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Research paper

Farmers and their data: An examination of farmers' reluctance to share their data through the lens of the laws impacting smart farming



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ABSTRACT

The absence of legal and regulatory frameworks around the collection, sharing and use of agricultural data contributes to the range of challenges currently being faced by farmers considering adoption of smart farming technologies. Many laws potentially influence the ownership, control of and access to data, in this paper we examine the attitudes of farmers to the collection, control, sharing and use of their farm data. Australian agriculture and the attitudes of Australian farmers to the adoption and uptake of smart farming technologies is used to highlight the tensions, however the issues and challenges raised are common to many agricultural industries throughout the world. We combine insights from a survey of Australian farmers with a legal analysis of the way in which agricultural data are collected, controlled, shared and used. We argue that the lack of transparency and clarity around issues such as data ownership, portability, privacy, trust and liability in the commercial relationships governing smart farming are contributing to farmers' reluctance to engage in the widespread sharing of their farm data that smart farming facilitates. At the heart of the concerns is the lack of trust between the farmers as data contributors, and those third parties who collect, aggregate and share their data. The aim of this paper is to examine the issues giving rise to this lack of trust. We conclude with recommendations on how to address these concerns and facilitate the improved adoption of smart farming technologies, focusing on the need for the social architecture of the agricultural data relationships to change. To achieve this change, open dialogue, education and awareness raising and good data governance are essential to help build trust in the adoption of smart farming systems.

1. Introduction

With the exponential growth of digital technologies occurring within agricultural systems, smart farming (also referred to as digital agriculture, digital farming, and precision agriculture) has captured the attention of numerous scholars, from the technical to the social sciences (Eastwood et al., 2017; Sonka, 2016; Carolan, 2017a, b, c; Bronson and Knezevic, 2016). Much of the attention has been on the promised potential of smart farming and the Internet of Things on farm (Wolfert et al., 2017). Farmers are embracing new digital and robotic technologies that are transforming the way they farm and digitalisation, more generally, is fundamentally changing the way agricultural technology and input suppliers interact with farmers, processors, manufacturers, retailers and the broader agri-food sector. However, as Carolan (2017a, b, c: 748) notes, '[w]hile adopting these technologies at high rates,

conventional farmers nevertheless have mixed feelings over their use.'

There are a number of reasons for farmers' 'mixed feelings' towards smart farming technologies. Some of the challenges relate to the moral and ethical questions about access, cost, scale and support, which will determine whether it will ever be possible, or indeed desirable, for all farms to be 'big data enabled', or whether it is an inevitable progression of modernisation in agriculture (Fleming et al., 2018). Other challenges relate to farm data ownership, privacy, cybersecurity and the equitable sharing of the benefits of digitisation and data collection (Wolfert et al., 2017; Fleming et al., 2018; Kosior, 2018). In the hyperbolic discussions of smart farming and digital technology, what is often missing is an examination of farmers' concerns. This paper steps back from the attention and promise of what smart farming can bring to the productivity and the profitability of farms to shine a light on farmers' attitudes and concerns about the expansion and uptake of smart farming technologies within

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their farming enterprises. We examine the issues arising from the ubiquitous data collection, sharing and use of agricultural data, particularly as they relate to the legal and regulatory frameworks on data ownership, access and use, and in so doing, highlight some of the concerns that farmers have identified over the increasing aggregation, collection and use (and re-use) of agricultural data.

Importantly, farmers have much in common with the broader community when it comes to the concerns they have about data collection, sharing and use. While there are currently no legal or regulatory frameworks that are aimed at agricultural data specifically, the existing broader legal and regulatory frameworks around data collection both inform and are informed by concerns over data ownership, access and use (Jakku et al., 2018). We argue it is necessary to understand farmers' concerns over data collection and use in the context of current legal and regulatory frameworks, such as the data contracts and licences, privacy and consumer laws, the development of Agricultural Data Codes of Practice (Sanderson et al., 2018), and in some jurisdictions proposed *sui generis* agricultural data sharing laws, such as the US Agriculture Data Act of 2018 which aims to facilitate agricultural data collection with the United States Department of Agriculture (Janzen, 2018). Such concerns can, in turn, inform the development of best practice in agricultural data sharing frameworks that would address farmers' concerns and improve commercial relationships in agricultural industries. This study examines farmers' attitudes to data sharing across seventeen different agricultural sectors in Australia: including cotton, grains, fisheries, meat and livestock, horticulture, wool, sugar and dairy. This breadth of coverage was facilitated by the fact that this was the first time all of Australia's 15 Rural Research and Development Corporations came together collaboratively to fund research on the issues that each industry was confronting with the digitalisation of agriculture.

This paper is structured as follows. Firstly, we provide some contextual background on the issues surrounding farmers' concerns regarding data ownership, access and use. We then outline the methods we used to identify and assess Australian farmers' knowledge and attitudes towards the collection and use of agricultural data. In the results section that follows, we present the key findings in relation to three areas: (i) knowledge of data terms and conditions; (ii) attitudes towards profit from data; and (iii) attitudes towards access and sharing of data. We then discuss the key areas of concerns for farmers that discourage the sharing of data including clarity and transparency of data terms and conditions; questions of ownership and the sharing of data; privacy concerns; inequality of bargaining power; and a lack of benefit sharing. What becomes clear in our examination of farmers' concerns over data licences is that the willingness to share data is implicitly linked to trust. This supports the work of Jakku et al. (2018: 2) who argue that 'Big Data applications are socio-technical, their development and deployment being a product of social interactions between people, institutional and regulatory settings, as well as the technology itself'. For the purposes of this article, we define trust as a willingness to accept some risk and vulnerability towards others (Luhmann, 2001) and the 'favourable expectation regarding other people's actions and intentions' (Möllering, 2001: p. 404). We highlight that a more thorough understanding of the legal settings of smart farming, particularly the terms and conditions of the agricultural data licences, can increase the likelihood of farmers' willingness to share data. That said, we caution that there is a need to avoid a 'one-size-fits all' model to agricultural data sharing. A 'one-size fits all' approach to data sharing in the agricultural context will be at best inappropriate, and at worst, detrimental to those who are contributing the data.

2. Background

Whether, and why, farmers are willing to share agricultural data is an important and timely contribution to the scholarship of smart farming, because it reflects broader societal concerns and controversies

over the ever-increasing use and misuse of data. A lack of trust in the way data is managed has become part of an everyday conversation between individuals and a wide range of industries (Bowcott and Hern, 2018). The most recent and well-known case is perhaps the Cambridge Analytica controversy. In March 2018, the *New York Times* and *Observer* exposed how data analytics firm, Cambridge Analytica, misused personal information from over 50 million Facebook users. Facebook users had 'to contend with the fact that through no fault of their own, their personal information was harvested and weaponised by the fractious company that provided analytics for the Brexit campaign and Donald Trump's presidential campaign' (Common, 2018). The interesting thing to note here is that it was the terms of the Facebook licence agreement that allowed those uses to be made of the data: with Facebook arguing that those individuals affected had originally consented to give away their information. Significantly, when trying to address and correct such breaches of trust, one must prioritise transparency. Common (2018) observes that 'for too long, social media companies have been allowed to keep users and regulators in the dark, shielding their practices behind claims of proprietary technology and excessive secrecy'.

While the Facebook scandal and controversy raised the awareness of the public at large over the potential for the misuse of personal data, for some time now the issue of data misuse and controversy has been well known to farmers and the agricultural community. There have been a number of high profile agricultural specific data controversies and scandals. One example is the well-known data breach that occurred in 2014, where one of Monsanto's servers left exposed some customers' credit-card information and Monsanto employee data (Bunge and Dreibus, 2014). In 2017, a class action was brought by a group of chicken farmers in the Oklahoma District Court against Tyson Foods Inc. (*Haff Poultry v Tyson et al.*, 2017) and other chicken processors for allegedly sharing production data (e.g. grower payments, broiler weights, type of feed and medicine used, and transportation costs) with third parties without the consent of 38 chicken farmers. The data was shared to keep payments below competitive levels. Key issues for the chicken farmers were that the processors' data aggregation did not adequately anonymise the data and the data was unlawfully shared between the processors to reduce grower payments.

Agricultural technology providers, many now coming from industries outside the agricultural community, have introduced lengthy and complex software licence agreements that govern the way that farmers' data will be collected, managed and shared with their smart farming technology providers. The scope and extent of the terms of the software licences embedded into farming equipment (e.g. the sensors, robotics, drones, tractors and the agricultural machinery) are rarely discussed or even mentioned at the point of sale. Interestingly, many farmers have been surprised by the fact that the mere act of turning on their machinery or downloading the technology means that they have agreed to a broad range of terms that regulate who can access and use data generated on their farms. A farmer would, therefore, not know for certain whether they have granted permission for the agri-businesses to share their farm data without permission. The very issue of whether consent by farmers to share their data was needed or obtained has really only been highlighted as an issue since the enactment of the General Data Protection Regulation (GDPR, 2018) in Europe in 2018.

Despite the growing importance of, and concerns over, agricultural data, there is little specific or empirical research into the concerns of farmers over agricultural data collection and use. While some studies have examined attitudes within specific industries and crops, such as the survey conducted by the American Farm Bureau in 2016 (American Farm Bureau Federation, 2016) and Carolan (2016) and Jakku et al (2018), the present study is unique as it is the first to examine farmers' attitudes to sharing data in an agricultural context with the focus on legal and regulatory analysis. In so doing, this paper illuminates some of the reasons underlying farmers' reluctance to engage in the smart farming technologies that result in the widespread sharing of their on-farm data.

3. Method

This paper combines insights from a survey of 1000 Australian farmers, across seventeen agricultural sectors, with a discussion of the legal and regulatory challenges related to agricultural data, both of which were conducted as part of a larger Precision Agriculture to Decision Agriculture (P2D) project (Leonard et al., 2017).

3.1. Procedures and participants

A specialised agricultural research survey company was engaged to conduct the data collection. The sampling specifications for each sector were defined in consultation with participating Research Development Corporations (RDCs). To recruit producers to participate in the survey, various RDCs publicised the survey activity in their newsletters and invited their members to participate by contacting the survey company on a specially designated phone line and email address. In addition, potential participants were drawn from the survey company's database. To be eligible for answering the survey questions, participants had to be decision makers or members of management team for their farm. The survey was conducted via computer-assisted telephone interviewing (CATI) during the period of 7 March 2017 to 18 April 2017.

In total, 1000 producers across 17 industries participated in the survey. For respondents who had multiple components to their business (i.e., it spanned more than one sector; e.g., beef and grain), they were asked to indicate the major component of their business. For example, if the respondent had both beef and grain, and indicated beef as the major component to their business, the respondent would be classified as beef/grain mixed. This classification principle applies to all other mixed combinations (i.e., beef/sheep mixed, sheep/grain mixed, and grain-grain/beef/sheep).

In the survey, participants were asked whether they collected any on-farm data (e.g., pasture/vegetation mapping, yield mapping, soil mapping, and individual animal or herd feeding data). Of the 1000 participants, 895 stated that they collected one or more types of on-farm data. For those data collectors, further data related questions were asked, and the findings are presented in this paper. Table 1 presents the demographic information of the participants who collected data.

3.2. Measures

Table 2 summarises the measures used to assess participants'

Table 1
Demographic characteristics (N = 895).

Industry	Number of participants	Gender (Male %)	Average age	Education				
				Didn't complete Year 12	Completed Year 12	Post-secondary qualification	University degree	Postgraduate degree
Beef only	115	82.6%	59.9	44.3%	27%	11%	15.7%	1.7%
Beef/grain mixed	59	88.1%	56.7	40.7%	18.6%	16.9%	22.0%	1.7%
Beef/sheep mixed	90	81.1%	57.9	31.1%	20.0%	20.0%	23.3%	5.6%
Sheep meat only	51	96.1%	57.1	52.9%	17.6%	15.7%	11.8%	2.0%
Sheep/grain mixed	78	88.5%	55.5	43.6%	20.5%	17.9%	11.5%	6.4%
Sheep wool	83	83.1%	59.4	41.0%	25.3%	18.1%	9.6%	6.0%
Dairy	87	92.0%	58.6	54.0%	14.9%	16.1%	11.5%	3.4%
Pork	15	80.0%	55.5	46.7%	13.3%	13.3%	26.7%	0.0%
Poultry eggs/meat	23	91.3%	61.6	47.8%	21.7%	21.7%	4.3%	4.3%
Aquaculture	29	96.6%	51.6	20.7%	13.8%	3.4%	20.7%	41.4%
Grain only	66	90.9%	53.1	31.8%	24.2%	12.1%	22.7%	9.1%
Grain/beef/sheep	63	90.5%	54.9	34.9%	28.6%	15.9%	17.5%	3.2%
Cotton	29	82.8%	49.4	10.3%	17.2%	27.6%	31.0%	13.8%
Rice	15	73.3%	56.4	26.7%	13.3%	26.7%	20.0%	13.3%
Sugarcane	55	94.5%	59.6	60.0%	10.9%	20.0%	5.5%	3.6%
Vegetables	23	95.7%	56.9	43.5%	4.3%	13.0%	17.4%	21.7%
Wine grapes	14	85.7%	53.3	35.7%	21.4%	14.3%	21.4%	7.1%

understanding of the arrangements they had with their service/technology providers regarding the data collected through their services, and the trust in them to maintain the privacy of the data. These measures were only applied to those who collected at least one type data.

In relation to willingness to share agricultural data, 1.8% and 1.5% of participants respectively chose 'not sure' in relation to their willingness to share data with technology and service provider businesses. Subsequently, the answers of 'not sure' were deleted and treated as missing values. The scores for sharing the two types of data were highly correlated ($r = .87$, $p < .001$). Hence, they were averaged, with higher scores indicating higher level of willingness to share agricultural data with technology and service providers.

4. Results

4.1. Knowledge of terms and conditions

Overall, the majority (74%) of respondents did not know much about the terms and conditions relating to data collection in their agreement with service providers, with only 9% indicating they had a good understanding of the terms and conditions (see Fig. 1). There was variation across sectors for this knowledge (see Fig. 2). Relative to other sectors, respondents from the cotton sector reported the most knowledge, though in absolute terms they indicated they did not know much. Conversely, and relative to other sectors, sheep wool and vegetable had the least knowledge. The remaining sectors showed a stable trend of knowing little about their agreement with the service providers.

4.2. Direct access to data by service/technology providers

Regarding direct access to data by service/technology providers, half of the respondents reported they would feel uncomfortable if service/technology providers had direct access to their data through the services they provided them, with only 24% indicating they were comfortable or extremely comfortable (see Fig. 3). Again, variation existed across the sectors (see Fig. 4). In particular, beef/grain mixed and poultry eggs/meat sectors were the least comfortable with service/technology providers having direct access to their data. Comparatively, the grain only, rice, wine grape and vegetable sectors were the most comfortable.

Table 2
Measures used to assess participants' understanding of data arrangements.

Measure	Description	Question	Scale
Terms and conditions	To examine producers' understanding of the terms and conditions with service providers in relation to farm data collection.	"For tools (such as machines and apps) used to collect on-farm data, how much do you know about the terms and conditions relating to data collection in your agreement with the service providers?"	1 = don't know at all 5 = know very well
Data access	To examine producers' attitude towards farm data access by service providers.	"For any of on-farm data collected, how comfortable are you if the service/technology providers (such as John Deere or a weather station provider) have direct access to your data through the services they provide you?"	1 = not comfortable at all 5 = extremely comfortable
Profit making	To examine producers' attitude towards making profit from their farm data by service providers.	"If the service/technology providers had direct access to their client's data including yours, how comfortable are you if they use the data to make profit for themselves?"	1 = not comfortable at all 5 = extremely comfortable
Data privacy	To examine producers' trust in service providers in maintaining the privacy of their farm data.	"If the service/technology providers have direct access to your data, how much do you trust them to maintain the privacy of your farm data?"	1 = No trust at all 5 = Total trust
Third-party data sharing	To examine producers' trust in service providers not sharing their farm data.	"If the service/technology providers have direct access to your data, how much do you trust them not to share the data with third parties?"	1 = No trust at all 5 = Total trust
Willingness to share agricultural data	To examine producers' willingness to share their on-farm input and production data with service providers.	"Please indicate how comfortable you are to share farm input data such as fertilizers and pesticides application with technology and service providers?" "Please indicate how comfortable you are to share production data with technology and service providers?"	1 = not comfortable at all 5 = extremely comfortable; 6 = not sure

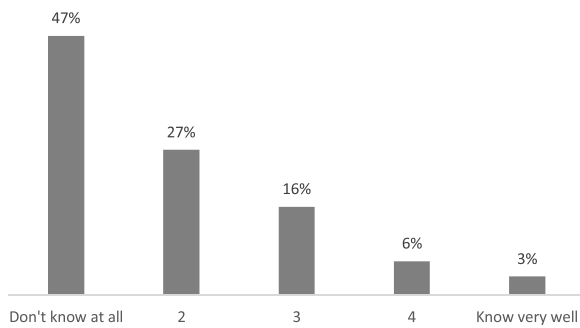


Fig. 1. Knowledge of terms and conditions for data collection agreement with service providers.

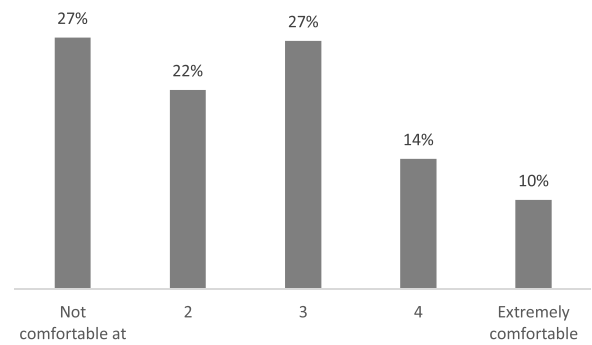


Fig. 3. Comfort in service/technology providers having access to producers' data.

4.3. Attitude towards profit making from producers' data by service/technology providers

The majority of respondents (67%) did not feel comfortable if service/technology providers used the data to make profits for themselves

(see Fig. 5). In particular, respondents from aquaculture, poultry, and grain/beef/sheep sectors felt the most uncomfortable with service providers making profits from the data (see Fig. 6).

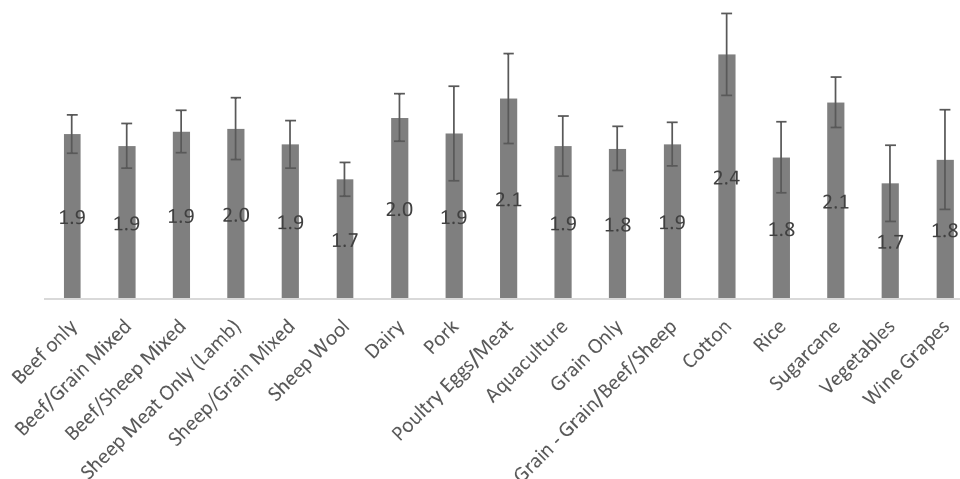


Fig. 2. Knowledge of terms and conditions for data collection agreement with service providers by sector (1 = don't know at all, 5 = know very well).

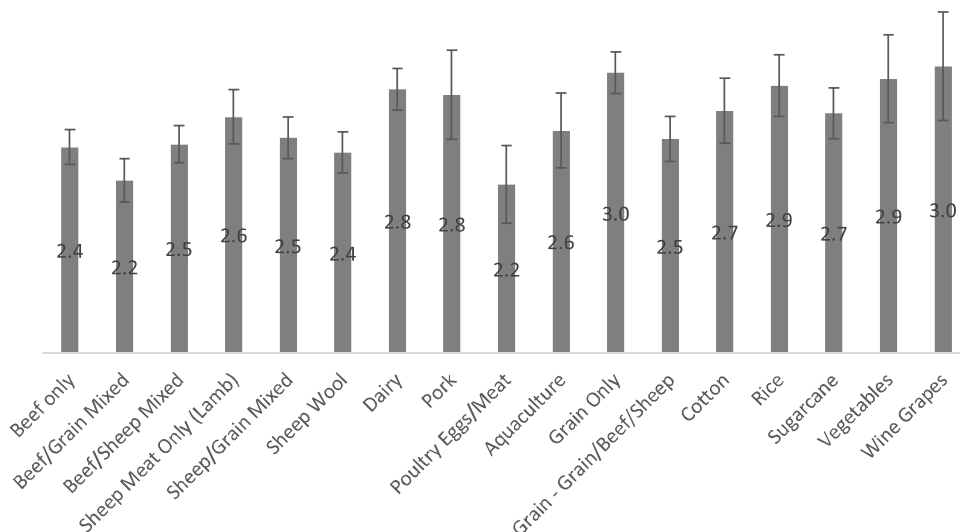


Fig. 4. Comfort in service/technology providers having access to producers' data by sector (1 = not comfortable at all, 5 = extremely comfortable).

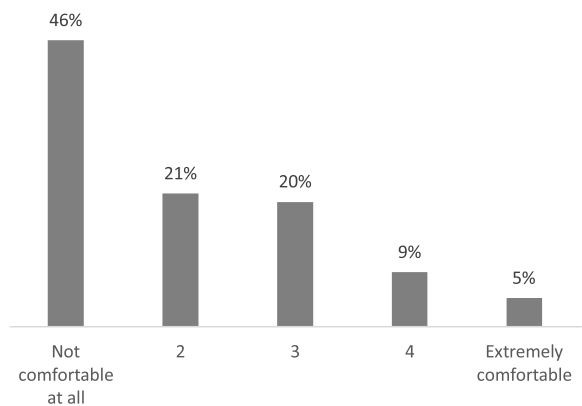


Fig. 5. Comfort in service/technology providers using client data to make profit for themselves.

4.4. Trust in service/technology providers maintaining privacy and not sharing producers' data with third party

Overall, if service/technology providers had direct access to respondents' data, more than half (56%) of the respondents displayed no

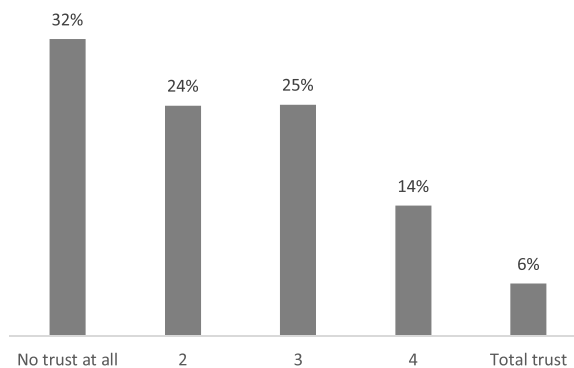


Fig. 7. Trust in service/technology providers maintaining privacy of producers' data.

trust at all to little trust in service/technology providers maintaining the privacy of their data, and not to share their data with the third parties (62%) (see Figs. 7 and 9, respectively). Comparatively, respondents from the cotton sector showed higher levels of trust (see Fig. 8), while those from the poultry eggs/meat reported the lowest (see Fig. 10).

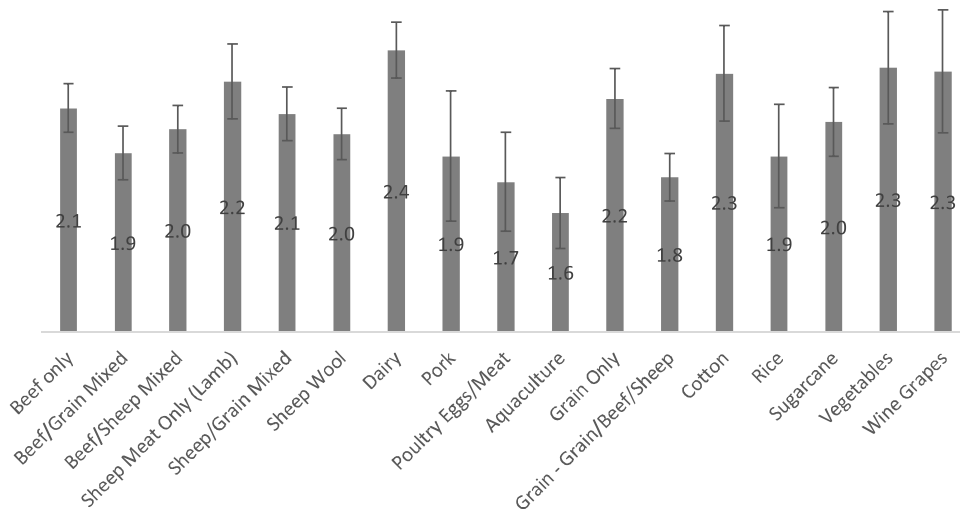


Fig. 6. Comfort in service/technology providers using client data to make profit for themselves by industry (1 = not comfortable at all, 5 = extremely comfortable).

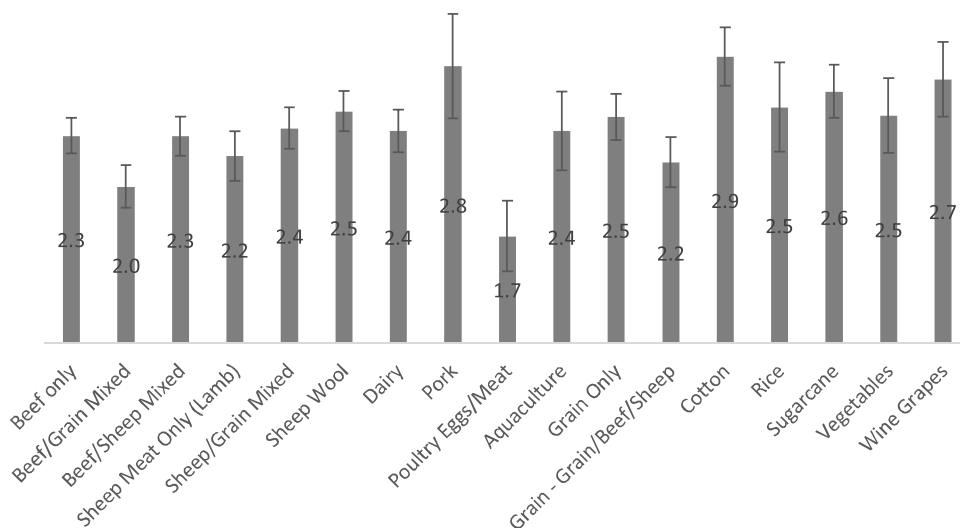


Fig. 8. Trust in service/technology providers maintaining privacy of producers' data by sector (1 = no trust at all, 5 = total trust).

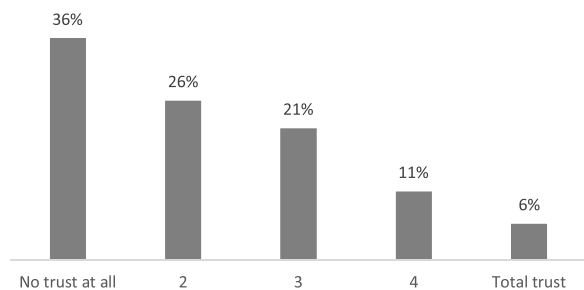


Fig. 9. Trust in service/technology providers not sharing producers' data with third parties.

4.5. Relationship between concerns and willingness to share agricultural data

Participants reported moderate levels of willingness for sharing data with service and technology providers ($M = 3.19, SD = 1.25$). Further, levels of willingness to share on-farm input and production data with service/technology providers were significantly related with participants' understanding of terms and conditions, attitudes toward service/technology providers' direct access to their data, and making profits from their data, as well as trust in service/technology providers'

maintaining the privacy of and not sharing their data with third parties (see Table 3). In particular, more knowledge of terms and conditions was linked with higher levels of willingness of data sharing; higher comfort levels of service/technology providers' direct data access and making profit with the data was associated with higher levels of willingness of data sharing; and higher levels of trust in service and technology providers' maintaining data privacy and not sharing with third party were associated with higher levels of willingness to data sharing with service/technology providers. However, it is worthwhile to note that, as shown in Table 3 as well as presented in earlier sections, participants reported low levels on all aspects related to the service providers.

5. Discussion

Our research results indicate that farmers currently lack trust in the way in which their farm data is being collected and managed. The lack of trust in the way that agribusinesses are dealing with farm data is hardly surprising. Evidence of a lack of trust between farmers and agribusiness in relation to the way in which their agricultural data was being managed was also found by the American Farm Bureau Federation, who, in 2016, conducted a survey of over 400 farmers and found, for example, that 77 per cent of those polled were concerned

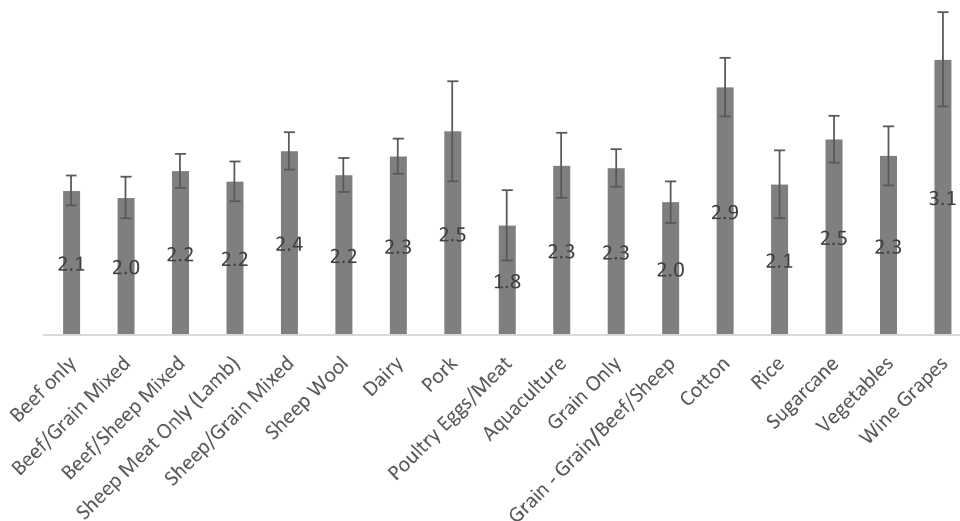


Fig. 10. Trust in service/technology providers not sharing producers' data with third parties by sector (1 = no trust at all, 5 = total trust).

Table 3
Correlation between concerns and willingness to share agricultural data.

	M (SD)	1	2	3	4	5
1. Terms and conditions	1.92 (1.09)	–				
2. Data access	2.57 (1.29)	.23***	–			
3. Profit making	2.05 (1.19)	.19***	.58***	–		
4. Data privacy	2.38 (1.22)	.17***	.49***	.50***	–	
5. Third-party data sharing	2.25 (1.22)	.16***	.47***	.47***	.79***	–
6. Willingness to share	3.19 (1.25)	.07*	.37***	.40***	.33***	.30***

(N = 878).

about which entities can access their ag-data (American Farm Bureau Federation, 2016). Furthermore, ethical concerns have been raised about data ownership and privacy, reliance on digital networks, and changes to farming practice and advisory structures (Carolan, 2016; Jago et al., 2013), including changes in farming roles as a result of automation. Smart farming is thus both a driving force of the evolution of agricultural knowledge and innovation systems, and the site of concern. Indeed, as Jakku et al., (2018: 7) note, “issues of trust and transparency, based on normative roles between farmers and agribusinesses, have the potential to constrain the willingness of farmers to participate in smart farming technologies.” Therefore, if digital agriculture and data are to transform agri-food networks, trust around agricultural data access and use needs to be fostered (Barnard-Wills, 2017; Box et al., 2017).

Having analysed and interpreted the results of the survey undertaken, it is clear that an awareness and understanding of the terms and conditions of agricultural data licences affects farmers’ attitudes toward data, including their willingness to share their data. While the focus of this paper is primarily on the legal relationships in smart farming, especially the scope and operation of the agricultural data licenses, we also consider the broader technical and social implications of the ever-evolving smart farming relationship (e.g. De Beer, 2016; Sanderson et al., 2018). Our research results highlight the importance of trust and confidence. Furthermore, in a recent review of data access and sharing, Australia’s Productivity Commission concluded that a ‘[l]ack of trust by both data custodians and users in existing data access processes and protections and numerous hurdles to sharing and releasing data are choking the use and value of Australia’s data. In fact, improving trust community-wide is a key objective’ (Productivity Commission, 2017: p. 2). Similarly, improving trust and confidence around the legal settings of smart farming – starting with data licences – will potentially facilitate the sharing of data by farmers.

While this lack of trust highlights farmers’ concerns about data collection and use, by examining the results in relation to legal and regulatory frameworks our research reveals a more sophisticated and nuanced understanding of farmers’ concerns in five key areas:

- a) a lack of transparency about the terms of use in data licences;
- b) ownership of data /sharing;
- c) privacy concerns;
- d) inequality of bargaining power; and
- e) lack of benefit-sharing between farmers (i.e. data contributors) and third-party advisers/agribusiness (i.e. the data aggregators).

Each of these concerns will be discussed in turn in the following sections.

5.1. Lack of transparency about the terms of use in data licences

The fact that so many farmers are unaware of the terms that govern the ownership and use of, and access to, their data indicates that there appears to be very little discussion about issues relating to data ownership or access prior to entering a contract for agricultural technology or services. The lack of transparency in legal contracts more generally

leads to dissatisfaction and frustration. More specifically, while detailed clauses and terms and conditions might (technically) comply with the relevant laws and policies, they provide little insight to the users of these contracts. This leads to cognitive dissonance: that is, a discrepancy between what the contracts say and what farmers think that they say (Dreyer and Ziebarth, 2014: pp. 531–532).

If farmers do not understand the implications of what they are signing, they are often unaware of how much control the agricultural service provider is asserting over their data or the extent to which their farm data is being shared and traded. This has significant consequence for the agricultural industry as a whole, as it forms the basis for the lack of trust that farmers have towards some of the new digital services and products on offer.

When thinking about improving the transparency of data licences, it is useful to consider the number of, and inconsistency between, data licences entered into by farmers, which in turn makes the issue of the ownership and the sharing of data even more complex. As part of their smart farming businesses, farmers enter numerous contracts with different parties for products and services. Some of the contractual relationships that farmers enter into that involve the collection and collation of agricultural data include contracts with chemical/fertiliser suppliers, broader service providers (e.g. telecommunications, sensors, soil testing, drones, etc., agri-technology/agri-business providers), and third parties and professional advisers (e.g. agronomists, contractors and advisers).

Many data licences involve the use of a ‘click wrap’ agreement (where the click of an ‘I agree’ icon signifies consent to the terms of a software licence), and this is often the way farmers enter into and agree to data licences for agricultural technology. The data licences that are embedded in digital agricultural technologies are usually complex standard-form licence agreements that are generally non-negotiable and presented on a ‘take it or leave it’ basis when the technology is adopted. The terms of use of the technology are, therefore, agreed to either at the time of downloading an app or turning on a machine. Often a data licence will also provide links to other policy documents such as the agricultural technology provider’s privacy policy. In some cases, it is the privacy policy rather than the terms of use of the data licence that outlines who may have access to the data generated under the agreement. Each different agricultural sector has an industry-focused range of commercial relationships. The more vertically integrated the industry, the tighter the contractual relationships tend to be.

5.2. Ownership and sharing of data

When thinking about data, it is important to note that, while many believe that data attracts a form of property generally falling within the intellectual property regime, the reality is that ownership rights in data will only arise if copyright law can protect the data (or the database is protected under the *EU Database Directive*). Not all data or collections of data will attract copyright protection. Despite this, many of the debates still focus on ‘ownership of agricultural data.’

Copyright law may provide protection for tables or compilations of data where the selection and arrangement of the data has resulted from the input of some human labour, skill or effort. Importantly, though, it

has long been recognised that raw data, information or mere facts are not protectable subject matter under copyright law.

It is worth noting that most other countries, such as the United Kingdom, Canada and the United States, take a similar approach to data ownership. That is, the law of copyright is the primary means by which ownership of datasets (but not raw data) may be claimed. However, by way of contrast, in the European Union database creators have been given a specific property right, known as a database right since 1996. This is a right to prevent extraction and/or reutilisation of the whole or of a substantial part of the contents of a database. To gain this protection, the database creator must establish that there has been a substantial investment in the obtaining, verification or presentation of the contents. The term of protection is 15 years, but it is renewable whenever the database holder makes any substantial change to the contents of the database. To determine whether a use is an infringement of the database right, both the qualitative and/or quantitative measure will be considered (*Directive on the Legal Protection of Databases 1996*).

A discussion of 'who owns data', however, raises more questions than it answers. It is important to note that, even where data is protected under copyright law, the ownership of copyright can often be varied by contract. So, where there is a contractual arrangement entered into between a farmer and a third party (such as adviser, processor, or agribusiness) that addresses ownership of the data collected, it will be the ownership provisions in the data contract that will often override the position in copyright law. In recognition of the fact that copyright law allows contracts to override its ownership provisions, it pays to look more closely at the nature of the many and varied agricultural data relationships and the data contracts that are entered into between the data contributors (i.e. farmers) and smart farming technology providers (i.e. data aggregators). It is these contracts, rather than the relevant laws, that will govern the agricultural data relationship, as these contracts are the primary means by which agricultural data is being controlled, managed and shared.

While there is a focus on clarifying data ownership (Ferrell, 2017), building trust and confidence in ag-data relationships requires more than clarification about data ownership. The language of 'ownership' distracts everyone from the important issues of collection, control and access (Wiseman and Sanderson, 2017). Put simply, it is possible to 'own' data but have little control over who and how the data is used.

Another general concern of farmers and producers is the fact that their data is regularly traded or disclosed to third parties, leaving them unaware of who knows the details of their commercial enterprises. This is a concern that is shared more broadly with the disclosure of data to third parties was recognised by Australia's Productivity Commission as '[o]ne of the most potentially pernicious practices' (Australian Productivity Commission, 2017: p. 212) that not only has a potential economic detriment but also erodes trust and the willingness to share data now and in the future.

What is interesting to note is that there were different attitudes toward sharing various data with different actors (other farmers, agricultural industry-based organisations, technology and service providers, research institutions). Respondents were more willing to share their data with other farmers and research institutions, and least willing to share with technology and service providers (Zhang et al., 2017).

Perhaps unsurprisingly, our research showed that farmers who had a better understanding and awareness of the conditions of use of data, i.e. the terms of their data licences, were more willing to engage in sharing of data. This is consistent with other research that knowledge of a website's data use practices can influence disclosure behaviour (Leon et al., 2013). A lack of transparency over the terms of the data licences that govern the use of their agricultural data is a problem. This is because the less farmers know about who can use their data and for what purposes, the less likely they are to share. As noted earlier in Section 5.1, farmers expressed concern about the lack of information they were given about data ownership, control and sharing prior to entering contracts with agri-businesses, which in turn forms the basis for the lack

of trust that producers have towards some of the new digital services and products. To some degree, this general lack of information prior to ag data contracting, was one the impetuses for the US Farm Bureau to develop their Privacy and Security Principles in 2014 (American Farm Bureau Federation, 2019). Copa-Cogeca et al. (2018). Though, after five years of operation, it is essential that a review of the impact of the US Farm Bureau's Principles on not only the disclosure of information but the equity in the data sharing relationship is conducted. It is not enough to merely count the number of companies that have signed up to the Principles (Sanderson et al., 2017: pp. 15–17).

To date, one of the key initiatives to improve clarity around ownership and sharing of data has been the emergence of ag-data codes of practice. The emergence of ag-data codes of practice such as the American Farm Bureau's Privacy and Security Principles for Farm Data and New Zealand's Farm Data Code of Practice (Farm Data Accreditation, 2016) and the European (Copa-Cogeca et al., 2018) have attempted to address some of the concerns identified above. The ultimate aims of ag-data codes of practice are inextricably linked to consent, disclosure, transparency and, ultimately, the building of trust (Sanderson et al., 2018). However, while these schemes aim to encourage great transparency by encouraging best practice in data management by technology providers as well as educating farmers to seek clarification about the control, access and sharing of their farm data by agribusinesses, as noted in the preceding paragraph, their success and impact remains to be seen.

5.3. Privacy concerns

Interestingly, as many of the data misuse scandals and controversies have shown, many individuals who are concerned with their privacy are still willing to disclose personal information to a website and have that information used to create consumer profiles if the website has transparent and fair procedures in place to protect privacy (Chellappa and Sin, 2005; Bansal et al., 2016).

The issues raised about the privacy of agricultural data is one that appears to be sailing under the radar of many privacy scholars. While the concerns of misuse of personal data has seen a fairly rapid and expansive response from the law, in the form of a myriad of new privacy laws being introduced around the world, the very issue of whether all or some farm data falls within the scope of 'personal data' is one that has yet to be debated. While many farmers would argue that all data arising from their farming operations are personal to them (i.e. the size of their farm, the varieties grown, the productivity and therefore income derived), the law of privacy might not necessarily agree.

The entry into force of the General Data Protection Regulation 2016 (GDPR) on 25 May 2018 has had a major impact on privacy and data protection laws around the world. It highlights that the protection, privacy and security of personal data has now become the focus. This Regulation applies to the processing of personal data by controllers or processors in relation to the activities of their establishment in the EU, regardless of where the processing actually takes place. What this means is that multi-national organisations whose data may be processed in the EU, will have to comply with the wide-ranging provisions of this Regulation. The general theme of the Regulation is that organisations must be accountable for all of their data processing activities. Of particular interest, is the expansive notion of 'consent' that has been incorporated into the GDPR. When consent has been obtained to process personal data, the controller must be able to demonstrate that the consent is freely given, specific and informed. Consent will be purpose limited, i.e. it will permit processing only for explicitly specified purposes. The consent obtained must be intelligible, easily accessible, and in clear and plain language. This is intended to eliminate any confusion as to whether consent has or has not been given, and whether it can be implied by a particular action (or inaction). Data subjects must also have the right to revoke their consent at any time and it must be as easy to withdraw consent as it is to give it. In addition to the expanded

notion of consent, are the right of individuals to move their data from one controller to another (the right of portability) and to have their data deleted (the right to be forgotten). In short, the GDPR places new responsibilities on data controllers and data processors to be more transparent in their dealings with individuals when their data is being harvested, collected and managed.

What is interesting is that while the GDPR has raised the benchmark in terms of how data aggregators (controllers and processors) manage the data they harvest, this is, by no means, the high-water mark for privacy protections in relation to data use. We are seeing GDPR-like legislation being introduced in Australia, for example, a new *Data Sharing and Release Framework*, which includes a Consumer Data Right that will be rolled out into different industries, with the agriculture industry following on from the banking, insurance and telecommunications industries. On June 28, 2018, California passed a sweeping new privacy bill, AB 375, now known as the California Consumer Privacy Act of 2018 (CCPA). The new law contains many detailed provisions, many of which are similar to the concepts found in the GDPR. For example, both require enhanced transparency over what businesses do with personal data and require disclosures to consumers on how the business collects personal data, how it processes the data, and to whom it transfers or sells the data.

There is general concern that once farm data is released and shared, it ultimately might fall into the wrong hands. The recent Facebook data breach as discussed above has highlighted to many how far and wide their data may be shared without their knowledge or consent. When thinking about how changes to the management of personal data and information impact upon the collection, management and sharing of agricultural data, a number of issues come to mind. While not all farm or agricultural data will be considered to be personal data (e.g. machine data), the fact that much of the data being collected from farms is linked to the GPS location., It may be argued that some of the data being collected on farms, particularly that can be linked to reveal income and potential profitability, will more than likely to be considered to be personal data. This is even more likely now given the broad notion of personal information that has been embraced and reinforced by the GDPR-led expansion of privacy law.

Potentially more important than the impact of the GDPR on the flow of some agricultural data, is the recently adopted Regulation on a framework for the free flow of non-personal data in the EU. This Regulation was formally signed by the European Parliament and the Council on 14 November 2018 and will start to apply in May 2019. This Regulation compliments the GDPR in that it aims at removing obstacles to the free movement of non-personal data within the EU. In turn, the free flow of data will enable the rapid development of data economy and emerging technologies such as the Internet of Things, artificial intelligence and autonomous systems. Non-personal data has been defined to include, for instance, machine-generated data or commercial data. Specific examples are aggregated datasets used for big data analytics, data on precision farming that can help to monitor and optimise the use of pesticides and water, or data on maintenance needs for industrial machines (European Parliament, 2018). What is interesting to note is that data on precision farming are being categorised as non-personal for the purposes of this Regulation. However, as noted below, increasingly, with the geo-location of agricultural data from precision farming being tied data back to an individual farm and farmer, it is arguable that that this data is personal data deserving of protection under privacy law. The potential for overlap between the reach of privacy law and other regulatory regimes such as this, will need careful consideration. The European Commission has recognised that guidance will need to be given on how to handle data sets that have both personal and non-personal data to allow companies to better understand the interaction between the GDPR and the new Regulation (European Commission, 2018). However, it is the distinction of which farm data is personal and which data is not that requires more analysis. Interestingly, the proposed Regulation encourages self-regulation through the

development of codes of conduct that will allow users to switch between service providers without hindrance (similar to the GDPR right of mobility), and focuses on vendor lock-in practices in the private sector.

5.4. Inequality of bargaining power

Another theme that arises from the results is the feeling of powerlessness and vulnerability that farmers feel when entering into contractual arrangements with large international technology providers. There is clear inequality of bargaining power present between the farmers and the technology provided when smart farming technologies are adopted on farm. This is often referred to as the digital data divide – a divide between those who contribute the data and those who control, aggregate and share the data (Andrejevic, 2014). Many agricultural technology companies are large multinational corporations, many of which have little or no past experience in agriculture. The power imbalance between data contributors and data aggregators is evidenced by the inability of farmers to negotiate the standard terms of the large agribusiness' data licences that govern the agricultural technology, and is well accepted (Carbonell, 2016; Jakku et al., 2018).

The fact that many large agri-businesses or technology providers are also foreign owned is another important factor when examining the level of trust and confidence that farmers have in their terms of use. Often the licence agreements that govern the data sharing and use of their farm data will be governed by the law of the country where that company is registered, and this creates uncertainty over the level of protection afforded to farmers. For example, farmers may not have the benefit of consumer or other legislative protections of their own country, where the dispute is taken to an overseas jurisdiction.

In response to this digital divide, there have been attempts to address the inequality of bargaining power in the agricultural context. For example, in Australia there has been a ramping up of agricultural expertise within the ACCC, the Australian Consumer and Competition Watchdog by the appointment of an Agricultural Commissioner. Small farming businesses have received support through amendments made to unfair terms legislation within consumer protection laws, aimed at 'small businesses' that employ fewer than 20 persons, which would incorporate of large number of farming enterprises (Wiseman, 2016). This reform does indicate that the practice of using standard form contracts comes with a responsibility on the part of the larger businesses to ensure that their contractual terms are transparent and fair in the sense that they do not go beyond what is legitimate to protect their interests and that they do not create a significant imbalance in the parties' rights and obligations.

5.5. Lack of benefit sharing between data aggregators and data contributors

A fifth area of concern that was identified was the issue of who gained the benefit of data sharing. Significantly, social exchange theory suggests that reciprocity is paramount for social exchanges including in the context of data sharing (Shurma, 2016). However, many farmers are concerned that advisers or agri-businesses derive the greatest financial benefit from their farm data, leading to the belief that there is little reciprocity, which in turn further reduces farmers' willingness to share data. This is not to say that there are no benefits for farmers. For example, Wolfert et al (2017) suggests benefits to farmer from smart machines and sensors, and their data sharing are many, including informing farm management decisions on 'real-time' awareness of the circumstances; be it autonomy of rain gauges, tractors or other machinery.

6. Conclusion

It is commonly recognised that digital technology and big data applications are 'socio-technical' and that they are a product of the relationships between people, technology, institutions and social and

legal frameworks (Jakku et al., 2018; Vines et al., 2013). What we have done in this paper is linked farmer concerns about agricultural data with the legal rights and frameworks around smart farming and digital technology. Specifically, we have shown that farmers' concerns over data licenses have a direct impact on their willingness to share agricultural data and, therefore, suggesting the potential impact of smart farming and digital technology in farming. Currently, farmers feel that they bear too much of the risk and vulnerability, and do not benefit from the rewards that smart farming brings.

If smart farming is going to realise its potential, then the broader legal and regulatory issues must not be ignored. To this end, when thinking in particular about the current complex data licences presented to farmers on a take it or leave it basis, there are a number of key messages for stakeholders. If data is to be shared, it is essential to ensure that the terms and conditions of data licences are understandable and transparent. Attention must be paid to those terms that regulate who has access to the data, who derives the benefits of data sharing as well as privacy concerns. Building knowledge, through education and awareness raising within agricultural stakeholder communities around the issues arising from the collection, control, sharing and use of agricultural data more generally is a fundamentally important part of the strategy to ensure better data management practices. These matters are best addressed through open and transparent governance frameworks that are implemented without exception through the agricultural industries. Until the legal dimensions of the socio-technical big data discussion taking place in Smart farming is addressed, farmers will continue to have 'mixed feelings' towards the ways in which they are being made to interact with smart farming technologies and their providers.

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