Rural R&D for Profit Program

Accelerating Precision to Decision Agriculture
Final Report

Cotton Research and Development Corporation

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Contents

Plain English summary

The P2D project brought together all 15 Research and Development Corporations (RDCs) for the first time to develop six projects that evaluated the current and desired state of digital agriculture in Australia. Recommendations are provided by the P2D project to ensure Australian primary producers are able to overcome the challenges currently limiting digital agriculture and profit from their data.

Eight regional stakeholder workshops were held in five states and producers were surveyed across the nation to better understand the current perceptions and needs for digital agriculture by producers and other stakeholders. The project commissioned six detailed technical reports to address key areas that are constraining digital agriculture moving towards its promised potential in Australia. A Summary Report has been delivered which brings together the key findings and aggregates the 67 detailed recommendations into 13 key recommendations. It also provides direction on the next steps required to implement the recommendations.

The principle findings of the P2D project are:

- Digital agriculture in Australia is in an immature state in many parts including strategy, culture, governance, technology, data, analytics, and training.[5] This is to the detriment of innovation and producer adoption of digital agriculture in Australia.
- With maturity, the economic modelling identified that the implementation of digital agriculture across all Australian production sectors (as represented by the 15 RDCs) could lift the gross value of agricultural (including forestry and fisheries) production by $20.3 billion (a 25% increase on 2014-15 levels).[6]
- To achieve maturity, cross-industry and cross-sector collaboration is vital as many of the issues impeding maturity are common and this scale of investment is required to implement solutions for Australian conditions and to keep pace with the rest of the world.

The P2D project has detailed a clear value proposition and pathway forward for transformational improvement in Australian farm business management and decision making through digital agriculture. For this potential to be realised, it will be essential for industry, RDCs, government and the commercial sector to commit to work together.

The P2D project has detailed a value proposition and identified a pathway forward for transformational improvement in Australian farm business management and decision making through digital agriculture. The 67 recommendations from the six P2D technical reports have been aggregated into 13 detailed recommendations.

Delivery of these recommendations could result in a lift in the gross value agricultural production (GVP) of $20.3 billion. For this potential to be realised, it will be essential for industry, RDCs, government and the commercial sector to commit to work together in each of the following areas:
- Policy
- Strategy
- Leadership
- Digital literacy
- Enablers.

This historic collaboration of RDCs to jointly fund the P2D project has occurred because many of the issues associated with the transition to digital agriculture are not industry specific. Consequently, the recommendations from this project are focused on benefiting all industries. A cross-industry approach to providing the leadership, governance, connectivity, datasets and platforms and increased digital literacy is required.

The project summary recommendations in brief include:

1. Develop a Data Management Policy for Australian Digital Agriculture.

2. Develop a voluntary Data Management Code of Practice and a Data Management Certification or Accreditation Scheme.

3. Policy and investment to improve telecommunications to farms and rural businesses.

4. New investment models including public/private investment.

5. RDC's develop Digital Agriculture Strategy's and implementation roadmap.

6. Big Data Reference Architecture and Data Management Implementation Plan.

7. Establish, review and refine foundational data sets.

8. Establish a Digital Agriculture Taskforce for Australia (DATA) headed by the Chief Digital Agricultural Officer – to deliver outcomes.

9. Establish a Digital Agriculture Taskforce for Australia Working Group (DATAWG) – to provide guidance.

10. Provide education and capacity building to increase digital literacy in the agricultural sector.

11. Establish baseline patterns of data usage and a national mobile network coverage (data speed and volume) database.

12. Digitise and automate data collection including for regulatory compliance activities.

13. Execute a cross Industry Survey every three years to identify producers' needs and issues in digital agriculture.

Implementing the recommendations from the project will set the stage for increasing the profitability of producers, providing clarity and trust in data ownership and access rights, and stimulating an innovation environment that facilitates the development and adoption of technology.

The support of all of the Rural Research and Development Corporations and the Australian Government has enabled the P2D project to benefit from a co-ordinated national approach. The thirteen key recommendations provide a clear sight of the way ahead and a next phase of P2D has a compelling case.

It is recommended that all RDCs co-invest in enacting the recommendations at the national scale and seek co-investment from the Australian Government through the Rural R&D for Profit program. For Australian agriculture to realise the potential $20.3 billion benefit from digital agriculture, the functional engine of digital agriculture needs to be operational.

Recommendations from this report detail the key strategy components of policy, strategy, leadership, digital literacy and enablers that must be addressed for the elements of trust, confidence, functional delivery and operational effectiveness to achieve data driven practice change by producers.

The P2D project has detailed a clear value proposition and pathway forward for transformational improvement in Australian farm business management and decision making through digital agriculture. For this potential to be realised, it is essential for industry, RDCs, government and the commercial sector to work together. The P2D project has the benefit of being supported by all of the RDCs and the Australian Government, enabling a co-ordinated national approach. The thirteen recommendations provide clear sight of the way ahead and a next phase of P2D has a compelling case.

The next steps in delivery of a successful digital agriculture program will enable Australian agriculture to remain internationally competitive and at the forefront of best practice for production, environment and community benefit.

It is recommended that the P2D Project Management Committee agrees in principle to:

1. All RDCs co-invest in enacting the recommendations at the national scale via a Phase 2 P2D project and seek co-investment from the Australian Government through Round 4 of the Rural R&D for Profit program.
2. Nominated RDC representatives on the P2D Project Steering Committee lead the process of developing a detailed joint investment submission to the Australian Government Rural R&D for Profit Program.
3. Support the agricultural, forestry and fisheries industries to convene the Digital Agriculture Taskforce for Australia (DATA) and Working Group (DATAWG) to advise on good data policy for the sector.

The Council of Rural Research and Development Corporation CEOs unanimously agreed in principle in December 2017 to support a process of implementing next steps in delivery of these recommendations. The P2D summary Report was released by the Hon. David Little proud, Minister for Agriculture and Water Resources at on the 6 March at Outlook 2018.

Abbreviations and glossary

Term	Meaning
AgTech	Commonly used in the investment community to describe digital technologies used in agriculture.
Big Data	Computerised analytics systems that interrogate extremely large databases of information in order to identify particular trends and correlations.
Cloud computing services	Cloud storage is a model of data storage where the digital data is stored in logical pools, the physical storage spans multiple servers (and often locations), and the physical environment is typically owned and managed by a hosting company.
Decision agriculture	Conclusion or action resulting from the application of knowledge and/or information that may be derived from digital agriculture.
Digital agriculture	Digital agriculture typically involves both the collection and analysis of data to improve both on- and off-farm decision making leading to better business outcomes.
Digital disruption	Digital and associated technologies that 'disrupt the status quo, alter the way people live and work, rearrange value pools, and lead to entirely new products and services', often in a relatively short period of time (Manyika et al., 2013).
Information and communication technologies (ICT)	ICT is a broad term used to refer to technologies that involve the use of computers, computer networks, telephone networks and internet networks to manage data and information.
Internet of Things	• Devices such as sensors, machines, and other digital instruments which are connected to each other and the internet so that they are able to collect and exchange data with each other.
Open Data	Data that is: 1. freely available to download in a reusable form. Large or complex data may be accessible via a service or facility that enables access in-situ or the compilation of sub-sets 2. licensed with minimal restrictions to reuse 3. well described with provenance and reuse information provided 4. available in convenient, modifiable and open formats managed by the provider on an ongoing basis.

1 Project rationale and objectives

The transition from analogue business and production models to digital is creating challenges and opportunities across all industry sectors, domestically and internationally. Agriculture is not immune.

Australia has been a world-leading player in the development of precision agricultural tools. For example, the Australian company Beeline released the first navigation system for agriculture more than 20 years ago. Despite our innovative culture, the Australian AgTech market is in its infancy compared to countries such as the United States of America (USA) and Israel.[6]

Information and communication technology (ICT) and automation spill over from overseas is occurring in some industries including cropping, dairy and intensive livestock. However, Australian production systems face some unique challenges that require home-grown solutions to enable appropriate data based decision making.

Many Australian producers are finding it difficult to navigate the digital agricultural marketplace and worry about unwise investments without a guarantee of return. Producers lack trust in data management systems, access by third parties and are unclear about the terms that govern their data including who owns their data. Many producers and agricultural stakeholders require improved digital skills and knowledge and are frustrated by the unreliability of telecommunications connectivity and the inadequate services currently supporting the adoption of digital technology.

A lack of producer control and under-utilisation of data to make decisions are putting Australian agriculture at a global disadvantage. The value placed on data and technology varies between agricultural industries, but producers are becoming more skilled at deploying precision agriculture (PA) technologies. The volume of data gathered from farm machinery, sensors and digital technologies is increasing exponentially. Increased temporal and spatial information about the status of soil, water, crops, animals and pasture, etc, is of little value unless it can be used to make and action improved decisions. How to use this data to improve on-farm profitability often remains the challenge.

The Accelerating Precision to Decision Agriculture (P2D) project was focused on three main aims:

- Facilitating the development of digital technology in Australian agriculture.

- Fostering the establishment of appropriate legal frameworks, data systems and access to critical datasets.

- Identifying the data communications systems required to deliver the benefits of digital agriculture to the Australia farm and agribusiness sectors.

Project Outcomes include:

- To increase the profitability of Australian farm businesses by providing business strategies to realise the economic potential of digital agriculture.

- To foster the development of the rules, systems and communications requirements needed to ensure that farm, industry and environmental data is accessible, scalable, and portable while protecting the rights of the data owners.

- Through the involvement of all 15 rural RDC's to develop a whole of agriculture approach to the adoption of digital agriculture technologies and systems.

Project Deliverables include:

- Recommendations for the best options to support the interaction between publicly funded R&D and next generation commercial decision support and data collection tools.

- Policy options and frameworks for ownership and management of and access to big data.

- A value proposition for producers to participate in the agricultural big data economy.

- Information packages for farmers to increase their knowledge, skills and confidence to adopt digital agriculture technologies.

- Improved cross-sectoral industry research collaboration.

2 Method and project locations

The project has taken a multidisciplinary approach to the research partners using a series of research and analyses techniques. The following details the key methods and approach used, plus the national reach of the project to industry stakeholders. The findings from this research were used to develop a series of six technical reports.

Desktop Research

Project research partners undertook desktop research activities investigating how digital agriculture and big data manifests across the participating RDC industry supply chains, the challenges producers face working with the data and opportunities for the data collected to help producers make decisions to increase profit. Research sources included material obtained from the web, interviews with producers and tool providers along with relevant pre-existing research documents and papers.

Producer Survey

A producer survey was conducted by the P2D project to further expand on the insights that were gained from the regional industry workshops. The survey contained targeted questions from each member organization to gain a macro, cross industry view of the use of Big Data to drive decisions on farm.

A specialised agricultural research survey company KG2 was engaged to conduct the data collection. 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 of producers in table 1 was conducted via computer-assisted telephone interviewing (CATI) during the period of 7 March to 18 April in 2017.

The survey questionnaire was designed in consultation with Precision to Decision (P2D) project members and participating Research and Development Corporations (RDCs). The sampling specifications for each industry were defined in consultation with participating RDCs.

Analysis of the findings was conducted across three key themes:

    (i)   Telecommunication infrastructure;

    (ii)   Status of current data collection; and

    (iii)   Producer attitudes 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.

Table 1. Number of respondents per industry across states

Industry	State							Total
	NSW	QLD	VIC	TAS	SA	WA	NT	
Beef only	23	63	22	1	7	9	1	126
Beef/Grain Mixed	28	21	4	1	5	5	0	64
Beef/Sheep Mixed	59	9	17	0	3	6	0	94
Sheep Meat Only (Lamb)	29	2	19	1	5	3	0	59
Sheep/Grain Mixed	45	0	20	1	15	13	0	94
Sheep Wool	37	3	20	2	11	16	0	89
Dairy	21	9	58	5	1	0	0	94
Pork	1	6	3	0	4	1	0	15
Poultry Eggs/Meat	19	1	9	1	0	0	0	30
Aquaculture	9	4	5	4	5	1	2	30
Grain Only	19	8	13	0	14	23	0	77
Grain - Grain/Beef/Sheep	18	4	12	0	12	27	0	73
Cotton	17	13	0	0	0	0	0	30
Rice	15	0	0	0	0	0	0	15
Sugarcane	7	58	0	0	0	0	0	65
Vegetables	13	8	5	0	3	1	0	30
Wine Grapes	4	1	2	0	6	2	0	15
Total	364	210	209	16	91	107	3	1,000

Workshops

The project partners participated in eight industry workshops designed to present a forum in which the P2D project participants may solicit information from producers and industry representatives regarding collection of data, their day-to-day data use, data challenges and opportunities for using data to drive profit. During the reporting period D2D collaborated with CSIRO/Data 61 and project assigned workshop facilitators to plan the eight regional industry workshops. Attendee profiles were developed along with the format and approach required to maximise the opportunities for insights.

The 8 stakeholder workshops (Table 2) were conducted during December 2016 – April 2017 as part of the broader P2D project. Participants were encouraged to offer their views about on-farm telecommunications, data and digital agriculture technology use in their business, including both both challenges and opportunities. Producers were invited to share any experiences to illustrate their particular points. The session 'Identifying future needs' within each workshop also provided an insight into the future needs of on-farm telecommunications and data use in their business.

Table 2. P2D industry stakeholder workshops

Date	Workshop Location	Industry focus
5 December 2016	Gatton, Qld	Horticulture
1 March 2017	Townsville, Qld	Sugarcane
2 March 2017	Tamworth, NSW	Cotton, Grains, Livestock
16 March 2017	Northam, WA	Grains
28 March 2017	Wagga Wagga, NSW	Grains, Wine grapes
29 March 2017	Tatura, Vic	Horticulture, Dairy
30 March 2017	Launceston, Tas	Forestry, Fisheries
27 April 2017	Tanunda, SA	Wine grapes

The P2D workshop attendance and participation varied by industry but usually involved producers, agronomists and advisors. In some cases, government scientists, academics, and digital platform consultants and banking officials also attended. These workshops followed a structured format, and were facilitated by consultants, where participants were interviewed about current use of digital technologies and asked where they thought there was significant value in further adoption.

A major difficulty was getting producers to attend the workshops. The reasons were manifold including clash with harvesting and time of day to list a few. But given many large producers use consultants to manage different aspects of their production cycle, having a large proportion of agricultural service providers attending should not be surprising. And in hindsight the project was more relevant to these attendees.

Interviews

In addition to the workshops, a large number of interviews were conducted with stakeholders and interested parties. These helped identify the key issues around agricultural data use, telecommunications and governance in Australia. In addition to the regional workshops and interviews, the researchers analysed the possible future state of agricultural data rules in Australia and proposed a viable framework for the effective management of Australian agricultural data and recommendations for the transitional phase. This work provided an effective and efficient data governance framework for Australian agriculture including best practice contracts for Australian producers. It aslo provided significant insight on needs, issues and solutions for regional telecommunications for the use of data in business.

Data collection

The primary data collection process of this project was based on a series of interviews with people involved in Australian agriculture. This was done based on a number of different avenues. First, we attended eight regional workshops across multiple agricultural sectors and locations in Australia (details below). These workshops varied in their composition depending on the industry but typically involved primary producers, agronomists and advisors. In some cases, government scientists, academics, and digital platform consultants and banking officials also attended. These workshops followed a structured format where participants were interviewed about current use of digital technologies and asked where they thought there was significant value in further adoption.

A second avenue of activity was targeted at the fifteen research and development corporations. We conducted interviews with representatives from these. The third avenue was a workshop with technology companies that are active in Australian agriculture. These companies included those providing both hardware-based and software-based solutions. This information was supplemented by interviewing additional product representatives. The fourth avenue was through the engagement of agricultural data experts to explore existing data holdings and to discuss high value opportunities to pursue.

In building the data register and the decision-tool register, we adopted a bottom-up and top-down approach. The steps we followed were:

- Step 1 (bottom-up): hold a series of workshops and interviews (described above) to identify the core datasets and decision tools
- Step 2 (bottom-up): use the findings from the workshops/interviews to expand the search by conducting a desktop review with Google – this search used keywords such as agricultural data/analytics/decision/tools/software/platforms to form a more complete list of agricultural datasets and tools
- Step 3 (top-down): search data catalogue sites such as data.gov.au, portal.geoscience.gov.au, poama.bom.gov.au, portal.aodn.org.au, data.aurin.org.au and the individual state government data repositories for agricultural datasets
- Step 4 (top-down): search the OzNome (https://research.csiro.au/oznome/) catalogue for agricultural datasets and decision tools not yet identified from the previous steps – the OzNome project is a new initiative to connect information across Australia by harvesting metadata from publicly available data sites
- Step 5 (top-down): use a panel of domain experts to critique relevance of register entries.

Use Cases and Requirements for a Big Data Reference Architecture

The D2D CRC identified several cross-cutting industry use cases for Big Data. These use cases were used to form the basis of the requirements for the Big Data Reference Architecture (BDRA) and were used throughout the D2D CRC deliverables to illustrate the application of the BDRA in the solution design process.

The Big Data Reference Architecture (BDRA) provides a framework to assist RDC and Agricultural projects with needs in Big Data collection, storage and analysis. The BDRA guides solution architectures by assisting with requirements definition and identifying appropriate strategies and design patterns for Big Data concerns. The intended audience is managers, architects, business analysts, solution designers and any other roles involved in scoping,

requirements definition or solution design for Big Data projects within the RDCs. As there are currently several research tasks ahead of the BDRA in the project critical path work on the BDRA there have not yet been any deliverables made available from this activity, these will be provided in future project stages.

The product catalogue provides descriptions of available products at the time of the project, i.e. a form of product stocktake. D2D CRC have started the process of collating applicable current market offerings for Agricultural Big Data. The intention of the product catalogue is to provide a reference of available technologies while not making specific recommendations to a single product or vendor. Products will be assessed on capability and referenced as such.

The Example Architectures provide tutorials for using the BDRA to design a concrete solution architecture, for a selection of the use cases. Again, this activity has forward dependencies in the critical path, for example the completion of the use cases and as such is yet to commence.

Economic impact analysis

The research reported on here covers two broad areas: firstly, an analysis of the potential benefit to the Australian economy from the unconstrained implementation of decision agriculture is presented; and secondly, various aspects that will impact the delivery of those benefits to farmers are reported including likely business models for the delivery of decision agriculture products and services.

Benefits to the economy were predicted using the Centre for International Economics (CIE)-Regions Food Processing model (CIE-Regions FP model), a general equilibrium model of the Australian economy with a focus on agriculture and food processing (see Appendix 1 for additional information).

Step 1. Potential from unconstrained decision agriculture.

The potential of unconstrained decision agriculture was determined by estimating the cumulative impact of several factors, the first being the increase in productive potential delivered by digital technologies.

There are three critical factors which determine the productive potential of a plant or animal:
- The genetic potential of the plant or animal;
- The environmental limitations placed on realising the genetic potential; and
- The decision-making or management that exploits genetic potential within environmental limitations.

While farmers have very little control over the first two points, the third point is the application of production management skills and decision-making, which is completely in the control of the producer. A full implementation of decision agriculture would deliver producers, in a timely fashion, all the data, information and analysis that they need such that all the constraints on productivity that are within the control of the producer are eliminated. In this case, the productive potential would only be limited by the genetic potential and environmental limitations for which the producer has no control.

The economic benefit from productivity improvements that can be assumed to result from fully adopted decision agriculture therefore becomes the difference between the genetically and

environmentally limited yield, and current production practice - in which productivity may be constrained by management decisions as well as genetic and environmental potential.

The ability to determine unconstrained productive potential will differ between agricultural sectors. The grains sector for example is relatively advanced in this area with the Commonwealth Scientific and Industrial Research Organisation (CSIRO) led Yield Gap project (www.yieldgapaustralia.com.au). While other sectors may not be as advanced in being able to quantitatively define the Yield Gap, the rationale supporting the concept can be widely understood, and informed opinion given on potential improvement.

The productive potential information used for this project was obtained through a series of interviews with experts identified by each participating RDC. The interviews followed a structured process of defining best practice and then applying known improvements that result from implementation of decision agriculture. The interviews also posed a series of "what if?" scenarios relating to access to data, appropriate analytics, unconstrained connectivity, and level of adoption of digital technology.

The shocks that were applied to the CIE-Regions FP model were determined by grouping suites of similar technologies into production factors or key decision areas. For example, for the grains sector, better nutrient application was identified as a single shock since the contribution that better nutrient application has to the overall yield gap could be estimated and better nutrient application encompasses a suite of digital applications. Likewise, for the beef industry, animal health and monitoring has been identified as a shock since the contribution that increased animal health makes to productivity improvement can be reasonably estimated, and there is a distinct grouping of digital technologies that provide information for this factor.

The methodology used to forecast the unconstrained potential of decision agriculture for each sector can be considered a 'top down' approach, however, it has been tempered wherever possible with rigorous 'bottom up' ground-truthing through comparison to benchmarking information or other known and measurable productivity figures. If there was not clear information available about unrealised genetic potential then benchmarking studies were examined, so that estimations of possible improvement did not go beyond what is known to be possible and being achieved by the very top producers. Due to this approach being taken, the authors believe that the modelling results are relatively conservative as they do not forecast improvements beyond what is known to be achievable.

It is important to remember however, that the shocks applied to the CIE model estimate the size of the opportunity under a best-case scenario. How much of that opportunity is realised is highly dependent on an array of factors and may differ significantly between sectors. The GVP increases estimated for each sector are intended to be a guide for the potential of digital agriculture and the authors acknowledge that industry structural differences, economic and trade circumstances will determine the ultimate growth of each industry.

Through the consultative phase of the project there were also several impacts of decision agriculture that were suggested to the research team as significant but were not included in the CIE-Regions FP modelling. These were impacts related to issues such as biosecurity and traceability. The ability for decision agriculture to provide platforms to better monitor biosecurity impacts was almost universally acknowledged, however attributing a financial benefit to better monitoring was problematic since biosecurity platforms do not provide

immediate improvement but instead provide insurance against market loss. Since the purpose of this study was to forecast the immediate benefit to the economy of unimpeded decision agriculture the research team decided that biosecurity, traceability and similar issues lay outside the scope of the analysis. These issues have been included in the commentary as there is no doubt that decision agriculture will deliver significant benefits, however they have not been included in the economic modelling.

Step 2. Impact of enabling functions on realising productive potential of decision agriculture.

The full adoption of decision agriculture resulting in the realisation of unconstrained potential is unlikely for several reasons, some of which are the limited application of the enabling functions of decision agriculture as investigated by the P2D program.

An estimation of the extent to which each of those enabling functions individually acts as a barrier to the unconstrained potential of decision agriculture is confounded by the way that they are inextricably linked to each other. The enabling functions that the P2D program has investigated include:

- Appropriate data;
- Appropriate decision support analytics;
- Connectivity infrastructure;
- Value propositions; and
- Trust.

While each of these enablers is important in their own right, each also depends on the others in the context of the full expression of decision agriculture. For example, trust issues can be overcome more easily by compelling value propositions, which in turn create a market pull for the installation of connectivity infrastructure, and facilitate the aggregation of useful data.

The linked nature of these enabling functions requires that they be thought of as a set of infrastructure and policy requirements that need to be implemented simultaneously to enable decision agriculture. If any one of these enabling functions remained as a barrier, it would limit the full expression of decision agriculture.

To this end, the methodology used in determining the impact of enabling functions on the economic benefit that may be realised has been qualitative rather than quantitative. Commentary has been provided on how each of the enabling functions may impact on the shocks applied to the CIE-Regions FP model however in terms of a financial impact they have all been considered to have equal effect.

The business models component of this project included an extensive literature review to provide insight on the prevalence of various types of business models in the technology and start-up community. This information was overlaid with observations obtained from the industry and agribusiness workshops conducted throughout the length of the P2D program as well as information provided from Prassack Advisors regarding international trends and opportunities.

The impact of enabling functions of decision agriculture was considered in relation to the likely development of these business models across the various sectors in Australian agriculture, forestry and fisheries.

3 Project achievements

3.1 Project level achievements

Australia has been a world-leading player in the development and use of advanced agricultural technologies such as precision agriculture. For example, agricultural industry adoption of auto-steer technology is the highest in the world (Llewellyn & 2014). Despite our innovative culture, the Australian AgTech market is in its infancy compared to countries such as the United States of America (USA) and Israel (Perrett *et al.* 2017). Australian agriculture is on the brink of major change as we enter a new era of digital agriculture. The transition from analogue business and production models to digital is creating challenges and opportunities across all industry sectors, domestically and internationally. Agriculture is not immune from this change.

Information and communication technology (ICT) and automation spill over from overseas is occurring in some industries including cropping, dairy and intensive livestock. However, Australian production systems face some unique challenges that require home-grown solutions to enable appropriate data based decision making.

Many Australian producers are finding it difficult to navigate the digital agricultural marketplace and worry about unwise investments without a guarantee of return. Producers lack trust in data management systems, access by third parties and are unclear about the terms that govern their data including who owns their data. Many producers and agricultural stakeholders require improved digital skills and knowledge and are frustrated by the unreliability of telecommunications connectivity and the inadequate services currently supporting the adoption of digital technology.

The value placed on data and technology varies between agricultural industries, but producers are becoming more skilled at deploying precision agriculture (PA) technologies. The volume of data gathered from farm machinery, sensors and digital technologies is increasing exponentially. Increased temporal and spatial information about the status of soil, water, crops, animals and pasture, etc, is of little value unless it can be used to make and action improved decisions. How to use this data to improve on-farm profitability often remains the challenge. A lack of producer control and under-utilisation of data to make decisions are putting Australian agriculture at a global disadvantage. Australia clearly cannot afford to be left behind.

A project Summary Report has summarised all the findings from the Accelerating precision agriculture to decision agriculture project (P2D project), funded via the Australian Government Department of Agriculture and Water Resources Rural R&D for Profit program and all 15 Research and Development Corporations (RDCs). The P2D project has evaluated the current state of digital agriculture in Australia, modelled the potential future economic benefits and makes recommendations to realise these potential economic gains at the farm gate. This project is believed to be the first time globally that an entire industry sector has taken a national coordinated approach to tackle issues associated with digital transformation. Key findings of the P2D project have been summarised. Recommendations and next steps are also detailed.
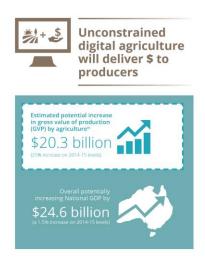
Key findings

With maturity, the economic modelling identified that the implementation of digital agriculture across all Australian production sectors (as represented by the 15 RDCs) could lift the gross value of agricultural (including forestry, and fisheries and aquaculture) production by $20.3 billion (a 25% increase on 2014-15 levels) (Perrett *et al.* 2017). Four areas are highlighted where cross-sectoral collaboration could unlock over $1 billion of economic benefits. There are: Automation and labour savings $7.4B e.g. machinery, animal handling & product processing; genetic gains through objective data $2.9B e.g. animal & variety selection; tailoring inputs to need $2.3B e.g. fertiliser seed, & water and; market access and biosecurity $1B e.g. pest & disease control (Figure 1).

Figure 1

Summary of potential unconstrained impact of digital agriculture to gross value of production (GVP).

Today, digital agriculture in Australia is in an immature state. It's important to recognise this is not a unique state to just the agricultural sector, or this country, although Australia is behind countries like USA. The study rates the digital maturity of the Australian agricultural sector as 'ad-hoc', highlighting issues of leadership, value proposition, trust and legal barriers, connectivity availability of appropriate data, digital literacy, data analysis and decision support tools. The Australian market for digital agriculture products and services is in its relative infancy compared to the scale and pace of developments occurring in other parts of the world. However, the full economic potential of digital agriculture will struggle to be realised until there is a data management policy that sets out principles on data management.

A common cross-industry need for greater leadership in digital agriculture was identified. Cross-industry collaboration is required for digital agriculture policy, governance and strategy development and implementation as currently, the legal and regulatory frameworks around agriculture data are fragmented, piecemeal and ad hoc (Wiseman & Sanderson 2017). 56% of producers indicated having no trust or little trust in service/technology providers maintaining their data privacy not sharing their data with third parties (*Zang et al. 2017*) and robust guiding policy at a national scale is required. Australian producers want to know that their data is adequately protected and used fairly.

Implementing a data management code of practice and certification or accreditation provides mechanisms to increase transparency and trust. One way this will be achieved is by developing trust and greater transparency about the terms of use that govern the collection, aggregation, ownership, storage and dissemination of data. This trust and transparency are essential prior to producers entering into commercial relationships with third-party advisers and technology service providers

Producers indicated the value of changing to digital agriculture is not clear. Value was not only related to monetary value, but also peace of mind, confidence, social and lifestyle factors. If digital agriculture is to be adopted, it needs to be sustained by consistency of service and support and the reliability of technology (Skinner *et al.* 2017). A lack of access to mobile and internet telecommunications infrastructure is a major impediment to the adoption of digital agriculture systems (Lamb 2017). This is costing producers, agribusinesses and the Australian economy billions of dollars each year in terms of lost productivity (and profitability). While connectivity is only one of the five constraints to the progression to digital agriculture, it is considered to be the engine. Without connectivity, digital agriculture is not possible. The project survey highlights the difficulties from reliance of the current mobile phone network with 55% of producers using the mobile phone network for internet, yet 43% had patchy or no mobile reception across their property (Zang *et al.* 2017). An improved understanding of producers' data needs and servicing these needs is required (Lamb 2017).

The whole agriculture value chain irrespective of industry sector could gain from improved access and interoperability of stored data through dissemination of datasets that are valuable across the rural sector that are also widely used in other industries (Barry *et al.* 2017). Many of the producers and supply chain organisations that participated in the regional stakeholder workshops commented that they 'struggled to access and integrate data'.

The standardisation of data formats introduces inter-operability benefits both for users and developers. Within the international agricultural sector, access to open datasets has been proven to accelerate the availability and adoption of digital agriculture solutions. However, much of the data resulting from publicly funded research activities in Australia is not made available for common use. Public/private investment models would need to support integration of corporate data into foundational datasets and the improved accessibility of data gathered by government bodies to the corporate sector.

A digital skills and capability gap was identified across the value chain. It was identified that education support was not only required to up-skill the agricultural sectors but also to generate more data scientists and engage them with agriculture (Skinner *et al.* 2017). While the state of data maturity by industry shows some maturity, the approach to deploying big data solutions

across the agricultural sector is uncoordinated and ad hoc. A big data reference architecture provides a common starting point for digital agriculture systems (Skinner *et al.* 2017).

Key Recommendations

This Summary Report brings together the key findings and aggregates the 67 detailed recommendations into 13 key recommendations to the Agricultural sector to realise the potential economic gains of digital agriculture in five areas of policy, strategy, leadership, digital literacy and investment.

One of the first steps for industry in implementing good data management procedures is to establish a national data management policy. This is a set of broad, high level principles that will form the guiding framework in which data access and management can operate. More specifically, a data management policy for Australian digital agriculture must consider issues such as data custodianship and access, data collection and storage, data harmonisation and standardisation, data stewardship, data security, data portability, data lifecycle management and data audits.

By addressing the constraints identified in the P2D project, this policy will support both the adoption of existing digital agriculture technologies and practices, as well as facilitate the emergence of new business models and their associated products and services.[6] In addition, a data management policy for Australian agriculture will help ensure that the full economic and social potential of decision agriculture will be achieved.

There is an absence of clear digital strategies within the RDCs, as evident from interviews and observations gathered during the P2D project. This indicates that the RDCs lack a clear roadmap for the adoption of digital agriculture.

Key recommendations in brief are:

Policy

1. Develop a Data Management Policy for Australian Digital Agriculture.

2. Develop a voluntary Data Management Code of Practice and a Data Management Certification or Accreditation Scheme.

3. Policy and investment to improve telecommunications to farms and rural businesses.

4. New investment models including public/private investment.

Strategy

5. RDC's develop Digital Agriculture Strategy's and implementation roadmap.

6. Big Data Reference Architecture and Data Management Implementation Plan.

7. Establish, review and refine foundational data sets.

Leadership

8. Establish a Digital Agriculture Taskforce for Australia (DATA) headed by the Chief Digital Agricultural Officer – to deliver outcomes.

9. Establish a Digital Agriculture Taskforce for Australia Working Group (DATAWG) – to provide guidance.

Digital Literacy

10. Provide education and capacity building to increase digital literacy in the agricultural sector.

Enablers

11. Establish baseline patterns of data usage and a national mobile network coverage (data speed and volume) database.

12. Digitise and automate data collection including for regulatory compliance activities.

13. Execute a cross Industry Survey every three years to identify producers' needs and issues in digital agriculture.

Interviews with the RDCs identified a lack of technical leadership within industry organisations from a national to a community level. To address this, staffed by a small cross-industry team of data scientists, technologists and legal experts, Digital Agriculture Taskforce for Australia (DATA) would have the broad objectives of:

- Identifying and initiating collaborative data opportunities.

- Building foundational datasets.

- Developing and supporting implementation of a cross-industry digital agricultural strategy.

- Refining and growing a Big Data Reference Architecture.

- Monitoring and guiding telecommunications and connectivity; and

- Developing data science capability.

A Digital Agriculture Taskforce for Australia Working Group (DATAWG) should be established to drive the policy and investment required to advance digital agriculture in Australia. The group would consist of representatives from the 15 Research and Development Corporations (RDCs), Government and peak industry and commercial representative bodies and relevant industry experts.

Currently, all 15 RDCs fund projects within their respective industries without cross-industry collaboration or the requirement for leveraging similar research carried out in other industry sectors. This represents a significant cost duplication to levy payers. A consolidated approach to digital agriculture would provide an opportunity for RDCs to collaborate and find new and efficient ways to consolidate, analyse and act upon data at a whole of industry scale.

At the heart of digital agriculture are telecommunications connectivity and data analysis leading to better informed decision making and implementation. The technologies, enabling functions and many datasets that support digital agriculture are not sector specific. The commonality of issues reinforces the need for cross-sectoral collaboration to produce uniform policy in areas that will facilitate the unconstrained implementation of digital agriculture

There is a need, both in the research and development (R&D) sector and in industry, for people with digital skills who also understand the agricultural sector. Evidence from the regional stakeholder workshops indicates that the Australian university system is not producing sufficient agronomists with the required skills and that current incentives to change this situation are insufficient. Education and training are required at all levels within the industry to increase knowledge and understanding of connectivity options, best practice in data management and use and data licensing. New programs should also be developed to provide the relevant skills to the emerging agricultural workforce that will be required to progress decision agriculture.

A review of the skills required by producers to maximise the benefits derived from digital agriculture is recommended to provide a foundation for the development of educational packages. The establishment of demonstrator sites could be considered to enable producers gain first-hand experience of innovations and best practice in data management in a practical environment. Skill gaps have already been identified in the areas of on-farm telecommunications and data science, but a more comprehensive analysis is required

Conclusions

To achieve maturity, cross industry and cross-sector collaboration is vital as many of the issues impeding maturity are common and this scale of investment is required to implement solutions for Australian conditions and to keep pace with the rest of the world. The P2D project has detailed a clear value proposition and pathway forward for transformational improvement in Australian farm business management and decision making through digital agriculture. For this potential to be realised, it is essential for industry, RDCs, government and the commercial sector to work together.

The recommended next steps are for all RDCs co-invest in the recommendations with the Australian Government and to support the establishment of Digital Agriculture Taskforce for Australia (DATA) and Working Group (DATAWG). The next steps in delivery of a successful digital agriculture program will enable Australian agriculture to remain internationally competitive and at the forefront of best practice for production, environment and community benefit.

3.2   Contribution to program objectives

The Accelerating Precision to Decision Agriculture (P2D) project was focused on three main aims:

- Facilitating the development of digital technology in Australian agriculture.

- Fostering the establishment of appropriate legal frameworks, data systems and access to critical datasets.

- Identifying the data communications systems required to deliver the benefits of digital agriculture to the Australia farm and agribusiness sectors.

Project Outcomes included:

- To increase the profitability of Australian farm businesses by providing business strategies to realise the economic potential of digital agriculture.

- To foster the development of the rules, systems and communications requirements needed to ensure that farm, industry and environmental data is accessible, scalable, and portable while protecting the rights of the data owners.

- Through the involvement of all 15 rural RDC's to develop a whole of agriculture approach to the adoption of digital agriculture technologies and systems.

Project Deliverables included:

- Recommendations for the best options to support the interaction between publicly funded R&D and next generation commercial decision support and data collection tools.

- Policy options and frameworks for ownership and management of and access to big data.

- A value proposition for producers to participate in the agricultural big data economy.

- Information packages for farmers to increase their knowledge, skills and confidence to adopt digital agriculture technologies.

- Improved cross-sectoral industry research collaboration.

This has been the first research project to estimate a whole of agriculture potential benefit of digital agriculture. In doing this it has generated knowledge about where the benefit will be realised and what barriers need to be removed. It has estimated a significant economic benefit to primary producers will occur through a more mature digital agriculture environment and has suggested policy changes, targeted investments and extension pathways to achieve accelerated development of digital agriculture.

Implementing the recommendations from the project will set the stage for increasing the profitability of producers, providing clarity and trust in data ownership and access rights, and stimulating an innovation environment that facilitates the development and adoption of technology.

The support of all of the Rural Research and Development Corporations and the Australian Government has enabled the P2D project to benefit from a co-ordinated national approach. The thirteen key recommendations provide a clear sight of the way ahead and a next phase of P2D has a compelling case. .

The P2D project has achieved the objectives of the Rural R&D for Profits program objective through delivering:

- A detailed understanding of the current issues, needs and opportunities to deliver a digital agriculture future to Australian producers.

- A series of recommendations for a whole of agricultural sector approach addressing future needs for policy, strategy, leadership, digital literacy and industry enablers.

- The project has fostered a whole of agriculture sector approach to the future implementation of digital agriculture programs that will deliver benefit to primary producers

- Delivery of these recommendations could result in a lift in the gross value agricultural production (GVP) of $20.3 billion.

The P2D project has detailed a clear value proposition and pathway forward for transformational improvement in Australian farm business management and decision making through digital agriculture. For this potential to be realised, it will be essential for industry, RDCs, government and the commercial sector to commit to work together.

4   Collaboration

This is the first project to be supported by all fifteen rural Research and Development Corporations (RDCs), whose levy-paying members reflect the diversity of food and fibre production in Australia. In doing so, it takes a whole-of-agriculture approach to the adoption of digital agriculture technologies and systems, and explores opportunities for improved cross-sectoral industry research collaboration.

The collaboration of research partners who contributed to this project were an essential component of the successful delivery of this project. The cross discipline approach was a key element to this successful delivery. Organisations included; The Australian Farm Institute, Griffith University, University of the Sunshine Coast (USC) , CSIRO, CSIRO Data 61, University of New England (UNE) and the Data to Decisions CRC. Consulting agencies werwe the Centre for International Economics, Prassack Advisors and Agthentic who also contributed to the project.

These collaborations has aided innovation through the lifetime of the project and beyond by providing insight into the challenges presented by the three V's of Big Data use (velocity, variety and volume) along with challenges relating to interoperability of data between vendors along the various agricultural supply chains. The varying size of the chosen organizations will help the project deliver valuable outcomes for the widest audience.

There is opportunity for the collaborations to continue beyond the project as the project recommendations may lead to the establishment of industry bodies that will facilitate ongoing collaboration between the partner research organisations.

5 Extension and adoption activities

The P2D producer workshops held across Australia delivered information about the current state of digital agriculture to participants, producers, advisors and other stakeholders with the opportunity to inform the project on issues relevant their experience with digital agriculture.

Since these workshops, there has been considerable industry and public interest in the project. This resulted in a unforeseen and growing demand on research partners in support of education and outreach activities on top of planned project review and communication activities. The following details the extension activities that are above and beyond what the project targets set out to achieve:

Industry Stakeholder Forums/Webinars – Producer and agricultural industry feedback on the Summary and Technical reports was sought:

- Delivered 27 November 2017: 1 pm – 4 pm, Federal Golf Club, Red Hill, Canberra ACT

- Delivered 28 November 2017: 9 am – 12 noon ESDT, Clifton's Level 3, 10 Spring St, Sydney NSW plus Webinar

These forum's were organised to communicate outcomes from all P2D projects and targeted stakeholders with an interest in the development of digital agriculture in Australia.

Agribusiness Forum/Webinar – Agribusiness feedback on the Summary and Technical reports is welcomed

- Delivered 28 November 2017: 1 pm – 4 pm ESDT, Clifton's Level 3, 10 Spring St, Sydney NSW plus Webinar

This forum communicated outcomes from all P2D projects and was targeted more specifically at stakeholders involved in agribusiness and the delivery of digital agriculture products and services.

Industry Presentations/Events

12 July 2017 - Telecommunications briefing LX Group at UNE SMART Farm (Simon Blyth)
18 July, 2017 - Telecommunications briefing MLA stakeholder briefing (Sam Gill), SFIC
22 July 2017 - Telecommunications briefing CISCO (via hackathon, SFIC) Allyn Medway
26 July 2017 - Telecommunications briefing ABC Catalyst (interview)
27 July 2017 - Telecommunications briefing MLA/Optus stakeholder briefing (MLA Syd- via telco)
2 August 2017 - Telecommunications briefing AARNet (telco)
24 August 2017 - Telecommunications briefing AgQuip Telstra presentation/briefing
28 August 2017 - Telecommunications briefing NFF/AgForce, SFIC (Georgie Somerset)
28 August 2017 - Telecommunications briefing MLA/Optus briefing (telco)
29 August 2017 - Telecommunications briefing NSW Parliament Standing Committee on State Development
30 August 2017 - Telecommunications briefing Hassad (telco into Dubbo)
31 Aug – 1 Sept 2017 - Telecommunications briefing Telstra, NBNCo and Cotton industry briefing (Moree)
8 September 2017 - Telecommunications briefing Jobs for NSW, SFIC

12-15 September 2017 - Telecommunications briefing Southern Dirt Techspo and Rabobank
19 September 2017 - P2D briefing NFF telecommunications and social policy committee
19 September 2017 - Telecommunications briefing AgTech Cluster - New England
25-26 September 2017 - Telecommunications briefing Uni Adelaide
3 October 2017 – P2D Briefing with IoTAA
4 October 2017 - Telecommunications briefing KPMG (on behalf of Vic DJEDTR)
4 October 2017 - Telecommunications briefing ABC Rural
4 October 2017 - P2D briefing IOTAA
4 October 2017 - Telecommunications briefing Dept Prime Minister and Cabinet
9 October 2017 - UNE D Lamb Interview Farifax Media (The Land)
10 October 2017 - Telecommunications briefing Department Agriculture and Water Resources
19 October 2017 – P2D briefing of project findings to Department of Agriculture and Water Resources
19 October 2017 – P2D briefing of project findings to NFF
19 October 2017 – P2D briefing of project findings to Richard Hyatt, Minister of Agriculture Office
19 October 2017 – P2D briefing of project findings to GRDC, Council RDCs, AgriFutures Australia
27 October 2017 – P2D Project Management Committee Meeting – Briefing and sign-off with all RDCs
6 November   Telco Review briefing Optus (Paul Sheridan)
7 November 2017 – P2D briefing AgriFutures Australia RDC AgTech Meeting
8 November 2017 – P2D briefing AgTECH17 Emerald
13 November 2017 – P2D briefing Rural, Regional and Remote Communications Coalition (RRRCC)
21 November 2017 – P2D briefing Cotton Australia Panel Meeting Sydney
24 November   Telco Review briefing Michael McCormick (Minister Small Business and innovation) UNE SMART Farm
28 November 2017 - P2D briefing NFF Members Council - Canberra
30 November   Telco Review briefing DAFWA (Katanning Research Farm, WA)
5 December 2017 - Telco Review briefing MLA/Hitachi, UNE SMART Farm
12 December – 2017 - Telco Review briefing DAWR, UNE SMART Farm
12 December 2017 – P2D presentation and recommendations to Council Rural RDCs CEOs - Canberra
2 February 2018 - Council RDCs AgTech Collaboration Workshop
6 March 2018 – Chair and P2D presentation at Outlook 2018 Canberra
15 March 2018 – Tulloona Conservation Group Field Day – P2D presentation - Moree
20 March 2018 – Grain Producers Australia – Grains Policy Council P2D briefing - Sydney
20 March 2018 – NFF Farm Data Workshop - Sydney
26 March 2018 – Fisheries and Aquaculture representative organisation P2D presentation Canberra

Other conference presentations

Conference Presentations on project findings presented at the Australian Farm Institute – Harvesting the benefits of digital agriculture conference (See attachments 11-13)
http://farminstitute.org.au/news-and-events/upcoming-events/harvesting-the-benefits-of-digital-agriculture/presentations:

- P2D connectivity – State of Play: A review of on-farm telecommunications challenges and opportunities in supporting a big data future for Australian Agriculture – David Lamb and Sam Gill
- Harvesting the Benefits of digital agriculture – Richard Heath
- Law, Trust and Ag Data – Leanne Wiseman

- Wiseman L. and Sanderson J. (2018) Embedding the FAIR principles into a National Agricultural Data Governance Framework: an Australian perspective . *Interest Group on Agricultural Data (IGADA) Research Data Alliance pre meeting – 11th international Research Data Alliance Conference Berlin, Germany.* https://www.rd-alliance.org/plenaries/rda-eleventh-plenary-meeting-berlin-germany
- Heath R. (2018) Digital Agriculture – the case for urgent investment. 13-14 March 2018 – AgTech Summit Melbourne. https://www.informa.com.au/event/agtech-summit/
- Lamb D., Mazumdar S., Rainbow R., Sanderson J. and Wiseman, L. (2018) Accelerating precision agriculture to decision agriculture. 13-14 March 2018 – AgTech Summit Melbourne. https://www.informa.com.au/event/agtech-summit/
- Heath R. (2018) World Agri-Tech Innovation Summit 2018 Austrade breakfast briefing panel presentation. Driving Innovation in Australian Agriculture. 20-21 Mrach 2018 San Francisco USA. https://worldagritechusa.com/agenda/

A project description was presented as part of broader presentations delivered to:

- Lamb, D.W. and Newman, C (2016) "Agtech in Australian agriculture - the future is in our hands". Farm Writers' Association of NSW, Luncheon (Panel session), Grace Hotel, Sydney NSW. 11th November.
- Lamb, D.W. (2016) "Ideas to innovation". GrowAg Conference, Rural Industries Research and Development Corporation (RIRDC). Albury, NSW. 21st – 23rd September.
- Lamb, D.W. (2016) "Smart Farming". 56th Annual Conference, Grassland Society of Southern Australia. Hamilton, Vic. 31st August – 1st September.
- Lamb, D.W. (2016) "Smart Farming for our farming". Innovative Technologies for Agricultural Systems Forum, Markus Oldham College, Geelong Vic 10 August.
- Heath, R. (2017) "Will digital agriculture deliver on the hype? New research and development projects and industry case studies" Gulargambone Grains Research Update 27 February 2017 & Dubbo 28 February to 1 March 2017.

The project stakeholder consultation workshops were conducted in Canberra and Sydney and were available via webcast. These workshops presented the findings and recommendations of the P2D program and allowed the opportunity to provide feedback to inform the final versions of the technical reports.

Industry Stakeholder consultation on the Summary and Technical Report findings were delivered at Forums/Webinars in November 2017 to allow producer and agricultural industry feedback on the Summary and Technical reports was sought. This included 35 people in person and 46 logins by webinar, some of which had multiple people viewing. These Forums's were organised to communicate outcomes from all P2D projects and targeted stakeholders with an interest in the development of digital agriculture in Australia. An Agribusiness Forum communicated outcomes from all P2D projects and was targeted more specifically at stakeholders involved in agribusiness and the delivery of digital agriculture products and services. The project has already had impact with several industry stakeholders referencing the P2D reports in support of its findings and recommendations:

http://www.nff.org.au/read/5828/new-report-finds-24-billion-reasons.htmlhttp://www.graingrowers.com.au/media-centre/media-releases/770-graingrowers-addresses-farmers-data-use-concerns-in-an-agtech-first
https://gateway.kpmg.com.au/static/A2D2%20Prospectus%20(1).pdf

Conference presentations to be presented post completion of the P2D project include:

- Rainbow R. (2018) Enabling Digital Agriculture in Australia. *Hort Connections Conference 18-20 June 2018 Brisbane Australia. http://hortconnections.com.au/*
- Trindall J. and Rainbow R, (2018) Accelerating precision agriculture to decision agriculture: Enabling digital agriculture in Australia. *International Conference on Precision Agriculture, 24-27 June 2018 Monreal Canada. https://www.ispag.org/icpa*
- Wiseman L. and Sanderson J. (2018) Realising the full potential of precision agriculture: encouraging farmer 'buy-in' by building trust in data sharing. *International Conference on Precision Agriculture, 24-27 June 2018 Monreal Canada. https://www.ispag.org/icpa*

6   Lessons learnt

This was a difficult project to manage, given the logistics of organising workshops and meetings with project staff as well as RDCs and participants. The limited window of time available to complete the project workshops and the short duration of the project presented many challenges to keep to the planned timetable. The project has ultimately delivered on time and on budget. Many external factors such as growing industry frustration with the technologies in question (ie that were the subject of the review), as well as significant policy/review activity underway (eg ACCC, Productivity Commission) meant there was considerable public interest in the project. This resulted in a growing (unforeseen) demand in project staff having to support education/outreach activities on top of review activities.

The Telecommunications Review elicited, and continues to elicit considerable industry interest. The topic area was timely. Given telecommunications and connectivity is a considerable challenge to agriculture at a range of levels. The project team were unprepared for the demand for follow up briefings (the list above does not include an approximately equivalent amount of declined invitations to present and brief). This exercise of undertaking this project has been an important awareness raising activity for industry as well as policy makers. It is important for succession planning around the outcomes, specifically education and ongoing industry liaison/support be undertaken.

One lesson learnt has been the value of the collaboration between the RDCs. While each industry has specific challenges and issues, there are many issues that are common to each industry and collaborative research projects such as the P2D project has highlighted this. The collaborative nature of the research team was also a major benefit in this project. Strength lies in interdisciplinary researchers working collaboratively together. Future projects building on P2D will hopefully adopt a similar collaborative approach. How the program can be improved

The research team worked extremely well together and with industry however, perhaps improvements could have been made to the way in which internal communication between RDCs, industry and researchers were managed. More open lines of communication between industry and researchers would have resulted in a stronger two-way exchange of unhindered and unfettered information. Greater researcher presence at industry events and national stakeholder meetings would have developed a stronger relationship between industry needs and the research results, improving the relevance of the research outcomes.

With the large number of project partners, the use of Zoom videoconferencing has been an essential element to cost effective regular meetings to ensure the coordinated delivery of this project on time and on budget. The Zoom system appears to work very well across a range of available bandwidths and devices. It is recommended that the Federal government provide access to this videoconferencing system to communicate with an increasing number of RDCs who are using this platform.

7 Appendix - additional project information

7.1 Project, media and communications material and intellectual property

Reports

The P2D project has produced a series of reports including a Summary Report and a series of six technical reports. A number of webinars and other fact sheets on project objectives and overview of findings were also produced. All reports are available for web-based download at: https://www.crdc.com.au/precision-to-decision

P2D Summary Report – Accelerating precision agriculture to decision agriculture: Enabling digital agriculture in Australia

Implementing the recommendations from the P2D project will set the stage for increasing the profitability of producers, providing clarity and trust in data ownership and access rights, and stimulating an innovation environment that facilitates the development and adoption of technology. This Summary Report brings together the key findings and aggregates the 67 detailed recommendations into 13 key recommendations. It also provides direction on the next steps required to implement the recommendations.

P2D Technical Reports

Six P2D reports commissioned to address key areas that are constraining digital agriculture moving towards its promised potential in Australia include:

1. Producer survey of digital agriculture - The needs and drivers for the present and future of digital agriculture in Australia.

The survey results provides valuable benchmarking data that have helped inform strategies developed in the broader P2D project aimed ensuring that Australian producers can better utilise agricultural data to enhance profitability while protecting their rights. The survey also identifies producers' data needs to capitalise on the opportunities created by digital agriculture and big data.

Zhang, A., Baker, I., Jakku, E. and Llewellyn, R. (2017). Accelerating precision agriculture to decision agriculture: The needs and drivers for the present and future of digital agriculture in Australia. A cross industries producer survey for the Rural R&D for Profit 'Precision to Decision' (P2D) project. CSIRO and Cotton Research and Development Corporation, Australia.

2. Data connectivity for digital agriculture

This report introduces the key telecommunications technologies and services utilised, or at least on offer, to Australian producers and a small number of illustrative case studies of producers

and service providers. The report also includes a discussion of future opportunities and the provision of recommendations aimed at further enabling Australian producers to realize a big-data future for their farming business.

Lamb, D. (2017). Accelerating precision agriculture to decision agriculture: A review of on-farm telecommunications challenges and opportunities in supporting a digital agriculture future for Australia. University of New England and Cotton Research and Development Corporation, Australia.

3. The legal dimensions of digital agriculture in Australia

Currently, the legal and regulatory frameworks around agricultural data are piecemeal, fragmented and ad hoc. The report outlines the current state of data rules dealing with data ownership, access, use, liability and licensing in Australian agriculture and presents recommendations to ensure that the legal and regulatory framework for Australian agriculture is digital and data ready.

Wiseman, L. and Sanderson, J. (2017). The legal dimensions of digital agriculture in Australia: An examination of the current and future state of data rules dealing with ownership, access, privacy and trust. Griffith University, USC Australia and Cotton Research and Development Corporation, Australia.

4. Current and future state of agricultural data for digital agriculture in Australia

This report identifies which datasets and decision-support tools were currently being used across different agriculture sectors and explore where future investment opportunities may exist. The report identifies five main cross-sectoral data types that warranted further analysis. These were soils, weather, imagery, land use and property boundaries. For each of these data types we have documented the key existing datasets, discussed the trends and opportunities and made recommendations about a desired future state.

Barry, S., Darnell, R. Grundy, M, Moore, A, Robertson, M, Brown, J, Gaire, R and George, A. (2017). Precision to Decision – Current and future state of agricultural data for digital agriculture in Australia. CSIRO and Cotton Research and Development Corporation, Australia.

5. A big data reference architecture for digital agriculture

The BDRA provides a framework to assist RDC projects with needs in Big Data collection, storage and analysis. To achieve this, the BDRA guides solution architectures by assisting with requirements definitions and identifying appropriate strategies and design patterns for Agricultural Big Data challenges. The reference architecture can facilitate collaboration between RDCs by creating a common language and approach when addressing Big Data challenges.

Skinner, A., Wood, G., Leonard, E. and Stollery, T. (2017). Advancing precision agriculture to decision agriculture: A big data reference architecture for digital agriculture in Australia. Data to Decisions CRC and Cotton Research and Development Corporation, Australia.

Data to Decisions CRC, and Cotton Research and Development Corporation. Email report questions and feedback to – D2DCRC@Base64

6. Analysis of the economic benefit and strategies for delivery of digital agriculture in Australia

This report estimates that the unconstrained implementation of decision agriculture would result in a lift in the gross value of agricultural (including forestry and fisheries) production of $20.3 Billion (a 25% increase on 2014–15 levels) and would have major flow-on effects to other parts of the economy. This research will help guide ongoing investments by government and RDCs in areas that reduce current barriers to decision agriculture. It will also assist with targeting investments in areas in which there is a strong business case or high-impact productivity and profitability benefits for decision agriculture.

Perrett, E., Heath, R., Laurie, A. and Darragh, L. (2017). Accelerating precision agriculture to decision agriculture – analysis of the economic benefit and strategies for delivery of digital agriculture in Australia. Australian Farm Institute and Cotton Research and Development Corporation.

Digital agriculture and big data tools:

The following web based tools have been developed through this research:

- A Big Data Reference Architecture for Digital Agriculture (link is external): developed by the Data to Decisions CRC, this tool incorporates example decision trees defining the data needs for an agricultural data system with full consideration of data systems existing in the broader economy

- Register of cross-sectoral agricultural and environmental datasets and decision support tools (link is external): Including resource links for industry developed by CSIRO DATA 61 detailing existing data systems in the broader economy considering cross-sectoral agricultural and environmental data sets and decision support tools

- An online grower toolbox (link is external): developed by Griffith University and USC, providing best practice guidance material for growers and industry - Including 10 fact sheets with resources for producers/groups including key considerations for producers in understanding data rules, ownership, access, use, liability and licensing in Australian agriculture; plus effective and efficient data governance framework for Australian agriculture including best practice contracts for Australian producers and options and frameworks for ownership and management of and access to big data.

Conference Presentations, Journal Articles and other publications

Project findings have been presented/produced at:

Conference Presentation: L. Wiseman, 2 August 2016, Looking After your Ag Data: Ownership Control and Access, 18th National Cotton Conference, Gold Coast http://www.australiancottonconference.com.au/presentationspapers/2016-proceedings/wiseman-leanne/

The P2D Project has featured in two recent issues of the *Farm Institute Insights* newsletter, Accelerating precision agriculture to decision agriculture (link is

external) (August 2016) and Big data cooperatives in the United States (link is external) (November 2016).

Lamb, D.W. (2017) Telecommunications and Australian agriculture: Will top down meet bottom up? *Australian Farm Policy Journal.* FPJ1403E 14 (3): 31-47. http://farminstitute.org.au/LiteratureRetrieve.aspx?ID=160589

Lamb, D.W. (2017) Telecommunications for PA- evolution or revolution? *20th Precision Agriculture Symposium in Australasia', 14-15 August 2017, Sydney* https://www.spaa.com.au/pdf/514_PASymposium17ProceedingLR.pdf

Sanderson, J., Wiseman, L., Zhang, A., Baker, I., Jakku, E., Llewellyn, R., Skinner, A. and Rainbow, R. (2017) Data law, governance, survey of drivers and reference architecture for Precision to Decision Agriculture (P2D). *20th Precision Agriculture Symposium in Australasia', 14-15 August 2017, Sydney* https://www.spaa.com.au/pdf/514_PASymposium17ProceedingLR.pdf

Wiseman L. and Sanderson J. (2018) Embedding the FAIR principles into a National Agricultural Data Governance Framework: an Australian perspective . *Interest Group on Agricultural Data (IGADA) Research Data Alliance pre meeting – 11th international Research Data Alliance Conference Berlin, Germany.* https://www.rd-alliance.org/plenaries/rda-eleventh-plenary-meeting-berlin-germany

Heath R. (2018) Digital Agriculture – the case for urgent investment. 13-14 March 2018 – AgTech Summit Melbourne. *https://www.informa.com.au/event/agtech-summit/*

Lamb D., Mazumdar S., Rainbow R., Sanderson J. and Wiseman, L. (2018) Accelerating precision agriculture to decision agriculture. 13-14 March 2018 – AgTech Summit Melbourne. *https://www.informa.com.au/event/agtech-summit/*

Heath R. (2018) World Agri-Tech Innovation Summit 2018 Austrade breakfast briefing panel presentation. Driving Innovation in Australian Agriculture. 20-21 Mrach 2018 San Francisco USA. https://worldagritechusa.com/agenda/

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Wiseman L. and Sanderson J. (2018) Realising the full potential of precision agriculture: encouraging farmer 'buy-in' by building trust in data sharing. *International Conference on Precision Agriculture, 24-27 June 2018 Monreal Canada.* https://www.ispag.org/icpa

The following general articles have also been published:

CRCA Knowhow - https://issuu.com/refractionmedia/docs/knowhowmagazine2017 (page 28)

AFI Newsletter February 2017 "Digital agriculture and connectivity" -AFI 'In my view"
http://www.farminstitute.org.au/newsletter/2017/February/view

http://www.d2dcrc.com.au/featured/d2d-crc-develop-big-data-architecture-australias-
agriculture-sector/

http://www.farminstitute.org.au/newsletter/2016/August/pipeline

Changes to contract laws could give small farming businesses more control of data
and innovation https://theconversation.com/changes-to-contract-laws-could-give-small-
farming-businesses-more-control-of-data-and-innovation-69275

Big Data cooperatives in the United States
http://www.farminstitute.org.au/newsletter/2016/November/discoveries

Media releases

The project has prepared and released 10 press releases approved by CRDC and The
Department of Agriculture and Water Resources over the 18 months of the project. These media
releases were distributed to over 230 national and regional media outlets:

- New digital blueprint to unleash billions of dollars in profit (6 March 2018)
- Report recommends Australian agriculture go digital (link is external) (14 December
  2017)
- Digital agriculture could unlock production gains of $20.3 billion (link is external) (24
  November 2017)
- Securing the future through digital agriculture (link is external) (21 November 2017)
- A wake-up call for on farm telecommunications (link is external) (6 October 2017)
- Barriers to digital agriculture impacting on profit (link is external) (29 September 2017)
- A blueprint for decision-making that delivers profit (link is external) (19 June 2017)
- Cutting through the telco jargon to drive profit through 'big data' (link is external) (3
  May 2017)
- Lessons learnt from big data use in America could cut costs for Australian farmers (link
  is external) (27 February 2017)
- New laws should give Australian farmers more control over data (link is external) (6
  February 2017)
- Growers establish their 'Big Data' requirements (link is external) (29 November 2016)

RDCs and a number of organisations communicated project findings through their industry
publications and general press:

http://www.nff.org.au/read/5828/new-report-finds-24-billion-reasons.html

This includes the Australian producer owned company Grain Growers Limited supporting the key recommendations and providing complete transparency with plain English description of their data use principles for their product ProductionWise:
http://www.graingrowers.com.au/media-centre/media-releases/770-graingrowers-addresses-farmers-data-use-concerns-in-an-agtech-first

Rural Press also gave national coverage of the project findings in late 2017
http://www.farmonline.com.au/story/5132374/rdcs-team-up-to-reap-20b-digital-payday/

The Hon. David Little proud MP, Minister for Agriculture and Water Resources released the P2D Summary Report and web based tools at Outlook 2018 and provided the following media release Driving digital transformation across agriculture (6 March 2018)
http://minister.agriculture.gov.au/littleproud/Pages/Media-Releases/Driving-digital-transformation-across-agriculture.aspx

Media content that could be used by RDC was supplied to all 15 RDCs on the 20 March 2018 for use in all RDC flagship publication/industry magazines to announce the final outputs of this important project. The content particularly highlights the unprecedented level of collaboration involved with this project – which was funded by all 15 RDCs – as well as key outcomes and next steps https://drive.google.com/open?id=1NdC6OkISe3_vAqTGGfQ0-_oMZ8x0Q5d6

All publications resulting from this project reside in the public domain. Copyright of all publications is owned by the author organisation and CRDC.

The project has contributed to a Australian Farm Institute publication, Accelerating Precision to Decision: A special edition of the Australian Farm Policy Journal. This publication has been made available for free download at http://farminstitute.org.au/LiteratureRetrieve.aspx?ID=162379

7.2   Equipment and assets

No equipment or assets were funded through this project. All reports and on-line tools are in the public domain and available for web-based download at:
https://www.crdc.com.au/precision-to-decision

7.3   Evaluation report

This project was a very large collaboration between all 15 RDCs, Research Organisations and private consultants. CRDC was responsible for managing the budget, milestone reporting and project management. The Project Management Committee (PMC) consisted of representatives from RDCs and the research providers, which met once every six months to oversee the project.

The Program Management Agreement detailed governance arrangements for all investors into the project. Research agreements between CRDC and lead research organisations documents detailed governance arrangement for each of the key activities. All consultancy services were procured via a limited tender process. The nominated RDCs on the Project Steering Committee (PSC) recommend the procurement outcomes to the PMC for approval.

CRDC was responsible for sub-project contractual arrangements and final approval of sub-project progress and final reports and project payments. Sub-project contracts all had well-defined milestones and quality assurance, delivery timeframes, and budget requirements. CRDC has engaged a project leader/coordinator who was responsible for:
1) Six monthly / annual reporting to the Department, RDCs and project partners

2) Development and implementation of the project monitoring and evaluation and communication and extension plan,
3) Co-ordinating project activities such as workshops and producer surveys,
4) Co-ordinating the process for the engagement of external consultants;
5) Convening 6 monthly project PMC meetings.

The Project Steering Committee (PSC) managed oversight of the project operations. All investor research organisation partners and 4 nominated RDCs participated in PSC meetings. The PSC met monthly by videoconference and was chaired by the project leader/coordinator.

The P2D project will be monitored for performance delivery under the structure and reporting requirements for the program management agreement reflecting the head agreement with the Commonwealth. All Research Agreement milestone deliverables reflect delivery requirements to the Commonwealth project agreement. Progress against these milestones was mapped and monitored through the use of Gantt charts using the SmartSheets cloud software system, providing transparent tools for research partners to table milestone delivery progress in monthly Project Steering Committee Meetings chaired by the Project Leader/Coordinator Project evaluation.

Confidence and value of project engagement with stakeholders was measured at all P2D project workshops through an exit survey. Average rankings of all eight workshops indicated a good to high level of facilitation and engagement and value of workshops. Most importantly the average workshop score of 6 out of 7 for the high value of the workshop discussion indicates that these workshops were a valuable use of time for participants.

The P2D project industry stakeholder survey on big data analytics needs and opportunities of at least 1000 producers across all Australian agricultural industries provide a baseline measure. This will enable a future survey of the same individuals at a point in the future, where a real measure of practice change and impact from this project can be measured.

Potential future project impacts have been identified through the case study development and economic analysis delivered through the project. Confidence in these impacts was the measure of project impact through agreement for RDCs, government and other stakeholders to progress investment in the options for business implementation delivered through the project. This has been achieved by the Council of Rural Research and Development Corporation CEOs unanimously agreeing in principle in December 2017 to support a process of implementing next steps in delivery of these recommendations.

Table 2 Project delivery against key performance indicators (KPIs)

KPI no.	KPI description	Status against KPIs	Date	Progress achieved against KPI	Outputs
1.3	Update on previous milestone report - Provide a list of all partner organisations and the status of partner agreements, including the date signed or the date expected to be signed (Output 1(c)).	☒ Achieved ☐ Partially achieved ☐ Not achieved	Delivered 25 August 2016	The project partner organisations now include all 15 RDCs. A final Program management agreement detailing the project collaboration terms and co-investment commitment has been signed by all project partners and was executed by CRDC on the 26 October 2016.	A detailed list of all project partner PMA, research and consultancy agreements including the dates signed has been detailed in the previous progress report.
2.1	Provide a list of consultants engaged to undertake the economic assessment, evaluation of business models and the producer survey (Output 2(d))	☒ Achieved ☐ Partially achieved ☐ Not achieved	Delivered 30 Delivered January 2017	The subcommittee appointed by the Project Management Committee (PMC) including Jane Trindall, Sam Gill and Anthony Kachenko reviewed the responses for the Limited Request For Tenders received for the P2D stakeholder survey, economic impacts and business implementation consultancies. CRDC recommended that the following consultancies which met the key selection criteria had their Full Research Proposals reviewed and finalised. This was endorsed by the PMC to allow contracting to proceed: **CSIRO (Principal Researcher Emma Jakku)** Producer survey to identify accelerating precision agriculture to decision agriculture (P2D) needs and issues **Australian Farm Institute (Principal Research Richard Heath)** Analysis of the economic benefit and strategies for delivery of decision agriculture. (combining the economic impacts and business implementation consultancies into one contract)	The recommended organisations from the request for tender process were selected and endorsed by the PMC comprising and a full research proposal was finalised and submitted to CRDC for contracting. Signing of contracts has been completed.

2.2	Provide a project plan endorsed by the project steering committee (Output 2(a))	☒ Achieved ☐ Partially achieved ☐ Not achieved	Delivered 15 December 2016	An updated P2D project plan was discussed with RDCs and the Department of Agriculture and Water Resources at a PMC on the 8 December 2016. A revised plan was finalised and endorsed by the project Steering committee (PSC) on the 15 December 2016	An updated P2D project plan was finalised and endorsed by the project PSC on the 15 December 2016.
2.3	Provide the communication and extension plan (Output 2(b))	☒ Achieved ☐ Partially achieved ☐ Not achieved	Delivered 15 December 2016	The P2D project communications and extension activities plan was discussed with participating RDCs and the Department of Agriculture and Water Resources at a PMC meeting on the 8 December 2016. A revised plan was finalised and endorsed by the PSC on the 15 December 2016	A project communications and extension plan was finalised and endorsed by the project PSC on the 15 December 2016.
2.4	Provide the monitoring and evaluation plan (Output 2(c))	☒ Achieved ☐ Partially achieved ☐ Not achieved	Delivered 15 December 2016	The P2D project monitoring an evaluation plan was discussed with participating RDCs and the Department of Agriculture and Water Resources at a Project management Committee on the 8 December 2016. A revised plan was finalised and endorsed by the project Steering committee on the 15 December 2016	A project monitoring and evaluation plan was finalised and endorsed by the project PSC on the 15 December 2016.
2.5	Provide an update on communication and extension activities (Output 3(a) and 3(b)).	☒ Achieved ☐ Partially achieved ☐ Not achieved	30 January 20167	Since the project was initiated in July 2016, there have been 2 national press releases and 5 research partner articles delivered in printed, conference and web articles. A P2D – Advancing Precision Agriculture to Decision Agriculture project website page and brochure was established and hosted by the Australian Farm Institute on the 29 November 2016 at http://www.farminstitute.org.au/P2Dproject The first pilot stakeholder workshop was held with the Horticulture/Vegetable Industry in Gatton QLD on the 5 December 2016. A further 7 workshops are planned for March/April 2017. The AFI has	The P2D project is well on track in delivery of its communications and extension plan, currently exceeding the original planned targets. Coordinated project workshops are now planned for stakeholders at additional locations for agricultural industries, plus an additional Agribusiness Forum. Media articles have been quadrupled from original plans.

				established an agribusiness forum to inform the project on commercial developments, possibilities, limitations and impediments for digital agriculture. At least three meetings will be held during the project. The first forum was held on 18 November 2016.	
2.6	Provide a brief account of the progress in identifying and establishing contact with representatives from United States universities including international travel to the United States (Output 4(a)).	☒ Achieved ☐ Partially achieved ☐ Not achieved	Delivered 15 August 2016	Richard Heath travelled to the USA from the 30th July to the 13th August 2016. Multiple contacts were made with Universities and researchers and distributed to the rest of the P2D project team. A written and verbal report was also compiled and presented to the Project Steering committee. P2D researchers have subsequently made contact with researchers identified in the US.	A link to online presentation of US trip and key contacts has been provided to all P2D project partners https://drive.google.com/open?id=0B78gBTZIeRSxdThBNVUwYVNJOEk
2.7	Provide a brief account of the international case studies of agricultural data use completed (Output 4(b)).	☒ Achieved ☐ Partially achieved ☐ Not achieved	Delivered 9 January 2017	The three case studies have been identified and final drafts have been submitted to CRDC for review. Agrian, Harvest Mark and Farmers Business Network (FBN) were selected based on contacts made in the US and in consultation with P2D project management. Final drafts of the Agrian, FBN and Harvest Mark case studies have been completed. The FBN case study delivery was delayed until mid December due to the availability of the FBN CEO. The delay in this case study was approved by the P2D project manager Rohan Rainbow due to the desirability of FBN as subject matter.	Final draft case study reports were submitted to CRDC for review on the 9 January 2017. Final versions of these reports have been provided to P2D project partners in electronic form for further review in project delivery.
2.8	Provide a brief account of the progress in assessing identifying cases where use of agricultural data is likely to have high-value uses and productivity benefits (Output 5(a)).	☒ Achieved ☐ Partially achieved ☐ Not achieved	Delivered 30 January 2017	Identification of cases in which ag-data is likely to have high value uses is well underway with the project including identification of: cropping technology, software and hardware licenses, fuel use, GPS location, livestock management, satellite imagery, personal information,	While it was still early in the project, a few clear issues were identified: • Industry and / or grower collaboration may be impeded by cultural and / or competitive forces

				aggregation and disaggregation of datasets. Also the current and future needs and capability for data connectivity has been investigated. To assist in the identification of these cases, individual industry interviews have taken place with key stakeholders plus the initial pilot workshop. Additional planned workshops will further inform potential high values uses of agricultural data.	• Role of financial institutions and current practices unclear • Clearly marked differences in industries in aspects of collection, storage and aggregation of data • Use of data may be more through secondary sources (through advisors) rather than direct use. A value proposition for increased data use needs to be developed and is still unclear – this is an important focus of the project output delivery going forward. Issues with data communications is more significant than had been anticipated and requires additional planning for project activities.
3.1	Provide an update on communication and extension activities (Output 3(a) and 3(b)).	☒ Achieved ☐ Partially achieved ☐ Not achieved	Delivered 31 July 2017	A total of 127 participants including producers, advisors and commercial agribusiness representatives attended a total one of the 8 project workshops across Australia: • Workshop 1: Horticulture Gatton QLD - 5 December 2016 (Previous reporting period) • Workshop 2: Meat, grains, cotton farming enterprise, Tamworth NSW - 1 March 2017; • Workshop 3: Horticulture, sugar, Townsville QLD - 3 March 2017; • Workshop 4: Grains and wool Northam, WA - 16 March 2017; • Workshop 5: Pork, grains, rice farming enterprise, Wagga Wagga NSW - 28 March 2017;	During the reporting period: - A further 7 workshops were delivered with Information from workshops used to inform progress in the separate P2D project Analysis of the economic benefit and strategies for delivery of decision agriculture. - Four media releases on the project approved by the department have been issued. - Nine formal project presentations have been presented to industry stakeholders - During the progress report period presentations have been given to the GRDC National Panel, The National Farmers Federation board and the NSW

				• Workshop 6: Dairy industry, Tatura Vic - 29 March 2017; • Workshop 7: Forestry industry, Launceston, TAS - 30 March 2017; • Workshop 8: Grape and wine, Tanunda SA - 27 April 2017. Media releases and project presentations to stakeholders in excess of the planned communications schedule have been delivered.	Farmers board about the project. - Two general articles on project findings were produced (See section 7 of this report for specific details)
3.2	Provide a brief account of progress in assessing the current state of agricultural data, rules, communication and systems in Australia (Output 4(a), 4(b), 4(c)).	☒ Achieved ☐ Partially achieved ☐ Not achieved	Delivered 31 July 2017	The project survey report provides a benchmark of Australian producers' needs, perceived risks and benefits, and expectations associated with digital agriculture. The project survey contributes towards fulfilling the Rural R&D for Profit program objectives by helping to 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. Desktop research to catalogue key on-farm communications modalities has been completed. The interviews and case studies have provided a good cross section of technologies currently in use; predominantly relying upon mobile network (static sensors and telematics), radio (in particular 915, 2.4 GHz) and, in a small number of examples, satellite direct communications. Analysis of the current state of agricultural data sources has been completed incorporating a register of cross-sectorial agricultural data sets and decision support tools and gaps with relevant characteristics such as custodian, where it	A cross-agricultural industry survey of 1000 producers across Australia has been delivered in a finalised report. Three case studies on successful north American big data programs for agricultural production have been developed by the Australian Farm Institute . Six reports have been completed in assessing the current state of agricultural data, rules, communication and systems in Australia. Two reports have been finalised and four are preliminary draft reports. (See section 6 for specific report details) A register has been completed of cross-sectoral agricultural data sets and decision support tools and gaps with relevant characteristics such as custodian, where it is held,

				is held, license or access model, information model, bandwidth requirement/architectural classes, quality, usability, integrity, and format.	license or access model, information model, bandwidth requirement/architectural classes, quality, usability, integrity, and format.
				A draft report has been established on current rules around data in Australia which includes identifying and classifying data, current legislation, current guidelines and practices and notable challenges and opportunities	
3.3	Provide a brief account of progress in preparing for the future state of agricultural data, rules, communication and systems in Australia (Output 5(b)).	☒ Achieved ☐ Partially achieved ☐ Not achieved	Delivered 31 July 2017	Key project findings and recommendations in preparing for the future state of agricultural data, rules, communication and systems in Australia have been drafted into preliminary reports. This includes options for making public data sets more easily available and delivering tools aimed for researchers and experts to a more producer-friendly delivery. A workshop is planned for early September 2017 to develop a draft executive summary report on the whole of project findings detailing key recommendations and options for next steps for future investment in delivering outcomes to producers. This draft executive summary will be delivered to the Project Management Committee including investing RDCs and the Department of Agriculture and Water Resources, in late October 2017. It is proposed that external stakeholder consultation will start from early November 2017.	Findings from desktop studies, workshops, and interviews have been assembled and reviewed to provide direction in the future use of agricultural data. A recommended preliminary draft Big Data Reference Architecture has been developed which can be accessed at https://p2d.d2dcrc.net/ Two final and four preliminary draft reports have been completed, outlining the current and futures state of digital agriculture. (See section 6 for specific report details). A set of 42 draft recommendations have been proposed so far across the six preliminary draft reports. Recommendations on high value economic opportunities and business delivery models will be delivered in a future report. Approval by the Department of Agriculture and Water Resources (subject to additional Project Management Committee

					Approval) is sought for public release of the following finalised project reports: Zhang A, Baker I, Jakku E and Llewellyn R (2017). The needs and drivers for the present and future of digital agriculture in Australia. A cross-industries producer survey for the Rural R&D for Profit 'Precision to Decision' (P2D) project., CSIRO and CRDC. Lamb, D. (2017) Accelerating precision agriculture to decision agriculture: A review of on-farm telecommunications challenges and opportunities in supporting a digital agriculture future for Australia. University of New England and CRDC.
4.1	Provide an account of completed communication and extension activities (Output 3(a), 3(b), 3(c) and Section E1(h)).	☒ Achieved ☐ Partially achieved ☐ Not achieved	Delivered 30 November 2017	*Press Releases* – Four Department of Agriculture and Water Resources approved press releases have delivered by the project partners during the milestone delivery period since reporting on the 31 July 2017. *Industry Stakeholder Forums/Webinar* – Producer and agricultural industry feedback on the Summary and Technical reports was sought: • Delivered 27 November 2017: 1 pm – 4 pm, Federal Golf Club, Red Hill, Canberra ACT • Delivered 28 November 2017: 9 am – 12 noon ESDT, Clifton's Level 3, 10 Spring St, Sydney NSW plus Webinar These forum's were organised to communicate outcomes from all P2D	Four P2D project **media releases delivered** since 31 July 2017 can be viewed at the project webpage www.farminstiture.org.au/P2Dproject: - A wake-up call for on farm telecommunications - Securing the future through digital agriculture - Barriers to digital agriculture impacting on profit - Digital agriculture could unlock production gains of $20.3 billion *Three Industry Stakeholder Forums/Webinars* were delivered to allow producer and agricultural industry feedback on the Summary

				projects and targeted stakeholders with an interest in the development of digital agriculture in Australia. ***Agribusiness Forum/Webinar*** – Agribusiness feedback on the Summary and Technical reports was sought: • Delivered 28 November 2017: 1 pm – 4 pm ESDT, Clifton's Level 3, 10 Spring St, Sydney NSW plus Webinar This forum communicated outcomes from all P2D projects and was targeted more specifically at stakeholders involved in agribusiness and the delivery of digital agriculture products and services. ***Industry Presentations/Events*** The project has delivered 34 briefings to government, RDC, industry and commercial stakeholders since 31 July 2017. These are listed in detail in section 7. Media and communications. ***Three Conference Presentations and Journal Articles*** - on project findings have been presented at: Lamb, D.W. (2017) Telecommunications and Australian agriculture: Will top down meet bottom up? *Australian Farm Policy Journal.* FPJ1403E 14 (3): 31-47. http://farminstitute.org.au/LiteratureRetrieve.aspx?ID=160589 Lamb, D.W. (2017) Telecommunications for PA- evolution or revolution? *20th Precision Agriculture Symposium in Australasia', 14-15 August 2017, Sydney* Sanderson, J., Wiseman, L., Zhang, A., Baker, I., Jakku, E., Llewellyn, R., Skinner, A. and Rainbow, R. (2017) Data law, governance,	and Technical reports was sought. This include 35 people in person and 46 logins by webinar, some of which had multiple people viewing. ***Three Conference Presentations and Journal Articles*** - on project findings have been presented since 31 July 2017: Lamb, D.W. (2017) Telecommunications and Australian agriculture: Will top down meet bottom up? *Australian Farm Policy Journal.* FPJ1403E 14 (3): 31-47. http://farminstitute.org.au/LiteratureRetrieve.aspx?ID=160589 Lamb, D.W. (2017) Telecommunications for PA-evolution or revolution? *20th Precision Agriculture Symposium in Australasia', 14-15 August 2017, Sydney* Sanderson, J., Wiseman, L., Zhang, A., Baker, I., Jakku, E., Llewellyn, R., Skinner, A. and Rainbow, R. (2017) Data law, governance, survey of drivers and reference architecture for Precision to Decision Agriculture (P2D). *20th Precision Agriculture Symposium in Australasia', 14-15 August 2017, Sydney*

				survey of drivers and reference architecture for Precision to Decision Agriculture (P2D). *20th Precision Agriculture Symposium in Australasia', 14-15 August 2017, Sydney*	
4.2	Provide a brief account of progress and work completed in assessing the current state of agricultural data, rules, systems and communication in Australia (Outputs 4(a), 4(b), 4(c)).	☒ Achieved ☐ Partially achieved ☐ Not achieved	Delivered 30 November 2017	The project has delivered a P2D Summary Report – Accelerating precision agriculture to decision agriculture: Enabling digital agriculture in Australia. These reports provide a detailed review of the current state of agricultural data, rules, systems and communication in Australia Implementing the recommendations from the P2D project will set the stage for increasing the profitability of producers, providing clarity and trust in data ownership and access rights, and stimulating an innovation environment that facilitates the development and adoption of technology. This Summary Report brings together the key findings and aggregates the 67 detailed recommendations into 13 key recommendations. It also provides direction on the next steps required to implement the recommendations. A four-page overview report has also been produced. A further four P2D technical reports to address key areas that are constraining digital agriculture moving towards its promised potential in Australia have been produced including: ***Legal aspects of digital agriculture and trust -*** The legal dimensions of digital agriculture in Australia: An examination of the current and future state of data rules dealing with ownership, access, privacy and trust. Griffith University and USC Australia . ***Data sources for use in digital agriculture -*** Current and future state of agricultural data for digital agriculture in Australia. CSIRO.	In addition to the Technical and Summary Reports, supporting video presentation of some of the reports can be accessed at http://farminstitute.org.au/p2dprojectforums The following web based tools have been delivered through this project define the current state: • Data to Decisions CRC 'A Big Data Reference Architecture for Digital Agriculture' – Incorporating example decision trees defining the data needs for an agricultural data system with full consideration of data systems existing in the broader economy. • CSIRO DATA61 – Register of cross-sectoral agricultural and environmental datasets and decision support tools. • Griffith University and USC - an online grower toolbox, best practice guidance material for growers and industry.

			A big data reference architecture for digital agriculture - A big data reference architecture for digital agriculture in Australia. Data to Decisions CRC ***Economic benefit and strategies for digital agriculture -*** Analysis of the economic benefit and strategies for delivery of digital agriculture in Australia. Australian Farm Institute All reports and supporting video presentation of some of the reports can be accessed at http://farminstitute.org.au/p2dprojectforums The assessment is made against seven key pillars of success for digital maturity, namely strategy, culture, governance, technology, data, analytics and training, indicates that the overall digital maturity of the agricultural sector is ad hoc. This infers that the industry does not systematically and consistently use data to drive decisions and consequently opportunities to improve productivity and profit at the farm gate and through the value chain are being lost.	

| 4.3 | Provide a brief account of progress in preparing for the future state of agricultural data use (Outputs 5(a), 5(b), 5(c), 5(d)). | ☒ Achieved
☐ Partially achieved
☐ Not achieved | Delivered 30 November 2017 | The project has delivered a P2D Summary Report – Accelerating precision agriculture to decision agriculture: Enabling digital agriculture in Australia. These reports provide a detailed review of the future state of agricultural data, rules, systems and communication in Australia Implementing the recommendations from the P2D project will set the stage for increasing the profitability of producers, providing clarity and trust in data ownership and access rights, and stimulating an innovation environment that facilitates the development and adoption of technology. This Summary Report brings together the key findings and aggregates the 67 detailed recommendations into 13 key recommendations. It also provides direction on the next steps required to implement the recommendations. A four-page overview report has also been produced.

A further four P2D technical reports to address key areas that are constraining digital agriculture moving towards its promised potential in Australia have been produced including:

Legal aspects of digital agriculture and trust - The legal dimensions of digital agriculture in Australia: An examination of the current and future state of data rules dealing with ownership, access, privacy and trust. Griffith University and USC Australia .

Data sources for use in digital agriculture - Current and future state of agricultural data for digital agriculture in Australia. CSIRO.

A big data reference architecture for digital agriculture - A big data reference architecture for digital agriculture in Australia. Data to Decisions CRC | In addition to the Technical and Summary Reports, supporting video presentation of some of the reports can be accessed at http://farminstitute.org.au/p2dprojectforums

The following web based tools have been delivered through this project can be used to implement a future state:

• Data to Decisions CRC 'A Big Data Reference Architecture for Digital Agriculture' – Incorporating example decision trees defining the data needs for an agricultural data system with full consideration of data systems existing in the broader economy.

• CSIRO DATA61 – Register of cross-sectoral agricultural and environmental datasets and decision support tools.

• Griffith University and USC - an online grower toolbox, best practice guidance material for growers and industry.

Quantifying the value of a future state of digital agriculture to Australia was a fundamental part of the P2D project. Using the |

			Economic benefit and strategies for digital agriculture - Analysis of the economic benefit and strategies for delivery of digital agriculture in Australia. Australian Farm Institute All reports and supporting video presentation of some of the reports can be accessed at http://farminstitute.org.au/p2dprojectforums The P2D project has detailed a value proposition and identified a pathway forward for transformational improvement in Australian farm business management and decision making through digital agriculture. The 67 recommendations from the six P2D technical reports have been aggregated into 13 detailed recommendations. Delivery of these recommendations could result in a lift in the gross value agricultural production (GVP) of $20.3 billion. For this potential to be realised, it will be essential for industry, RDCs, government and the commercial sector to commit to work together in each of the following areas: - Policy - Strategy - Leadership - Digital literacy - Enablers.	Centre for International Economics-Regions Food Processing Model (CIE-Regions FP model), the Australian Farm Institute (AFI) predicted the potential economic benefit of the unconstrained transition to digital agriculture. When digital agriculture is fully implemented in Australia, it is estimated that this would boost the value of agricultural production, including forestry and fisheries, by 25% (compared to 2014-15 levels). This is a $20.3 billion boost to the gross value of agricultural production (GVP) (Table 2.1). The overall potential increase in national gross domestic product (GDP), including the flow-on effect to other parts of the Australian economy, is estimated to be $24.6 billion. These estimates are considered to be a conservative best-case situation. They assume a 100% uptake of digital agriculture and exclude any costs associated with the adoption of digital technologies.
5.1	KPI 5.1 – Provide the final evaluation of the Activity (Output 2(e)).	☒ Achieved ☐ Partially achieved ☐ Not achieved	Delivered 28 February 2018	This report details the evaluation of the project in section 8.2.	This report details the achievement of all project KPIs.

5.2	KPI 5.2 – Provide a list of published research (Output 3(c)).	☒ Achieved ☐ Partially achieved ☐ Not achieved	Delivered 28 February 2018	A detailed list of all reports, publications and communications materials is detailed in section 7.1 of this report.	All publications resulting from this report are available for web-based download at: https://www.crdc.com.au/precision-to-decision
5.3	KPI 5.3 – Final report that brings together the findings and analysis completed under Activity B5 on the current state of agricultural data, rules, systems and communications in Australia, including international case studies (Outputs 4(a), 4(b) and 4(d)).	☒ Achieved ☐ Partially achieved ☐ Not achieved	Delivered 28 February 2018	Section 3.1 in this report provides a summary of the project findings and analysis on the current state of agricultural data, rules, systems and communications in Australia, including international case studies. Further detail is found in the P2D summary report and six technical reports detailed in section 7.1 of this report.	The current state of agricultural data, rules, systems and communications in Australia, including international case studies are detailed in the summary report and technical reports available for web-based download at: https://www.crdc.com.au/precision-to-decision
5.4	KPI 5.5 – Final report that brings together the findings, analysis and recommendations completed under Activity B6 on the future state and phase state of agricultural data, rules, systems and communications in Australia, including high-value proposition use cases, business strategies and economic analysis (Outputs 5(a), 5(b), 5(c), 5(d)).	☒ Achieved ☐ Partially achieved ☐ Not achieved	Delivered 28 February 2018	A P2D Summary Report and brief overview report approved for public release brings together the findings, analysis and recommendations completed under this project.	The P2D Summary Report that brings together the findings, analysis and recommendations on the future state and phase state of agricultural data, rules, systems and communications in Australia, including value proposition use cases, business strategies and economic analysis is available for web-based download at: https://www.crdc.com.au/precision-to-decision

7.4 Budget

A detailed financial report statement will be provided by 20 July 2018 as per contract.