TECHNICAL REPORT

ACCELERATING PRECISION AGRICULTURE TO DECISION AGRICULTURE

Enabling digital agriculture in Australia

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The needs and drivers for the present and future of digital agriculture in Australia. A crossindustries producer survey for the Rural R&D for Profit ‘Precision to Decision’ (P2D) project. A Zhang, I Baker, E Jakku and R Llewellyn

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**Executive Summary**

The aim of the project was to benchmark Australian producers’ needs, perceived risks and benefits, and expectations associated with digital agriculture and big data context. Such understanding will inform strategies aimed at 1) better utilising agricultural data to enhance productivity and profitability, and 2) better capitalising on the opportunities created by digital agriculture and big data.

In consultation with P2D project members and participating RDCs, CSIRO designed the survey questionnaire and conducted a survey of 1000 producers across 17 agricultural industries during the period of 7 March to 18 April 2017. The sampling specifications for each industry was defined in consultation with relevant participating RDCs.

The study investigated producers’ needs, perceived risks and benefits, and expectations from three aspects: telecommunication infrastructure, the status of current data collection, and data sharing and concerns in the big data context.

**Key findings**

*Telecommunication infrastructure*

- The vast majority of respondents (94%) had an internet connection for their business, dominated by mobile phone networks (55%) and landline (30%), with NBN associated technologies still at an early stage in application, including NBN fixed wireless (16%), NBN interim satellite service (15%), NBN sky muster (12%), and NBN fibre/fibre-to-node (1%). There were variations in how internet was connected across industries.

- Satisfaction with home office internet connectivity was evenly divided, with 30% of respondents being satisfied or extremely satisfied, meanwhile another 30% being not satisfied or not satisfied at all. There were variations across industries, with respondents from wine grapes, sugarcane, and dairy reporting higher levels of satisfaction, and those from cotton, poultry, beef/grain mixed, pork, and grain only reporting the lower levels of satisfaction.

- Mobile coverage across entire farm was commonly poor, with only 34% of respondents having most or full coverage, and 43% having no coverage at all or little coverage. There were variations across industries, with sugarcane, dairy, wine grapes, and aquaculture reporting comparatively better coverage.

- There was limited adoption of on-farm telecommunication infrastructure, with only 25% of respondents having radio links to devices (e.g., connecting weather station to farm office), or mobile data linked devices (e.g., weather station being directly linked to the mobile network), or both. Among those users, 72% found it moderately-to-extremely challenging to keep on-farm telecommunication systems working.

- Nearly half (49%) of the respondents did not have any on-farm telecommunication infrastructure and had no plan to install in the next 5 years.
There were great variations in the adoption rates of on-farm telecommunication infrastructure across the industries. Comparatively, respondents from cotton (60%), aquaculture (45%), and vegetables (43%) had higher adoption rates, while those from beef/sheep mixed (17%) and sheep wool (18%) had the lowest rates.

Knowledge of on-farm telecommunication options was limited across all industries, with 61% of respondents stating that they knew nothing at all or very little. Respondents from cotton and aquaculture appeared to be comparatively knowledgeable.

More than half (53%) of respondents reported that they relied on themselves only (including family members and employees) to sort out their telecommunication needs.

**The status of current data collection**

- In cropping industries, 87% of respondents collected at least one type of data. The most collected data was financial data (72%), followed by yield mapping data (51%) and soil mapping data (41%), while weed pressure mapping data (11%) had the lowest rates of collection. In general, respondents valued the data quite positively in helping them making farm management decisions.

- There were variations in the types of data collected across the cropping industries. Respondents from cotton industry appeared to be the most active collectors. There were also variations across states and farm sizes.

- In livestock industries, 91% of respondents collected at least one type of data. The most collected data was financial data (79%), followed by veterinary medicine record (63%), animal breeding data (57%), and individual animal or herd production data (56%). In general, all types of data were regarded as quite useful in informing farm management decisions.

- There were variations in the types of data collected across livestock industries. Respondents from dairy and pork industries reported the highest data collection rates. There were variations in data collection rates across states and farm sizes.

- The overall data evaluation by respondents who have collected data was very positive in relation to the data helping farm management decisions, efficiency of running farm, and risk management, but comparatively less so for farm business profit.

- Overall, the more types of data collected by respondents, the more positive they were in valuing the overall contribution the data made. And respondents who did not collect any data regarded the data much less useful in all aspects.

- The majority of respondents (74%) knew nothing at all or very little about the terms and conditions for their data collection agreement with service providers. Nearly half of respondents would not be comfortable if service providers had direct access to the data, with only 24% of respondents would be comfortable or extremely comfortable.

- The trust in service providers maintaining privacy and not sharing data with third parties was very low. More than half respondents (56%) did not trust service
providers would maintain the privacy of their data, and 62% did not trust service providers not to share their data with third parties.

- The majority respondent (67%) would not be comfortable if service providers make profit out of their data without sharing the profit with them.

**Attitude towards data sharing and concerns in the big data context**

- There was no consensus in relation to who would benefit the most from aggregated farm data. Thirty four percent of respondents regarded farmers and another 34% regarded agribusinesses as the main beneficiaries, 21% indicated government, while 11% were not sure.
- There was great variations across industries on who would benefit the most from aggregated data. For example, more respondents from aquaculture (57%), cotton (47%), and rice (47%) believed that farmers would benefit the most; more respondents from grain mixed (48%), beef/sheep (43%), beef/grain mixed (41%), sheep meat only (41%), and pork (40%) believed agribusiness would benefit the most; and more respondents from beef only (29%) and sheep wool (28%) believed the government would benefit the most.
- Regarding sharing various data with different actors (other farmers, agricultural industry-based organisations, technology and service providers, research institutions, and Australian Bureau of Statistics(ABS)), respondents were more willing to share their data with other farmers and research institutions, and least willing to share with technology and service providers.
- In general, the majority of respondents were comfortable in sharing data. Comparatively, respondents were more willing to share weather station and soil test data than farm input and production data.
- Beliefs of who would benefit the most from aggregated farm data affect attitude towards data sharing. Comparatively, respondents who thought farmers would benefit the most were more willing to share data with all actors.
- Positive evaluation of data was also associated with greater willingness to share data with all actors, especially with research institutions and ABS.
- Despite a general willingness to share data, farmers need reassurance to address concerns about how the aggregated data will be governed and used. The majority of respondents reported great concerns over aggregated data in relation to privacy, financial advantage taken by other businesses, and the potential for it to be used to influence the markets such as produce prices and land value.

**Implications**

The findings of the present survey have explored producers’ needs, attitudes, and concerns in relation to the current status of telecommunication infrastructure for, adoption of, and perceived value of digital agriculture technologies, as well as the future application of aggregated agricultural data. This broad and in-depth benchmark has great implications for key stakeholders including governments, RDCs, and research institutions to develop targeted strategies and policies, which will enable producers better utilise agricultural data.
for productivity and profitability and capitalise on the opportunities created by digital agriculture and big data.

The following are the key implications:

- The potential utilisation of agricultural data technologies remains limited by the fact that only a minority of farms have reliable mobile data coverage over their farm area and the NBN is still in the roll-out phase. This will constrain potential utilisation of agricultural data at least in the short term.
- Given the generally low level of awareness and the very early stage of development and adoption, a concerted effort among all stakeholders to help identify the potential value proposition of on-farm telecommunication infrastructures and agricultural data applications could be influential. The experiences of cotton producers who are on relatively more advanced adoption paths may be worth further investigation for other industries to learn from. Further investigation to identify the underlying barriers is also needed.
- As most current users report it challenging to keep on-farm telecommunication systems working, potential adopters are less likely to gain positive learnings from existing adopters. Targeted support and improvements for current users, where potential industry benefits are identified as being high, may be warranted.
- Given that producers heavily relied on on-farm skills to sort out their telecommunication needs, a platform using plain language to provide technical information, training, and support will be very beneficial for producers.
- The terms and conditions for data collection agreement with service providers need to be provided in plain English. In addition, data privacy and ownership needs to be clearly defined and communicated to producers, and agreed by producers.
- The development of aggregated farm data should be centred on the benefits and needs of producers, with other stakeholders (especially farmer organisations and research institutions) playing key roles to enable the development. Such structural establishment will encourage producers to share their data and, in turn, help realise the potential value of big data.
- Improved governance frameworks for aggregated farm data should be established to address producers’ concerns and build their trust. Such frameworks should aim to build producers’ trust in the systems through addressing transparency, privacy, data ownership, and control.

Future research

With the rapid advancement of digital agriculture technologies and application of big data, it is imperative to have up-to-date information about Australian producers’ needs and issues so that valuable opportunities for intervention can be identified early. A general survey across the industries in three years is recommended. More targeted studies focusing on particular aspects for particular industries on a more regular basis will help to inform strategies at the industry level.
1. Introduction

Advances in digital technologies offer the potential for transformational change in Australian agriculture, providing new ways to improve productivity and profitability for Australian producers. Rapid developments in computing power, sensing technologies, robotics, Big Data, the Internet of Things, and Cloud Computing are creating opportunities for more data-driven approaches to farm management, sometimes referred to as ‘smart farming’ (Wolfert, Gee, Verdouw, & Bogaardt, 2017) or decision agriculture (Heath 2017).

Computers and sensor technologies have been used by some Australian farmers to help manage in-field variability for the last couple of decades, a practice known as precision agriculture (Bramley, 2009; Robertson et al., 2012). The term precision agriculture tends to be more commonly used in the cropping sector and refers to information technology tools (e.g. global positioning system (GPS), variable-rate technology (VRT), soil sensors and yield monitors) that enable farmers to electronically monitor soil and crop conditions and develop targeted crop management treatments (Aubert, Schroeder and Grimaudo 2012; Llewellyn and Ouzman 2014). Similarly, digital agriculture is a related but broader term that refers to the use of digital sensors and information more generally to support farm management decisions (Keogh and Henry, 2016).

More recently, advances in digital agriculture and big data analytics are being applied in the agricultural sector via new software tools that can capture, store, and manipulate increasing volumes of data to create decision-support tools for guiding better farm management decisions (Griffith et al., 2013; Keogh and Henry, 2016; Wolfert et al., 2017), creating the opportunity for decision agriculture. In contrast to precision agriculture which involves a collection of individual enabling technologies that may or may not be connected, decision agriculture uses a more integrated system of systems, connecting multiple datasets and drawing on advances in data analytics (Heath 2017). Thus, moving from precision agriculture to decision agriculture captures the idea that, while precision agriculture has primarily focused on bringing together information about in-field variation, decision agriculture refers to the new potential to aggregate multiple data sources through big data analytics to improve on-farm decision-making processes and modify practices at a whole-of-business level. Big data analytics are an important enabler for decision agriculture. The term big data refers to the capability to extract information and insights at a large scale, where previously it was economically and technically not possible to do so (Sonka, 2015). This is achieved through the use of “computerised analytical systems that interrogate extremely large databases of information in order to identify particular trends and correlations” (Keogh and Henry, 2016, p. 4).

The application of digital agriculture tools and big data analytics through decision agriculture can increase farm productivity through input efficiencies and increased output — these gains have been estimated to be approximately 10-15% in the cropping sector (Keogh and Henry, 2016). However, analysis of early experiences with big data applications reveals that their success hinges upon multiple factors. These include the willingness of stakeholders to share and integrate data, end-user acceptance of new technologies, and the existence of protocols for protecting farmers’ rights to privacy, and data ownership and control (Eastwood and Yule, 2015; Griffith et al., 2013; Kaloxylos et al., 2014; Poppe, Wolfert, Verdouw, & Renwick, 2015).
Realising the potential benefits of digital agriculture and big data, therefore, requires conducive technical, social, and institutional conditions. The adoption of new technologies in agriculture is a complex activity influenced by many factors (Kuehne et al., 2017; Pannell et al., 2006; Pierpaoli, Carli, Pignatti, & Canavari, 2013). Much like some of the precision agriculture technologies that preceded it (e.g. variable rate application), decision agriculture is not a simple ‘plug-and-play’ technology. This means that unlike technologies that can provide immediate and obvious benefits (e.g., autosteer), decision agriculture requires a higher level of skill, interpretation, and judgement, which makes it a more challenging adoption scenario (Robertson et al., 2012). This is further complicated by the technical requirements needed to make adoption of these new technologies possible, which often rely on smart devices connecting to and interacting via network infrastructure (Wolfert et al., 2017), thus needing to be supported by appropriate telecommunications infrastructures.

The ability of new farm machinery to collect many types of on-farm data, and the potential of big data applications to make use of aggregated farm data, also raises questions about the ownership, access, and use of farm data (Keogh and Henry 2016). These may be important factors influencing producers’ willingness to adopt new precision agriculture technologies and share farm data. For instance, Jakku et al. (2016) found that there was a high degree of concern among grain growers about the potential for third party use of and benefit from on-farm data. The authors also found that there was a desire for transparency about who would be using the data, for what purpose, what value this would generate, and how that benefit would be distributed. Issues of trust appear to be central to concerns about data ownership and transparency, which in turn depend on appropriate institutional, legal and regulatory arrangements.

2. Objectives

The objective of this survey was to enhance the understanding of effective data technology adoption and data sharing pathways, which take into account producers’ needs, perceived risks and benefits, and expectations across a wide range of agricultural industries. The results will inform strategies aimed at:

1. Ensuring that Australian producers increase their uptake of precision agriculture technologies and can better utilise its data to enhance profitability while also protecting their rights.

2. Addressing producers’ data needs and issues so they can better capitalise on the opportunities created by digital agriculture and big data, while proactively managing the potential risks associated with these new technologies.
3. Method

3.1 Measures

The survey questionnaire was designed in consultation with P2D project members and participating RDCs. The full questionnaire is attached in Appendix A. To achieve the goals of the research project, the survey was designed to collect data toward the following objectives:

- To benchmark the current state of agricultural data systems, which include types of telecommunication infrastructure used, types of data collected and how they were stored, and software used to manage the data;
- To examine how producers perceive the usefulness of the data in supporting farm management outcomes, their concerns over the ownership and privacy of the data they have collected, and the potential uses of aggregated agricultural data; and
- To explore producers’ willingness to share various types of data with different actors, which include other farmers, agricultural industry-based organisations, technology and service provider businesses, research institutions, and the Australian Bureau of Statistics (ABS).

3.2 Participants and procedure

A specialised agricultural research survey company (KG2) was engaged to conduct the data collection. The survey was conducted via computer-assisted telephone interviewing (CATI) during the period of 7th March to 18th April in 2017. The sampling specifications for each industry were defined in consultation with participating RDCs. Potential participants were drawn from KG2’s database. In addition, various RDCs publicized the survey in their newsletters and invited their members to participate by contacting KG2 on a specially designated phone line and email address. The survey response rate is presented in Appendix B.

In total, 1,000 producers across 17 industries participated in the survey. For respondents who had multiple components to their business (i.e., it spanned more than one industry; for example, beef and grain), they were asked to indicate the major component of their business. The survey items were answered in relation to 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, and all answers would refer to their beef component. On the other hand, if the respondent indicated grain, the respondent would be classified as grain/beef mixed, and all answers would refer to their grain component. This classification principle applies to all other mixed combinations (i.e., beef/sheep mixed, sheep/grain mixed, and grain - grain/beef/sheep).

Table 1 presents the number of respondents from each state and industry. Table 2 presents the average farm size and business intensity for each industry. Table 3 presents the demographics of the respondents for each industry.
### Table 1. Number of respondents per industry across states

<table>
<thead>
<tr>
<th>Industry</th>
<th>State</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NSW</td>
<td>QLD</td>
</tr>
<tr>
<td>Beef only</td>
<td>23</td>
<td>63</td>
</tr>
<tr>
<td>Beef/Grain Mixed</td>
<td>28</td>
<td>21</td>
</tr>
<tr>
<td>Beef/Sheep Mixed</td>
<td>59</td>
<td>9</td>
</tr>
<tr>
<td>Sheep Meat Only (Lamb)</td>
<td>29</td>
<td>2</td>
</tr>
<tr>
<td>Sheep/Grain Mixed</td>
<td>45</td>
<td>0</td>
</tr>
<tr>
<td>Sheep Wool</td>
<td>37</td>
<td>3</td>
</tr>
<tr>
<td>Dairy</td>
<td>21</td>
<td>9</td>
</tr>
<tr>
<td>Pork</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Poultry Eggs/Meat</td>
<td>19</td>
<td>1</td>
</tr>
<tr>
<td>Aquaculture</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>Grain Only</td>
<td>19</td>
<td>8</td>
</tr>
<tr>
<td>Grain - Grain/Beef/Sheep</td>
<td>18</td>
<td>4</td>
</tr>
<tr>
<td>Cotton</td>
<td>17</td>
<td>13</td>
</tr>
<tr>
<td>Rice</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>7</td>
<td>58</td>
</tr>
<tr>
<td>Vegetables</td>
<td>13</td>
<td>8</td>
</tr>
<tr>
<td>Wine Grapes</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>364</td>
<td>210</td>
</tr>
</tbody>
</table>

### Table 2. Average farm size and business intensity by industry

Note: For business intensity, two respondents from aquaculture, one from beef/sheep mixed, and one from sheep for wool did not provide production data.

<table>
<thead>
<tr>
<th>Industry</th>
<th>Average farm size (hectares)</th>
<th>Business Intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Unit</td>
</tr>
<tr>
<td>Beef only</td>
<td>11,723</td>
<td>Total Number of Beef Cattle</td>
</tr>
<tr>
<td>Beef/Grain Mixed</td>
<td>6,779</td>
<td>Total Number of Beef Cattle</td>
</tr>
<tr>
<td>Beef/Sheep Mixed</td>
<td>6,792</td>
<td>Number of beef cattle</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of sheep</td>
</tr>
<tr>
<td>Sheep Meat Only (Lamb)</td>
<td>8,726</td>
<td>Total Number of Sheep</td>
</tr>
<tr>
<td>Sheep/Grain Mixed</td>
<td>3,466</td>
<td>Total number of sheep</td>
</tr>
<tr>
<td>Sheep Wool</td>
<td>7,281</td>
<td>Total Number of Sheep</td>
</tr>
<tr>
<td>Dairy</td>
<td>397</td>
<td>Total Number of Cows Milked</td>
</tr>
<tr>
<td>Pork</td>
<td>998</td>
<td>Total Number of Sows</td>
</tr>
<tr>
<td>Poultry Eggs/Meat</td>
<td>140</td>
<td>Total Number of Hens/Birds</td>
</tr>
<tr>
<td>Aquaculture</td>
<td>130</td>
<td>Annual production in kg or dozen</td>
</tr>
<tr>
<td>Grain only</td>
<td>3,936</td>
<td>Hectares planted to grain</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hectares planted to grain</td>
</tr>
<tr>
<td>Cotton</td>
<td>6,866</td>
<td>Hectares planted to cotton</td>
</tr>
<tr>
<td>Rice</td>
<td>2,424</td>
<td>Hectares planted to rice</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>335</td>
<td>Hectares planted to sugarcane</td>
</tr>
<tr>
<td>Vegetables</td>
<td>589</td>
<td>Hectares planted to vegetables</td>
</tr>
<tr>
<td>Wine grapes</td>
<td>882</td>
<td>Hectares planted to wine grapes</td>
</tr>
<tr>
<td>Industry</td>
<td>Number of respondents</td>
<td>Gender (women)</td>
</tr>
<tr>
<td>------------------------</td>
<td>-----------------------</td>
<td>----------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aquaculture</td>
<td>30</td>
<td>3%</td>
</tr>
<tr>
<td>Pork</td>
<td>15</td>
<td>20%</td>
</tr>
<tr>
<td>Beef only</td>
<td>126</td>
<td>16%</td>
</tr>
<tr>
<td>Beef/Grain Mixed</td>
<td>64</td>
<td>13%</td>
</tr>
<tr>
<td>Beef/Sheep Mixed</td>
<td>94</td>
<td>19%</td>
</tr>
<tr>
<td>Dairy</td>
<td>94</td>
<td>9%</td>
</tr>
<tr>
<td>Poultry Eggs/Meat</td>
<td>30</td>
<td>13%</td>
</tr>
<tr>
<td>Sheep Meat Only (Lamb)</td>
<td>59</td>
<td>3%</td>
</tr>
<tr>
<td>Sheep/Grain Mixed</td>
<td>94</td>
<td>12%</td>
</tr>
<tr>
<td>Sheep Wool</td>
<td>89</td>
<td>17%</td>
</tr>
<tr>
<td>Cotton</td>
<td>30</td>
<td>17%</td>
</tr>
<tr>
<td>Grain Only</td>
<td>77</td>
<td>8%</td>
</tr>
<tr>
<td>Grain - Grain/Beef/Sheep</td>
<td>73</td>
<td>10%</td>
</tr>
<tr>
<td>Rice</td>
<td>15</td>
<td>27%</td>
</tr>
<tr>
<td>Wine Grapes</td>
<td>15</td>
<td>13%</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>65</td>
<td>5%</td>
</tr>
<tr>
<td>Vegetables</td>
<td>30</td>
<td>3%</td>
</tr>
<tr>
<td>Total</td>
<td>1000</td>
<td>12%</td>
</tr>
</tbody>
</table>
4. Results

The report’s findings are presented in three parts:

4.1. Telecommunication infrastructure
4.2. The status of current data collection
4.3. Attitude toward data sharing and concerns about aggregated farm data

In addition to the cross-industry comparisons, cross-state and cross-farm size comparisons were also conducted.

**Cross-state comparisons** were conducted separately for grain (including grain only, and grain mixed with beef and/or sheep) and broadacre livestock industries (including beef only, beef/grain mixed, beef/sheep mixed, sheep meat only, sheep/grain mixed, and sheep wool).

These two categories were chosen because the industries within each category grouped together due to the similarity in the nature of their business operations and their sufficient number of respondents across the five major states. Tasmania and the Northern Territory were not included in the cross-state comparisons due to their limited number of respondents. Only statistically significant differences between states were presented in the following sections.

**Cross-farm size comparisons** were conducted separately for broadacre cropping industries (including grain only, grain mixed with beef and/or sheep, cotton, and rice), and broadacre livestock industries (including beef only, beef/grain mixed, beef/sheep mixed, sheep meat only, sheep/grain mixed, sheep wool, dairy, and pork).

The farm sizes were divided into four categories using quartile values of land area responses: small, medium, large, and extra-large farms (see Table 4). Only statistically significant differences between farm sizes were presented in the following sections.

<table>
<thead>
<tr>
<th>Farm size category (sample size)</th>
<th>Land area</th>
<th>Farm size category (sample size)</th>
<th>Land area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small (48)</td>
<td>212 – 1,439 ha</td>
<td>Small (160)</td>
<td>11 – 608 ha</td>
</tr>
<tr>
<td>Medium (49)</td>
<td>1,440 – 2,629 ha</td>
<td>Medium (159)</td>
<td>608.5 – 1,400 ha</td>
</tr>
<tr>
<td>Large (46)</td>
<td>2,630 – 4,999 ha</td>
<td>Large (162)</td>
<td>1,400.5 – 3,240 ha</td>
</tr>
<tr>
<td>Extra-large (52)</td>
<td>5,000 – 100,000 ha</td>
<td>Extra-large (154)</td>
<td>3240.5 – 108,000 ha</td>
</tr>
</tbody>
</table>

4.1 Telecommunication infrastructure

4.1.1 Importance of internet connectivity

There was a strong consensus regarding the importance of internet connectivity to businesses (see Figure 1). Seventy-nine percent of respondents regarded internet connectivity to be important or extremely important to their business. However, there was some variation in its importance across industries (see Figure 2). On average, sugarcane and sheep meat producers placed the lowest importance on internet connectivity and cotton the highest.
4.1.2 Current internet connection and telecommunication infrastructures

Internet connection

The vast majority of respondents (94%) had an internet connection for their business, with landline and mobile phone networks the most prevalent connection options. The low rates of NBN associated technology use revealed that it is still in its early stages of application. Figure 3 presents the percentage of respondents who used each of the particular technologies to connect to the internet (note: respondents could choose multiple options). Although multiple choices were sought, the results need to be treated with caution as landline use was unusually low. Further investigation is needed to verify this finding.
Across industries, there was considerable variation in the adoption rates of technologies used to connect businesses to the internet. Landline, one of the two major types of internet connection methods, was more popular among respondents from more intensive industries (including vegetables, poultry eggs/meat, sugarcane, and dairy), and less so for broadacre industries (including beef/grain mixed, grains, and sheep) (see Figure 4).

**Figure 3. Types of internet connection to business**

Compared to the other connection options, the mobile phone network was the most used connection method, and had particularly high use in cotton, aquaculture, and grain only industries (see Figure 5).

**Figure 4. Internet connection to business via landline by industry**
Figure 5. Internet connection to business via mobile phone network by industry

Among the NBN associated technologies, NBN fixed wireless (16%), NBN interim satellite service (15%), and NBN sky muster (12%) were more in use than NBN fibre/fibre-to-node, but their adoption rates varied across industries (see Figure 6, Figure 7, Figure 8). Dairy (36%), pork (33%), and sugarcane (28%) industries had the highest rates of adoption for NBN fixed wireless technology. The use of NBN interim satellite service was most prevalent for rice (33%) and grain/beef/sheep mixed (25%) industries. Finally, beef only (21%), beef/sheep mixed (21%), pork (20%), and grain/beef/sheep mixed (19%) industries had the highest rates of use for NBN sky muster.

Figure 6. Internet connection to business via NBN fixed wireless by industry
In broadacre livestock industries, there were differences for the use of NBN associated technologies across farm sizes. A significantly greater proportion of respondents from small farms (25%) were connected to the internet via NBN fixed wireless, followed by medium (16%), large (14%), and extra-large farms (10%). Additionally, a significantly greater proportion of producers from extra-large farms (26%) were connected to the internet via NBN sky muster, followed by large (15%), medium (9%), and small farms (5%).

In broadacre livestock industries, there were differences across states for the use of the NBN associated technologies. Respondents from WA were the heaviest users of NBN interim satellite services (31%), followed by QLD (24%), VIC (20%), NSW (15%), and SA (13%).
Respondents from QLD were the heaviest users of NBN sky muster (29%), followed by NSW (15%), WA (14%), SA (11%), and VIC (8%).

**On-farm telecommunication infrastructure**

Figure 9 presents the percentage of respondents who had one of various on-farm telecommunication infrastructure arrangements. Only 25% of respondents had either links to devices (e.g., connecting weather station or gate back to farm office or other location on farm), or mobile data linked devices (e.g., weather station was directly linked to the mobile network), or both. Another 26% did not have any on-farm telecommunication infrastructure, but were considering installing something within the next 5 years. Nearly half (49%) of the respondents did not have any, and had no plans to install.

Among the users of telecommunication infrastructure (see Figure 10), the cotton industry (60%) was well-equipped with telecommunication infrastructures, followed by aquaculture (45%) and vegetable industries (43%). On the other hand, some industries had a low percentage of respondents with on-farm telecommunication infrastructure, including beef/sheep mixed (17%), sheep wool (18%), and beef only (21%) industries.
There were differences between the states for the grain industry’s adoption of various telecommunication infrastructures.

Table 5 shows the percentage of grain growers from each state that have one of various on-farm telecommunication infrastructure arrangements.

Table 5. Types of on-farm telecommunication infrastructure for grain industries by state

<table>
<thead>
<tr>
<th>State</th>
<th>Both — radio links to devices and mobile data linked devices</th>
<th>Radio links to devices only</th>
<th>Mobile data linked devices only</th>
<th>None at present, but considering to install something within next five years</th>
<th>None at present, and have no plans to install any telecommunication infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSW (N = 35)</td>
<td>0%</td>
<td>9%</td>
<td>31%</td>
<td>40%</td>
<td>20%</td>
</tr>
<tr>
<td>QLD (N = 11)</td>
<td>9%</td>
<td>0%</td>
<td>9%</td>
<td>18%</td>
<td>64%</td>
</tr>
<tr>
<td>VIC (N = 24)</td>
<td>8%</td>
<td>0%</td>
<td>8%</td>
<td>46%</td>
<td>38%</td>
</tr>
<tr>
<td>SA (N = 24)</td>
<td>8%</td>
<td>0%</td>
<td>17%</td>
<td>17%</td>
<td>58%</td>
</tr>
<tr>
<td>WA (N = 50)</td>
<td>0%</td>
<td>12%</td>
<td>18%</td>
<td>28%</td>
<td>42%</td>
</tr>
</tbody>
</table>

In addition, there was variations in telecommunication infrastructure use across farm sizes. Within broadacre livestock industries, a significantly greater proportion of respondents from medium (19%) and large farms (19%) used mobile data linked devices, followed by small (16%) and extra-large (9%) farms. Within broadacre cropping industries, a significantly greater proportion of respondents from extra-large farms (23%) used radio links to devices, followed by large (17%), small (13%), and medium farms (9%).
Challenge in keeping on-farm telecommunication systems working

Among the 244 respondents who already had links to devices and/or mobile data linked devices as their on-farm telecommunication infrastructure, approximately three-quarters of respondents (72%) found it challenging or extremely challenging to keep on-farm telecommunication systems working (see Figure 11).

![Figure 11. Challenge in keeping on-farm telecommunication systems working](chart)

Knowledge of on-farm telecommunication options

In general, respondents had very limited knowledge about the options available to connect devices on their farm (see Figure 12). Sixty-one percent of respondents reported that they knew nothing at all or very little, with only 5% of respondents knowing a lot about the options available.

![Figure 12. Knowledge of on-farm telecommunication options](chart)

Respondents from the cotton industry knew the most about options to connect devices to their farm, while sugarcane, sheep/grain mixed, dairy, and beef only industries knew the least (see Figure 13).
Figure 13. Knowledge of on-farm telecommunication options by industry

Internet coverage and satisfaction with internet connectivity

Coverage across farm

Thirty-four percent of respondents had almost complete or full internet coverage on their farm, while 43% of respondents had very patchy or no coverage across their farm (see Figure 14). Figure 15 displays the percentage of respondents across industries that had very patchy or no coverage across their farm. On average, dairy and sugarcane industries had the best coverage across their farms, while beef and cotton had the patchiest coverage (see Figure 16).

Figure 14. Mobile network coverage across entire farm
In broadacre livestock industries, there were significant differences across states in mobile network coverage. Respondents from VIC ($M = 3.30, SD = 1.13$) reported the highest coverage, followed by NSW ($M = 2.68, SD = 1.20$), WA ($M = 2.52, SD = 1.19$), SA ($M = 2.49, SD = 1.03$), and QLD ($M = 2.07, SD = 1.06$).

Unsurprisingly, large farm sizes were associated with poorer coverage for both broadacre cropping and broadacre livestock industries. In broadacre cropping industries, coverage was rated as poorest by respondents from extra-large farms ($M = 2.25, SD = 0.95$), followed by large ($M = 2.80, SD = 1.07$), medium ($M = 2.84, SD = 1.23$), and small farms ($M = 3.00, SD = 1.27$). In broadacre livestock industries, coverage was rated as poorest by
respondents from extra-large farms ($M = 2.02, SD = 1.02$), followed by large ($M = 2.72, SD = 1.09$), medium ($M = 2.98, SD = 1.26$), and small farms ($M = 3.39, SD = 1.34$).

**Satisfaction with internet connectivity**

Among the respondents who had an internet connection ($N = 941$), approximately one-third of respondents (30%) were satisfied or extremely satisfied with their home office internet connectivity, with nearly one-fifth (18%) not satisfied at all (see Figure 17).

![Figure 17. Satisfaction with home office internet connectivity](image)

The correlation analysis revealed that satisfaction with internet connectivity was positively associated with coverage across the farm ($r = .26, p < .001$).
Help with telecommunication needs

To sort out their communication needs, approximately half of the respondents (53%) used only themselves (including family members and employees), and 21% used a combination of themselves and a telecommunication service provider (see Figure 19). There was some variation across the industries (see Appendix D).

Figure 18. Satisfaction with home office internet connectivity by industry

Satisfaction with internet connectivity - by industry
(N = 941; 1 = not satisfied at all, 5 = extremely satisfied)

Who has helped you in sorting out your telecommunication needs?
- overall (N = 980)

Figure 19. Types of assistance sought for telecommunication needs
Note: Yourself = Yourself (including family members and employees); Consultant = Fee-for-service consultant; TSP = Telecommunication Service Provider.
4.2 The status of current data collection

This section includes the types of data that were collected, where they were stored, and how useful producers regarded them in helping them making farm management decisions.

4.2.1 Types of data collected, stored, and perceived usefulness

Cropping and livestock industries collected different sets of data due to their divergent business operation needs. Hence, in the following section, the survey findings are presented separately for cropping and livestock industries.

Cropping industries

Among cropping industries, 87% of respondents collected at least one type of data. Figure 20 presents the average number of different types of data that were collected in each industry.

![Average number of types of data collected by data collecting respondents - by cropping industries (N = 265; Zero scores were removed from the calculations)](chart)

**Figure 20. Average number of data types collected by cropping industries**

Note: Zero scores were removed from the calculations.

Types of data collected

Table 6 presents the percentage of respondents from each cropping industry that currently collected major types of data. Of note, financial data (72%) was the most collected data across industries, followed by yield mapping data (51%) and soil mapping data (41%). Of the listed data types, weed pressure mapping data (11%) had the lowest rates of collection.

There was variation in the types of data collected across cropping industries. In particular, respondents from the cotton industry were the most active in collecting the various types of data.

For the grain industry (including grain only and grain mixed), there were differences in collection rates of soil mapping data, financial data, and no data collection across states. With the soil mapping data, respondents from NSW reported the highest collection rate (60%),
followed by WA (54%), QLD (25%), VIC (24%), and then SA (19%). With the financial data, again those from NSW reported the highest collection rate (78%), followed by WA (78%), VIC (72%), SA (54%), and then QLD (33%). With no data collection at all, respondents from QLD reported the highest rate (42%), followed by SA (23%), VIC (16%), WA (10%), and then NSW (3%).

In addition, there were variations in collection rates of yield mapping data and soil mapping data across farm sizes. A significantly greater proportion of respondents from extra-large farms (75%) collected yield mapping data, followed by producers on small (48%), medium (53%), and large (57%) farms. A significantly greater proportion of respondents from extra-large farms (60%) collected soil mapping data, followed by producers from small (35%), medium (35%), and large (46%) farms.
Table 6. Data collection rates for types of data by cropping industries

<table>
<thead>
<tr>
<th>Industry</th>
<th>Yield mapping</th>
<th>Soil mapping</th>
<th>Crop sensing (e.g., NDVI)</th>
<th>Weed pressure mapping</th>
<th>Soil moisture sensor</th>
<th>On-farm weather station</th>
<th>Finance</th>
<th>Irrigation use</th>
<th>None of the listed data is collected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grain Only (N = 77)</td>
<td>61%</td>
<td>46%</td>
<td>25%</td>
<td>12%</td>
<td>22%</td>
<td>36%</td>
<td>70%</td>
<td>4%</td>
<td>14%</td>
</tr>
<tr>
<td>Grain/Beef/Sheep (N = 73)</td>
<td>49%</td>
<td>38%</td>
<td>12%</td>
<td>11%</td>
<td>19%</td>
<td>26%</td>
<td>69%</td>
<td>7%</td>
<td>14%</td>
</tr>
<tr>
<td>Cotton (N = 30)</td>
<td>73%</td>
<td>53%</td>
<td>33%</td>
<td>13%</td>
<td>67%</td>
<td>47%</td>
<td>83%</td>
<td>60%</td>
<td>3%</td>
</tr>
<tr>
<td>Rice (N = 15)</td>
<td>60%</td>
<td>47%</td>
<td>20%</td>
<td>20%</td>
<td>20%</td>
<td>33%</td>
<td>93%</td>
<td>67%</td>
<td>0%</td>
</tr>
<tr>
<td>Sugarcane (N = 65)</td>
<td>51%</td>
<td>40%</td>
<td>17%</td>
<td>11%</td>
<td>8%</td>
<td>22%</td>
<td>68%</td>
<td>15%</td>
<td>15%</td>
</tr>
<tr>
<td>Vegetables (N = 30)</td>
<td>33%</td>
<td>27%</td>
<td>23%</td>
<td>7%</td>
<td>37%</td>
<td>40%</td>
<td>70%</td>
<td>60%</td>
<td>23%</td>
</tr>
<tr>
<td>Wine grapes (N = 15)</td>
<td>0%</td>
<td>33%</td>
<td>7%</td>
<td>0%</td>
<td>53%</td>
<td>47%</td>
<td>73%</td>
<td>80%</td>
<td>7%</td>
</tr>
<tr>
<td>Total (N = 305)</td>
<td>51%</td>
<td>41%</td>
<td>20%</td>
<td>11%</td>
<td>26%</td>
<td>32%</td>
<td>72%</td>
<td>25%</td>
<td>13%</td>
</tr>
</tbody>
</table>

Data storage

Table 7 displays a percentage breakdown of how various types of data were stored by respondents from cropping industries. ‘On farm electronically’ was the most prominently used storage option for most types of data, accounting for approximately half of the storage for most types of data. The next most used method was ‘on farm on paper’, followed by ‘in-cloud services’. The least utilized method was a ‘service provider’.

Table 7. Data storage methods for types of data in cropping industries

<table>
<thead>
<tr>
<th>Data type</th>
<th>Location of stored data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>On farm on paper</td>
</tr>
<tr>
<td>Yield mapping (N = 157)</td>
<td>21%</td>
</tr>
<tr>
<td>Soil mapping (N = 125)</td>
<td>36%</td>
</tr>
<tr>
<td>Crop sensing (e.g., NDVI) (N = 60)</td>
<td>23%</td>
</tr>
<tr>
<td>Soil moisture sensor (N = 80)</td>
<td>15%</td>
</tr>
<tr>
<td>On-farm weather station (N = 99)</td>
<td>30%</td>
</tr>
<tr>
<td>Finances (N = 219)</td>
<td>12%</td>
</tr>
<tr>
<td>Irrigation use (N = 76)</td>
<td>28%</td>
</tr>
</tbody>
</table>
Usefulness of the data

Table 8 presents the findings on how useful respondents believed that each type of data that they had collected was in helping them make farm management decisions. Overall, as indicated by the average scores, all types of data were regarded as quite useful for informing farm management decisions. In particular, financial data was rated as the most useful, followed by irrigation use data, weed pressure mapping data, and soil moisture sensor data.

Table 8. Reported usefulness of types of data for farm management decisions by data collectors in cropping industries

<table>
<thead>
<tr>
<th>Data type</th>
<th>Usefulness of data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 = No use at all</td>
</tr>
<tr>
<td>Yield mapping (N = 157)</td>
<td>3%</td>
</tr>
<tr>
<td>Soil mapping (N = 125)</td>
<td>2%</td>
</tr>
<tr>
<td>Crop sensing (e.g., NDVI) (N = 60)</td>
<td>3%</td>
</tr>
<tr>
<td>Weed pressure mapping (N = 33)</td>
<td>-</td>
</tr>
<tr>
<td>Soil moisture sensor (N = 78)</td>
<td>3%</td>
</tr>
<tr>
<td>On-farm weather station (N = 99)</td>
<td>2%</td>
</tr>
<tr>
<td>Finances (N = 216)</td>
<td>1%</td>
</tr>
<tr>
<td>Irrigation use (N = 76)</td>
<td>1%</td>
</tr>
</tbody>
</table>

Livestock industries

Among livestock industries, 91% of respondents collected at least one type of data. Figure 21 presents the average number of different types of data that were collected for each industry.

Figure 21. Average number of data types collected by livestock industries

Types of data collected

Table 9 presents the percentage of respondents for livestock industries that currently collected major types of data. Across the livestock industries, financial data (79%) was the most
collected, followed by veterinary medicine record (63%), animal breeding data (57%), and individual animal or herd production data (56).

There was variation in the types of data collected across livestock industries. Respondents from dairy and pork industries reported the highest data collection rates across all data type categories.
### Table 9. Data collection rates for types of data by livestock industries

<table>
<thead>
<tr>
<th>Industry</th>
<th>Soil mapping</th>
<th>Pasture/vegetation mapping</th>
<th>Individual animal or herd production</th>
<th>Individual animal or herd feeding</th>
<th>On-farm weather station</th>
<th>Animal breeding</th>
<th>Finances</th>
<th>Veterinary medicine record</th>
<th>Water use/quality</th>
<th>None of the listed data is collected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef only (N = 126)</td>
<td>23%</td>
<td>33%</td>
<td>54%</td>
<td>23%</td>
<td>26%</td>
<td>50%</td>
<td>78%</td>
<td>63%</td>
<td>25%</td>
<td>9%</td>
</tr>
<tr>
<td>Beef/Grain Mixed (N = 64)</td>
<td>28%</td>
<td>30%</td>
<td>52%</td>
<td>25%</td>
<td>45%</td>
<td>41%</td>
<td>86%</td>
<td>67%</td>
<td>23%</td>
<td>8%</td>
</tr>
<tr>
<td>Beef/Sheep Mixed (N = 94)</td>
<td>29%</td>
<td>29%</td>
<td>52%</td>
<td>23%</td>
<td>42%</td>
<td>61%</td>
<td>83%</td>
<td>70%</td>
<td>19%</td>
<td>4%</td>
</tr>
<tr>
<td>Sheep Meat Only (Lamb) (N = 59)</td>
<td>20%</td>
<td>24%</td>
<td>44%</td>
<td>29%</td>
<td>49%</td>
<td>54%</td>
<td>70%</td>
<td>63%</td>
<td>17%</td>
<td>14%</td>
</tr>
<tr>
<td>Sheep/Grain Mixed (N = 94)</td>
<td>27%</td>
<td>19%</td>
<td>31%</td>
<td>16%</td>
<td>31%</td>
<td>47%</td>
<td>71%</td>
<td>45%</td>
<td>23%</td>
<td>17%</td>
</tr>
<tr>
<td>Sheep Wool (N = 89)</td>
<td>23%</td>
<td>24%</td>
<td>56%</td>
<td>27%</td>
<td>38%</td>
<td>67%</td>
<td>79%</td>
<td>72%</td>
<td>19%</td>
<td>7%</td>
</tr>
<tr>
<td>Dairy (N = 92)</td>
<td>37%</td>
<td>27%</td>
<td>80%</td>
<td>50%</td>
<td>17%</td>
<td>77%</td>
<td>82%</td>
<td>70%</td>
<td>38%</td>
<td>7%</td>
</tr>
<tr>
<td>Pork (N = 15)</td>
<td>20%</td>
<td>13%</td>
<td>93%</td>
<td>80%</td>
<td>27%</td>
<td>93%</td>
<td>93%</td>
<td>100%</td>
<td>67%</td>
<td>0%</td>
</tr>
<tr>
<td>Poultry Eggs/Meat (N = 30)</td>
<td>10%</td>
<td>17%</td>
<td>60%</td>
<td>43%</td>
<td>17%</td>
<td>20%</td>
<td>70%</td>
<td>53%</td>
<td>57%</td>
<td>23%</td>
</tr>
<tr>
<td>Aquaculture (N = 30)</td>
<td>0%</td>
<td>0%</td>
<td>87%</td>
<td>47%</td>
<td>47%</td>
<td>63%</td>
<td>90%</td>
<td>37%</td>
<td>97%</td>
<td>3%</td>
</tr>
<tr>
<td>Total (N = 693)</td>
<td>25%</td>
<td>25%</td>
<td>56%</td>
<td>30%</td>
<td>33%</td>
<td>57%</td>
<td>79%</td>
<td>63%</td>
<td>29%</td>
<td>9%</td>
</tr>
</tbody>
</table>
In broadacre livestock industries, there were some statistically significant differences across states in the collection rates of breeding data. Respondents from SA (63%) reported the breeding data collection rate, followed by VIC (63%), NSW (55%), WA (48%), and QLD (39%).

In addition, across farm sizes there was variation in the collection rates of pasture/vegetation mapping, individual animal or herd production and feeding, on-farm weather station, and animal breeding data. Regarding pasture/vegetation data, respondents from extra-large (32%) and large farms (31%) reported the highest collection rates, followed by medium (23%) and small farms (20%). Regarding individual animal or herd production data, respondents from small farms (68%) reported the highest collection rate, followed by extra-large (52%), medium (49%), and large (48%) farms. Regarding individual animal or herd feeding data, respondents from small farms (38%) reported the highest collection rate, followed by large (28%), medium (25%), and extra-large farms (23%). Regarding on-farm weather station data, respondents from extra-large (40%) and large (40%) farms reported the highest collection rates, followed by medium (33%), and small farms (22%). Regarding animal breeding data, respondents from small farms (69%) reported the highest collection rate, followed by those from medium (57%), large (56%), and extra-large (50%) farms.

Data storage

Table 10 displays a percentage breakdown of how various types of data were stored by respondents from livestock industries. Overall, ‘on farm on paper’ storage was the most prominent storage option, followed closely by ‘on farm electronically’. Conversely, storing data through ‘in-cloud’ and ‘service provider’ were the least used options.

Table 10. Data storage methods for types of data in livestock industries

<table>
<thead>
<tr>
<th>Data type</th>
<th>Location of stored data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>On farm on paper</td>
</tr>
<tr>
<td>Soil mapping (N = 171)</td>
<td>53%</td>
</tr>
<tr>
<td>Pasture/vegetative mapping (N = 173)</td>
<td>49%</td>
</tr>
<tr>
<td>Individual animal or herd production (N = 387)</td>
<td>42%</td>
</tr>
<tr>
<td>Individual animal or herd feeding (N = 208)</td>
<td>50%</td>
</tr>
<tr>
<td>On-farm weather station (N = 232)</td>
<td>63%</td>
</tr>
<tr>
<td>Animal breeding (N = 392)</td>
<td>53%</td>
</tr>
<tr>
<td>Finances (N = 546)</td>
<td>21%</td>
</tr>
<tr>
<td>Veterinary medicine record (N = 437)</td>
<td>65%</td>
</tr>
<tr>
<td>Water use/quality (N = 204)</td>
<td>49%</td>
</tr>
</tbody>
</table>
Usefulness of the data

Table 11 presents the findings on how useful respondents believed each type of data was in helping them make farm management decisions. Overall, as indicated by the average scores, all types of data were regarded as quite useful for informing farm management decisions. In particular, financial data was rated as the most useful, followed by individual animal or herd feeding and production data, and animal breeding data. On-farm weather station data was rated comparatively least useful.

Table 11. Usefulness of types of data for farm management decisions in livestock industries

<table>
<thead>
<tr>
<th>Data type</th>
<th>Usefulness of data</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 = No use at all</td>
<td>2</td>
</tr>
<tr>
<td>Soil mapping (N = 171)</td>
<td>3%</td>
<td>9%</td>
</tr>
<tr>
<td>Pasture/vegetative mapping (N = 173)</td>
<td>1%</td>
<td>12%</td>
</tr>
<tr>
<td>Individual animal or herd production (N = 387)</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td>Individual animal or herd feeding (N = 208)</td>
<td>1%</td>
<td>7%</td>
</tr>
<tr>
<td>On-farm weather station (N = 232)</td>
<td>7%</td>
<td>11%</td>
</tr>
<tr>
<td>Animal breeding (N = 390)</td>
<td>1%</td>
<td>2%</td>
</tr>
<tr>
<td>Finances (N = 546)</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>Veterinary medicine record (N = 436)</td>
<td>5%</td>
<td>12%</td>
</tr>
<tr>
<td>Water use/quality (N = 204)</td>
<td>3%</td>
<td>8%</td>
</tr>
</tbody>
</table>

4.2.2 Software use

Only the respondents who collected one or more types of data were asked what types of financial management and production management software they used to manage their data.

The findings presented here need to be interpreted with caution. As the phone survey covered a broad range of issues and was not focused on software use, respondents may not have had enough time to identify all the software they use.

Financial management software

The heaviest users of financial management software were from pork, cotton, grain mixed, and vegetable industries, where about three-quarters of respondents used a financial management software (see Figure 22). The sugarcane industry had by far the lowest usage rate of 22%.
For respondents who used financial management software to manage their financial data, they were asked about the details of the software. Table 12 displays the types of financial management software used, and the proportion of users within each industry who used each financial management software.

**Figure 22. Financial management software use by industry**
### Table 12. Types of financial management software use by industry

<table>
<thead>
<tr>
<th>Industry</th>
<th>AgData</th>
<th>Agrimaster</th>
<th>BankLink</th>
<th>CashBooks</th>
<th>CashFlow</th>
<th>MYOB</th>
<th>QuickBooks</th>
<th>Quicken</th>
<th>Reckon</th>
<th>Xero</th>
<th>Don't know</th>
<th>Miscellaneous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef only (N = 53)</td>
<td>28%</td>
<td>6%</td>
<td>4%</td>
<td>4%</td>
<td>4%</td>
<td>13%</td>
<td>13%</td>
<td>4%</td>
<td>4%</td>
<td>8%</td>
<td>8%</td>
<td>13%</td>
</tr>
<tr>
<td>Beef/Grain Mixed (N = 34)</td>
<td>38%</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
<td>0%</td>
<td>6%</td>
<td>9%</td>
<td>3%</td>
<td>3%</td>
<td>9%</td>
<td>9%</td>
<td>18%</td>
</tr>
<tr>
<td>Beef/Sheep Mixed (N = 50)</td>
<td>18%</td>
<td>2%</td>
<td>4%</td>
<td>2%</td>
<td>4%</td>
<td>16%</td>
<td>6%</td>
<td>4%</td>
<td>10%</td>
<td>10%</td>
<td>18%</td>
<td></td>
</tr>
<tr>
<td>Sheep Meat Only (Lamb) (N = 26)</td>
<td>23%</td>
<td>4%</td>
<td>4%</td>
<td>4%</td>
<td>0%</td>
<td>8%</td>
<td>8%</td>
<td>12%</td>
<td>4%</td>
<td>19%</td>
<td>12%</td>
<td>8%</td>
</tr>
<tr>
<td>Sheep/Grain Mixed (N = 39)</td>
<td>28%</td>
<td>10%</td>
<td>0%</td>
<td>5%</td>
<td>13%</td>
<td>8%</td>
<td>10%</td>
<td>5%</td>
<td>3%</td>
<td>0%</td>
<td>18%</td>
<td>3%</td>
</tr>
<tr>
<td>Sheep Wool (N = 41)</td>
<td>17%</td>
<td>12%</td>
<td>2%</td>
<td>7%</td>
<td>12%</td>
<td>10%</td>
<td>10%</td>
<td>2%</td>
<td>5%</td>
<td>7%</td>
<td>10%</td>
<td>5%</td>
</tr>
<tr>
<td>Dairy (N = 47)</td>
<td>0%</td>
<td>0%</td>
<td>2%</td>
<td>6%</td>
<td>13%</td>
<td>6%</td>
<td>11%</td>
<td>11%</td>
<td>11%</td>
<td>15%</td>
<td>21%</td>
<td>11%</td>
</tr>
<tr>
<td>Pork (N = 12)</td>
<td>17%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>33%</td>
<td>25%</td>
<td>0%</td>
<td>8%</td>
<td>0%</td>
<td>8%</td>
<td>17%</td>
</tr>
<tr>
<td>Poultry Eggs/Meat (N = 13)</td>
<td>8%</td>
<td>0%</td>
<td>8%</td>
<td>0%</td>
<td>15%</td>
<td>15%</td>
<td>15%</td>
<td>0%</td>
<td>0%</td>
<td>8%</td>
<td>23%</td>
<td>15%</td>
</tr>
<tr>
<td>Aquaculture (N = 20)</td>
<td>5%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>35%</td>
<td>20%</td>
<td>0%</td>
<td>20%</td>
<td>5%</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>Grain Only (N = 45)</td>
<td>27%</td>
<td>31%</td>
<td>0%</td>
<td>0%</td>
<td>2%</td>
<td>7%</td>
<td>4%</td>
<td>2%</td>
<td>2%</td>
<td>4%</td>
<td>9%</td>
<td>18%</td>
</tr>
<tr>
<td>Grain - Grain/Beef/Sheep (N = 49)</td>
<td>20%</td>
<td>47%</td>
<td>0%</td>
<td>2%</td>
<td>4%</td>
<td>4%</td>
<td>8%</td>
<td>0%</td>
<td>4%</td>
<td>4%</td>
<td>8%</td>
<td>6%</td>
</tr>
<tr>
<td>Cotton (N = 22)</td>
<td>55%</td>
<td>5%</td>
<td>0%</td>
<td>5%</td>
<td>0%</td>
<td>5%</td>
<td>0%</td>
<td>5%</td>
<td>0%</td>
<td>9%</td>
<td>9%</td>
<td>23%</td>
</tr>
<tr>
<td>Rice (N = 7)</td>
<td>57%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>14%</td>
<td>0%</td>
<td>14%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>29%</td>
</tr>
<tr>
<td>Sugarcane (N = 12)</td>
<td>0%</td>
<td>0%</td>
<td>8%</td>
<td>0%</td>
<td>0%</td>
<td>33%</td>
<td>33%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>8%</td>
<td>17%</td>
</tr>
<tr>
<td>Vegetables (N = 17)</td>
<td>6%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>35%</td>
<td>24%</td>
<td>6%</td>
<td>12%</td>
<td>6%</td>
<td>12%</td>
<td>12%</td>
</tr>
<tr>
<td>Wine grapes (N = 8)</td>
<td>13%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>50%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>13%</td>
<td>25%</td>
</tr>
<tr>
<td>Total (N = 495)</td>
<td>21%</td>
<td>11%</td>
<td>2%</td>
<td>3%</td>
<td>5%</td>
<td>11%</td>
<td>12%</td>
<td>4%</td>
<td>5%</td>
<td>7%</td>
<td>11%</td>
<td>13%</td>
</tr>
</tbody>
</table>
Production management software

Among the 895 respondents who collected one or more types of data, only 191 respondents indicated that they used production management software to manage their data. Again, this figure needs to be interpreted with caution. It is likely that the findings underestimated the real practice due to the survey method not being designed for this purpose. For example, 48 respondents could not recall the name of the software they used, and only 4 respondents reported the use of the common software Excel (see Appendix C).

Figure 23 presents the percentage of data collectors across industries that used at least one type of production management software. Respondents from grain only, pork, grain mixed, cotton, and vegetable industries were the highest users, with sheep meat only, beef only, poultry, and wine grapes industries the lowest users.

![Figure 23. Production management software use by industry](image)

### 4.2.3 Overall evaluation of contributions made by the data collected so far

For the respondents who collected one or more types of data \( (N = 895) \), they were asked to evaluate the overall contributions these data made to various aspects of their business. In general, evaluations were quite positive. The following findings are from the respondents who had collected one or more types of data.

**Farm management decisions**

Overwhelmingly, 92% of respondents reported that the data they had collected was useful or extremely useful in helping them make farm management decisions (see Figure 24). In particular, respondents from aquaculture, pork, cotton, and vegetable industries found that the data they were currently collecting was highly useful in helping making farm management decisions (see Figure 25).
Compared to those who collected data ($M = 3.94, SD = 0.99$), respondents who didn’t collect any data ($N = 105, M = 2.34, SD = 1.25$) thought that data, if they were to collect it, would be significantly less useful in helping make farm management decisions.

![Graph showing usefulness of data](image)

**Figure 24. Usefulness of data for making farm management decisions**

How useful is the previously mentioned data you currently collect in helping you make farm management decisions? - overall ($N = 895$)

- No use at all: 2%
- 2: 6%
- 3: 23%
- 4: 34%
- Extremely useful: 35%

**Figure 25. Usefulness of data for making farm management decisions by industry**

**Farm business profit**

Overall, respondents found that the data had made quite a positive contribution to their farm business profit (see Figure 26). About half (51%) believed that the data helped increase their business profit to a moderate or great extent, especially among the respondents from aquaculture and pork industries (see Figure 27). Only 15% found it had little or no positive contribution.

Compared to those who collected data ($M = 3.46, SD = 1.03$), respondents who didn’t collect any data ($M = 2.01, SD = 1.13$) thought that data would make significantly less contribution to business profit if they were to collect it.
Efficient running of the farm

Overall, the majority of respondents found that the data had been useful in increasing efficiency on their farm, with 19% claiming that the data increased efficiency greatly, and only a cumulative 12% finding it had little or no positive contribution to farm efficiency (see Figure 28). Again, aquaculture and pork industries reported the greatest contribution of the data to farm efficiency (see Figure 29).

Compared to those who collected data ($M = 3.58$, $SD = 1.01$), respondents who didn’t collect any data ($M = 2.18$, $SD = 1.25$) thought that collecting data would make significantly less contribution to the efficient running of their farm if they were to collect it.
How much contribution has the previously mentioned data you currently collect made to the efficient running of your farm?
- overall \((N = 895)\)

<table>
<thead>
<tr>
<th>Contribution</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>No positive contribution at all</td>
<td>4%</td>
</tr>
<tr>
<td>2</td>
<td>8%</td>
</tr>
<tr>
<td>3</td>
<td>33%</td>
</tr>
<tr>
<td>4</td>
<td>37%</td>
</tr>
<tr>
<td>Increased efficiency greatly</td>
<td>19%</td>
</tr>
</tbody>
</table>

**Figure 28. Contribution of data to efficient running of farm**

How much contribution has the previously mentioned data you currently collect made to the efficient running of your farm?
- by industry \((N = 895; 1 = \text{no positive contribution at all}, 5 = \text{increased efficiency greatly})\)

**Figure 29. Contribution of data to efficient running of farm by industry**

**Risk management**

Overall, 16% found that the collected data improved risk management greatly, and the majority (64%) found that it made a positive contribution, with only 6% finding it had no positive contribution at all (see Figure 30). There was not much variation across industries (see Figure 31), apart from aquaculture and pork industries that indicated the greatest contribution of the data to improved risk management.

Compared to those who collected data \((M = 3.40, SD = 1.11)\), respondents who didn’t collect any data \((M = 2.25, SD = 1.31)\) thought that the data would make significantly less contribution to risk management of their farm operations if they were to collect it.
For producers to actively engage with precision agriculture and fully utilise digital agricultural technologies, it is essential for them to appreciate the benefits of these technologies. Hence, it is important to understand the drivers of producers’ positive evaluations toward agricultural data enabled through digital agricultural technologies.

Data appreciation was calculated by averaging the overall evaluations of contributions to ‘helping farm management decisions’, ‘increasing business profit’, ‘increasing efficiency of running farm’, and ‘improving risk management’ (see above section; 1 = no use at all, 5 = extremely useful). Hierarchical multiple regression analyses were conducted to identify the key predictors of data appreciation.
Due to the divergent nature of business operations, two sub-groups of industries were created based on their similar business operations. These sub-groups are broadacre cropping industries (including grain only, grain mixed, cotton, and rice) and broadacre livestock industries (including beef only, beef/grain, beef/sheep, sheep meat only, sheep/grain, and sheep wool). A hierarchical multiple regression analysis was conducted separately for each sub-group.

**Broadacre cropping industries**

Table 13 presents the findings of the hierarchical multiple regression analysis for broadacre cropping industries.

When only demographic variables were considered, there was evidence of associations between education and land size with degree of data appreciation; however, when a broader range of predictors (see Table 13) were included and considered simultaneously in the model, education and land size, along with age, gender, and years in industry were not statistically significant predictors of data appreciation ($M = 3.47$, $SD = 0.88$). Poor technical support for digital agricultural technologies ($M = 3.23$, $SD = 1.12$) and perceived low return of agricultural technologies and equipment ($M = 3.19$, $SD = 1.06$) were also not significant predictors.

Instead, regarding maximising production as important ($M = 4.63$, $SD = 0.68$), knowledge of telecommunication options ($M = 2.45$, $SD = 1.12$), and greater total number of data types collected ($M = 2.86$, $SD = 1.94$) predicted greater data appreciation. Moreover, the knowledge and number of data types collected interacted in predicting data appreciation. As shown in Figure 32, respondents with low levels of knowledge appreciated the value of the data only when they had collected more types of data. However, respondents with higher levels of knowledge of telecommunication options had a high appreciation for the value of the data regardless of how many types of data they collected.
Table 13. Hierarchical multiple regression analysis predicting appreciation of data for broadacre cropping industries.

Note: * p < .05, ** p < .01. Poor technical support, low return in tech/equipment investment, maximising production important, and knowledge of telecommunication options were all measured on a 5-point scale (1 = strongly disagree/know nothing at all, 5 = strongly agree/know a lot).

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Step 1</th>
<th>Step 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R² = .093 F (5, 186) = 3.80 p = .003</td>
<td>R² change = .158 F change (6, 180) = 6.31 p &lt; .001</td>
</tr>
<tr>
<td>Age</td>
<td>β</td>
<td>β</td>
</tr>
<tr>
<td>Gender</td>
<td>.14</td>
<td>.10</td>
</tr>
<tr>
<td>Education</td>
<td>.20*</td>
<td>.10</td>
</tr>
<tr>
<td>Years in industry</td>
<td>.04</td>
<td>.08</td>
</tr>
<tr>
<td>Total land size</td>
<td>.16*</td>
<td>.08</td>
</tr>
<tr>
<td>Poor technical support</td>
<td></td>
<td>.07</td>
</tr>
<tr>
<td>Low return in tech/equipment investment</td>
<td></td>
<td>-.09</td>
</tr>
<tr>
<td>Maximising production important</td>
<td></td>
<td>.19**</td>
</tr>
<tr>
<td>Knowledge of telecommunication options (Knowledge)</td>
<td></td>
<td>.15*</td>
</tr>
<tr>
<td>Number of data types collected (No. of data)</td>
<td></td>
<td>.26**</td>
</tr>
<tr>
<td>Knowledge X No. of data</td>
<td></td>
<td>-.14*</td>
</tr>
</tbody>
</table>
Figure 32. Interaction effect between degree of tech/equipment investment and knowledge of telecommunication options on data appreciation for broadacre cropping industries

Note: * p < .05, ** p < .01. Poor technical support, low return in tech/equipment investment, maximising production important, and knowledge of telecommunication options were all measured on a 5-point scale (1 = strongly disagree/know nothing at all, 5 = strongly agree/know a lot).

Broadacre livestock industries

Table 14 presents the findings of the hierarchical multiple regression analysis for broadacre livestock industries.

As in the cropping industries, when only demographic variables were considered, there was evidence of association between education and data appreciation. However, when additional predictors (see Table 14) were included and considered simultaneously in the model, along with the demographic factors, including years in industry, and land size, only age was significantly associated with data appreciation ($M = 3.40, SD = 0.99$). That is, younger respondents appreciated the value of the data more than older respondents.

Perceived low return of investment in agricultural technologies/equipment ($M = 2.98, SD = 1.14$) and regarding maximising production as important ($M = 4.47, SD = .83$) were also not significant predictors.

Instead, poorer technical support for digital agricultural technologies ($M = 3.02, SD = 1.15$), greater knowledge of telecommunication options ($M = 2.18, SD = 1.14$), and greater total number of data types collected ($M = 3.76, SD = 2.28$) significantly predicted greater data appreciation. Moreover, the knowledge and number of data types interacted in predicting data appreciation.

As shown in Figure 33, and similar to the pattern displayed for broadacre cropping industries, respondents with low levels of knowledge appreciated the values of the data only when they had collected more types of data. However, respondents with higher levels of knowledge appreciated the value of the data more even when they had not collected many types of data.
Table 14. Hierarchical multiple regression analysis predicting appreciation of data for broadacre livestock industries

Note: * p < .05, ** p < .01, *** p < .001

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Step 1</th>
<th></th>
<th></th>
<th>Step 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R² = .064</td>
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<td>β</td>
<td>R² change = .250</td>
<td>β</td>
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<td>F (5, 516) = 7.03</td>
<td>p &lt; .001</td>
<td>F change(6, 510) = 30.98</td>
<td>p &lt; .001</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>-.22**</td>
<td></td>
<td></td>
<td>-.16**</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>.02</td>
<td></td>
<td></td>
<td>.00</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>.14**</td>
<td></td>
<td></td>
<td>.02</td>
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<tr>
<td>Years in industry</td>
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<tr>
<td>Total land size</td>
<td>.00</td>
<td></td>
<td></td>
<td>-.03</td>
<td></td>
</tr>
<tr>
<td>Poor technical support</td>
<td></td>
<td></td>
<td></td>
<td>.09*</td>
<td></td>
</tr>
<tr>
<td>Low return in tech/equipment investment</td>
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<td></td>
<td></td>
<td>-.05</td>
<td></td>
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<tr>
<td>Maximising production important</td>
<td></td>
<td></td>
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<td>.04</td>
<td></td>
</tr>
<tr>
<td>Knowledge of telecommunication options (Knowledge)</td>
<td></td>
<td></td>
<td></td>
<td>.14***</td>
<td></td>
</tr>
<tr>
<td>Number of data types collected (No. of data)</td>
<td></td>
<td></td>
<td></td>
<td>.45***</td>
<td></td>
</tr>
<tr>
<td>Knowledge X No. of data</td>
<td></td>
<td></td>
<td></td>
<td>-.11**</td>
<td></td>
</tr>
</tbody>
</table>

Figure 33. Interaction effect between degree of tech/equipment investment and knowledge of telecommunication options on data appreciation for broadacre livestock industries.

Note: * p < .05, ** p < .01. Poor technical support, low return in tech/equipment investment, maximising production important, and knowledge of telecommunication options were all measured on a 5-point scale (1 = strongly disagree/know nothing at all, 5 = strongly agree/know a lot).
4.2.5 Trust in service/technology providers

For respondents who collected data (\(N = 895\)), they were asked about their understanding of the arrangement they have with their service/technology provider regarding the data collected through their services, and the trust in them to maintain the privacy of the data.

Understanding 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 Figure 34). There was variation across industries for this knowledge (see Figure 35). Relative to other industries, respondents from the cotton industry reported the most knowledge, though in absolute terms they indicated they did not know much. Conversely, and relative to other industries, sheep wool and vegetable industries had the least knowledge. The remaining industries showed a stable trend of knowing little about their agreement with the service providers.
Figure 34. Knowledge of terms and conditions for data collection agreement with service providers

For tools used to collect the previously mentioned data, how much do you know about the terms and conditions relating to data collection in your agreement with the service providers?

- by industry (N = 895; 1 = don’t know at all, 5 = know very well)

Figure 35. Knowledge of terms and conditions for data collection agreement with service providers by industry

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 Figure 36). Again, variation existed across the industries (see Figure 37). In particular, beef/grain mixed and poultry/eggs meat industries were the least comfortable with service/technology providers having direct access to their data. Comparatively, the grain only, rice, wine grape and vegetable industries were the most comfortable.
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?

- overall ($N = 895$)

![Figure 36. Comfort in service/technology providers having access to producers’ data](image)

**Figure 36. Comfort in service/technology providers having access to producers’ data**

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?

- by industry ($N = 895$; 1= not comfortable at all, 5 = extremely comfortable)

![Figure 37. Comfort in service/technology providers having access to producers’ data by industry](image)

**Figure 37. Comfort in service/technology providers having access to producers’ data by industry**

**Trust in service/technology providers maintaining privacy and not sharing producers’ data**

Overall, if service/technology providers had direct access to respondents’ data, more than half (56%) of the respondents displayed no 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 Figure 38 and Figure 40, respectively). Comparatively, respondents from the cotton industry showed higher levels of trust (see Figure 39), while those from the poultry eggs/meat reported the lowest (see Figure 41), respectively.
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?
- overall ($N = 895$)

Figure 38. Trust in service/technology providers maintaining privacy of producers’ 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?
- by industry ($N = 895$; $1 = no trust at all, 5 = total trust)

Figure 39. Trust in service/technology providers maintaining privacy of producers’ data by industry
Figure 40. Trust in service/technology providers not sharing producers’ data with third parties

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?
- overall \( (N = 895) \)

<table>
<thead>
<tr>
<th>Trust Level</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>No trust at all</td>
<td>36%</td>
</tr>
<tr>
<td>2</td>
<td>26%</td>
</tr>
<tr>
<td>3</td>
<td>21%</td>
</tr>
<tr>
<td>4</td>
<td>11%</td>
</tr>
<tr>
<td>Total trust</td>
<td>6%</td>
</tr>
</tbody>
</table>

Figure 41. Trust in service/technology providers not sharing producers’ data with third parties by industry

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?
- by industry \( (N = 895; 1 = \text{no trust at all}, 5 = \text{total trust}) \)

**Attitude towards profit making by service/technology providers from producers’ data**

The majority of respondents (67%) did not feel comfortable if service/technology providers used the data to make profits for themselves (see Figure 42). In particular, respondents from aquaculture, poultry, and grain/beef/sheep industries felt the most uncomfortable with service providers making profits from the data (see Figure 43).
4.3 Attitude toward data sharing and concerns about aggregated farm data

The survey explored producers’ willingness and concerns about data sharing in the context of aggregated farm data. To ensure all correspondents had the same understanding of the concept of aggregated farm data, the following definition was read out to the respondents before their opinions were sought on various questions.
When the data collected from many individual farms are combined together, they can be used to develop tools that support agricultural decision making. This combined data is referred to as "aggregated farm data". For the aggregated farm data to work, it will require individual farms to share their data.

4.3.1 Who will benefit the most from the aggregated farm data?

There was no consensus as to who would benefit most from aggregated farm data. As shown in Figure 44, 34% regarded farmers as the party who would benefit most, another 34% indicated agribusiness, 21% indicated government, and 11% were not sure.

![Figure 44. Perceived main beneficiary of aggregated farm data.](image)

There was noticeable variation across the industries as to who would benefit most from aggregated farm data. Comparatively, a greater proportion of aquaculture, cotton, and rice industry respondents thought farmers would benefit the most (see Figure 45); a greater proportion of respondents from grain mixed and beef/sheep mixed industries thought agribusiness would benefit most (see Figure 46); a greater proportion of respondents from beef only and sheep wool industries believed the government would benefit most (see Figure 47); and a greater proportion of respondents from the poultry industry were not sure who would benefit most (see Figure 48).
Figure 45. Farmers as perceived main beneficiary of aggregated farm data by industry

Figure 46. Agribusiness as perceived main beneficiary of aggregated farm data by industry
Figure 47. Government as perceived main beneficiary of aggregated farm data by industry

Figure 48. Not sure of perceived main beneficiary of aggregated farm data by industry
4.3.2 Willingness to share data in the aggregated farm data

This section explores producers’ willingness to share various types of data (i.e., weather station data, soil test data, farm input data, and production data) with other farmers, agricultural industry-based organisations, technology and service providers, research institutions, and the Australian Bureau of Statistics (ABS).

Weather station data

Overall, respondents were highly comfortable sharing weather station data with the five actors (see Figure 49). In particular, respondents were most comfortable sharing these data with other farmers, but least comfortable sharing with technology and service provider businesses. However, there was variation across industries in the willingness to share weather station data for the five actors.

Figure 49. Comfort in sharing weather station data with actors

Sharing with other farmers

As shown in Figure 50, 83% of respondents were comfortable or extremely comfortable sharing weather station data with other farmers, with only 3% being not comfortable at all.
Figure 50. Comfort in sharing weather station data with other farmers

As shown in Figure 51, vegetable, wine grapes, cotton, and grain only industries felt most comfortable sharing weather station data with other farmers. Comparatively, beef only, sheep meat, sheep wool, and sugarcane industries were least comfortable, though in absolute terms still indicated a high degree of willingness to share.

Figure 51. Comfort in sharing weather station data with other farmers by industry

Sharing with agricultural industry-based organisations

As shown in Figure 52, 75% of respondents were comfortable or extremely comfortable sharing weather station data with agricultural industry-based organisations, with only 7% not comfortable at all.
Figure 52. Comfort in sharing weather station data with agricultural industry-based organisations

As shown in Figure 53, cotton, vegetable, and wine grapes industries were extremely comfortable sharing weather station data with agricultural industry-based organisations. In absolute terms, the remaining industries were still highly comfortable sharing these data.

Figure 53. Comfort in sharing weather station data with agricultural industry-based organizations by industry

Sharing with technology and service provider businesses

As shown in Figure 54, 67% of respondents were comfortable or extremely comfortable sharing weather station data with technology and service provider businesses, with only 8% not comfortable at all.
Figure 54. Comfort in sharing weather station data with technology and service provider businesses

As shown in Figure 55, cotton, wine grape, and grain only industries were highly comfortable sharing weather station data with technology and service provider businesses. Comparatively, the least comfortable were the beef/grain mixed, sheep wool and beef only industries, although they were still comfortable sharing these data.

Weather station data with technology and service provider businesses
- by industry (N = 905; 1 = not comfortable at all, 5 = extremely comfortable)

Figure 55. Comfort in sharing weather station data with service/technology provider businesses by industry

Sharing with research institutions

As shown in Figure 56, 78% of respondents were comfortable or extremely comfortable sharing weather station data with research institutions, with only 5% not comfortable at all.
As shown in Figure 57, most industries were highly comfortable sharing weather station data with research institutions. Comparatively, the least comfortable were the sugarcane and beef/grain mixed industries, although in absolute terms their responses still indicated they were quite comfortable sharing these data.

### Sharing with Australian Bureau of Statistics (ABS)

As shown in Figure 58, 72% of respondents were comfortable or extremely comfortable sharing weather station data with the ABS, with only 9% not comfortable at all.
Figure 58. Comfort in sharing weather station data with the Australian Bureau of Statistics (ABS)

As shown in Figure 59, wine grapes, cotton, and vegetable industries were extremely comfortable sharing weather station data with the ABS. Comparatively, the least comfortable were the beef/grain mixed, sheep meat, beef only, and sugarcane industries, although in absolute terms their responses still indicated they were comfortable sharing these data.

Figure 59. Comfort in sharing weather station data with the Australian Bureau of Statistics (ABS) by industry

Soil test data

Overall, respondents were highly comfortable sharing soil test data with the five actors (see Figure 60). In particular, respondents were most comfortable sharing these data with other farmers, agricultural industry-based organisations, and research institutions. Comparatively,
respondents are least comfortable sharing these data with technology and service provider businesses.

**Figure 60. Comfort in sharing soil test data with actors**

**Sharing with other farmers**

As shown in Figure 61, 73% of respondents were comfortable or extremely comfortable sharing soil test data with other farmers, with only 4% not comfortable at all.

**Figure 61. Comfort in sharing soil test data with other farmers**

As shown in Figure 62, rice, wine grapes, and vegetable industries were most comfortable sharing soil test data with other farmers. The remaining industries showed a stable pattern of also being highly comfortable sharing these data with other farmers.
Figure 62. Comfort in sharing soil test data with other farmers by industry

Sharing with agricultural industry-based organisations

As shown in Figure 63, 71% of respondents were comfortable or extremely comfortable sharing soil test data with agricultural industry-based organisations, with only 5% not comfortable at all.

Figure 63. Comfort in sharing soil test data with agricultural industry-based organisations

As shown in Figure 64, rice, wine grapes, cotton, and vegetable industries were most comfortable sharing soil test data with agricultural industry-based organisations. Comparatively, the least comfortable were the grain only, grain (grain/beef/sheep), and sugarcane industries; however, in absolute terms they were still comfortable sharing.
Figure 64. Comfort in sharing soil test data with agricultural industry-based organizations by industry

Sharing with technology and service provider businesses

As shown in Figure 65, 57% of respondents were comfortable or extremely comfortable sharing soil test data with technology and service provider businesses, with only 10% not comfortable at all.

Figure 65. Comfort in sharing soil test data with technology and service provider businesses

As shown in Figure 66, the wine grapes industry was most comfortable sharing soil test data with technology and service provider businesses. Comparatively, the least comfortable in sharing with technology and service provider businesses was the cotton industry.
Figure 66. Comfort in sharing soil test data with service/technology businesses by industry

Sharing with research institutions

As shown in Figure 67, 75% of respondents were comfortable or extremely comfortable sharing soil test data with research institutions, with only 5% not comfortable at all.

Figure 67. Comfort in sharing soil test data with research institutions

As shown in Figure 68, the rice and wine grapes industries were highly comfortable in sharing soil test data with research institutions. Comparatively, the least comfortable sharing these data was the sugarcane industry. The remaining industries were quite comfortable sharing these data with research institutions.
Figure 68. Comfort in sharing soil test data with research institutions by industry

Sharing with Australian Bureau of Statistics (ABS)

As shown in Figure 69, 63% of respondents were comfortable or extremely comfortable sharing soil test data with the ABS, with only 10% not comfortable at all.

Figure 69. Comfort in sharing soil test data with the Australian Bureau of Statistics (ABS)

As shown in Figure 70, wine grapes and vegetable industries were most comfortable sharing soil test data with the ABS. Comparatively, the sugarcane industry was least comfortable, although in absolute terms they still indicated comfort sharing these data.
Overall, respondents were comfortable sharing farm input data (such as fertilisers and pesticides application) with the five actors (see Figure 71). In particular, respondents were most comfortable sharing these data with other farmers and research institutions, and comparatively least comfortable sharing with technology and service provider businesses.
Figure 72. Comfort in sharing farm input data with other farmers

As shown in Figure 73, there was noticeable variation across industries. Comparatively, dairy, rice, and wine grapes industries were most comfortable sharing farm input data with other farmers, while poultry eggs/meat, aquaculture, and grain only industries were least comfortable. The remaining industries were comfortable sharing these data.

Figure 73. Comfort in sharing farm input data with other farmers by industry

Sharing with agricultural industry-based organisations

As shown in Figure 74, 58% of respondents were comfortable or extremely comfortable sharing farm input data with agricultural industry-based organisations, with only 10% not comfortable at all.
Figure 74. Comfort in sharing farm input data with agricultural industry-based organisations

As shown in Figure 75, rice and wine grapes industries were most comfortable sharing farm input data with agricultural industry-based organisations. Comparatively, the least comfortable in sharing these data was the poultry eggs/meat industry. The remaining industries were slightly comfortable sharing these data.

Figure 75. Comfort in sharing farm input data with agricultural industry-based organizations by industry

Sharing with technology and service provider businesses

As shown in Figure 76, 44% of respondents were comfortable or extremely comfortable sharing farm input data with technology and service provider businesses, 28% neutral, and 14% not comfortable at all.
As shown in Figure 77, there was noticeable variation across industries. The wine grapes and dairy industries were most comfortable sharing farm input data with technology and service provider businesses. In contrast, the poultry eggs/meat industry was least comfortable sharing these data.

Sharing with research institutions

As shown in Figure 78, 67% of respondents were comfortable or extremely comfortable sharing farm input data with research institutions, with only 8% not comfortable at all.
Figure 78. Comfort in sharing farm input data with research institutions

As shown in Figure 79, wine grapes, rice, dairy, and sheep/grain mixed industries were highly comfortable sharing farm input data with research institutions. Comparatively, the least comfortable sharing these data were the poultry eggs/meat and sugarcane industries.

Figure 79. Comfort in sharing farm input data with research institutions by industry

Sharing with Australian Bureau of Statistics (ABS)

As shown in Figure 80, 60% of respondents were comfortable or extremely comfortable sharing farm input data with the ABS, with 12% not comfortable at all.
As shown in Figure 81, wine grapes and dairy industries were most comfortable sharing farm input data with the ABS. Comparatively, the least comfortable were sugarcane, beef/grain mixed, and grain only industries; however, their responses still indicated they were comfortable sharing these data with the ABS.

**Figure 80. Comfort in sharing farm input data with the Australian Bureau of Statistics (ABS)**

Overall, respondents were slightly comfortable sharing farm production data with the five actors (see Figure 82). In particular, respondents were most comfortable sharing these data with research institutions, and least comfortable sharing with technology and service provider businesses.

**Figure 81. Comfort in sharing farm input data with the Australian Bureau of Statistics (ABS) by industry**

**Production data**
**Figure 82. Comfort in sharing production data with actors**

**Sharing with other farmers**

As shown in Figure 83, 60% of respondents were comfortable or extremely comfortable sharing production data with other farmers, with only 10% not comfortable at all.

**Figure 83. Comfort in sharing production data with other farmers**

As shown in Figure 84, the dairy and sheep meat industries were most comfortable sharing production data with other farmers. Comparatively, the poultry industry was least comfortable. The remaining industries were slightly comfortable sharing production data with other farmers.
Figure 84. Comfort in sharing production data with other farmers by industry

**Sharing with agricultural industry-based organisations**

As shown in Figure 85, 55% of respondents were comfortable or extremely comfortable sharing production data with agricultural industry-based organisations, with 12% not comfortable at all.

![Production data with other farmers by industry](image)

**Figure 85. Comfort in sharing production data with agricultural industry-based organisations**

As shown in Figure 86, dairy, rice, and wine grapes industries were most comfortable in sharing production data with agricultural industry-based organisations. Comparatively, the poultry industry was the least comfortable. The remaining industries were slightly comfortable sharing these data.
Figure 86. Comfort in sharing production data with agricultural industry-based organizations by industry

Sharing with technology and service provider businesses

As shown in Figure 87, 40% of respondents were comfortable or extremely comfortable sharing production data with technology and service provider businesses, 30% neutral, and 16% not comfortable at all.

Figure 87. Comfort in sharing production data with technology and service provider businesses

As shown in Figure 88, dairy and wine grapes industries were most, but only slightly, comfortable sharing production data with technology and service provider businesses.
Comparatively, the poultry industry was the least comfortable. The remaining industries were at the middle point in terms of comfort/discomfort sharing these data.

![Bar chart showing production data with technology and service provider businesses by industry.](chart1.png)

**Figure 88. Comfort in sharing production data with service/technology provider businesses by industry**

**Sharing with research institutions**

As shown in Figure 89, 64% of respondents were either comfortable or extremely comfortable sharing production data with research institutions, with only 9% not comfortable at all.

![Bar chart showing production data with research institutions overall.](chart2.png)

**Figure 89. Comfort in sharing production data with research institutions**

As shown in Figure 90, dairy, rice, and wine grapes industries were highly comfortable sharing production data with research institutions. Comparatively, the least comfortable sharing
these data were the poultry and sugarcane industries, although their responses still indicated they were slightly comfortable sharing these data.

**Figure 90. Comfort in sharing production data with research institutions by industry**

**Sharing with Australian Bureau of Statistics (ABS)**

As shown in Figure 91, 59% of respondents were either comfortable or extremely comfortable sharing production data with the ABS, with 14% not comfortable at all.

**Figure 91. Comfort in sharing production data with the Australian Bureau of Statistics (ABS)**

As shown in Figure 92, dairy and wine grapes industries were highly comfortable sharing production data with the ABS. Comparatively, the beef/grain mixed, grain only, and sugarcane industries were least comfortable, although their responses still indicated they were slightly comfortable sharing these data.
Overall attitudes toward data sharing in the aggregated farm data

Figure 93 presents the overall findings of respondents’ willingness to share the four types of data with the five actors. In general, respondents were more willing and highly comfortable sharing data with other farmers and research institutions, and felt least comfortable sharing with technology and service providers.

Moreover, the findings suggested that respondents were more willing to share weather station data and soil test data than farm input data and production data. It appears that respondents were more hesitant to share information which involve their farming operations. For example, farm input data and production data are directly related to farming practices, while weather station data and soil test data were not influenced by farming practices.
Beliefs of who would benefit the most affect attitude towards data sharing

Regarding who would benefit the most from the aggregated farm data, four groups of respondents were identified from the survey item “Who will benefit the most from the aggregated farm data?” (also see p. 56-58). Three groups corresponded to respondents who regarded farmers, agribusiness, and government as benefitting most, and the final group indicated they were not sure.

The scores on willingness to share each of the four types of data with each actor were aggregated and averaged. The composite score was used as a general indicator of respondents’ willingness to share data with a particular actor. For example:

\[
\text{Willingness to share data with ‘other farmers’} = \frac{\text{willingness to share [weather station data + soil test data + farm input data + output data] with other farmers}}{4}
\]

To examine whether beliefs in the main beneficiary affected attitude toward data sharing, a series of analysis of variance (ANOVA) were conducted, with the four beneficiary groups as independent factor, and the composite score on willingness to share with each actor as dependent factor.

Figure 94 presents the average willingness to share data with each actor for each beneficiary group. The results of the ANOVA analyses suggested that respondents who thought farmers would benefit the most were significantly more comfortable sharing data with all actors compared to respondents from the other three groups. In addition, respondents who thought agribusiness would benefit the most were significantly more comfortable sharing data with other farmers, industry organisations, research institutions, and the ABS compared to respondents who thought the government would benefit most.
Figure 94. Willingness to share data with actors for different reported main beneficiaries of aggregated data

Appreciation of data currently collected affects attitude towards data sharing

To examine whether the overall evaluation of data usefulness affected respondents’ willingness to share data with each actor, correlations were calculated between the composite willingness to share data with each actor (see above section) and the overall evaluation of contributions made by the data in helping farm management decisions, increasing business profit, increasing efficiency, and improving risk management (also see p.59-81).

Table 15 presents the correlations between attitude towards data sharing and overall evaluation of data. The results suggested that evaluations of data were positively associated with greater willingness to share data with each actor. These effects were particularly strong with research institutions and the ABS.
Table 15. Correlations between willingness to share data with actors and data usefulness for farm outcomes

<table>
<thead>
<tr>
<th>Overall evaluation of data usefulness</th>
<th>Willingness of data sharing with each actor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Other farmers</td>
</tr>
<tr>
<td>Helping farm management decisions</td>
<td>0.19***</td>
</tr>
<tr>
<td>Increasing business profit</td>
<td>0.16***</td>
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<tr>
<td>Increasing efficiency</td>
<td>0.15***</td>
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<tr>
<td>Improving risk management</td>
<td>0.19***</td>
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</tbody>
</table>

Note: ***p < .001.

4.3.4 Confidence in the governance of aggregated farm data

The survey also explored the concerns respondents had towards aggregated farm data. The details are presented in the following section.

Concerns over profit making of the aggregated data by some businesses

Overall, respondents were quite concerned that the aggregated data could be used by some businesses to make money without sharing it with them (see Figure 95). In particular, 61% of respondents were concerned or extremely concerned, while only 18% showed little or no concern at all.

In broadacre cropping industries, respondents from small farms were least concerned ($M = 3.44, SD = 1.25$), followed by extra-large ($M = 3.85, SD = 1.24$), large ($M = 4.09, SD = 1.01$), and medium sized farms ($M = 4.16, SD = 1.16$).

![Figure 95. Concern in businesses using aggregated data to make profits without sharing with producers](image)

There was noticeable variation across the industries (see Figure 96). In particular, grain mixed (grain/beef/sheep) and rice industries were most concerned that some businesses may
make money off aggregated data without sharing with them. Comparatively, poultry and vegetable industries were least concerned, although in absolute terms they were still concerned.

How concerned would you be that the aggregated data could be used by some businesses to make money without sharing with you?
- by industry (N = 1,000; 1 = not concerned at all, 5 = extremely concerned)

Figure 96. Concern in businesses using aggregated data to make profits without sharing with producers by industry

Concerns over influencing market by some businesses using the aggregated data

Overall, respondents were quite concerned that some businesses may use the aggregated farm data to influence the market such as produce prices and land value (see Figure 97). In particular, 67% of respondents were concerned or extremely concerned, and only 14% showed little or no concern at all.

How concerned would you be that some businesses may use the aggregated farm data to influence market (such as produce prices and land value)?
- overall (N = 1,000)

Figure 97. Concern in businesses using aggregated data to influence the market

There was little variation across the industries (see Figure 98). On average, respondents from most industries were highly concerned that some businesses may use the aggregated farm
data to influence the market. In particular, beef only, beef/grain mixed, sheep/grain mixed, pork, grain mixed (grain/beef/sheep), and rice industries were most concerned.

How concerned would you be that some businesses may use the aggregated farm data to influence the market (such as produce prices and land value)?
- by industry (N = 1,000; 1 = not concerned at all, 5 = extremely concerned)

<table>
<thead>
<tr>
<th>Industry</th>
<th>Concern Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef only</td>
<td>4.0</td>
</tr>
<tr>
<td>Beef/Grain Mixed</td>
<td>3.9</td>
</tr>
<tr>
<td>Sheep Meat Only (Lamb)</td>
<td>3.8</td>
</tr>
<tr>
<td>Sheep/Grain Mixed</td>
<td>4.0</td>
</tr>
<tr>
<td>Sheep Wool</td>
<td>3.9</td>
</tr>
<tr>
<td>Dairy</td>
<td>4.0</td>
</tr>
<tr>
<td>Pork</td>
<td>3.7</td>
</tr>
<tr>
<td>Poultry Egg/Meat</td>
<td>3.9</td>
</tr>
<tr>
<td>Aquaculture</td>
<td>3.8</td>
</tr>
<tr>
<td>Grain Only</td>
<td>4.1</td>
</tr>
<tr>
<td>Grain/Grain/Beef/Sheep</td>
<td>3.3</td>
</tr>
<tr>
<td>Cotton</td>
<td>4.1</td>
</tr>
<tr>
<td>Rice</td>
<td>3.7</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>3.7</td>
</tr>
<tr>
<td>Vegetables</td>
<td>3.3</td>
</tr>
<tr>
<td>Wine Grapes</td>
<td>3.0</td>
</tr>
</tbody>
</table>

Figure 98. Concern in businesses using aggregated data to influence the market by industry

Concerns over privacy of own farm data in the aggregated data

Overall, respondents were quite concerned about the privacy of their farm data in the aggregated data (see Figure 99). In particular, 58% of respondents were concerned or extremely concerned, and only 18% showed little or no concern at all.

How concerned would you be about the privacy of your farm data in the aggregated data?
- overall (N = 1,000)

<table>
<thead>
<tr>
<th>Concern Level</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>not concerned at all</td>
<td>10%</td>
</tr>
<tr>
<td>2</td>
<td>23%</td>
</tr>
<tr>
<td>3</td>
<td>25%</td>
</tr>
<tr>
<td>4</td>
<td>33%</td>
</tr>
<tr>
<td>extremely concerned</td>
<td></td>
</tr>
</tbody>
</table>

Figure 99. Concern in privacy of farm data when in the aggregated data

As shown in Figure 100, most industries were concerned about the privacy of their farm data in the aggregated data. Respondents from the beef/grain mixed and grain mixed (grain/beef/sheep) industries were the most concerned.
Figure 100. Concern in privacy of farm data when in the aggregated data by industry
5. Conclusion

The present survey has benchmarked Australian producers’ needs, perceived risks and benefits, and expectations associated with digital agriculture technology currently and in the big data context. Those key factors were examined from three aspects: telecommunication infrastructure, the status of current data collection, and data sharing and concerns in the big data context.

Telecommunication infrastructure

First, there were pronounced variations across the industries in most of the areas examined, suggesting that the industries were at different stages of digital agriculture technology adoption and recognition of the values of agricultural data, as well as facing different barriers. Hence, it is important for each industry to develop targeted strategies to address its unique issues and challenges. Meanwhile, it is also equally important to recognise that there were shared issues and challenges across the industries, which highlight the necessity for the industries to join forces to address them more effectively. In particular, the concerns over the governance of aggregated farm data were high for respondents from all industries. While aggregated farm data is still emerging in Australia, it will progress quickly given the rapid development of data technology and the trends occurring overseas, especially in the US. It is critical to establish the institutional structure and governance around aggregated farm data with producers’ concerns and lessons from overseas taken into consideration.

Second, the present survey indicated that the adoption of on-farm telecommunication infrastructure was very limited, with only 25% of respondents having radio links to devices, and/or mobile data linked devices. The majority of those users found it was challenging to keep the systems working. In addition, knowledge of on-farm telecommunication options was limited across all industries. These findings highlight the urgent needs of concerted efforts to effectively communicate the value proposition of on-farm telecommunication infrastructures and agricultural data, as well as the on-farm telecommunication options, which is essential for producers to recognise the value and take actions. Furthermore, more than half of respondents relied on themselves (including family members and employees) only to sort out their telecommunication needs, it will be beneficial for producers to establish a platform using plain language to provide on-farm telecommunication information, training, and support.

Third, satisfaction with home office internet connectivity was considerably low with only 30% of respondents satisfied. There were differences in the levels of satisfaction across the industries, however, the underlining issues may involve many aspects including the coverage across the farm. For example, respondents from cotton industry reported the lowest level of satisfaction with their home office internet connectivity, though they were the major users of digital technologies. In this case, it is likely that the satisfaction rating reflected their expectations for the internet connectivity to meet their higher levels of demand.

The status of current data collection

First, the findings of the survey revealed that there were variations in the collection rates of various agricultural data. For example, the collection of yield mapping data (51%) and soil mapping data (40%) were the highest in cropping industry, and the collection of veterinary medicine record (63%) and animal breeding data (57%) were the highest in livestock industry. Although improvements may have been achieved, it is still a long way to go for the industries to catch up and fully utilise the precision agriculture technologies.
As suggested by the findings that knowledge of telecommunication options and collection of data were associated with positive evaluation of agricultural data, concerted efforts will be beneficial to effectively communicate the value proposition of agricultural data and provide the associated technologies in plain English.

Second, the current arrangement of data collection between producers and service providers may impose some potential issues and conflicts. Such concerns were underpinned by three key aspects: 1) Respondents had limited knowledge about the terms and conditions in relation to data collection in their agreement with service providers; 2) respondents had very low trust in service providers to maintain privacy and not to share data with third parties; and 3) the majority of respondents were not comfortable for service providers to make profit out of their data without sharing the profit with them.

Certain mechanism should be explored to ensure that producers’ rights are protected and benefits are fairly shared. The terms and conditions for data collection agreement with service providers need to be provided by service providers in plain English. In addition, in the agreement, both data privacy, ownership and control needs to be clearly defined and communicated to producers, and agreed by producers.

**Attitude towards data sharing and concerns in the big data context**

First, the results revealed that there was no consensus in relation to who would benefit the most from aggregated farm data, with farmers as beneficiary (34%) and agribusinesses as beneficiary (34%) equally regarded. Further analysis revealed that believers of farmers as the beneficiary were more willing to share their data with all actors, and those with positive evaluation of data were also more willing to share their data with all actors. These findings suggested that the development and establishment of aggregated farm data should be centred on the benefits and needs of producers, with other stakeholders (especially farmer organisations and research institutions) playing key roles to enable the development. Further, the value proposition of agricultural data as well as aggregated farm data needs to be clearly communicated to producers. Such structural arrangement will build trust and encourage producers to share their data and, in turn, realise the potential value of big data.

Second, although respondents displayed a general willingness to share data, they also reported great concerns over aggregated data in relation to privacy, financial advantage taken by other businesses, and the potential for it to be used to influence the markets such as produce prices and land value. Hence, producers need reassurance to address concerns about how the aggregated data will be governed and used. Institutional structure and governance frameworks for aggregated farm data should be established to address producers’ concerns and build their trust in the systems through addressing transparency, privacy, data ownership, and control.

**Future research**

With the rapid advancement of digital agriculture technologies and application of big data, it is imperative to have up-to-date information about Australian producers’ needs and issues, so that the transformational values of the advancements can be fully capitalised. A general survey across the industries in three years is recommended. More targeted studies focusing on particular aspects for particular industries on a more regular basis will help to inform strategies at the industry level.
6. References


Appendix A

P2D producer survey — Full questionnaire

Q1. Good morning, this is (insert your name) calling from K62, we are a specialist agricultural market research company. How are you? We are conducting a study that aims to identify Australian producers’ needs and issues in relation to using agricultural data. The questions will revolve around your experience with agricultural data systems and tools. The study is conducted by CSIRO and funded by the Department of Agriculture and Water Resources. The study will take around 20 minutes to complete. Would you be able to help us with this study? Your survey responses are held in the strictest of confidence and will remain anonymous. Results from the study will be shared in scientific publications. If participants have further questions or concerns/complaints about the research, CSIRO Human Research Ethics Officer on (07) 3833 6099 Project Information: Airoy Zhang on (07) 3833 5998

Make sure your are speaking to the decision maker

Yes 1
No...

Q2. Ok great. I will let you know that the call is being recorded for quality assurance and training purposes. Firstly, could I confirm the state that you are in?

SA 1
QLD 2
VIC 3
TAS 4
NT 5

Q3. What type of farming operation do you run?...

Aquaculture (Salmon) 1
Aquaculture (Prawns) 2
Aquaculture (Other) 3
Beef Only 4
Dairy 5
Dairy Sheep Mixed 6
Dairy Sheep Wool 7
Dairy Pigs 8
Dairy Eggs 9
Poultry Meat (Chicken) 10
Poultry Meat (Turkey) 11
Poultry Meat (Duck) 12
Sheep Meat Only (Lamb) 13
Sheep Grain Wool 14
Cattle 15
Oven Only 16
Rice 17
Sugar cane 18
Vegetables 19
Wine Grapes 20

*Q3a. What is the total area of your property, including any leased land and any unused land?...

Hectares 1
Acre 2

*Q3b. Does the majority of your on farm income come from grain or livestock?...

Do not answer if true

Oven 1
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Q30c. DUMMY - HIDDEN QUESTION FOR WHAT QUESTIONS THEY GET

Do not answer if true

Grain
1

Q30d. DUMMY - GRAIN SPECIALIST QUOTA

Do not answer if true

Grain
1

Q30e. For your Aquaculture enterprise, what is your estimated annual production? . . .

Answer (Q30e) = (Q30e.1) + (Q30e.2) + (Q30e.3)

[Make sure you got the exact figure and description - e.g. 10,000 Kilos Salmon]

Determined Annual Production
1

Q30f. What is the total number of beef cattle? . . .

Answer (Q30f) = (Q30f.1) + (Q30f.2) + (Q30f.3)

Total Number of Beef Cattle
1

Q30g. What is the total number of beef cattle and sheep? . . .

Answer (Q30g) = 1

[Must have 100 beef cattle & 800 sheep minimum requirement, otherwise flag as beef only or sheep only as main farm type]

Beef cattle
1
Sheep
2

Q30h. How many cows milked? . . .

Answer (Q30h) = 1

Q30i. How many sows? . . .

Answer (Q30i) = 1


Answer (Q30j) = 1

Q30k. What is the total number of birds you self produce each year? . . .
**Q5h.** What is the total number of sheep for lamb? .

**Answer:** $\text{Q5h} = 12$

<table>
<thead>
<tr>
<th>Total Number of Sheep for Lamb</th>
<th>1</th>
<th>( \text{Q5h}_1 )</th>
</tr>
</thead>
</table>

*Note: If \( \text{Q5h}_2 \times 800 \) go to QTERNM*

**Q5i.** How many hectares/areas planted to cotton? .

**Answer:** $\text{Q5i} = 15$

<table>
<thead>
<tr>
<th>Total Number of Sheep for Wool</th>
<th>1</th>
<th>( \text{Q5i}_1 )</th>
</tr>
</thead>
</table>

*Note: If \( \text{Q5i}_2 \times 800 \) go to QTERNM*

**Q5j.** How many hectares/areas planted to grain? .

**Answer:** $\text{Q5j} = 17 \text{ OR } \text{Q5j} = 1$

<table>
<thead>
<tr>
<th>Must have a minimum of 500 Hectares</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Hectares</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acres</td>
<td>2</td>
</tr>
</tbody>
</table>

*Note: If \( \text{Q5j}_2 \times 800 \) go to QTERNM*

**Q5k.** How many hectares/areas planted to rice? .

**Answer:** $\text{Q5k} = 15$

<table>
<thead>
<tr>
<th>Hectares</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acres</td>
<td>2</td>
</tr>
</tbody>
</table>

*Note: If \( \text{Q5k}_2 \times 800 \) go to QTERNM*

**Q5m.** How many hectares/areas planted to sugar cane? .

**Answer:** $\text{Q5m} = 19$

<table>
<thead>
<tr>
<th>Hectares</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acres</td>
<td>2</td>
</tr>
</tbody>
</table>

*Note: If \( \text{Q5m}_2 \times 800 \) go to QTERNM*

**Q5n.** How many hectares/areas planted to vegetables? .

**Answer:** $\text{Q5n} = 19$

<table>
<thead>
<tr>
<th>Hectares</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acres</td>
<td>2</td>
</tr>
</tbody>
</table>

*Note: If \( \text{Q5n}_2 \times 800 \) go to QTERNM*
Q50. How many hectares/acre planted to wine grapes?...

Q56p. What is the total number of sheep?...

End

Q6. How many years have you been farming in the ___ industry?...

Q7. The following questions are about your on-farm telecommunications and internet connections...

Q8. How is your business connected to the internet?...

Q9. On a 1 to 5 scale, where 1 is not satisfied at all and 5 is extremely satisfied, How satisfied are...
Q10. When using your mobile phone for voice calls, or a smart tablet, or any other device that communicates via the mobile network, such as a weather station, how do you describe your coverage across your entire farm on a 1 to 5 scale, where 1 is no coverage anywhere on the farm and 5 is full coverage?...

<table>
<thead>
<tr>
<th>1 No coverage anywhere on the farm</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 Full coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Q12. What on-farm telecommunication infrastructure do you already have?...

Read out and record

Links to devices (e.g. connecting your weather station or gate to your farm office or other location on your farm) 1 Q12.1
Mobile data transfer devices (e.g. weather station is directly linked to the mobile network) 2 Q12.2
None at present, but considering to install something within the next 5 years 3 Q12.3

None at present, and have no plans to install any telecommunications infrastructure on your farm 4 Q12.4

Q13. On a 1 to 5 scale, where 1 is not challenging at all and 5 is extremely challenging, how challenging is it to keep these on-farm telecommunication systems working?...

Answer: Q12.1 + Q12.2 + Q12.3 + 3

<table>
<thead>
<tr>
<th>1 Not challenging at all</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 Extremely challenging</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Q14. On a 1 to 5 scale, where 1 is nothing at all and 5 is know a lot, how much do you know about the options available to connect devices on your farm (such as radio links, wifi and local area networks)?...

<table>
<thead>
<tr>
<th>1 Nothing at all</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 Know a lot</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Q15. Who has helped you in sorting out your telecommunication needs?...

Read out: Multiple answers allowed

You do it yourself without the help of others 1 Q15.1
You have had help from family members and employees 2 Q15.2
You have had help from a professional consultant or engineer 3 Q15.3
You have had help from other farmers 4 Q15.4
You have had help from an advertising agency 5 Q15.5
You have had help from a government agency 6 Q15.6
You have had help from an industry association 7 Q15.7
You are still trying to decide 8 Q15.8
You have had help from an academic institution 9 Q15.9
You have had help from an international organization 10 Q15.10
**Q16.** New farming machines and technologies can collect a lot of data including the status of soil, water, crops, pasture and animals. The following questions are about the data you collect on your farm. . . . What agricultural data do you currently collect on your farm? . . .

**Answer F[Q16] = 1**

**Read out and record**

<table>
<thead>
<tr>
<th>Data Type</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield mapping</td>
<td>1</td>
</tr>
<tr>
<td>Soil mapping</td>
<td>2</td>
</tr>
<tr>
<td>Crop sensing (NDVI)</td>
<td>3</td>
</tr>
<tr>
<td>Weed pressures mapping</td>
<td>4</td>
</tr>
<tr>
<td>Soil moisture sensor data</td>
<td>5</td>
</tr>
<tr>
<td>On-farm weather station data</td>
<td>6</td>
</tr>
<tr>
<td>Financial data</td>
<td>7</td>
</tr>
<tr>
<td>Irrigation data</td>
<td>8</td>
</tr>
<tr>
<td>None</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>7</strong></td>
</tr>
</tbody>
</table>

**Q17.** Im now going to read out those types of data that you currently collect and could you please tell me where that data is stored? . . .

**Answer F[Q17] = 1**

**On farm** | **On farm electronics** | **In cloud** | **Service Provider** | **Not sure** |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield mapping</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Soil mapping</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Crop sensing (NDVI)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Weed pressures mapping</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Soil moisture sensor data</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>On-farm weather station data</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Financial data</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Irrigation data</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

**Q17b.** Im now going to read out those types of data that you currently collect and could you please tell me where that data is stored? . . .

**Answer F[Q17] = 2**

**On farm** | **On farm** | **In cloud** | **Service Provider** | **Not sure** |
|------------|------------|--------------|----------------------|--------------|

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<table>
<thead>
<tr>
<th>Provider</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Extremely useful</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil mapping</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>0</td>
<td>Q16a_1</td>
</tr>
<tr>
<td>Pedotexture mapping</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>0</td>
<td>Q16a_2</td>
</tr>
<tr>
<td>Individually tagged</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>0</td>
<td>Q16a_3</td>
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<tr>
<td>Individual animal or herd record</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>0</td>
<td>Q16b_1</td>
</tr>
<tr>
<td>Individual animal or herd feeding</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>0</td>
<td>Q16b_2</td>
</tr>
<tr>
<td>Crop variety</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>0</td>
<td>Q16a_4</td>
</tr>
<tr>
<td>Organic matter</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>0</td>
<td>Q16a_5</td>
</tr>
<tr>
<td>Water quality</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>0</td>
<td>Q16b_3</td>
</tr>
</tbody>
</table>

*Q18. Where 1 is no use at all and 5 is extremely useful, how useful is this data in helping you make farm management decisions?...

Answer: [Recorded Value]

<table>
<thead>
<tr>
<th>Provider</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Extremely useful</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vane mapping</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>Q16b_1</td>
</tr>
<tr>
<td>Soil mapping</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>Q16b_2</td>
</tr>
<tr>
<td>Individually tagged</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>Q16b_3</td>
</tr>
<tr>
<td>Individual animal or herd record</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>Q16b_4</td>
</tr>
<tr>
<td>Individual animal or herd feeding</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>Q16b_5</td>
</tr>
<tr>
<td>Crop variety</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>Q16b_6</td>
</tr>
<tr>
<td>Organic matter</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>Q16b_7</td>
</tr>
<tr>
<td>Water quality</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>Q16b_8</td>
</tr>
</tbody>
</table>

*Q18b. Where 1 is no use at all and 5 is extremely useful, how useful is this data in helping you make farm management decisions?...

Answer: [Recorded Value]

<table>
<thead>
<tr>
<th>Provider</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Extremely useful</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil moisture sensor</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>Q16b_1</td>
</tr>
<tr>
<td>On-farm weather station data</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>Q16b_2</td>
</tr>
<tr>
<td>Financial data</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>Q16b_3</td>
</tr>
<tr>
<td>Irrigation</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>Q16b_4</td>
</tr>
</tbody>
</table>

*Q20. Do you use financial management software?...

Answer: [Recorded Value]
Q20a. What are they?...

```
<table>
<thead>
<tr>
<th>Answer</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Record verbatim in full</td>
<td></td>
</tr>
</tbody>
</table>
```

Q20b. What are they?...

```
<table>
<thead>
<tr>
<th>Answer</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Record verbatim in full</td>
<td></td>
</tr>
</tbody>
</table>
```

Q21. Do you use production management software including precision agriculture data management software?...

```
| Yes | 1 |
| No | 565 |
```

Q21a. What are they?...

```
<table>
<thead>
<tr>
<th>Answer</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Record verbatim in full</td>
<td></td>
</tr>
</tbody>
</table>
```

Q21b. What are they?...

```
<table>
<thead>
<tr>
<th>Answer</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Record verbatim in full</td>
<td></td>
</tr>
</tbody>
</table>
```

Q21c. Who helps you to analyse and interpret the above data?...

```
| Data not used | 1 |
| Family and employees | 2 |
| Freelance independent consultants | 3 |
| Service providers | 4 |
```

Q22. Overall, how useful is the previously mentioned data you currently collect in helping you make farm management decisions? On a scale of 1 to 6 where 1 is no use at all and 6 is extremely useful...

```
| 1 | No use at all |
| 2 |
| 3 |
| 4 |
| 5 | Extremely useful |
```

Q22a. Overall, how useful would the previously mentioned data be in helping you make farm management decisions if you had them? On a scale of 1 to 6 where 1 is no use at all and 6 is extremely useful...

```
| 1 | No use at all |
| 2 |
| 3 |
| 4 |
| 5 | Extremely useful |
```

Q23. Overall, how much contribution has the previously mentioned data you currently collect made to your farm business profit? On a 1 to 5 scale, where 1 is no positive contribution at all and 5 is increased profit greatly...

```
| 1 | No use at all |
| 2 |
| 3 |
| 4 |
| 5 | Extremely useful |
```
Q23b. Overall, how much contribution would the previously mentioned data make to your farm business profit if you had them? On a 1 to 6 scale, where 1 is no positive contribution at all and 6 is increased profit greatly, . . .

**Answer:** No positive contribution at all 1

Q24. Overall, how much contribution has the previously mentioned data currently made to the efficient running of your farm? On a 1 to 6 scale, where 1 is no positive contribution at all and 6 is increased efficiency greatly, . . .

**Do not answer:** No positive contribution at all 1

Q24b. Overall, how much contribution would the previously mentioned data make to the efficient running of your farm, if you had them? On a 1 to 6 scale, where 1 is no positive contribution at all and 6 is increased efficiency greatly, . . .

**Answer:** No positive contribution at all 1

Q25. Overall, how much contribution would the previously mentioned data currently make to the risk management of your farm operations? On a 1 to 6 scale, where 1 is no positive contribution at all and 6 is improved risk management greatly, . . .

**Do not answer:** No positive contribution at all 1

Q25b. Overall, how much contribution would the previously mentioned data make to risk management of your farm operations if you had them? On a 1 to 6 scale, where 1 is no positive contribution at all and 6 is improved risk management greatly, . . .

**Answer:** No positive contribution at all 1

Q26. When you need to work with two or more different datasets (such as soil data and weather data) on a 1 to 6 scale, where 1 is not hard at all and 6 is extremely hard, how hard do you find it to combine them together? . . .
Q27. For tools (such as machines and apps) used to collect the previously mentioned data, on a scale where 1 is not at all and 5 is extremely well, how much do you know about the terms and conditions relating to data collection in your agreement with the service providers?...

<table>
<thead>
<tr>
<th>1 Not at all</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 Extremely well</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.29</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Q27b. For any of the previously mentioned data, 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, on a 1 to 5 scale where 1 is not comfortable at all and 5 is extremely comfortable?...

<table>
<thead>
<tr>
<th>1 Not comfortable at all</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 Extremely comfortable</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.27</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Q28. If the service technology providers have direct access to your data, including yours, on a 1 to 5 scale where 1 is not trust at all and 5 is total trust, how much do you trust them to maintain the privacy of your farm data?...

<table>
<thead>
<tr>
<th>1 Not at all</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 Extremely comfortable</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.28</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Q29. If the service technology providers have direct access to your data, on a 1 to 5 scale where 1 is not trust at all and 5 is total trust, how much do you trust them not to share the data with third parties?...

<table>
<thead>
<tr>
<th>1 Not at all</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 Total trust</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.29</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Q30. Thinking about your experiences and what you know about digital agricultural technologies, please indicate your agreement with the following statements on a 1 to 5 scale, where 1 is strongly disagree and 5 is strongly agree...

<table>
<thead>
<tr>
<th>1 Not at all</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 Total trust</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Q32.** When the data collected from many individual farms are combined together, they can be used to develop tools that support agricultural decision-making. This combined data is referred to as “aggregated farm data.” For the aggregated farm data to work, it will require individual farms to share their data. We would like to know your opinions about issues related to data sharing. On a 1 to 5 scale, where 1 is not comfortable at all and 5 is extremely comfortable, can you please indicate how comfortable you are to share the following data... with other farmers...

<table>
<thead>
<tr>
<th>1 Not sure</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Comfortable be at all</th>
<th>1 Not sure</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Comfortable be at all</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Weather Station data</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td><strong>2. Soil test data</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td><strong>3. Farm input data such as fertilizers &amp; pesticides application</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td><strong>4. Prediction data</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>

**Q33.** Using that same scale, can you please indicate how comfortable you are to share the following data with Agricultural industry-based organisations (such as farmer associations, RDCs)...

<table>
<thead>
<tr>
<th>1 Not sure</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Comfortable be at all</th>
<th>1 Not sure</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Comfortable be at all</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Weather Station data</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td><strong>2. Soil test data</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td><strong>3. Farm input data such as fertilizers &amp; pesticides application</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td><strong>4. Prediction data</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>

**Q34.** Using that same scale, can you please indicate how comfortable you are to share the following data with technology and service provider businesses...

<table>
<thead>
<tr>
<th>1 Not sure</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Comfortable be at all</th>
<th>1 Not sure</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Comfortable be at all</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Weather Station data</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td><strong>2. Soil test data</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td><strong>3. Farm input data such as fertilizers &amp; pesticides application</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td><strong>4. Prediction data</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>

**Q35.** Using that same scale, can you please indicate how comfortable you are to share the...
following data with research institutions (such as universities, CSIRO).

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Not sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot</td>
<td>comfortable</td>
<td>low at all</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Q36. Using that same scale, can you please indicate how comfortable you are to share the following data with the Australian Bureau of Statistics (ABS)?

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Not sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot</td>
<td>comfortable</td>
<td>low at all</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Weather Station data

Q37. When your farm data becomes part of the aggregated data, how concerned would you be about the ownership of your farm data, on a 1 to 6 scale where 1 is not concerned at all and 6 is extremely concerned?

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Not sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot</td>
<td>comfortable</td>
<td>low at all</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Farm input data such as farm input data and other cattle production data

Q38. Who do you think will benefit most from the aggregated farm data?

Farmers

Q39. Using the same scale, how concerned would you be that the aggregated data could be used by some businesses to make money without sharing with you?

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Not sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot</td>
<td>comfortable</td>
<td>low at all</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Q40. Using the same scale, how concerned would you be that some businesses may use the aggregated farm data to influence market (such as produce prices and land values)?

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Not sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot</td>
<td>comfortable</td>
<td>low at all</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Q42. Using the same scale, how concerned would you be about the privacy of your farm data in the aggregated data?...

1  Not concerned at all
2
3
4
5  Extremely concerned

Q43. Finally, I just have some demographic questions. Could you please tell me your exact age?...

RECORD THE EXACT AGE

Q44. What is your highest level of education?...

Read out and record

Did not complete year 12  1
Completed year 12  2
Post-secondary qualification - agriculture  3
Post-secondary qualification - other  4
Undergraduate degree - agriculture  5
Undergraduate degree - other  6
Postgraduate degree - agriculture  7
Postgraduate degree - other  8

Q46. Does anyone involved in managing the farm have a university degree?...

Answer: if [Q46] = 1 OR [Q45] = 2 OR [Q45] = 3 OR [Q45] = 4

Yes  1
No  555

Q51. Gender ...

DO NOT ASK

Male  1
Female  2

Q52. Thank you for your time and best of luck with the rest of the season!... END
## Appendix B

### Survey response rate

<table>
<thead>
<tr>
<th>Industry</th>
<th>Quotas achieved</th>
<th>Farm records loaded into CATI</th>
<th>Number of calls required to achieve one completed survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horticulture - vegetables</td>
<td>30</td>
<td>1118</td>
<td>37</td>
</tr>
<tr>
<td>Wine grapes</td>
<td>15</td>
<td>375</td>
<td>25</td>
</tr>
<tr>
<td>Sheep only (wool) farms</td>
<td>89</td>
<td>3205</td>
<td>36</td>
</tr>
<tr>
<td>Sheep only (sheep meat) farms</td>
<td>59</td>
<td>1690</td>
<td>29</td>
</tr>
<tr>
<td>Beef only farms</td>
<td>126</td>
<td>1142</td>
<td>9</td>
</tr>
<tr>
<td>Beef/sheep</td>
<td>94</td>
<td>1745</td>
<td>19</td>
</tr>
<tr>
<td>Grain and sheep (mixed) - Sheep as main enterprise</td>
<td>94</td>
<td>2608</td>
<td>28</td>
</tr>
<tr>
<td>Grain and beef (mixed) - Beef as main enterprise</td>
<td>64</td>
<td>1561</td>
<td>24</td>
</tr>
<tr>
<td>Grains – including grains only; and main grain in sheep/grain or beef/grain mixed</td>
<td>150</td>
<td>4932</td>
<td>33</td>
</tr>
<tr>
<td>Rice</td>
<td>15</td>
<td>359</td>
<td>24</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>65</td>
<td>980</td>
<td>15</td>
</tr>
<tr>
<td>Cotton</td>
<td>30</td>
<td>1540</td>
<td>51</td>
</tr>
<tr>
<td>Dairy</td>
<td>94</td>
<td>1651</td>
<td>18</td>
</tr>
<tr>
<td>Poultry (eggs)</td>
<td>16</td>
<td>410</td>
<td>26</td>
</tr>
<tr>
<td>Poultry (meat)</td>
<td>14</td>
<td>320</td>
<td>23</td>
</tr>
<tr>
<td>Pigs</td>
<td>15</td>
<td>430</td>
<td>29</td>
</tr>
<tr>
<td>Aquaculture</td>
<td>30</td>
<td>292</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1000</strong></td>
<td><strong>24358</strong></td>
<td><strong>24</strong></td>
</tr>
</tbody>
</table>

Overall, from all calls made: 32% went to an answering machine; 28% had no answer; 21% asked to call back; 14% refused; and 5% completed the survey.

### Main reasons for refusing survey

<table>
<thead>
<tr>
<th>Main reasons for refusing survey</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm size not meeting minimum requirements</td>
<td>23%</td>
</tr>
<tr>
<td>Selling farm</td>
<td>17%</td>
</tr>
<tr>
<td>Leased out farm</td>
<td>14%</td>
</tr>
<tr>
<td>Sheep numbers too small</td>
<td>11%</td>
</tr>
<tr>
<td>Cattle numbers too small</td>
<td>7%</td>
</tr>
<tr>
<td>Hobby farmer</td>
<td>6%</td>
</tr>
<tr>
<td>Other</td>
<td>6%</td>
</tr>
<tr>
<td>No reason—hung up</td>
<td>54%</td>
</tr>
<tr>
<td>Retired</td>
<td>3%</td>
</tr>
<tr>
<td>Farm type not relevant to survey</td>
<td>3%</td>
</tr>
<tr>
<td>Only do paper based surveys</td>
<td>3%</td>
</tr>
<tr>
<td>Don’t do phone surveys</td>
<td>2%</td>
</tr>
</tbody>
</table>
## Appendix C

### Types of production management software use

<table>
<thead>
<tr>
<th>Software</th>
<th>Number of respondents</th>
<th>Software</th>
<th>Number of respondents</th>
<th>Software</th>
<th>Number of respondents</th>
</tr>
</thead>
<tbody>
<tr>
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Appendix D

Appendix D displays the rates of using the various options to sort out telecommunication needs across industries.

Question: Who has helped you in sorting out your telecommunication needs?

![Bar chart showing rates of using various options to sort out telecommunication needs across industries. The options include: Beef only, Beef/Grain Mixed, Beef/Sheep Only (Lamb), Sheep/Grain Mixed, Sheep Wool, Dairy, Pork, Poultry Eggs/Meat, Aquaculture, Grain Only, Grain - Grain/Beef/Sheep, Cotton, Rice, Sugarcane, Vegetables, Wine Grapes. The rates range from 2% to 71% for different industries.]

![Bar chart showing rates of using a fee-for-service consultant. The rates range from 3% to 23% for different industries.]

P2D Producer Survey | 97
Yourself + fee-for-service consultant + telecommunication service provider
AT CSIRO, WE DO THE EXTRAORDINARY EVERY DAY

We innovate for tomorrow and help improve today – for our customers, all Australians and the world.

Our innovations contribute billions of dollars to the Australian economy every year. As the largest patent holder in the nation, our vast wealth of intellectual property has led to more than 150 spin-off companies.

With more than 5,000 experts and a burning desire to get things done, we are Australia’s catalyst for innovation.

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