive licence, the Attribution-NonCommercial-NoDerivs (CC BY-NC-ND) licence, requires that the user provide attribution, not make commercial use of the work, and not make derivatives of the work. The other four licences fall in between these two licences in terms of permissiveness.

Each of the licences has its own logo composed of a set of graphical marks that visually indicate the responsibilities associated with using the content, i.e., a mark for Attribution, a mark for NonCommercial, and so on. Creative Commons licences have a "three-layer" design (n.d.e) that makes them easy to use and have contributed to their success. The licences' legal language is supported by a human-readable layer that is easy to understand, and by a machine-readable layer that lets software (e.g., Google Image Search) understand what licence has been applied. Creative Commons has developed a licence wizard that makes it easy for owners choose a licence.

Costs and benefits of participating
One of the benefits of using Creative Commons is the degree of control that copyright owners have over how their works are licensed. This layering of licences allows them to be adapted to a broad range of use cases. For example, copyright owners (i.e., data collectors, for the purposes of this study) can choose whether or not to allow the data to be used for commercial purposes.

Open Data Commons
The Open Data Commons provides three licences that allow the owners of copyrighted databases to authorise the use of their databases while still retaining and limiting certain rights.

Background of the resource
The Open Data Commons (ODC) seeks to "provide legal solutions for open data" (Open Data Commons, n.d.). The licences are hosted by an Advisory Council made up of legal and subject-matter experts who draft and manage the licences. The most recent update to the licences occurred with the publication of the ODC Attribution License (ODC-BY) in 2010 (Hatcher, 2010). An organisational email discussion list was last active in November 2018 (odc-discuss, n.d.).

Characteristics of the pooled resource
The ODC organisation does not provide statistics or usage rates for its licences, which may be attributed to the lack of a machine-readable layer in the licence's design. Like the Creative Commons licence, the ODC licences are non-rivalrous—anyone can use the licensed databases without limiting other uses. The ODC licences, however, exclude certain rights that are granted by Creative Commons. Specifically, the ODC licences only provide access to *sui generis* database rights and copyrights held in the

structure of databases (e.g., organisational fields and tables), and not to the content of the database being licensed (e.g., crop yield data).

Members and their roles
Data collectors are the primary members of the Open Data Commons. They must choose to use the ODC licence to make databases publicly available. Data users may find that ODC-licensed databases are less usable, if they are concerned about rights to the data inside licensed databases. Data contributors are not involved in ODC licensing because copyright in database structures are wholly owned by collectors.

Governance mechanisms
Open Data Commons offers three licences to data collectors wishing to make their data open: an Attribution License (ODC-BY), an Open Database License (ODbL), and a Public Domain Dedication and License (PDDL). Similar to the choices under the Creative Commons system, data collectors can choose whether they wish to put their databases in the public domain, or to limit certain rights such as: requiring attribution, requiring sharing under the same terms of use, and/or allowing adapted works. All three licences are version 1, and include both a human-readable summary as well as the legal licence but not a machine-readable version. A graphical mark is not offered; instead, the licences are applied through a textual statement.

Costs and benefits of participating
The ODC licences offer a useful tool for sharing information about data structures. Collectors may benefit from being able to exclude copyright to data—which may or may not exist—when licensing their databases. However, these exclusions may limit the usefulness of ODC-licensed databases for users of agricultural data. Another potential risk to using an Open Data Commons licence is the organisation's lack of activity since 2010. Copyright law is not static, and data collectors would be wise to ensure that the licence continues to adequately meet their needs.

4. The need for a model licence, certification mark, and organisational support
Successful creation of an agricultural data commons would, in our analysis, require a model back-to-front licence, and a certification mark, both supported by a public interest organisation and its supporting community.

Model licence
A model back-to-front licence would consist of two linked licences covering the two main relationships in the agricultural data commons. The first of the two linked licences, for data collection, would be between data collectors and data contributors. The second licence, the distribution licence that would make the data openly available, would be between data collectors and data users. (The distribution licence would fulfil the assurances of privacy, control, and openness made in the collection licence.)

A model back-to-front licence for agricultural data collection would help data-collecting SMEs to meet their legal obligations and would address the related social dilemmas of: how to avert conflict between contributors and collectors; and how to coordinate apportionment of benefits between contributors, collectors and users. Abalobi, for example, expressed a need for sophisticated legal solutions that will help them to manage their relationships with contributors and users (Abalobi interviewee, personal communication, 2017).

The findings of our study suggest that the model back-to-front licence must have several key characteristics. First, the licence should balance the needs of all stakeholders. This balancing can be achieved by, among other things, providing tools to help data collectors engage with contributors, users, and other stakeholders. These tools could include model terms of use statements, model licences, and other resources detailing best practices for engaging stakeholders.

Second, the licence should be modular. The Creative Commons and Open Data Commons licensing schemes have shown the value in providing a suite of licences that address a variety of usage scenarios. The Creative Commons licences maximise adoption by letting creators choose which licence best fits their needs. The Open Data Commons fills a gap by allowing collectors to license database structures without licensing the data they contain. Similarly, the back-to-front licence should give data collectors a variety of options to choose from in order to meet specific business models. The modular model licence would need to provide for: variances in what and how much data is made open; opportunities for other benefit-sharing measures; and varying degrees of control over data.

Finally, the model licence would need to be designed so as to maximise use. Following the successful practices developed by Creative Commons, the licence should consist of three layers, with the legal code of the licence supported by both a human-readable layer and a machine-readable layer. While the human-readable layer is important for simplicity of use, the machine-readable layer is particularly important, in order to maximise use by app developers.

The organisation supporting this back-to-front licence would need to address several potential challenges. Collectors may want more individual control over specific licence terms than are possible with a model licence. Adoption may be slow, as many collectors, which this proposed model relies on, may be hesitant to open up their data. And collectors who want to implement a data commons will still face the challenges of working with their third-party vendors to ensure conditions that respect the commitments they make in the licence.

Furthermore, because open licences are rarely if ever considered in court, the status and enforceability of the back-to-front licence will remain somewhat uncertain, with

the degree of its legal force resulting as much from social convention as from legal precedent. (However, in this respect, open copyright licensing contracts may not be much different from other contracts governed more by general principles than specific rulings.)

Certification mark

In order for a data commons to garner sufficient support, there would need to be mechanisms in place to motivate engagement. Ostrom (1990, pp. 185–187) describes how monitoring and graduated sanctions are necessary to ensure mutual participation in the commons. In the context of a knowledge commons, participants will often experience rewards and benefits that help motivate participation (Frischmann et al., 2014, p. 37). However, motivations that work in other knowledge commons may not provide sufficient benefits in this context. We suggest using a certification mark to motivate participation in the agricultural data commons.

Certification marks are trademarks that a certifying organisation issues to entities that meet qualifying standards (see Fromer, 2017, p. 127; Mogyoros, 2015). In an agricultural data commons, a certification mark would indicate to contributors, collectors, and users: (1) that the data is sourced equitably; (2) that the collector offers open data; and (3) that the collector is using the particular back-to-front licence required by the certification mark. Simply stated, the mark would be an indication of the best practices followed throughout the value chain related to the data (see De Beer, 2017a, p. 21). Use of the mark would motivate collectors to participate in the agricultural data commons—by drawing positive attention to collectors' open data collection practices and building trust in the collectors among data contributors and users.

A relevant example is the Fair Trade movement (Fairtrade International, n.d.), which uses certification marks to support marginalised producers in low-income countries, and which has its origins in agriculture production. The Fair Trade movement has been successfully used as a template in many sectors, including being adapted to the music and forestry industries (Fair Trade Music International, n.d.; Leonardi, Clement, & Defranceschi, 2012).

Organisational support

The model licence and certification mark would need to be supported, as is the case for Creative Commons and the Open Data Commons, by an organisation and community dedicated to building and managing the licence scheme. The proposed certification mark would, ideally, be governed and managed by a single organisation. This work could be done by an existing organisation, such as GODAN, Open Data Commons, or Creative Commons, or by a newly-created organisation (with attributes similar to Fairtrade International).

5. Conclusions

This study has developed the outlines of a model for an agricultural data commons that could address the inequities currently created by lack of data ownership rights for contributors of agricultural data. Supported by an independent organisation, this model licence could increase the pool of open data by providing incentives: (1) to data contributors, who need engagement, privacy, control and benefit-sharing; (2) to SME data collectors, who need sophisticated legal tools; and (3) to data users, who need access to useable data. Additionally, we have proposed that use of the model licence, and thus growth of the agricultural data commons, could be given a market-driven dimension through granting users of the model licence the ability to use a certification mark.

These governance mechanisms would increase access to agricultural data by fostering shared responsibility for the data as a common resource. This increased access to data would have the potential to address food insecurity by helping participants across food production chains make better decisions—in both developed- and developing-world contexts, but with particular relevance to the developing world and thus, in turn, with relevance to achievement of UN Sustainable Development Goal (SDG) 2 aimed at eradicating extreme hunger (UN, 2015, p. 17).

In addition to its relevance to the global effort to meet SDG 2, the field of agriculture was chosen for this study because of: (1) the recognition, in both the open data and agricultural communities, of inequitable treatment of contributors of agricultural data; (2) the presence of exemplar stakeholders, such as Plantwise and Abalobi, whose work has been amplified by organisations like GODAN and OD4D; (3) the presence of social certification examples, such as Fair Trade, that have pioneered market-driven equitable agriculture production; and (4) the origins of commons, and commons scholarship, in agriculture.

The model outlined in this article in support of enlarging the agricultural data commons could be broadly applicable to other contexts where contributors generate data and open access to data is valued. A back-to-front model licence and certification mark could be particularly useful in contexts where, as is increasingly the case, SMEs collect and use data.

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Appendix A: Text of John Deere's Data Services and Subscriptions Statement [1]

JOHN DEERE DATA SERVICES & SUBSCRIPTIONS STATEMENT

YOU CONTROL YOUR DATA

In an increasingly connected world, technology makes it easy for you to share your operation's data with others — if that's what you choose to do. When you entrust your data to John Deere and its subsidiaries through our Data Services and Subscriptions, we safeguard that data and honor the permissions you set for sharing it with others.

We created this statement to be clear about how we manage your data and to provide the details you need to make informed decisions about our Data Services and Subscriptions. This statement explains:

- your responsibilities for managing your data and sharing permissions, as well as your options in the event that you do not want John Deere to use or disclose your data
- the types of data we may collect from you
- how we may use or disclose that data
- our responsibilities for protecting and maintaining your data

By accessing or using any John Deere Data Services and Subscriptions, you agree that we may collect and process your personal information as described in our Privacy Policy, and you agree that we may use your data as described below and in the applicable terms of use. If you do not or cannot agree to these uses by John Deere, then you should not use John Deere Data Services and Subscriptions.

TYPES OF DATA WE COLLECT

We collect three kinds of data through the John Deere Data Services and Subscriptions, which include the John Deere Operations Center, JD Link™, and other offerings listed at www.JohnDeere.com/agreements:

Production Data is information about the work you do with your equipment and the land where you do that work. For example: • field task details • area worked • route travelled • crop harvested and yield data • agronomic inputs applied You can see and manage your Production Data in the John Deere Operations Center and mobile apps.	**Machine Data** is information that indicates machine health, efficiency, and function. Machine Data comprises: • machine health indicators, settings and readings • machine hours or life • machine location • diagnostic codes • software and firmware versions • machine attachments, implements or headers You can see some Machine Data in the John Deere Operations Center, JDLink Web and mobile apps. Some Machine Data is proprietary to John Deere.	**Administrative Data** is information that helps us support your account and activities in our system. For example: • your data sharing permissions • users linked to your account • machines, devices, and licenses linked to your account • number of acres and size of files • information about how you use your account You can see and manage some Administrative Data in the John Deere Operations Center and mobile apps.

1 Retrieved from https://www.deere.com/en/privacy-and-data/data_services/

We do not use or collect user-generated content. Some of our systems enable you to store and share information you or others create. This user-generated content includes variable rate prescriptions, notes, recordings, photographs, PDFs and other file types. We store and share this content only as you direct and to comply with court orders and legal or regulatory requirements.

YOU CONTROL WHO SEES YOUR DATA
Here are your options for controlling your account information when you use John Deere's Data Services and Subscriptions:

SHARING
You may share and disclose data in the John Deere Operations Center and other connected portals and apps. By setting permissions for your account, you control other parties' access and visibility into your data. You also control which John Deere dealers have access to data in your account. […] Please note that when you share your information with someone other than John Deere, the recipient may decide to copy, use, modify, or distribute it to others, and John Deere has no control over, or responsibility for, any such activities.

MANAGING
You may view, analyze, and manage Production Data, some Machine Data, and some Administrative Data in your account via the John Deere Operations Center and JDLink portals.

EXPORTING
You may download and export Production Data files in the John Deere Operations Center, and you may download some Machine Data from the JDLink portal.

DELETING, UPDATING, AND AMENDING
You may request that we delete, update or amend Machine Data, Production Data, and Administrative Data in your account and we will honor your request within five business days. Please note that deleting data may limit our ability to support you and, in some cases, may constitute a termination under the terms of any applicable Data Service and Subscription contracts between you and John Deere, and - subject to any applicable privacy laws - we may retain certain basic Machine or Administrative data for our record keeping purposes. Please review the terms of any such contract for details.

TO SERVE YOU
- We use your data to provide you with contracted services and offerings and to administer your account.
- We may share your data with John Deere affiliates and suppliers to provide you with contracted services and offerings and to administer your account. These affiliates and suppliers have committed to protect your data consistent with this statement and all applicable privacy and other laws. [7]
- Machine and Administrative Data only – We may share Machine Data and Administrative Data with John Deere dealers so they can support you, unless you explicitly restrict access to specific dealers.

TO LEARN FROM YOU
- We may use your data to develop and improve our products and services. For example, analyzing your data may spotlight trends that inform our product support, warranty services, and diagnostic or prognostic activities.
- We may combine your data with data from others and include your data in anonymized data sets. These anonymized data sets are proprietary to John Deere. John Deere is free to use and disclose the anonymized data, and John Deere may promote information and services derived from anonymized data. Anonymized data is never traceable back to you or your specific operations.

TO MARKET TO YOU

- We may use your data to market products and services to you, targeting offerings to match your activity, interests, and location if you provide any applicable consent. We will communicate with you only according to the preferences you set for your account.
- We may share your data with John Deere dealers so they can market products and services to you, targeting offerings to match your activity if you provide any applicable consent.

TO COMPLY WITH THE LAW

- We share your data as required by applicable laws, including data privacy and consumer protection laws. Our privacy statement is available at www.JohnDeere.com/legal.
- We may review and disclose your data to comply with court orders and legal or regulatory requirements; to prevent injury, death, losses, fraud or abuse; to protect John Deere's rights or to defend John Deere in legal proceedings; and to comply with requests from you.

We do not do anything else with your data without your separate consent. If you do not or cannot agree to the data uses described above, then you should not use John Deere Data Services and Subscriptions.

HOW WE PROTECT AND MAINTAIN YOUR DATA

SAFEGUARDING

We have implemented and will maintain standards and procedures designed to prevent misuse of information in your account:

- We maintain physical computer and network security.
- We educate our employees about the importance of data security and customer service through standard operating procedures and special training programs.
- We maintain security standards and procedures to help prevent unauthorized access to information about you, and we update and test our technology to improve the protection of your information.

STORING AND PROCESSING

We store and process data on secure servers in data centers in the United States. In the management of our systems network, we may move data across jurisdictions and may store or process your information outside your home country. . By using any John Deere Data Services and Subscriptions you agree that we may process and store your data in the United States.

DELETING

Please note that John Deere may retain data unless you delete your information as described above. After expiration of any applicable Data Service and Subscription contract, we may delete data at our discretion and subject to requirements in any applicable privacy, consumer protection, or other laws.

1. COUNTRIES

This statement applies in the United States of America, Canada, Australia, New Zealand, Argentina, Bolivia, Brazil, Colombia, Paraguay, Uruguay, and South Africa. For other countries see www.JohnDeere.com/legal.

2. JOHN DEERE DATA SERVICES AND SUBCRIPTIONS

The terms of use for the John Deere Data Services and Subscriptions are available at www.JohnDeere.com/agreements.

3. JOHN DEERE PRIVACY STATEMENT

In providing the John Deere Data Services and Subscriptions, we may receive, collect, use, manage, analyze, segment, index, transmit, transfer, store and process personal information which can include

names, contact data (telephone number, e-mail, address), and in some cases usage data (including website and mobile app use). Our Privacy Policy is available at www.JohnDeere.com/legal.

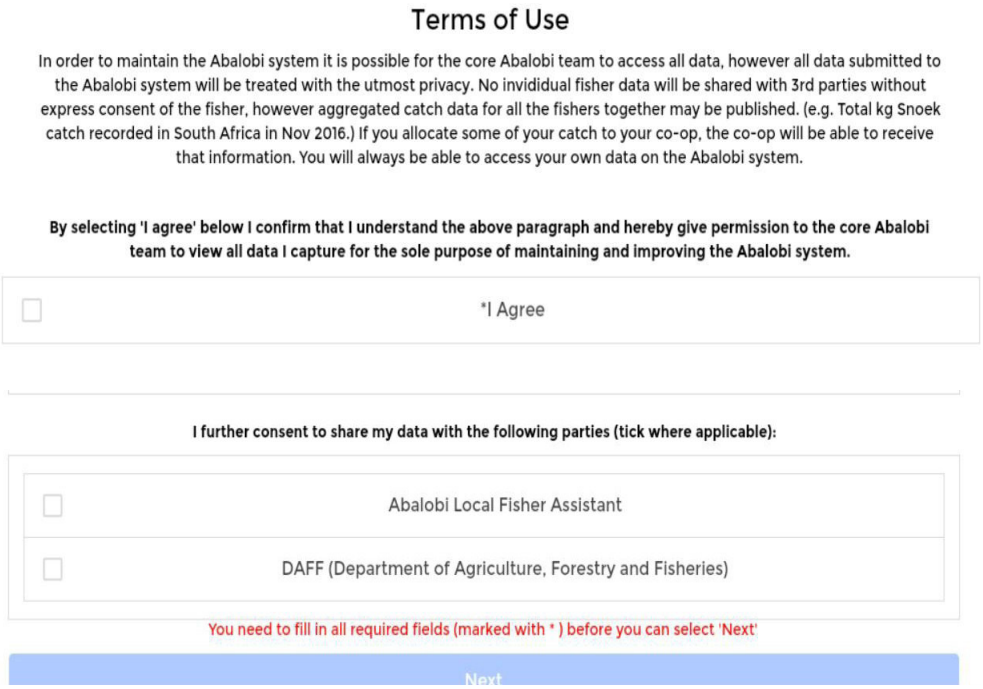
4. RESTRICTING DEALER ACCESS TO MACHINE DATA
To remove dealer access to Machine Data from machines in your account you must do both of the following: remove ServiceADVISOR Remote access for each machine from the Terminal Settings tab in the Operations Center and remove access to machine notifications and advisors from the Sharing tab on the JDLink portal.

5. DELETING, UPDATING, AMENDING MACHINE DATA, PRODUCTION DATA, AND ADMINISTRATIVE DATA
To request deletion, updates, or amendment of Machine Data, Production Data, or Administrative Data email jdlinksupport@JohnDeere.com, or call 800-251-9928. To understand how deletion may impact or terminate any John Deere Data Services or Subscriptions see www.JohnDeere.com/agreements. To understand your rights with respect to any personal information, see www.JohnDeere.com/legal.

6. MARKETING PREFERENCES Email PrivacyManager@JohnDeere.com for information about your marketing preferences or to change them.

7. ACCESS TO AFFILIATES
All references to "We" in this statement include Deere & Company and its subsidiaries. You may have granted John Deere Financial certain rights to access machine data about your equipment in your financing or lease documents, including the location, maintenance, operation and condition of your equipment. If permitted by your finance or lease agreement, John Deere Financial may continue to access machine data about your equipment during the term of the financing or lease agreement notwithstanding any election you may make. This could include reinstating machine data access if turned-off or otherwise disabled. Please review your finance or lease documents for more information.

Appendix B: Text of Abalobi data collection agreement [2]



Terms of Use

In order to maintain the Abalobi system it is possible for the core Abalobi team to access all data, however all data submitted to the Abalobi system will be treated with the utmost privacy. No invididual fisher data will be shared with 3rd parties without express consent of the fisher, however aggregated catch data for all the fishers together may be published. (e.g. Total kg Snoek catch recorded in South Africa in Nov 2016.) If you allocate some of your catch to your co-op, the co-op will be able to receive that information. You will always be able to access your own data on the Abalobi system.

By selecting 'I agree' below I confirm that I understand the above paragraph and hereby give permission to the core Abalobi team to view all data I capture for the sole purpose of maintaining and improving the Abalobi system.

☐ *I Agree

I further consent to share my data with the following parties (tick where applicable):

☐ Abalobi Local Fisher Assistant

☐ DAFF (Department of Agriculture, Forestry and Fisheries)

You need to fill in all required fields (marked with *) before you can select 'Next'

Next

2 Retrieved from a registration form linked to http://register.abalobi.org