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Stimulating private sector extension in Australian agriculture to increase returns from R&D

Research Report H:
Trial Two – The Precision Agriculture Trial

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Contents

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About the project

Stimulating private sector extension in Australian agriculture to increase returns from R&D is a three-year project to research, develop and test models to build the capacity of the commercial and private sector in delivering R&D extension services to Australian producers.

Led by Dairy Australia, the project is a collaboration involving nine partner organisations including six Research and Development Corporations (RDCs) – Dairy Australia, Meat & Livestock Australia, Cotton Research & Development Corporation, Sugar Research Australia, Australian Pork Limited, Horticulture Innovation Australia – as well as the Victorian and NSW governments, and the University of Melbourne.

The project is funded by the partners and the Australian Government's Department of Agriculture and Water Resources as part of the Australian Government's Rural Research and Development for Profit program.

The project is in response to the trend towards increasing roles for industry and private services in delivering agricultural extension. This represents a shift away from traditional, government-funded extension services over the past 20 years. Currently the extent of private sector involvement in extension varies across industries, depending on product markets, policy settings, regional issues and industry demographics.

The private sector is now a well-used information source for producers, however there is scope to enhance the capability of the private sector in delivering extension. Improving the capacity of private extension service providers will contribute to on-farm productivity gains and profitability.

Companion reports

This report describes the actions and outcomes from Trial 2, The Precision Agriculture Trial. It is one in a series of research reports prepared for the project *Stimulating private sector extension in Australian agriculture to increase returns from R&D*.

- Report A: Farmer demand
- Report B: Advisory services
- Report C: The advisory and extension system
- Report D: Farmer and adviser networks.
- Report E: Research results: Focus groups and surveys of farmers and advisers.
- Report G: Trial 1: The Processor Trial
- Report H: Trial 2: The Precision Agriculture Trial (this report)
- Report I: Trial 3: The Advisory Pathways Trial
- Report J: Trial 4: The Knowledge System Trial
- Report K: The four private advisory sector engagement trials: the co-innovation framework and cross-trial results

Background: Australia's evolving agricultural extension system

Over time, the means and mechanisms by which Australian farmers access and receive their information, advice and support has changed markedly. This is largely because there has been:

- Changes to the role of government and their investment in and coordination of agricultural extension services in each state of Australia.
- Variation in the way Australia's rural Research and Development Corporations have invested in and positioned extension functions.
- Variation in the extent to which a range of private providers have engaged in extension functions and the business models of agricultural service firms.
- Technological change in society, particularly, information and communication technologies.

Collaborative approaches offer the promise of more effective RD&E when applied to such complexity. The increased focus on collaboration in agricultural innovation systems is also due to a greater understanding of the failure of technology transfer models (Ayre and Nettle 2015, Hermans et al. 2015) and has been driven by policy and RD&E funding directives and the increased role of private research and extension actors.

One collaborative approach is co-innovation: Co-innovation is an engagement model that involves all stakeholders, especially end users, early on in the in the innovation process (Botha et al. 2017, Coutts et al. 2017, Turner et al. 2016). It implies that all stakeholders acknowledge that they are unable to achieve certain objectives on their own and need to come together with other actors who offer complementary capabilities and resources required to fully develop and implement the new idea or technology.

The private sector engagement trials were action research interventions that each explored a model of co-innovation to address one agricultural innovation challenge (see companion reports G, I, J and K). The trials were one of five components of *Stimulating private sector extension in Australian agriculture* and were designed to:

- identify practical proposals to strengthen private advisory sector roles in driving innovation
- improve profit on farm by filling current service gaps
- generate learning about what drives and hinders co-innovation.

The synthesis of findings and implications from across the trials contributes recommendations for nuanced engagement with the private advisory sector, and guidance for practising co-innovation in the agricultural research, development and extension (RD&E) system (Report K). This report describes the actions and outcomes from Trial 2: The Precision Agriculture Trial.

Executive summary

The promise of new technology development in agriculture is well publicised, with some claiming that 'digital disruption' will transform farming and food production (Australian Farm Institute 2017). However, despite the recognised potential and proliferation of digital technologies (Griffith et al. 2013, Walter et al. 2017), there has been an unexpectedly slow uptake of precision agriculture technologies by farmers and agricultural advisers worldwide (Jago et al. 2013, Tey and Brindal 2012).

The Precision Agriculture Trial (Trial 2) involved participants from the Australia horticulture, sugar and cotton sectors. It aimed to address a gap in knowledge about the capacity building needs and opportunities for private agricultural advisers to engage with new digital technologies (tools and DVA tool) in agriculture. While recent studies have identified opportunities and barriers for producers to engage with precision agriculture (European Parliamentary Research Service 2016, Trindall et al. 2018, Zhang et al. 2018) there is relatively little known about the needs, interests and enablers for private agricultural adviser. The research question guiding action research in The Precision Agriculture Trial was: *How can private agricultural advisers engage with precision agriculture technologies to maximise the benefits and minimise the risks of investment for their businesses?*

The objectives of the Precision Agriculture Trial were:

- To identify, prioritise and address challenges of engaging with precision agriculture for private agricultural advisors
- To enhance the capacity of private agricultural advisors to engage with digital agricultural tools and services in their businesses.

To address these objectives, an action research intervention was co-developed involving the Precision Agriculture Trial team. This was a collaboration between the Cotton Research and Development Corporation (CRDC), Sugar Australia, private agricultural advisory sector professionals, the Trial Project Officer (from AGK Services) and the University of Melbourne researcher.

Three workshops were held as part of the Precision Agriculture Trial intervention along with numerous other facilitated interactions amongst trial participants including teleconferences, face-to-face meetings and a program of video interviews.

The key findings from the Precision Agriculture Trial are:

- Private sector advisers face challenges in assessing and demonstrating the value proposition of new digital technologies for both enhancing advisory businesses and supporting productivity increases on-farm.
- Visioning enables collective ownership and commitment among private advisers to engage with the shared innovation challenge of precision agriculture.
- Decision support tools (DSTs), such as the Digital Value Assessment (DVA) Tool developed in the Precision agriculture Trial, enable private advisers to evaluate the risks, opportunities and benefits of digital tools and services for their businesses.
- There is value in collaboration between diverse people and private advisory businesses with interests in precision agriculture to support and network around R&D for the extension of new digital technologies.

Recommendations from the Precision Agriculture Trial are:

Recommendations for the co-development of the Digital Value Assessment (DVA) tool from the Precision Agriculture Trial:

- Undertake a peer review of the DVA tool involving agricultural and other industry experts in advisory services and precision agriculture from cotton, sugar, horticulture and dairy
- Consider funding sources and technical support (e.g. through the Melbourne Networked Society Institute) to co-develop the DVA tool to a proof-of-concept stage.
- Clarify the intellectual property (IP) arrangements for the DVA tool to preserve the IP of trial contributors/participants and facilitate further co-development of this tool.
- Communicate the findings of the Precision Agriculture Trial and the DVA tool to the private agricultural advisory sector via the RDCs and other appropriate forums.
- Participating RDCs actively promote and further invest in refining and distributing the DVA tool for wider use by private agricultural advisers and potentially adapting it for use by producers.

Recommendations for enhancing the capacity of the private advisory sector to engage with precision agriculture:

- Convene and support a cross-agricultural industry Community of Practice of Private Advisers in Precision agriculture as a forum for identifying shared issues and responses to innovation challenges of precision agriculture.
- RDCs to initiate and broker collaborative processes to engage private agricultural advisers in priority setting for R&D in precision agriculture. In order to effectively and efficiently realise the 'value' of precision agriculture for their respective communities of producers, RDCs need to work closely with the private advisory sector to identify the joint value proposition of digital tools/services for advisory and producer businesses
- Develop a typology of precision agriculture innovation challenges (common to agricultural sectors) to better target industry and government support for capacity building of private agricultural advisers through information provision, professional development and incentives for participation in R&D for precision agriculture. For example, identify the different innovation challenges of farm data curation and management, remote sensing applications, new digital tools (i.e. drones) etc for private agriculture advisers and how they can be supported to address these in collaboration with industry.
- Develop a professional development package for private agricultural advisers to support knowledge and skills development in precision agriculture based on common issues such as data curation and management, remote sensing applications and new digital tools (i.e. drones).
- Recognise the critical role of innovation brokers in facilitating collaborative process for engaging the private agricultural advisory sector in precision agriculture and fund and support this role as part of R & D for precision agriculture.

Opportunities and objectives

Based on the responses received from the regional forums and the subsequent workshop discussions with the Precision Agriculture Trial partners and private sector participants, the objectives of the Precision Agriculture Trial were:

- To identify, prioritise and address challenges of engaging with precision agriculture for private agricultural advisors
- To enhance the capacity of private agricultural advisors to engage with digital agricultural tools and services in their businesses.

The promise of new technology development in agriculture is well publicised, with some claiming that 'digital disruption' will transform farming and food production (Australian Farm Institute 2017). However, despite the recognised potential and proliferation of digital technologies (Griffith et al. 2013, Walter et al. 2017), there has been an unexpectedly slow uptake of precision agriculture technologies by farmers and agricultural advisers worldwide (Jago et al. 2013, Tey and Brindal 2012).

While recent studies have identified opportunities and barriers for producers to engage with precision agriculture (European Parliamentary Research Service 2016, Trindall et al. 2018, Zhang et al. 2018) there is relatively little known about the needs, interests and enablers for private agricultural advisers to engage. The Precision Agriculture Trial addressed this gap by bringing together a diverse group of private agricultural advisors with interests and expert knowledge and skills in digital technologies to work together to manage the uncertainty and complexity that characterises precision agriculture. The research question that guided this collaboration was: How can private agricultural advisers engage with precision agriculture technologies to maximise the benefits and minimise the risks of investment for their businesses?

Research methods

The trials in the *Stimulating private sector extension in Australian agriculture to increase returns from R&D* research project were action research interventions designed to co-develop responses to agricultural innovation challenges and a 'route to change' as part of the collaborative interactions. Following key principles of co-innovation, each of the four trials was a partnership between a R&D corporation or state government, a private advisory organisation, a social researcher from the University of Melbourne, and participants representing the diversity of adviser typologies in Australia, including: small to medium businesses/ sole traders, retailers/input suppliers, larger consulting firms and agribusiness firms, and producers. The engagement of the private advisory sector as key contributors to the trials was a central design element to ensure a good fit with the diversity of needs and aspirations in this sector.

Taking a co-innovation design approach

The four private sector engagement trials contributed to the overall *Stimulating private sector extension in Australian agriculture to increase returns from R&D* project aims of: increasing private sector engagement in driving innovation; making research more accessible to farmers through a more integrated and co-operative extension system; identifying barriers to private sector involvement in delivering R&D; stimulating further growth of a capable private sector through training and retention of professionals; and building a stronger connection between end-users and researchers by trialling different approaches to increase engagement.

The four trials took a co-innovation design approach, involving diverse groups of actors from agricultural industry bodies, public and private advisory sectors, and primary producers (Botha et al. 2017, Turner et al. 2016, Vereijssen et al. 2017) in all stages of developing the intervention to:

- facilitate collaborative identification of shared interests and desired change
- identify opportunities for the advisory service sector to expand its role in the system by:
- identifying the need for and developing new capacities at different levels of the system
- creating networks and initiate partnering with other orgs/ levels and sectors
- developing roles/ functions capable of addressing specific technical issues
- sharing information and learning, in order to enable ongoing adaptation, and hence
- building capacity to collaborate.

Coutts et al. (2017) identified that academics are yet to agree on specific characteristics of co-innovation (as a form of collaboration) and use of innovation platforms. The design of the action research engagement trials in this project was informed by a set of core collaborative principles, adapted from the literature on co-innovation (Botha et al. 2014, Coutts et al. 2017, Nederlof et al. 2011), cooperative inquiry (Blackmore 2010, De Jaegher et al. 2016, Heron and Reason 2001, Ison 2008, Kemmis et al. 2013), and the research team's prior experience with designing co-productive research for policy and the agricultural RD&E system (Ayre et al. 2018, Klerkx and Nettle 2013, Nettle et al. 2013, Paine and Nettle 2008, Paschen and Ison 2014). These principles (Text Box) shaped the design each of the trials' action components, from the initial conception of the trial contexts through to the various phases of their operationalisation.

Text Box 1 - Core principles of the collaborative action research trial intervention

1. **Inclusivity** – emphasises experiential learning from social interaction and supports multiple sources and 'forms' of knowledge.
2. **Diversity** – diversity and inclusion are important values in co-production.
   all stakeholders are involved in and able to contribute to the definition of the problem
   differences between stakeholders are accepted
   all are involved in joint processes of defining the problem and a solution.
3. **Equality** – co-production starts from a partnership approach in which everyone is equal and everyone has assets to bring to the process
   recognition of skills complementarity
   mutual decision making
   all participants are fully involved in research decisions as co-researchers.
4. **Accessibility** – access is a fundamental principle of co-production if everyone is going to take part on an equal basis.
5. **Reciprocity** – 'reciprocity' is a key concept in co-production. It ensures that people receive something back for putting something in; it builds on people's desire to feel needed and valued; and it means sharing responsibility for shared outcomes.

Additionally, the collaborative action pursued by this project drew on the complementary principles of co-innovation as described by Coutts et al. (2017) (Text Box 2).

Text Box 2 - Nine principles of co-innovation (Coutts et al. 2017)

1. Take time to understand the problem from many different views: By taking the time to understand the complex nature of a problem, and building a shared vision (or ambition for change), solutions will be more likely to succeed. Be prepared to consider a variety of solutions.

2. Be inclusive – ensure everybody is present who needs to be there in order to understand the problem, its causes and to develop workable solutions.

3. Engage with and value all sources of knowledge – seek new insights and take the time to listen to all the different perspectives – everyone brings something to the table.

4. Strive to learn from each other by actively listening and understanding – be open to new ideas by being willing to let your own understanding and perspectives evolve.

5. Keep sight of the shared vision or 'ambition for change': Agree on the nature of the problem, its causes and the desired outcome of the project.

6. Be honest, open and constructive in your interactions with other participants.
7. **Be aware of the wider context** of the problem and any changes that may occur.
8. Be flexible and adaptable: How we work together and the roles we have may change over time.
9. Stick with the co-innovation process despite its frustrations: Setbacks occur; working through historical or current tensions, and negotiating shared and workable solutions, are part of the process and will pay off.

It was critical to the development of the collaborative trial partnerships that partners and participants were involved early on in the process of developing the trials, from the trial concepts to the design of specific actions, analysis of findings and the presentation of recommendations for future actions at a final symposium. The trial governance structure and regular meetings, with updates and feedback, ensured all partners had access to ideas and material produced as part of the trial interactions (see the process of engagement of the private sector in action research trials Figure 3).

Collecting data from the trials

Trial data were collected using a mixed methods approach. Before the trials were established, the project team reviewed the international literature (and current engagement dynamics in the Australian RD&E system (Milestone 1, Reichelt et al. 2015), and ran four regional forums with advisers and farmers in South Australia, Victoria, Queensland and New South Wales (2016). Two national surveys of advisers and farmers were also conducted in 2016/ 2017 and informed aspects of the trials (Nettle et al 2017). The data collection from the operationalisation of the trials consisted of interviews, survey questionnaires and the researchers' participant observations.

Interviews: A first round of interviews with project partners from participating RDCs and state governments (n=12) was conducted by the research team in December 2016 to produce a snapshot of the partners' experiences and expectations of the trial process to date. This was followed up by a second round of interviews at different times of the individual trial processes as well as towards their completion.

Survey questionnaires: Over the course of two years, each trial conducted a number of workshops (4-8 per trial) to work through the stages of the trial process. The research team evaluated these workshops using a short questionnaire at the end of each session, asking participants about the perceived value of the particular workshop session and the collaborative approach more generally.

Participant observation: The researchers' participant observations of meetings and other trial-related interactions, in conjunction with the team's collective reflection on these observations and emerging insights and notes of these conversations, presented a third data source.

Research phases: Developing the four trial contexts

The four trial intervention contexts were developed according to a set of criteria that ensured that all:

- had cross-sectoral significance (i.e. make progress on areas that one industry could achieve or address on its own)
- sought to be of public, industry and private interest/good
- included a professional development/training component not used/available currently
- were able to demonstrate a link between RD&E investments reaching more farms/improving on-farm productivity.

The interventions shared a common structure for their establishment, implementation and analysis phases that ensured that all teams adhered to the core principles of collaborative inquiry and action

research. Each trial team adapted the methodological framework to its individual trial contexts and timelines as they emerged from each of the trials' actions (see individual trial reports H, I, J and K).

Phase A – Establishment – Co-defining the opportunity

- Identifying and refining the trial concept
- RDC leads, participating RDCs and RIRG researchers – nominate project officer
- Identifying and engaging with trial partners
- Defining the opportunities for collaboration through the trial
- Identify shared interests, problems and core participants.

Phase B – Intervention Action – co-innovation/ co-designing action

- Developing a co-design process for intervention in the identified area
- Identifying and implementing engagement, development and learning activities
- This is an action-oriented approach that follows a 'plan, do, review' cycle.

Phase C – Analysis

- Analyse the activities with regards to how they have addressed the gap/opportunity identified and what they contribute to answering the overall research questions.

Establishment – Co-defining the opportunity – step 1

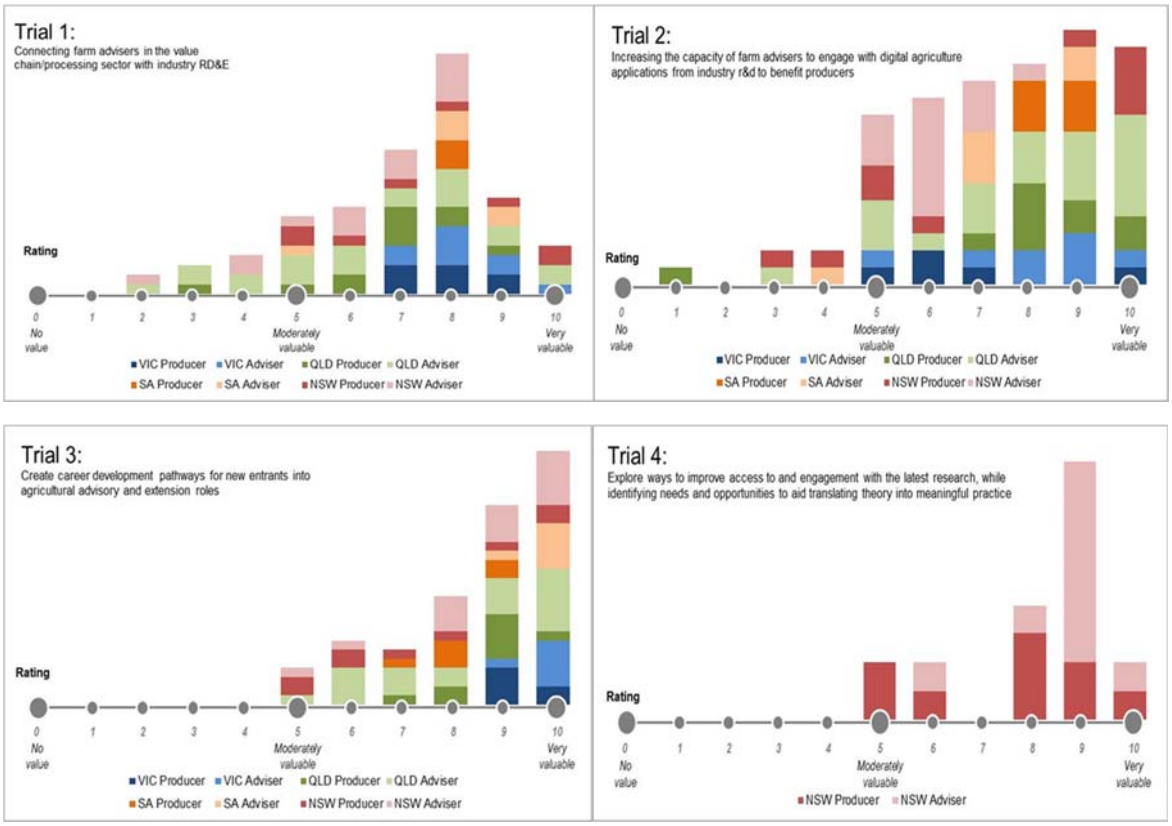
Identifying and refining the trial concept

Three draft trial concepts were developed based on project assumptions around gaps, needs, and opportunities for advisers derived from the international literature and in consultation with participating RDCs and representatives of the Victorian and New South Wales departments of primary industries. These concepts were based on broadly recognised gaps or opportunities within the current Australian RD&E system and a set of selection criteria designed to ascertain that the trials addressed:

- opportunities around engaging with the processing sector/ the supply chain
- gaps and opportunities in precision/ precision agriculture
- gaps in professional development and career pathways for new entrants into the advisory sector.

These three draft concepts were tested at four regional forums the project team conducted with advisers and producers in South Australia, Victoria, Queensland and New South Wales in early to mid-2016. The forum participants were invited to rank the suggested concepts by order of their perceived importance to the private sector and to provide detailed feedback on the drafts. A fourth trial concept, addressing the gaps in the agricultural knowledge system, was developed from additional forum responses and was test-run with participants at the last forum in New South Wales (Figure 2).

Figure 2: Regional practitioner ranking of three suggested trial concepts. A fourth was developed on the basis of additional feedback received and was ranked at a forum in NSW.



Establishing the trial teams

The trials were purposefully designed according to the key principles of co-innovation (text box 1). To ensure that the values of diversity, inclusion and equality were met, each core team consisted of an RDC or government lead, participating RDC representatives, a researcher from the University of Melbourne, and a Project Officer from the private advisory sector. The selection of trial participants further aimed to ensure representation of the diversity of adviser typologies in Australia by including small to medium businesses/sole traders, retailers/input suppliers, larger consulting firms and agribusiness firms as well as, wherever possible, other types of advisers not captured by this typology.

Engaging the private advisory sector as key contributors to the trial development was a central purposeful design element as they were the project's link to wider advisory networks and ensured that the trials were engaging an adequate range of individuals and types of advisers. The Project Officers were invited into a broker role that drew on their professional networks as well as their understanding and perspective of the problem the trial was addressing. They held a key role in ensuring that the private sector perspective guided the further definition of the trial concepts and trial actions.

Trial roles

Each core trial team consisted of one Industry Lead (RDC lead), one Project Officer (PO) and one Research lead from the UoM research team (RIRG lead).

The RDCs/ state governments:

Following the establishment of the trial concepts, the RDCs nominated the concepts of interest to them. A trial Industry Lead and participating roles were decided. Their role included:

- leading the establishment and progress of the trials
- identifying partners and actively support engagement
- engaging in the co-design process
- supporting responses to needs identified through the process.

The Project Officers:

Following an expression of interest process, four Project Officers and one trial consultant were appointed through a contractual agreement with the University of Melbourne. The Project Officers were professionals from the private advisory sector, with industry specific networks and experience in project design/development and workshop facilitation. Their role included:

- contributing a private advisory sector perspective to the definition of the trial opportunity
- identifying suitable trial partners and networks private advisory sector
- working with RDCs, trial partners and project researchers to enact the trial methodology
- facilitating all interactions between trial partners (broker role).

The project team researchers:

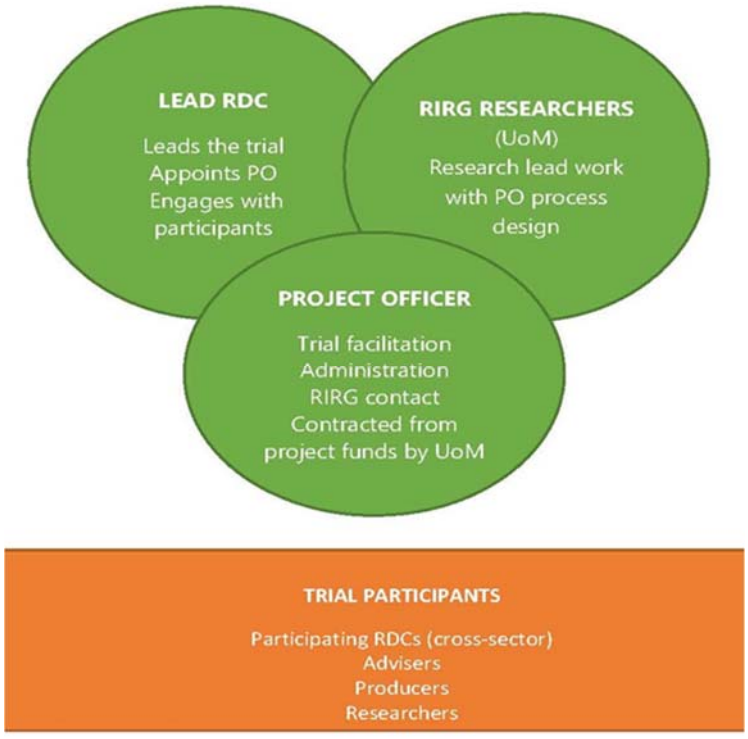
The role of the Research Lead included:

- development of the action research plan, structuring the trial communication documents, and overseeing the trial methodology
- working with the Project Officers to design facilitate trial engagement workshops
- gathering research data and providing feedback on insights gained to inform the co-design process.

Trial participants/partners:

Trial partners and participants were identified from the private advisory sector utilising both the RDCs' and Project Officers' networks. The RDC Leads, POs and Research Leads started engaging with prospective trial partners using a refined trial concept-briefing document.

Figure 1: Trial set up: participants and roles



Co-defining the trial opportunity – step 2

Following the initial engagement, the private sector trial partners were invited co-define the opportunities for collaboration through the trial and identify the shared interests or shared problems the trial was going to address, as well as who might be additional core participants that needed to be engaged. Inviting further diversity into the refined definition of the problem and opportunities was central to the collaborative process for a number of reasons:

1. It ensured inclusivity and diversity of adviser perspectives and resulted in a richer, more complex understanding of the problem/opportunity at hand.
2. The approach produced a break in habitual, linear approaches by recognising the diversity and complementarity of professional skills as a clear asset to the process.
3. The recognition of all trial participants as equal in the process contributed to improved mutual understanding of people's different professional contexts and needs.
4. Empowering participants as co-innovators and co-designers encouraged them to take ownership of the process and collective decision-making.
5. Mutual decision-making and commitment to collective action was intended to help create trust between different stakeholders.

Intervention Action – co-designing action

While each of the four trials operated at its own pace and according to the specific trial's contextual design, their implementation phase generally focused on developing a co-design process for the intervention action in the identified area. Once all participants had arrived at a shared understanding of the problem and the opportunity they were going to address, several rounds of workshops and meetings identified and designed engagement, development and learning activities to be implemented as part of the trial and beyond the project's duration. This action-oriented approach in the implementation phases followed a classic action research cycle of 'plan, do, observe, review'.

Figure 3: the process of engagement of the private sector in action research trials:

Participants in the Precision Agriculture Trial

Participants in the Precision Agriculture Trial included a Trial Team which was made up of an industry representative from the Cotton Research and Development Corporation (CRDC), two representatives from Sugar Australia, a researcher (University of Melbourne) and a Project Officer who was engaged to facilitate activity in the trial and work with the Trial Team to engage advisers/ participants.

Other key participants in the Precision Agriculture Trial were members of a Review Team of six private agricultural advisers in the Australian cotton (3) and sugar (3) sectors and a broader 'community of practice' (Wenger 2000) which included precision agriculture researchers, industry and government personnel and private advisers who were involved in the Trial through a Scoping Workshop (see below). Advisers who were invited to become involved in the Trial were identified through existing networks of Trial Team members. Six more private agricultural advisers were involved in a peer review process as part of the Trial and results of this will be reported separately after July 2018.

Travel costs to attend activities were covered by the project and participants were also offered a flat rate for attendance at meetings/workshops consistent with the Dairy Australia policy (as the Rural Development Corporation project lead). This was a nominal fee and does not necessarily align with the individual advisers' fee-for-service rates.

Approach and Activities in the Precision Agriculture Trial

The Precision Agriculture Trial action research intervention was inspired by an approach to engagement in R&D called Participatory Technology Assessment (pTA) (Geels 2007, Joss and Bellucci 2002, Marris et al. 2008). pTA is a collaborative approach to developing responses to the innovation challenges associated with new technologies where technology design and development processes involve people other than technical design experts. Popularised from the 1980s, it is a range of methodologies characterised by regular interactions between design experts and other societal actors in a given context (e.g. farmers and producers in agriculture). It involves processes of reflexivity and mutual learning (Schot 2001). pTA entails carefully facilitated interactions between innovation actors in networks supported by the key role of 'innovation brokers' (Klerkx et al. 2009). In contrast to traditional Technology Assessment approaches (Vanclay et al. 2013), it promotes wider consideration of issues relevant to the use of technological innovations, including ethical, environmental, health and political issues (Joss and Bellucci 2002; 6, Stirling 2008).

Three workshops were held as part of the Trial along with numerous phone conferences, meetings and presentations. Workshop 1 was a one-day Scoping Workshop (on 8 March 2017 in Toowoomba) to identify Priorities Issues and Proposed Actions for enhancing the capacity of private advisers to engage with precision agriculture. Participants included precision agriculture researchers, government extension personnel, private advisers from the cotton, sugar and horticulture sectors, and members of the Project Team. At this workshop, participants undertook a visioning process and identified Proposed Actions for addressing the number one priority issue of determining the 'value' of precision agriculture tools and services for private advisory businesses. They agreed to address the Proposed Action identified by the majority of participants: to develop a case study and/or method for assessing the costs and benefits of a digital tool or service for a private advisory business.

A group of six private agricultural advisers (three working in the sugar industry and three in the cotton industry) was established as the Precision Agriculture Trial Review Team. These people are from a range of different advisory business types including sole trader, Small/Medium Business (SME) and rural reseller company. Review Team members participated in two workshops—in Toowoomba on 14-15 August 2017 and in Brisbane on 21 February 2018.

At the first Review Team Workshop, participants developed a decision support tool (DST) to determine the 'value' of a digital agricultural tool or service for an advisory business, called the Digital Value Assessment (DVA) tool. The DVA tool aims to help private agricultural advisers identify the benefits, risks and opportunities of a precision agriculture technology (tool or service) for their businesses. The Tool is a structured decision process that an adviser can use to assess, as well as demonstrate, the 'value' of a digital tool or service for his/her business. It consists of a range of 'considerations', 'components' and 'questions' organised into an Excel spreadsheet. The nine 'considerations' that the Tool addresses are: technology; people; social licence; research and development; legal; environmental; financial; support and market (see Figure 4).

The draft DVA tool was tested by the Precision Agriculture Trial Review Team members who each used it to assess the considerations related to a digital tool or service for their advisory businesses. The technologies chosen by members to assess were: drones; new software platforms; soil testing technology; and digital data management and integration services. Each adviser developed and implemented a detailed Digital Technology Assessment Plan with milestones, timeframes and resources specified.

The process of testing the DVA tool by Review Team members began in September 2017 and was completed at the end of February 2018. In the intervening months, there was ongoing reflection on the Tool and its role in assessing different digital tools/services by Review Team members at two teleconferences (facilitated by the Project Officer in October and December 2017) and through video interviews (in December 2017/January 2018) with Review Team members. The Project Officer was also in regular contact with individual Review Team members to provide individual support and links to relevant resources as required.

At the second Review Team Workshop, Review Team and Trial Team members reflected on the overall utility of the DVA tool, how it could be improved and how it might influence and benefit advisory business practices and outcomes. As a result, a second draft of the Tool was developed, outcomes of the members' individual Digital Technology Assessment case studies were reported and documented and next steps in the Tool development process were identified including a Peer Review process to be undertaken from May to July 2018.

Social research methods employed in the Precision Agriculture Trial included: interviews (video and informal); participatory workshops; group discussions; evaluation questionnaires; and, participant observation.

Key results

This section presents key results from the Precision Agriculture Trial that demonstrate how the process and outputs of the Trial enhanced the capacity of private advisers to engage with precision agriculture.

Private sector advisers face challenges in assessing and demonstrating the value proposition of new digital technologies

The first key finding is that private sector advisers face challenges in assessing and demonstrating the value proposition of new digital technologies for both enhancing advisory businesses and supporting productivity increases on-farm. Responses from participants at the four regional forums and in the Precision Agriculture Trial confirmed that members of the private agricultural advisory sector recognise that determining the value proposition of new digital technologies is a key impediment to their investment in digital service delivery for increased on-farm practice productivity and profitability.

It is important to know how to efficiently and effectively assess and demonstrate the 'value' of new digital tools and services.

Advisers also experience substantial financial, operational and personal risks associated with operating in the uncertain digital environment, and the proliferation of different digital technologies has led to a sense of confusion and even isolation for some. Advisers are seeking practical approaches to demystifying the costs and benefits of digital tools/services and appreciate that learning from others with different experiences can improve their capacity to make investment decisions and develop new digital service offerings in their businesses.

Visioning enables collective ownership and commitment among private advisers to engage with the shared innovation challenge of precision agriculture

The second key finding is that visioning enables collective ownership and commitment among private advisers to engage with the shared innovation challenge of precision agriculture. In the Precision Agriculture Trial, participants undertook a visioning process in which they shared ideas about what the purpose of the trial should be and how it might proceed. This process established a mutual ownership and trust among the participants and allowed them to identify strategic issues and actions in relation to the complex domain of precision agriculture. It supported them to make sense (Wallis et al. 2013) together of the uncertainty and complexity of precision agriculture for the private advisory sector, for example, uncertainty related to market signals and the regulative and institutional environment for precision agriculture. For example, they identified the shared challenge of determining the potential 'value' of digital tools and services in the private agricultural advisory sector. This is consistent with the widespread uncertainty within agricultural industries, including among producers, related to the technical opportunity, the skills and knowledge required, and perceived and actual benefits to on-farm profit and production (Trindall et al. 2018). By bringing together people from different agricultural industries with industry representatives and other experts in precision agriculture, those involved could share their different perspectives of the mutual challenge of engaging with precision agriculture, recognise different approaches to this challenge and negotiate a way forward together to address it. The value of having different agricultural sectors working together on a common problem was recognised:

> It was great to hear other advisers have the same concerns and constraints that I am faced with every day. (Scoping Workshop participant, 8 March 2017)
>
> Given the different experiences in the room, it was great to be able to hear and voice positive and negative points of view. (Scoping Workshop participant, 8 March 2017)
>
> Just listening to everyone's issues [related to precision agriculture] and getting the reassurance that similar issues are being experienced in all [agricultural] commodities. (Scoping Workshop participant, 8 March 2017)
>
> Hearing points of view of a cross section of industries to collaborate on ideas. (Scoping Workshop participant, 8 March 2017)

A Digital Value Assessment (DVA) tool enabled private agricultural advisers to better manage risks and pursue opportunities of precision agriculture

A third key finding from Precision Agriculture Trial is that a Decision Support Tool, the Digital Value Assessment (DVA) tool, enabled private advisers to better manage risks and pursue opportunities of precision agriculture. The DVA tool, which emerged as a key output of this Trial, supported advisers learn in systemic (Ison 2010) and multi-dimensional ways (Schot and Geels 2007) about the challenges and opportunities of precision agriculture technologies for their businesses, for example:

> [The DVA tool and intervention] allowed for real-world discussions and application of skills and knowledge.
>
> [It was a] very worthwhile process to formalise a DVA tool [technology assessment] process that most participants were doing subconsciously.

Review Team members demonstrated an increased capacity to manage different innovation challenges related to precision agriculture as result of applying the tool. They indicated that the DVA tool supported them to systematically and strategically consider the range of technical, social, community, environmental, human, market factors – in addition to just the economic factors—related to potential investment in and applications of precision agriculture, and recognised the importance of these considerations to their future advisory business practices, for example:

> The [DVA] Tool has allowed me not just to look at the cost analysis...but also the legal ramifications, the information around IP [intellectual property] and who owns IP, where to go to source this information and evaluate it a bit more rigorously. We [advisers] all tend to do just the costs but what are the other things behind it? For me [in my advisory business], it could be staff savings, time savings? Also, the work place health and safety implications… (Review Team member 4, 18 January 2018)
>
> The power of the DVA tool is that it helps you think about things differently (Review Team member, 21 February 2018)

The DVA tool supported advisers to develop their capacity to both think and act in relation to digital technologies on three main levels.

Firstly, it supported them to address technical issues they had previously or may currently face in applying the use of different digital tools and services within their businesses. It provided a structured process by which to investigate, document and deliberate about the different considerations, and therefore better assess the risks, opportunities and benefits in the context of their particular business and clients' needs. For example:

> [The DVA tool] gave me a process to 'walk' through, step-by-step; where I could think about all the things that are in the DVA tool and what impacts the [case study digital] technology would have, what ramifications it might have, what return on investment we would get from the [soil mapping] technology… (Review Team member 3, 18 January 2018)
>
> [The DVA tool] helps you identify areas to investigate. Great safety net for deciding whether to implement a technology. Really helps sift and filter and organise. (RT member, 21 February 2018).

Secondly, use of the DVA Tool increased adviser capacity - including motivation, confidence, credibility and creativity - to assess the risks and pursue benefits of new digital tools and services and reformulate strategy for investment as a result. For example, it supported members to identify constraints or opportunities for new advisory service delivery based on digital tools and provide a defensible basis for investment.

> *It [the DVA tool] allowed me to work right through from the business case, present it to the Board [or my organisation] and look at the pros and cons [of the soil mapping technology]. So, it [the DVA tool] actually gave me a process to work through and think and walk my Board through it.* (Review Team member 3, 18 January 2018)
>
> *[The DVA tool] formalised what had previously been an 'ad hoc' process [of advisers assessing precision agriculture technologies]. [It] results in quantifiable justification for action [by advisers and their clients].* (Review Team Member, 15 January 2018)

> *I had tried to do this before [nominated digital tool/service assessment]…this process [DVA tool] has helped me to think it [the use/investment in a digital tool/service] through*. (Review Team member, 21 February 2018)

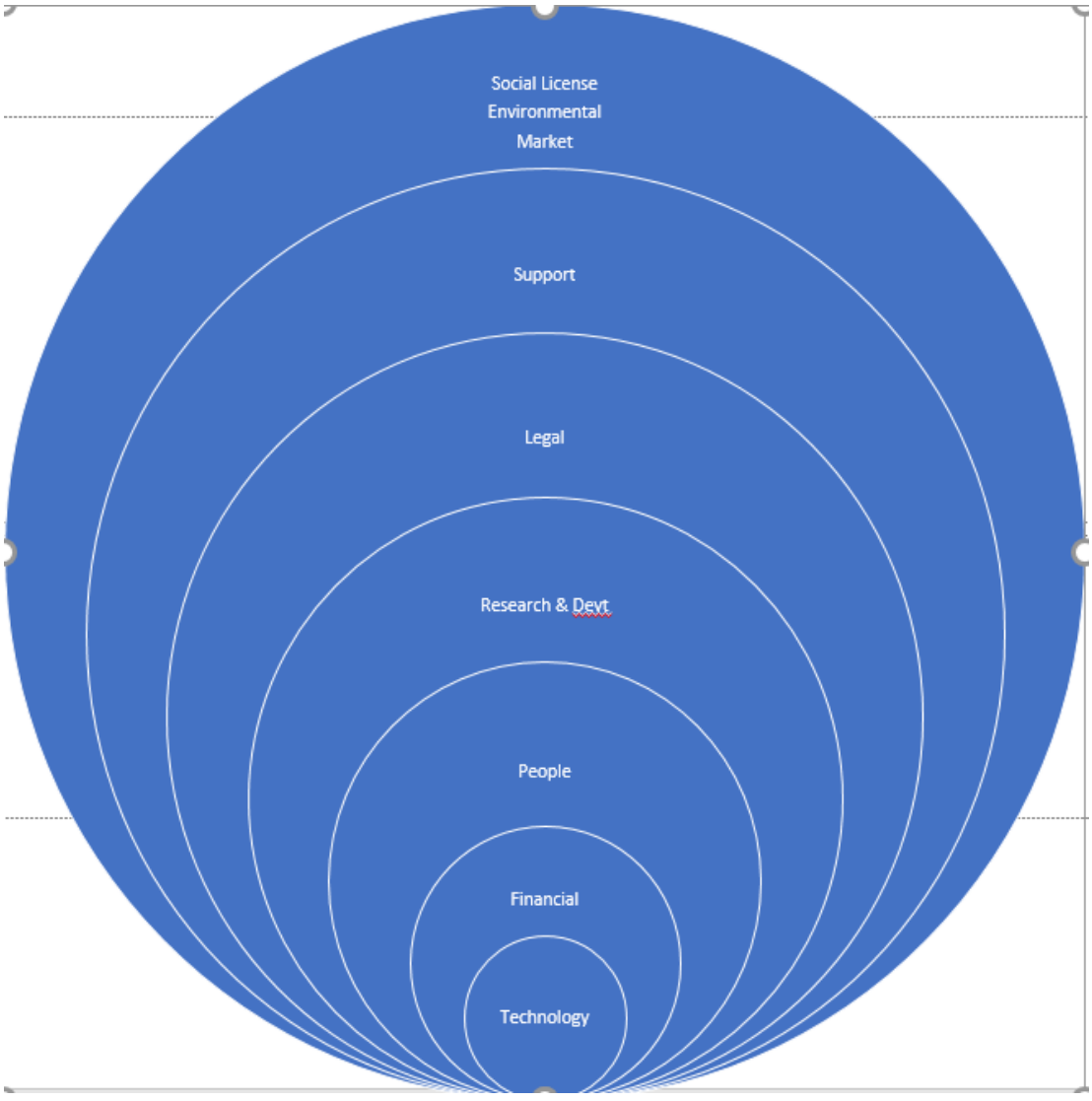
Participants also recognised that the DVA tool supported adviser capacity to communicate and credibly demonstrate the 'value' of new digital tools and services to actual and prospective farmer clients as part of their service delivery:

> *The best use of the DVA tool is to support communication.* (Review Team member, 21 February 2018)

> *[The DVA too allows me to…] demonstrate to clients the value proposition [of a digital tool/service*]. (Review Team member, 21 February 2018)

> *[The DVA tool provides] credibility - that you can show [clients] that you've considered all options - goes a long way*. (Review Team member, 21 February 2018)

Figure 4: Representation of the Digital Value Assessment tool.



Collaboration between diverse people and private advisory businesses enabled shared problem solving and learning for engagement with precision agriculture

The fourth key finding is that there is value in collaboration between diverse people and private advisory businesses with interests in precision agriculture. Private agricultural advisers, knowing what digital tools and services to invest in, when to invest, what skills and resources are required and what the competitive advantage these might represent (for their own and their clients' businesses) are key constraints to their engagement in precision agriculture (Zhang et al. 2018). Participants in the Precision Agriculture Trial recognised the value of having different agricultural industries and advisory businesses involved to learn from, share ideas with and create responses to common problems. Specifically, they noted that this diversity meant that 'different problem-solving' approaches challenged them to think differently about precision agriculture and engage with new possibilities for action. It was observed during trial activities that there is traditionally very limited interaction and communication between private service providers in the sugar and cotton industries. However, by recognising and working with the diversity of needs and practices of different advisers, the trial process (including the development of the DVA tool) enabled a productive, cross-sectoral response to the complex challenge of precision agriculture.

> *[The most valuable aspects of the Precision Agriculture Trial intervention for me were…] having people with different skill sets and from different areas to add their input*. (Review Team member 2, 18/1/18)

> *[The most valuable aspects of the intervention for me were…] cross-collaboration, the valuable project team formed.* (Review Team member 2, 18/1/18)

> *They [participants from other agricultural industries] had different issues and different problem solving so was good to talk to them and work through some of the issues we are facing.* (Review Team member 2, 18/1/18)

While participants in the Precision Agriculture Trial are involved in different types of private agricultural advisory businesses, there was no evidence that competitive behaviour might hinder either the desire or ability for them to work together on the shared issue of strengthening private advisory sector engagement with precision agriculture. Conversely, evidence of resource sharing between participants emerged through the Review Team Digital Value Assessment case studies. For example, arrangements were made to provide colleagues with access to software at reduced costs, and information and insights on aspects of its use and function were generously shared. Overwhelmingly, feedback from participants confirmed how productive it was for them to work collaboratively with like-minded people from other agriculture industries, regardless of their business type or goals.

> *People who were involved in the project [the Precision Agriculture Trial] from other [agricultural and allied] industries were good to work with and it was great to share knowledge among those [private advisory] businesses outside the sugar industry*. (Review Team member 2, 18/1/18)

Next steps

All members of the Precision Agriculture Trial Review Team commented that they would use the DVA tool in the future when faced with a decision related to investing in or using a digital tool or service, for example:

> The DVA tool will be useful in the future to address other issues that come up. (Review Team member 2, 18 January 2018)

While the DVA tool was developed by sugar and cotton private service providers, participants in the Precision Agriculture Trial recognised that it could be adapted to apply to other contexts and for other people and groups to use. A Review Team member, for example, suggested that the tool 'could apply to any investment decision' (RT member, 21 February 2018). Another member suggested that it could be adapted for use by their clients (i.e. farmers). The wider potential for applying the DVA tool was confirmed at the 'Stimulating private sector extension' project symposium in Sydney in March 2018, where the results of the Precision Agriculture Trial were shared with a wider audience of project participants.

Members of the Review Team also noted how they would know if the DVA tool had helped to build adviser capacity to engage with precision agriculture beyond the scope of the action research intervention.

Because of the outcomes of the Precision agriculture Trial and this appraisal, the Trial Team will develop a peer review process for the DVA tool to run from May to July 2018.

Conclusion and recommendations

Uncertainty and complexity related to digital disruption and new digital agricultural technologies are issues faced by private agricultural advisers as they seek to remain competitive in their business offerings. Given the important role the private advisory sector plays in agricultural innovation, findings ways to support private advisers to manage these innovation challenges related to precision agriculture is critical for both industry and public good outcomes. In the Precision Agriculture Trial, participants designed a process and a practical tool to address a key priority issue for private advisory sector engagement with precision agriculture: determining the value proposition for new digital tools and services for their businesses. This process, and the Digital Value Assessment (decision support) tool that emerged from it, enhanced the capacity of private advisers to engage with precision agriculture by supporting them to strategically and systematically identify and manage the risks and opportunities from investment in digital tools and services. There is a role for agricultural industry bodies and R&D institutions to support collaborative processes for enhancing advisory capacity in precision agriculture such as the process demonstrated in the Precision Agriculture Trial. By co-developing, investing in, hosting and promoting decision support tools like the DVA tool, agricultural industry bodies can continue to productively engage with private advisers on issues of how to harness and mobilise diverse skills and knowledge for agricultural innovation in a digitally disrupted world.

Recommendations

Recommendations for the co-development of the Digital Value Assessment (DVA) tool from the Precision Agriculture Trial:

- Undertake a peer review of the DVA tool involving agricultural and other industry experts in advisory services and precision agriculture from cotton, sugar, horticulture and dairy
- Consider funding sources and technical support (e.g. through the Melbourne Networked Society Institute) to co-develop the DVA tool to a proof-of-concept stage.
- Clarify the intellectual property (IP) arrangements for the DVA tool to preserve the IP of trial contributors/participants and facilitate further co-development of this tool.
- Communicate the findings of the Precision Agriculture Trial and the DVA tool to the private agricultural advisory sector via the RDCs and other appropriate forums.

- Participating RDCs actively promote and further invest in refining and distributing the DVA tool for wider use by private agricultural advisers and potentially adapting it for use by producers.

Recommendations for enhancing the capacity of the private advisory sector to engage with precision agriculture:

- Convene and support a cross-agricultural industry Community of Practice of Private Advisers in Precision agriculture as a forum for identifying shared issues and responses to innovation challenges of precision agriculture.
- RDCs to initiate and broker collaborative processes to engage private agricultural advisers in priority setting for R&D in precision agriculture. In order to effectively and efficiently realise the 'value' of precision agriculture for their respective communities of producers, RDCs need to work closely with the private advisory sector to identify the joint value proposition of digital tools/services for advisory and producer businesses
- Develop a typology of precision agriculture innovation challenges (common to agricultural sectors) to better target industry and government support for capacity building of private agricultural advisers through information provision, professional development and incentives for participation in R&D for precision agriculture. For example, identify the different innovation challenges of farm data curation and management, remote sensing applications, new digital tools (i.e. drones) etc for private agriculture advisers and how they can be supported to address these in collaboration with industry.
- Develop a professional development package for private agricultural advisers to support knowledge and skills development in precision agriculture based on common issues such as data curation and management, remote sensing applications and new digital tools (i.e. drones).
- Recognise the critical role of innovation brokers in facilitating collaborative process for engaging the private agricultural advisory sector in precision agriculture and fund and support this role as part of R & D for precision agriculture.

Project publications

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