final report

Project code: B.GFB.0003

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Date published: 11 October 2016

ISBN: 39 081 678 364

PUBLISHED BY
Meat and Livestock Australia Limited
Locked Bag 1961
NORTH SYDNEY NSW 2059

Scoping study in support of a co-innovation R&D for Profit proposal

Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government to support the research and development detailed in this publication.

Abstract

The Australian livestock industries underpin prosperous rural communities, natural resource management and the interests of families and rural communities across regional Australia. Yet these industries can face significant challenges in the face of climate variability, market volatility and policy uncertainty. These factors place significant pressure on the finances, health and well-being of individual producers, with flow on impacts on land condition and local communities. The complex sustainability challenges faced by agricultural producers require a coordinated multi-sector approach to innovation and adaptation to support improved decision-making.

Co-innovation, based on a multi-participant processes and partnerships, has been suggested as a suitable approach to addressing complex interactions between climate, environment, policy and markets such as those faced by agricultural producers. This multi-participatory process works by bringing together stakeholders with different skill sets and experiences to develop innovative solutions to enhance the adaptive capacity and sustainability of the agricultural production system.

This pilot study aimed to identify the RD&E needs in relation to risk, adaptation and resilience, particularly with respect to drought. It surveyed a range of stakeholders associated with the livestock industries in four regions of Australia in order to capture the range of issues faced by the industry and, in particular, current responses to risk and the barriers and drivers of adoption of new innovations (information, technologies, practices).

A number of potential opportunities for research and development investment aimed at building capacity to enhance the sustainability of the industry and regional communities which could be investigated in detail through R&D for Profit funding Round 3 were identified through this scoping project. Importantly, the information derived from this survey will provide a valuable starting point for a multi-stakeholder co-innovation process aimed at supporting more sustainable practices for increased profitability and resilience by decision makers in the Australian livestock industries.

Executive Summary

Without informed adaptive management, drought and extreme inter-annual climate variability can undermine the profitability and sustainability of Australia's primary industries. Co-innovation approaches have been suggested in addressing the complex challenges faced by agricultural producers. The co-innovation approach is based on multi-participant processes and partnerships aimed at developing innovative integrated solutions. This multi-participatory process works by bringing together stakeholders with different skill sets and experiences to address the complex interactions between climate, environment, policy and agricultural production systems.

To demonstrate faith in co-innovation and to provide support for a co-innovation project proposal through R&D for Profit funding Round 3, a scoping study was conducted in four regions in Australia that regularly experience long periods of low rainfall. The key aim of this scoping study was to identify RD&E issues to be investigated in detail through R&D for Profit funding.

The scoping study used a Rapid Rural Appraisal (RRA) approach, applying system wide thinking to map key R&D issues related to drought and climate risks; key management decisions; decision support; barriers to adoption and adaptation; community values; and future goals of multiple stakeholders associated with the livestock (red meat, dairy, sheep and wool) industries. The study used a semi-structured interview process to collect responses to a series of questions aimed at identifying industry RD&E needs in relation to risk, adaptation and resilience, particularly with respect to drought.

A total of 59 stakeholders were interviewed across four livestock production regions within Australia. These regions included livestock (beef, sheep and dairy) grazing systems around Longreach in western Queensland, beef cattle grazing production systems in the Kimberley/Pilbara region of north western Western Australia (WA); mixed farming systems in the sheep-wheatbelt of southern WA; and dairy and mixed farming (sheep, cattle) systems around Bendigo in northern Victoria.

The datasets were analysed using a semi-quantitative approach based on the frequency of words in survey responses and the frequency of associated or co-located words to identify key areas of relevance (interests, concerns etc.) as expressed by the interviewees. The results of these analyses are presented in this report along with selected quotes which exemplify key issues identified and provide some depth and context to the issues raised by the interview participants.

The results indicate that stakeholders are highly motivated by success, which in most cases means more sustainable and profitable farming systems providing a suitable lifestyle to rural families and benefits to communities. However, a number of barriers to adoption of new practices and technologies were identified, including affordability of new technology

(financial constraints); lack of clear demonstration of return to investment; nervousness about changing from what they have done historically; and fear of the unknown. While relatively frequent interactions were reported between producers and the 'input/supply chain' and 'agricultural consultant/education' groups', relatively fewer interactions were reported with government agencies and the finance sector, suggesting the need for a new integrated approach (such as co-innovation) in developing effective and innovative solutions.

The priority R&D issues identified that could be investigated in detail through R&D for Profit funding Round 3 include:

- *Pasture management and total grazing pressure*— including aspects of thresholds for pasture quantity and quality and land condition; timing of key decisions and/or decision points based on key indicators; and development of protocols and tools for monitoring and evaluation of key indicators.

- *Improved seasonal and multi-seasonal climate forecasts* — to allow producers the confidence and capability to make decisions such as to sell or agist livestock early before pastures degrade, stock lose weight and prices decline; or water market decisions to enhance water security (i.e. water buy back decisions). Relevant aspects of climate forecasting include multi-year climate forecast systems, with skill assessments; forecasts of upper or lower tercile rainfall for the wet season; and forecasts of start and end of wet season.

- *Integrating livestock, finance, economics, business and marketing management* — including whole farm analysis of pasture condition/productivity, environmental factors, herd dynamics, transport, profitability and taxation to meet (and compare) different market specifications; and managing change (e.g. transitioning from dairy to beef production system).

- *Building social networks, health and wellbeing* — includes tools and support for physical and mental health; planning for the future; peer to peer learning; and the importance of champions or role models to facilitate adoption of new technologies.

- *Innovations for better decision making for drought management and resilience* — for monitoring and reporting drought and drought recovery; monitoring natural resource and pasture conditions; improved financial and business planning; and supporting timely decision-making (i.e. decision support frameworks).

- *Barriers to adoption*—including financial constraints; the need for the benefits of research (including return on investment) to be demonstrated in the commercial world; lack of time; poor internet connection; producers willingness to change; and lack of skills in knowing how to integrate research outcomes into business.

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1 Background

Without informed adaptive management, drought and extreme inter-annual climate variability can undermine the profitability and sustainability of Australia's primary industries (O'Reagain & Scanlon, 2013). To ensure the future profitability and sustainability of these industries, governments and industry bodies must develop progressive policies that encourage agribusiness and primary producers to adapt to (plan for, manage for) drought and inter-annual climate variability (Head, 2014). Coupled with the adoption of pragmatic farming and management responses, innovative approaches utilising new technologies and strategic decision making processes are also needed so that primary producers and agri-business can remain sustainable and profitable in the face of these challenges (Meinke & Stone, 2005; Ash *et al.*, 2007; Greiner *et al.*, 2014).

The extent to which drought and climate variability undermines agricultural productivity and profitability depends on a combination of factors including the type of production system, its resilience to external impacts, resource use efficiency, access to relevant information and the ability to adapt (Eastwood *et al.*, 2012; Dowd *et al.*, 2014). Of these factors, those surrounding the ability to adapt and especially adaptation planning are inherently challenging, with long planning horizons compounding the complexity of the decision making process (O'Reagain & Scanlon, 2013). Despite the complexities, all agricultural sectors need to adapt and focus on developing their capacity to manage high climate variability through pragmatic and realistic management options. Agricultural industries that are able to adapt will not only minimise their exposure to risks associated with drought and climate variability, but may also be better able to take advantage of and profit more from favourable conditions.

Co-innovation approaches have been adopted in a wide range of agricultural settings and have repeatedly demonstrated significant on-ground benefit in addressing the complex challenges faced by agricultural producers (Klerkx & Nettle, 2013; Coutts *et al.*, 2014). The co-innovation approach is based on multi-participant processes and partnerships aimed at developing innovative integrated solutions. This multi-participatory process works by bringing together stakeholders with different skill sets and experiences to address the complex interactions between climate, environment, policy and agricultural production systems (Rossing *et al.,* 2010; Klerkx *et al.*, 2012).

Not dissimilar to the idea of an 'Agricultural Knowledge and Innovation System' (AKIS) designed to facilitate the learning and sharing of information in the agricultural sector (Knierim & Prager, 2015), co-innovation provides a framework and methodology which brings stakeholders from across a business supply chain together with the goal of facilitating innovative and/or adaptive solutions. As in an AKIS, where value is a function of the strength and integration of the multi-stakeholder network (Knierim & Prager, 2015), key aspects of the success of the co-innovation approach are for participants to work as partners,

collaboratively learning through experience using a systematic iterative adaptive approach to problem solving. While multiple stakeholders are involved in the co-innovation process, primary producers are a key motivator at the core of the approach, involved in project development, execution and implementation.

The first step in the co-innovation process is to gain a thorough understanding of the problem. This includes understanding the production system including the people, organisations, finances, resources, rules and existing knowledge of that system. The multidisciplinary group then works together to develop and iteratively test and evaluate innovations. The process is inclusive with the whole team being involved throughout the process; hence, end users are much more likely to adopt the final innovation as they have been participants throughout the innovation and evaluation process. As in an AKIS, the success of the co-innovation approach is likely to be a function of the level of dedicated resources (e.g. public investment), stakeholder engagement (particularly of landholders/managers), and integration/coordination/cooperation across the co-innovation network (Knierim & Prager, 2015). Currently, the knowledge and innovation system dealing with drought in Australia is highly fragmented and there is a significant need for coordination, collaboration and integration (Jeff Coutts, pers. com.).

The proposed Drought and Resilience R&D for Profit Round 3 project aims to develop co-innovative approaches to achieve 'Drought and Climate Resilience' for primary producers, specifically in the grazing livestock industries. This project would:

- Employ co-innovation processes to identify and promote innovative operational and strategic decision making and technical developments.
- Develop innovative on-farm/ station business management practices that assist farmers and pastoralists better manage Australia's variable climate, especially drought risk.
- Develop a whole industry systems approach to managing Australia's variable climate, including insights that inform Australia's State and Federal drought management policies.

Participants and stakeholders at the initial Co-innovation R&D for Profit workshop, held in Brisbane on 22 March 2016, supported the development of an R&D for Profit proposal to develop a co-innovation process to manage climate variability and increase producer resilience to drought (Fig. 1). However, not all stakeholders were present at the workshop. It was recognised that broad industry input was needed to ensure adequate representation of all stakeholder groups and relevant issues, particularly around the kind of system failures the R&D for Profit project will need to consider addressing. In order to kickstart the process and demonstrate faith in the co-innovation approach to the R&D for Profit Program and potential investors, we conducted an initial scoping study in four regions in Australia that regularly experience long periods of low rainfall. Results from this scoping study are presented in this report.

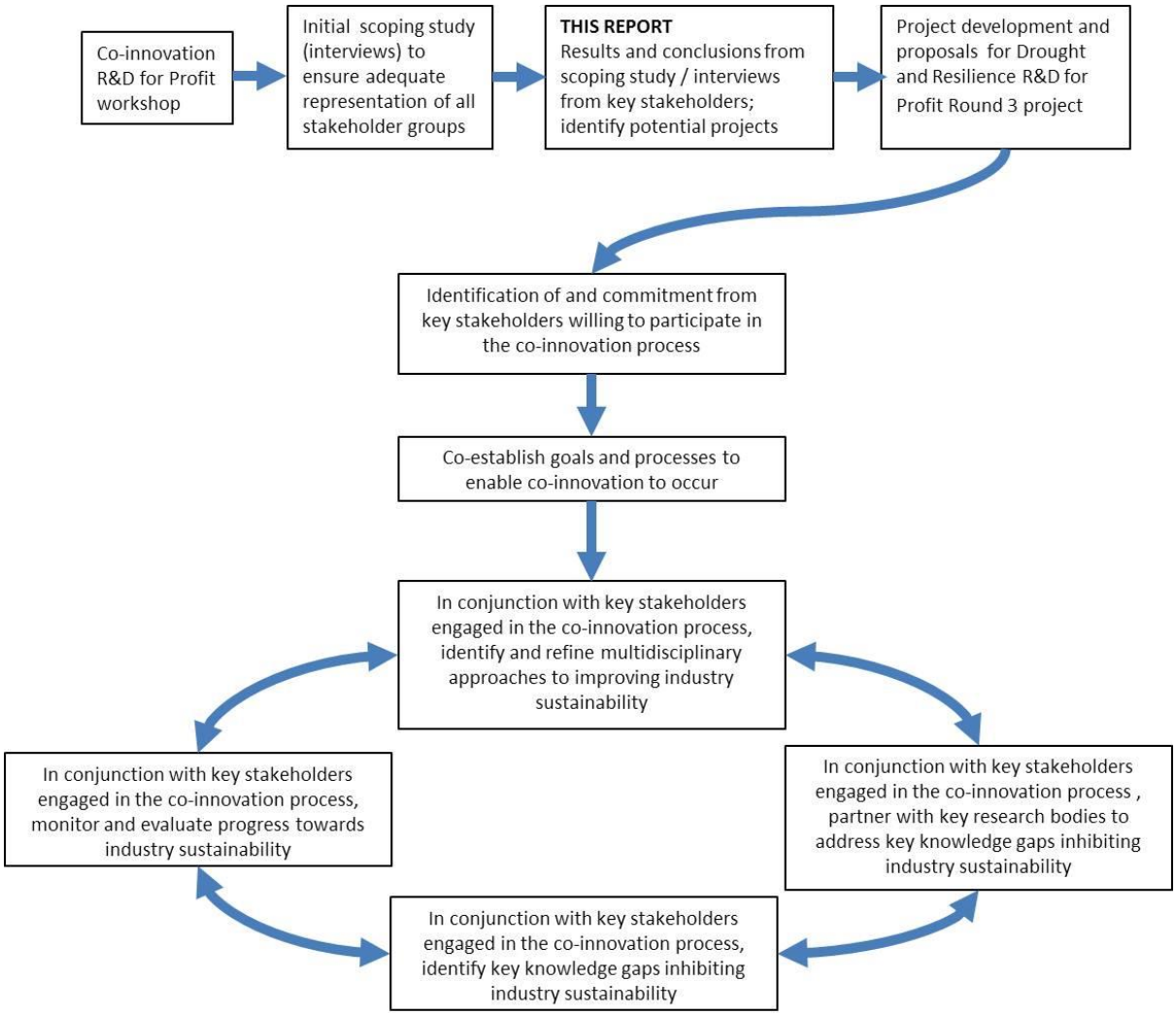


Figure 1: Conceptual diagram outlining key steps in the process of MLA co-innovation for sustainability project proposal development and delivery

2 Methodology

The scoping study used a Rapid Rural Appraisal (RRA) approach, applying system wide thinking (Beebe, 1995; Tate, 2009) to map key R&D issues related to drought and climate risks; key management decisions; decision support; barriers to adoption and adaptation; community values; and future goals of multiple stakeholders associated with the livestock (red meat, dairy, sheep and wool) industries.

2.1 Scoping study locations

The study covered four livestock production regions within Australia (Fig.2). These included:

- livestock (cattle/sheep) grazing systems around Longreach in western Queensland;

- beef cattle grazing/production systems in the Kimberley/Pilbara region of north western Western Australia (WA);
- mixed farming systems in the sheep-wheatbelt of south western WA; and
- livestock (dairy and beef cattle, sheep) and mixed farming production systems around Bendigo in northern Victoria.

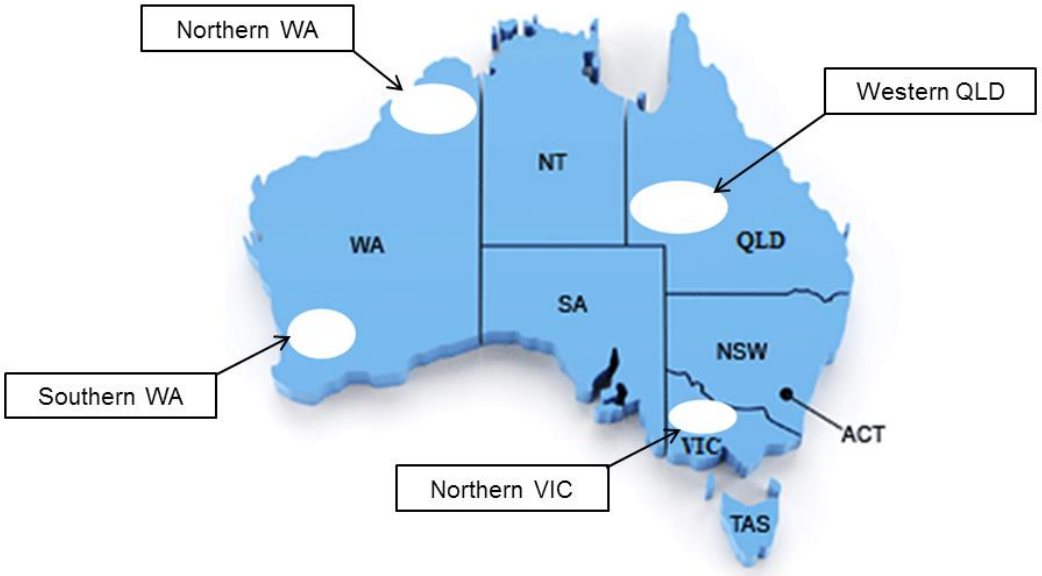


Figure 2: The approximate extent of the four livestock production regions surveyed.

2.2 Survey participants

A total of 59 interviews was conducted across a range of producers (approximately one-quarter of all interviewees) and associated stakeholder groups including financial institutions (e.g. bank managers); NRM and industry managers; extension officers; researchers; consultants; media personnel; agribusinesses; tourism operators; retailers; health professionals; educators; processors and local government employees.

The selection of interviewees was based on:

- key industry people identified by the Research and Development Corporations (RDCs), Meat & Livestock Australia (MLA), Australian Wool Innovation (AWI) and Australian Dairy Corporation and local operators; and
- a snowball technique (chain referral sampling) based on people suggested by other interviewees (Vogg, 1999; Atkinson & Flint, 2001).

2.2.1 Characteristics of the survey participants

Across the four regions surveyed, 24 people were interviewed in Longreach and the surrounding district; 11 in northern Victoria; eight in south-western WA; and 16 in the Kimberley/Kununurra region of north-west WA.

Of the 59 survey respondents, 15 identified as producers (cattle, sheep, dairy, mixed farming), 16 as government agency or industry RD&E staff, five as private consultants to the livestock industry and 23 as associated community members (from the health, education, financial and business sectors). Table 1 provides a breakdown of survey respondent identity by survey region.

Table 1: Self-identified role of survey respondents*. Figures in parentheses identified with more than one sector, but are included in the livestock industry sector counts in Table 2.

Industry sector	Northern WA	Western Qld	Southern WA	Northern Vic	Total
Producer	5	6 (4)	(5)	4	15
Value adder		1			1
Wholesaler	1				1
Financier		1			1
Banker				1	1
Service provider	2[c]	2	2	2	8
Materials supplier	1				1
Retailer	1	1		1	3
Researcher	1	1[a,b]			2
Educator		2	1[b]		3
Health provider		4			4
Extension Officer	3[a,c]	4	2	3	12
Manager	1		1[a,b,d]		2
Consultant			1[b]		1
Other	1	2	1		4
Total	**16**	**24**	**8**	**11**	**59**

* in response to Question 17 of the survey (Appendix A)

[a] Beef cattle; [b] Sheep; [c] Dairy; and [d] Mixed farming

Of those respondents who identified as producers, ten were involved in the beef cattle industry, five in dairy, seven in sheep and wool, and six in mixed (livestock and cropping) farming (Table 2). In some instances, survey respondents were involved in more than one of these industries; hence, the total number of producers may differ from that indicated in Table 1.

Table 2: Number of survey respondents who identified as producers by region and livestock industry sector.

Industry sector	Northern WA	Western Qld	Southern WA	Northern Vic	Total
Beef cattle	3	5	1	1	**10**
Sheep		3	3	1	**7**
Dairy cattle		3		3	**6**
Mixed	2	2	1	1	**6**

Survey participants also varied in terms of how long they had been associated with the region (Fig. 3). These ranged from less than one to over 50 years, with more than 50% (57.6%) of respondents associated with their regions for periods of between six and 25 years.

Figure 3. The number of years survey participants had lived in the region by survey region.

Similarly, participants varied in terms of the proportion of their business income which was derived from the livestock industries (Fig. 4).

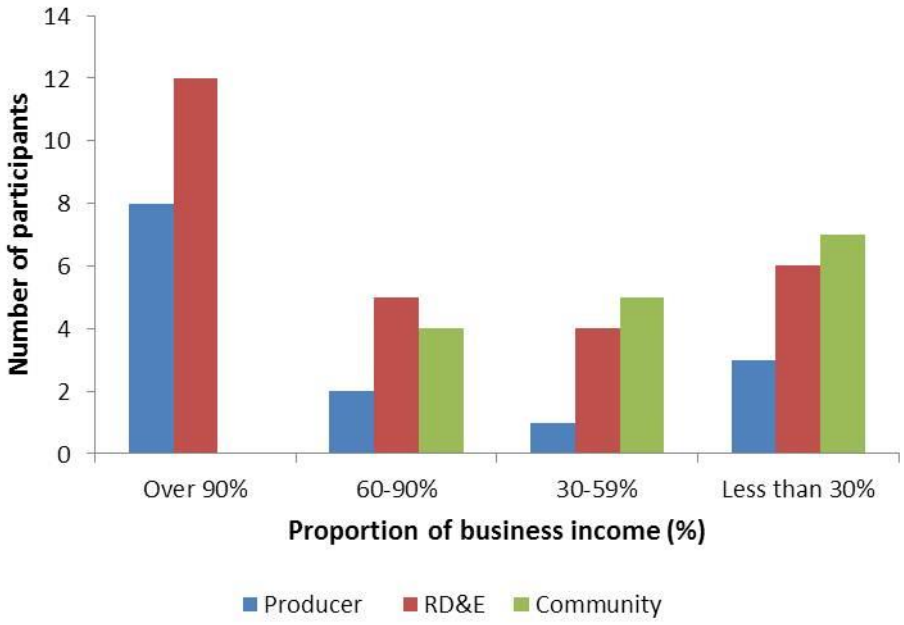


Figure 4. The relative importance of the livestock industry in term of contribution to business income by stakeholder group. The 'RD&E' category includes those who identified as 'researcher', 'extension officer' and 'consultant'; the 'community' group includes all who identified as other than 'producer' or those included in the 'RD&E' category.

2.3 Survey questions

The study used a semi-structured interview process to collect responses to a series of questions aimed at identifying industry RD&E needs in relation to risk, adaptation and resilience, particularly with respect to drought. Table 3 outlines the key focus of the 20 questions in the survey instrument. The full set of questions is available in Appendix A.

Interviews, which were recorded and later transcribed, were conducted and analysed by a multidisciplinary team using a Rapid Rural Appraisal (RRA) approach (Chambers, 1994; Crawford, 1997).

Table 3: An outline of the questions posed during stakeholder interviews*

Question	Theme/focus
Part A	**Introduction/background**
1.	Business background
2.	Reason for involvement in the business and the level of satisfaction
3.	Definition of success in the business
4.	Motivation to work in the business
Part B	**Livelihood and climate (drought) risks**
5.	Main risks to the viability of the business
6.	Actions taken to minimise business risks
7.	Sources of motivation to manage climate risk
8.	Reason for making a vital business decision
9.	Factors preventing the adoption of new solutions, technologies and practices
10.	Drivers that help the adoption of new solutions, technologies and practices
11.	External factors influencing your ability to manage business risk and viability
12.	External factors influencing your ability to deal with variability and extreme events
13.	Contacts with other businesses
Part C	**Business and social situation**
14.	Location
15.	Time at this location
16.	Main work
17.	Role in the livestock industry
18.	Proportion of business income related to livestock industry
19.	Sources of information and education in the business
20.	Main goals/aspirations in the business for the next 5 and 10 years

* See Appendix A for the complete set of survey questions.

2.4 Analysis of survey responses

Initial analysis of the content of the transcribed interviews was conducted using two reductive summative text analysis approaches:

I. a semi-quantitative approach using the frequency of words to identify key areas of relevance (interests, concerns etc.) as expressed by the interviewees (Hsieh & Shannon, 2005); and
II. the frequency of associated or co-located words (McInnes, 2004) was also calculated to provide context to the single word count.

The results of these analyses are presented in this report along with selected quotes which exemplify key issues identified and provide some depth and context to the issues raised by the interview participants.

A more in depth analysis, guided by theory and informed by previous research (Hsieh & Shannon, 2005), is also underway, the results of which will be reported at a later date.

2.4.1 Analysis of word frequency

Tables of word frequencies were created and, from these, word clouds were constructed to visualise the word frequency for different elements of the survey. Text word frequency tables and word clouds were constructed[1] from interviews for:

(1) all responses (all questions, all interviewees, all regions) combined;
(2) responses to questions (2, 3, 4 and 20) about success, motivation and goals/aspirations;
(3) responses to questions (5 and 6) pertaining to risk and risk management (overall; by region; by stakeholder group);
(4) responses to questions (9 and 10) about barriers and drivers of adopting new approaches and technologies (overall; by region; by stakeholder group);
(5) responses to questions (11, 12 and 13) about the impact of external factors on business success/sustainability.

Within the industry stakeholder groups surveyed, sector groupings (beef, dairy, sheep, cropping) included both producers and RD&E professionals who identified with that part of the livestock industry, while the community group represented participants who were not directly involved in the livestock industry (these included health care professionals, educators, retailers, accountants, bankers etc.). Interview responses were assigned to each of the agricultural industry areas, based on the participant's stated dominant source of income. In some surveys, several (up to four) people from the same farm or organisation were interviewed at once. These surveys were treated as a single response.

The text from interviews was analysed in R version 2.15.0 (R Development Core Team 2015) using the packages tm, SnowballC, wordcloud, stringr and RColorBrewer (Bouchet-Valat, 2014; Fellows, 2014; Neuwirth, 2014; Feinerer & Hornik, 2015; Wickham, 2015). Prior to analysis, punctuation and redundant generic words were removed from the text (e.g. words such as 'the', 'that', 'they' etc.). Within each group, similar words were also combined (e.g. 'agriculture' and 'agricultural'; 'success' and 'successful' etc.). Only words that were used three times or more were plotted in the word clouds.

[1] Questions 3 and 4, 5 and 6 and 9 and 10 were analysised together as interview responses to these questions often overlapped, and/or interviewees often gave responses to a question relevant to the two questions in one response. For example, when asked about risks in Question 5, respondents would also often mention how they managed risk, which was the focus of Question 6. Likewise, when talking about drivers and barriers to adaptation, respondents often covered the two topics in the same response. Combining the responses for analysis ensured that the analysis was inclusive of all responses around the general themes of these questions.

The word frequency analysis results presented in this report provide an indicative summary of the focus of discussion in response to the survey questions posed. There are a number of caveats to using such an approach. These include:

- Word frequencies represent the sum of interviewee responses, rather than an average per interview;
- Some individual's views may be more strongly represented than others (though this may be due to a greater level of direct experience with the questions asked);
- Results may have been influenced by the context and timing of interviews—in some areas, recent drought or good rainfall is likely to have been a factor in some peoples' responses;
- Some words have different meanings in different contexts. For example, 'time' was used in relation to 'that time I did this' and also in 'farmers don't have time to …'. This needs to be considered when interpreting the results for some words; and
- Uneven and limited survey numbers for some regions and/or industry stakeholder groups mean that the views of some regions and/or industry sectors are not as well represented as for others. For example, more cattle producers than sheep producers were interviewed; more people were interviewed in the western Queensland survey group than in other regions. We attempted to counter this problem by separately analysing transcripts for the different regions and groups, where relevant.

2.4.2 Analysis of word association

Word association was measured using the likelihood ratio statistic (G^2), which measures the strength of association between words (McInnes, 2004). Analysis of word associations was performed in R version 2.15.0 (R Development Core Team, 2015) using the package quanteda (Benoit & Nulty, 2016) and the likelihood ratio statistic, G^2 (McInnes, 2004).

The G^2 ratio provides a relative measure of word association based on how often a word occurs in conjunction with another against how often it occurs by itself or in other combinations in the document as a whole. The association measure (G^2) is calculated using the formula:

$$G^2 = 2 \times \sum_i \sum_j (n_{ij} \times \log \frac{n_{ij}}{m_{ij}})$$

where, *i* is the index documents; *j* is the index features (words); n_{ij} is the observed counts; and m_{ij} is the expected counts in a collocations frequency table of dimensions $(J - 2 + 1)^2$ (Benoit & Nulty, 2016). Pairs of words that frequently co-occur will have a higher G^2 ratio than those that occur either with a number of other words or by themselves.

Analysis of word association was conducted across the entire set of interviews for all word combinations and for specific words (i.e. 'success', 'risk' and 'adopt') relating to the key

themes of the survey. Words related to these key words were also included in this analysis (e.g. successful, succeed, adoption etc.)

3 Results

Frequently mentioned words and word combinations provide an indication of the main issues discussed in the interviews across the entire survey (Section 3.1) and around particular topics (Sections 3.2 to 3.5). Selected quotes add context and depth to the summary. The following sections provide word clouds, figures ranking the most frequently used words and ranked lists of word combinations for each of the analyses outlined in Section 2.4.1 and 2.4.2 as well as, where relevant, selected quotes from the interview transcripts.

3.1 General survey result

The word cloud comprising the 100 most frequently mentioned words (Fig. 5a) and list of the top 20 (relevant, non-generic) words (Fig. 5b) across the entire study provide an indication of the breadth and focus of the survey. Overall, local and property level issues predominate, with terms such as ‘time’, ‘drought’, ‘management’ and ‘water’ among those most frequently mentioned throughout the survey.

The most commonly occurring word combinations across all responses (all survey questions and all participants) begin to define some key issues and areas of concern. These include ‘mental’ and ‘health’; ‘cash’ and ‘flow’; ‘wet’ and ‘season’; ‘climate’ and ‘variability’ and ‘business’ and ‘success’ (Table 4).

(a)

(b)

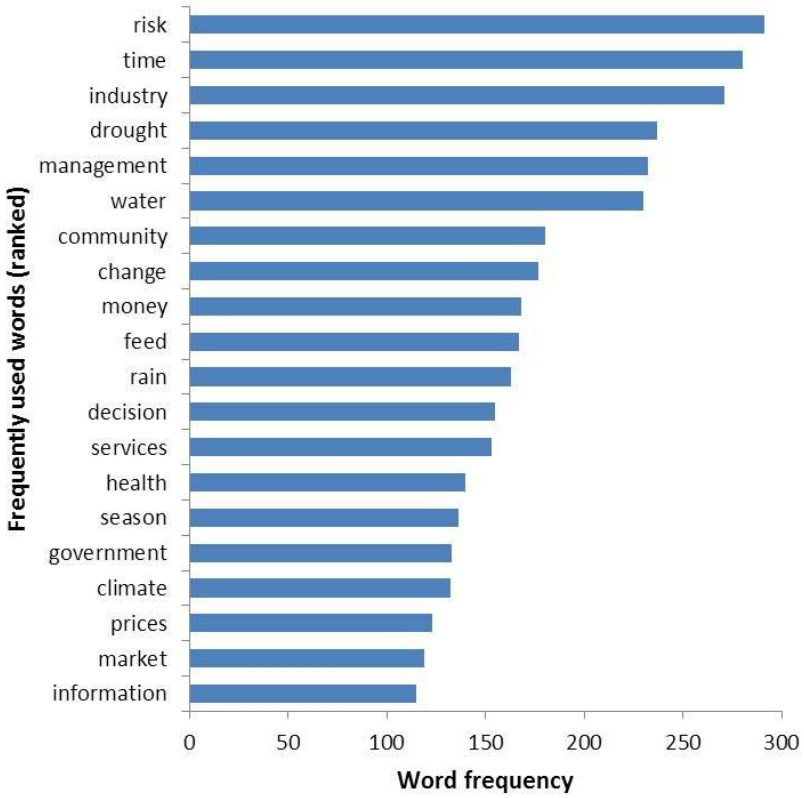


Figure 5. Word frequency across all interviews; (a) word cloud of the 100 most frequently mentioned words (text size is proportional to relative frequency); and (b) twenty of the most frequently mentioned words (generic words such as ‘farm’/’farmers’, ‘business’ and ‘cattle’ etc. have been excluded).

Table 4. Selected frequently co-occuring words across all interviews* (frequency count > 5; G^2 > 25).

Word 1	Word 2	Count	G^2
wet/dry	season	36	177.6
mental	health	31	332.6
cash	flow	26	299.5
risk	management	22	53.9
wild	dogs	19	276.9
short	term	19	200.1
climate	variability	19	173.3
business	success	18	36.9
extension	officer	17	173.1
health	services	17	75.0
climate	risk	17	48.3
live	export	16	179.6
climate	change	16	90.0
social	media	14	162.8
supply	chain	14	83.4
cattle	prices	13	84.8
adopt	technologies	13	81.8
bottom	line	11	71.2
carrying	capacity	11	70.8
wellness	network	10	139.7

Word 1	Word 2	Count	G^2
service	provider	10	98.1
health	Care	10	87.2
natural	disaster	10	73.2
rural	communities	9	72.6
business	Plan	9	39.6
cluster	fencing	8	120.7
succession	planning	8	95.7
professional	development	8	92.6
government	policy	8	60.3
local	community	8	40.5
rural	health	8	38.0
market	Risk	8	35.3
monitoring	evaluation	7	104.2
client	Base	7	89.0
technical	information	7	57.4
local	businesses	7	38.7
land	management	7	33.7
industry	development	7	31.4
water	market	7	28.8
grazing	pressure	6	59.9

3.2 Business motivations, aspirations and success

The responses to questions about success, motivation/aspiration and community (Questions 2, 3, 4 and 20; Appendix A) are shown in Figure 6. Additional to the words associated with the questions asked (e.g. success, business and community) the words ‘industry’, ‘motivation’, ‘profit’ and ‘services’ were most prominent.

(a)

(b)

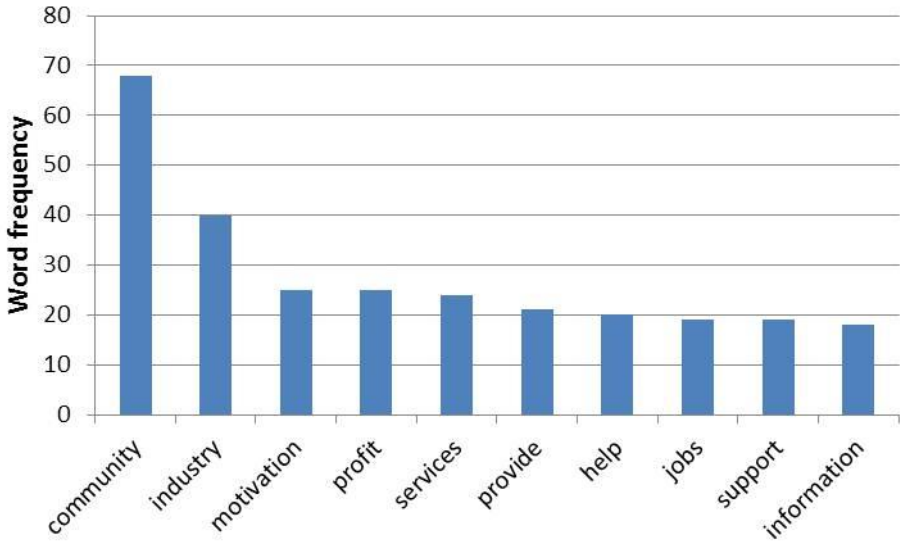


Figure 6. Word frequency across all interviews in response to questions about success, motivations and aspirations; (a) word cloud of the 100 most frequently mentioned words (text size is proportional to relative frequency); and (b) ten of the most frequently mentioned words (generic words such as 'business', 'success', 'farm'/'farmers' etc. have been excluded).

3.2.1 Motivations

In response to questions which asked 'What is it that drew you to this business/ industry/ region – what makes it enjoyable/ worthwhile for you?' and 'What is the motivation to do what you do?' (Questions 2 and 4, respectively), interviewees frequently responded that they were drawn to working in rural communities because of a passion for agriculture and for family and life style reasons. For example:

Producer, QLD:
"*I was born out here and, as a young fellow growing up, I thought that was probably what my parents wanted me to do - not that that was necessarily the case, but that's just what I know I guess and what I enjoy. I enjoy being out here - I don't enjoy the hustle and bustle of city life, I enjoy the life style out here. There's certainly aspects that we don't enjoy - when it's dry and livestock aren't surviving. It's the lifestyle and I enjoy working with cattle and I enjoy working with livestock and I enjoy the people in the bush. That's why I'm out here*."

Producer, QLD:
"*What drew me in, I guess, the industry - I love the industry and I love the area and the - just living out here but also supporting those that live and work and make their money out here."*

Community, south-western WA:
"*Being involved in agriculture is something I'm familiar with. I've spent most of my life living in regional Western Australia. I've got some good friends out here and I guess I like being part of the ever changing landscape, the ever changing conditions …*"

Producer, QLD:
"*I guess I personally was drawn into the business because my family owned the business. They set it up to be a great way of life…"*

RD & E, north-western WA:
"*My whole family is here. I like the atmosphere and I like the country. I love working with cattle all my life*."

An opportunity to learn, share knowledge and help farmers was also given as a reason why people enjoy working in agriculture:

RD & E, QLD:
"*To me, it's just integrating ecology with animal management and looking after the landscapes and trying to keep people in business at the same time*."

RD & E, QLD:
"*It's been my passion. ….I found that there's a lot of good information that was out there but it wasn't getting adopted by the industry so I just got more heavily involved in that aspect and in trying to improve adoption rates and uptake of information. What makes it enjoyable for me is that I like living in the bush and I like dealing with producers and I like the culture of the bush and I also enjoy seeing people actually progressing and improving their bottom line and I have a personal interest in the industry myself having been a producer so I can identify with the changes that happen on their place and the opportunity to travel around and see a lot of country and see how the operations vary so greatly from one region to another*."

RD & E, north-western WA:
"….*We got young energetic farmers who want to do new things which is really exciting. That is from the agricultural point of view. But also from the pastoral point of view a lot of production is taking place. It is an exciting place to be*."

RD & E, south-western WA:
"I've always had an interest in sustainable agriculture and how farmers can improve the sustainability of the farm without impacting their profits. I also have a background in research and my current job ticks both these criteria. I enjoy being able to give farmers a chance to try new things on their farm that they normally wouldn't risk."

3.2.2 Success

Words that were most frequently and most likely to be used in association with the term 'success' (Table 5) were about measurement of success ('mark', define', measure', indicator').

Table 5. Selected words frequently co-occuring with 'success' across all interview questions (frequency count ≥ 2; $G^2 > 5$).

Word	Count	G^2
business	22	36.88
mark	4	42.54
define	4	34.53
measure/indicator	3	10.21
sustainability	3	5.96
financial	2	8.31
driven	2	7.00
adopt	2	5.81

In responses to Questions 3 and 4 which asked 'In your view, what is success in your business and in the region?' and 'How do you define success?' (respectively), statements about success frequently included references to profitability and sustainability or longevity; for example:

Producer, south-western WA:
"Well, it's about short term and long term viability that offers - so, in short term I mean profitability and long term I mean sustainability - and that offers a suitable lifestyle to all the people—whole families—that operate those farms and stations."

Producer, QLD:
"In any business, the indicator of success is to be profitable."

Producer, north-western WA:
"Longevity. To get through the seasonal conditions and be able to continue on."

Producer, QLD:
"I don't look at it as success - more sustainability. If I can do this, year in year out, and grow herd numbers and capitalise on opportunities as I go, that's where I gain my success from."

Community, north-western WA:
"… long term profitability that allows the business to transition from one generation to the next."

RD & E, QLD:
"in my view, it's making sure that our natural resources are used sustainably and that they're there for the next generation."

Producer, QLD:
"… profitability and the use the country wisely with a long term view for the future."

Community, VIC:
"I would say it's helping successful farmers continue to grow their business and be profitable and sustainable. So for me that's what success is."

Producer, north-western WA:
"For us success is how many kilos of beef we can turn out and how many calves we can get on the ground. Being innovative is another successful thing. Being sustainable. All those things drive success."

Links between success and broader business activities were also highlighted:

Producer, QLD:
"A successful business - they need to think of the overall package, they need to think of obviously productivity, they also need to look at their future potential productivity. So relating what they're doing now to the future - they're the successful ones."

Producer, QLD:
"Success in our business is reflected by success in agricultural businesses—in sheep and beef producers actually improving their land management, improving their animal production and improving their financial position."

3.2.3 Goals and aspirations

Question 20 asked 'What are the main goals/aspirations for your farm business/this industry/your region for the next 5-10 years?'. Responses (below) are sorted by the three main stakeholder groups: producers, RD&E professionals and community groups.

Producers

Producers identified goals which included:

- post-drought recovery

Producer, QLD:
"Getting the property back to before it was before the drought. Growing the business. Getting debt down or managing your debt. Then going back into 100% sheep, might have a mob of cows, and getting more people back into the region, like getting a shearing team back into town, maybe three or four shearing teams in Longreach therefore you've got wives, more teachers, more kids, more footy teams, just more of everything."

- business and industry sustainability

Producer, VIC:
"To have a sustainable farm business that supports the lifestyle our family requires forever. We don't want to be the richest people in the world but we want a nice lifestyle and support the kids. And also help other people in the industry which is why we got into share farming. If we can get a couple of people on the way to farmer ownership, that is a win win situation."

RE & D, north-western WA:
"Bring more indigenous engagement into the beef industry. Double the value of the indigenous agriculture in the next 5-6 years. 50% of the current Aboriginal landholders are currently in a viable situation."

- financial security

Producer, VIC:
"To pay off our debt. Next 10 years to buy the farm."

- productivity and profitability

Producer, VIC:
"Improve productivity, have a strong management team, increase wool cut, improve meat quality."

Producer, QLD:
"To be productive, to keep my country in as pristine a state as I can. For the business to be successful. For my family to be happy."

- adoption of better management practices

Producer, QLD:
"Land acquisition. Growth of herd. Improve calibre of staff. Introduce production managers external to family. Continue to improve management practices."

- improved land condition

RD & E, QLD:
"I'd like to see continued improvement in management especially in management of land condition. You know, I still don't think it's as good as it could be. But I still think there's a level in industry that denies it's a problem. A lot of the regulations we're stuck with—I mean, industry … because there's 20% that don't manage well and that forces the rules the other 80 % have to deal with. But the other 80% won't do anything about the 20%; they allow it to keep happening. It's just seen as part of it.

- succession planning

Producer, north-western WA:
"I would like to think that we could fairly well control 80% and really drive segregation and the breeding side of things. At the end of the day we are here to produce kilos of beef. We need to get more calves on the ground. Our number one aim is to drive that as the hardest. Keep our head above water, keep vigilant and keep on top of LivEx. Then we have got it for the next generation."

- lifestyle

Producer, VIC:
"Well see we've got three girls, they don't want to do it…they will never do it. We really have no ambition to do anything else I suppose. We are realising that we are getting older and we have to do something differently. Really I like this little house, it's warm, it's cosy. We are quite happy here. But we are going to get old, we will probably end up going to an old people's home."

RD&E professionals

RD&E professionals identified goals which included:

- greater recognition and policy influence;

Producer, south-western WA:
"Being better recognised as part of the agricultural industry. Now it's to really get our strategy adopted and … actually see if we can influence policy or value chain markets."

- improved NRM outcomes

RD & E, south-western WA:
"Some of our natural resource issues are big and they need to be part of that value chain. We've actually the banking sector—that natural capital declaration that they signed is a real sign that people are valuing reinvestment in the condition of their land as actually a way of managing business risk and if the finance sector and the insurance sector is saying that's important the farmers will pick it up; that those measures that are put in place are actually going to generate some of the regional NRM outcomes that we're looking for."

- greater integration of management for sustainability

Producer, QLD:
"… that producers have more confidence in their business by improved management of both their stock and their resources and achieving that balance between productivity and future potential of their country."

Producer, north-western WA:
"The livestock industries right now are in a pretty good place financially you know their products - whether it's meat or wool or milk - well milk - is in high demand that the price is good - so in the next five years I don't see it getting any worse and I think that the industries are getting better at managing their operations. The less certain future that we all face and the need for more sophisticated management of farming operations and better particularly better prediction of what's coming— if more money can go into modelling and more precise climate prediction that is a really valuable tool for people on the land to be able to plan ahead with much more confidence and take a lot of the risk out of their operations."

- producers engaged in longer term planning horizons, improved risk management and better able to take advantage of opportunities when they arise. For example:

RD & E, north-western WA:
"Doubling the production of agriculture by 2025. That means opening up more land and getting more production. For the pastoral land, we are trying to get some of the pastoral leases more productive and working with the top producer to increase the calving survival rates."

RD & E, QLD:
"The purpose is to improve and make our primary industry businesses more sustainable. We want people to reduce the impact of the highs and lows by measuring risk and taking advantage of the risk."

Community groups

Community members identified goals which included:

- business growth and sustainability

Community, QLD:
"Any good business is there to be sold eventually and we are now in a point of time where our family have now moved away. We made the decision that we will be putting the business on the market next year."

Community, QLD:
"Make sure we are still open in 5 years and continue to provide high quality health services, with a minimal cost to the community."

Community, south-western WA:
"From a CBH perspective we want to be sustainable, accountable and successful and we want our grower cooperative members to be all of those things at the same time."

- valuing rural connectivity

Community, QLD:
"We're all in this together - town and country - and there still a little bit of that … there has been some resentment about how much support country people have received, from some town quarters because they haven't received anything - so, it's interesting, but I think we should reflect on and learn that we are in it together. Drought is a natural disaster and it's not reflected as a natural disaster in the legislation and it should be, because the flow on effect is equally as devastating."

Producer, north-western WA:
"Establish a cattle feeding industry in the valley, that we can feed 100 000 cattle in the area which will make a lot more employment in the area, maybe another 250 people. I would love to see more Aboriginal people working in the industry – feeding & cattle industry."

- regional industry and business diversification and innovation

RD & E, QLD:
"Expand my business to employ people on the technical side and possibly also more in the admin side, to try and do things a little bit efficiently. Improve my network base with other providers across the state. I would like to be in a position where I can actually develop a more holistic approach to how people manage their properties in terms of how I can be servicing their needs."

Community, QLD:
"Being able to be here for the next ten years that would be my goal. Re-evaluating what you're doing, looking at your business, coming up with new innovation, managing change, and trying to keep what's going on in the world and the local economy."

Producer, south-western WA:
"… Australian Farmland Conservancy raise $100 million for regenerative farming and 2000 more agriculturists."

- coping with change

Producer, north-western WA:
"Financial gain and reduce the amount of stress related to the seasonal conditions and financial constraints."

Community, VIC:
"Try and help the local dairy farms become more resilient, sustainable, so that they can survive the extreme volatility they have experienced in the last 15 years."

3.3 Risk and risk management

The most frequently mentioned words in response to questions 5 and 6 about risks to business viability and risk management (Fig. 7), across all interviewees and regions, indicate a clear emphasis on issues associated with climate ('drought', 'rain', 'season', 'climate') and resource ('water', 'feed') availability. Terms most frequently used in association with 'risk' (across all survey questions) included 'manage', 'climate', 'business' and 'market' (Table 6).

The business risk associated with drought and rainfall variability was frequently highlighted by producers. For example,

Producer, QLD:
"*…if we don't get rainfall, we don't have grass, we don't produce ... if we don't produce, we go broke, basically. In this country out here - there's probably three in five years that we survive fairly well. In the other two years, we make nothing*."

Community, VIC:
"if you're talking about where the climate seems to be heading, the main risks are that we have more droughts and worse droughts—longer drought—and that obviously has ramifications for income being much less certain which then has implications for the people who run those enterprise—you know, depression and family social problems and things like that—it has all those knock on effects. … often those people who go early have less stress than the ones who had a plan to keep their stock and who put aside feed and feed it all out; so they've made the investments and then that's run out and then they say 'well, I've already got a

strategy and now I have to buy in more feed.' I know in Queensland, some people went for three years feeding and that must have been extraordinarily stressful and their neighbours who just got out early—it wasn't stress free for the, but they didn't have to worry about spending and spending and spending."

(a)

(b)

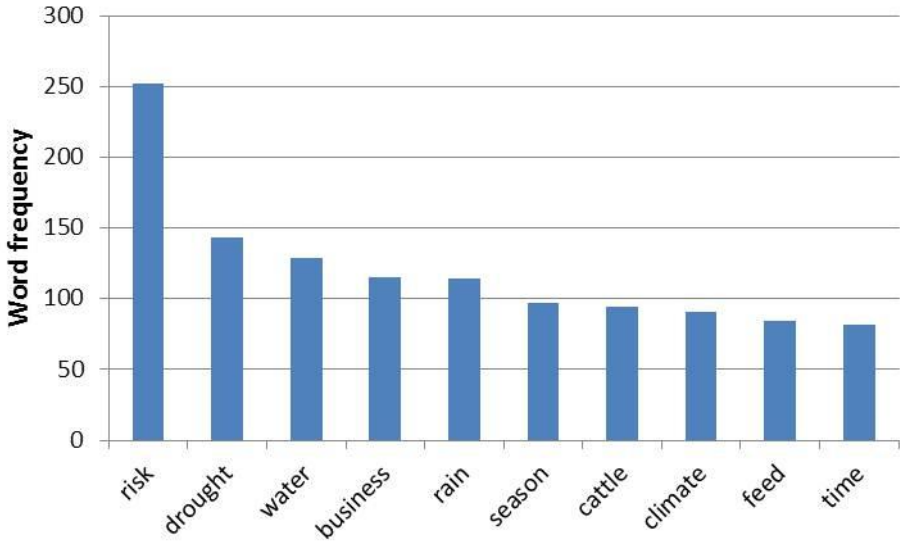


Figure 7. Word frequency in response to questions about risk and risk management; (a) word cloud of the 100 most frequently mentioned words (text size is proportional to relative frequency); and (b) ten of the most frequently mentioned words (common but generic words such as 'farm','farmers' and 'industry' are not included in this figure).

Table 6. Selected words frequently co-occuring with 'risk' across all questions (frequency count ≥ 2; $G^2 > 5$).

Word	Count	G^2
manage	35	50.98
climate	24	48.35
main	17	61.94
business	15	15.02
market	12	35.33
major	9	33.92
price	8	17.50
control	7	7.66
reduce	6	14.48
effect	6	7.98
influence	5	6.87
drought	5	5.24
minimise	4	20.39
frost	4	17.84
measure	4	17.31
lack	4	16.17
take	4	13.42

Word	Count	G^2
uncertainty	4	10.47
operational	4	8.64
financial	4	8.60
biosecurity	3	24.50
spread	3	17.37
viability	3	15.71
fire	3	11.72
specific	3	11.25
agriculture	3	10.59
low	3	10.59
losing/loss	3	9.82
factor	3	9.53
significant	3	8.36
strategy/strategic	3	8.14
deal	3	7.80
health	3	5.71

Similarly, the broader community, such as accountants and those in the banking sector, also highlighted business risks associated with drought. The important flow on effects throughout the community of drought were also mentioned:

> Community, QLD:
> "*Debtors are the biggest one…. During drought it is higher, during drought, during floods . Those two events. Floods, because they can't get to town, they don't have access to, they usually have internet problems, they can't do their shearing. That is the same with the drought, once they de-stock their numbers, and it is the same with the businesses … who I do with business with as well, they will carry a client who is on the land and … because they are not getting paid they are not paying us. So it's like a catch 22 situation. Generally speaking you don't have the cash flow and therefore it makes it hard for you to pay your wages, your superannuation, your tax, your everyday things. Very little control, as such, other than to be able to prop the business up in those time. Personally if you don't do that then your wages can't get paid. But that's true of every business in drought or flood situations*."

In terms of drought risk management, interviewees also spoke about:

- stocking rates and total grazing pressure

  Producer, QLD:
  ".. we stock reasonably heavily, but I'm also very conscious of spelling country and making sure that I've got grass in front of me and, if you carry that body of grass over, you get much better response in the spring. If you've got good ground cover, you've got better root structure in your grass. Once you start grazing it short on a regular basis, your root structure starts to diminish and your capability to grow grass quickly when the opportunity's there diminishes as well."

  RD & E, QLD:
  "Managing your land sustainably can definitely affect the resilience of your system to that drought and can definitely increase how well you can use that rainfall by conserving the moisture and the nutrients on your property. But, bearing in mind that drought is just a big steamroller , that you just have to manage through or at least try and minimise the effect on your business. … If things are going to bring you undone, it's because you're at the edge of ... if your equity gets too low, you're going to fall out the back end; if your land condition gets in a bad way, you could potentially run into problems, so it's probably about trying to maintain some of those key aspects of your business in a pretty strong position."

  RD & E, QLD:
  "Other production things is loss of growth rate due to pasture reduction; and environmental sustainability ... in short, there's been a level of overgrazing due to the drought - too many animals left on properties for too long. You get denuded areas or low cover, then all the other issues that stem from that. Poor land condition, increased erosion, increased weed."

- the timing of critical decisions

  RD & E, QLD:
  "People destock; that's probably the most common response to the drought. There's a level of destocking. Some of it's forced. Some of it's a management decision. Some of it's a reaction to running out of feed, running out of water, running out of molasses, getting kicked off agistment. Some are forced to make those decisions. The only thing I can add to that is that, talking to people, there's an element that acted early and decisively and had a plan, and followed the markets and the season - as the season declined, markets declined and they were actin. Then there's others - their attitude was to wait and see, and how long people waited depended on how successful that was. I mean, basically, anyone who waited was caught out eventually because the markets collapsed and they ran out of feed and water, so a lot of people

had to destock then because they had no water. A lot of people had to buy in hay and molasses. There's people that ran out of molasses so they had to destock then. Some of the long term issues ... potentially some have done some damage to land condition, so there's that resilience there that they've impacted on. And I know some have said, did it work the way you thought? Well, the markets catch a lot of people out because they're trying to anticipate it. They try and predict what they think's going to happen. At the end of the day, they need to be financial, so they'll sit and hope. Hoping that the markets are going to turn, cause they know - you get the big market trends, but within a trend you get peaks and troughs. If you're selling on a downward market, you're still looking for a peak. You're hoping to get a peak but generally you get a trough. I don't know if there's any long term impacts, I suppose people will slowly get the numbers up. Often, the learnings in a drought come out after the drought and they say 'Well, I made a mistake; I won't make that mistake again!'."

Producer, QLD:
"The biggest decision was to sell all the sheep. There were no tears. We had been on one blood line for 30 odd years. We just got a price, trucked them out, had no grass, had wild dogs. The grass was the biggest issue. No grass going forward and had missed out on summer rain. The previous year we fed a lot of sheep and cattle for no money at all. Sure, we kept them alive. Had it rained, we would have been laughing; but it didn't rain, so it cost us a lot of money. They didn't cut any wool. They were in good condition when we sold them; but talk to as many people as you can. Once you made that decision, whatever the decision is, it's just a weight of your shoulders. A decisions that is weighing me [down] at the moment is do we agist cattle or not? Do we take the money and sell them all now? Or do we put them on agistment for the next 8 months. Once the decision is made, I'll feel a lot better. It affects you; it's a bloody million dollar deal. That is thing that will affect the business in the next 2 years."

- the importance of sustainable land management.

Producer, QLD:
"Management of grazing pressure from kangaroos - that's been very underestimated. When we were trying to preserve the last of our grass, there were thousands and thousands of kangaroos. … I don't know how much pasture a roo consumes, but plenty! They're in competition with the grazing animals. I'm relatively green myself. We all have responsibility to keep some wildlife, but not running these numbers."

Producer, QLD:
"Your number one is pasture. If you don't have pasture you've got nothing and you've got to look after that and that's the thing—pasture is becoming denuded because

people are pushing more to make a buck; therefore your country is suffering long term. You are getting environmental damage."

3.3.1 Regional perspectives on risk and risk management

Similarities and differences were evident when responses were analysed by region (Fig. 8). Words identified in Figure 7 (above) for all survey responses across all regions combined—'risk', 'drought', 'water', 'business', 'rain', 'season', 'cattle', 'climate', 'feed', 'time'—were also among the most commonly mentioned words in each of the regions in response to these questions. While this suggests that these issues are common concerns across the regions surveyed, some variation was also evident between the regions (Figs. 8 & 9). Queensland participants were more likely to highlight health and management issues such as time and control; northern WA participants were more focused on feed availability and markets; Victorian participants spoke of water availability and irrigation issues; and southern WA participants were more likely to mention systems and change.

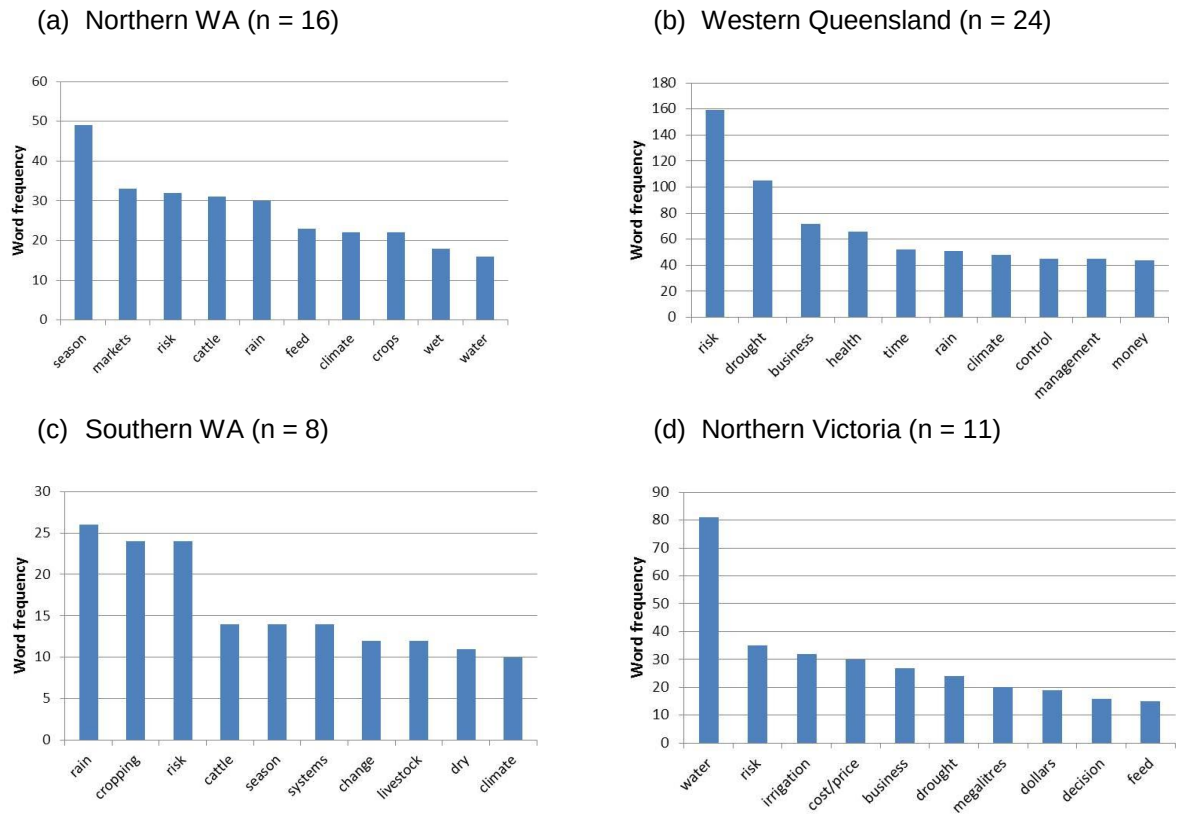


Figure 8. The ten most frequently mentioned words used in response questions about risk and risk management by region: (a) northern WA; (b) western Queensland; (c) southern WA); and (d) northern Victoria. Please note that the scale in each of these figures may differ. Common but generic words such as 'farm','farmers' and 'industry' are not included in this figure.

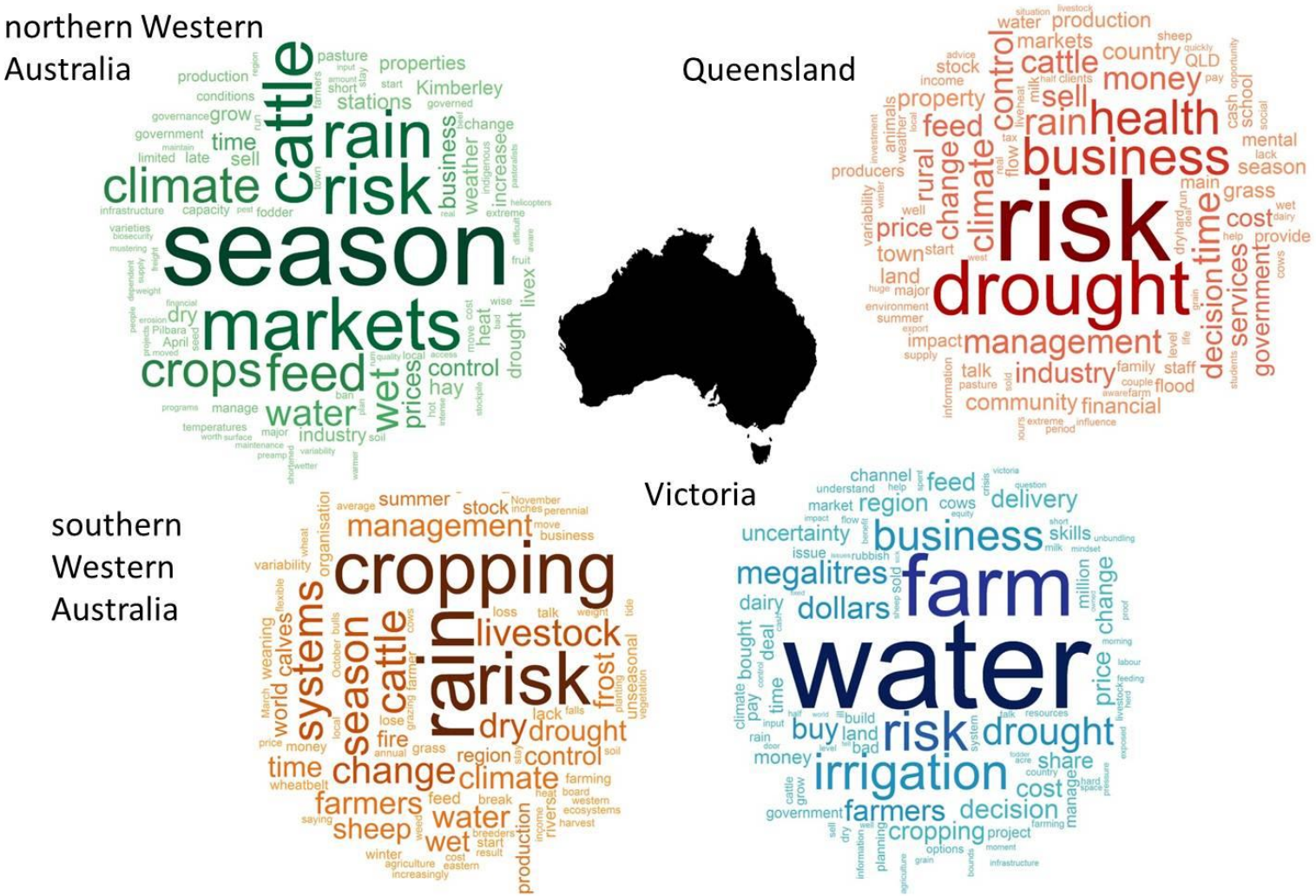


Figure 9. Word cloud for responses to questions about risk and risk management by survey regions (text size is proportional to relative frequency of word use)

Northern WA

Business vulnerability to seasonal climatic variability was talked about:

> Producer, south-western WA:
> *"Climate risk - it is very seasonal. Lately we had longer wet seasons which means it is hot and the tourists stay away or come only for a very short time. That means the tourist season is very short ... Farm wise, rain out of season is diabolical. Planting crop[s] becomes an issue."*

The importance for markets for cattle producers was also highlighted:

> Community, north-western WA:
> "*Price risk every time. When the industry is earning a quid, I am doing well. When things close down, I have to look for mining to keep things ticking along. As a backup plan. And government projects. The main driver is the international market. LivEx prices. If they are down and local beef prices are down, then there is nowhere to go*."

Western Queensland

The connection between drought risk and business (including markets) was summarised by producers from the Longreach area:

> Producer, QLD:
> "*The biggest risk is rainfall. That's the single .. well, it's not the single biggest risk, the markets are a big risk too.*"

> Producer, QLD:
> *"You look at the weather forecasting, you may not take 100% notice of it, but it's there in the back of your mind, yep Landline said August-October above average rainfall, average might only be 3 inches—might get 4 or 5—that is good. But if it doesn't happen, what is my response? And there are things that—I don't know how you get weather more accurate, but it's just the unpredictability—that are totally out of my control, are the things that affect me most. … We are [as] a group pretty conservative so if it was to come to weather, you would reach a date, so if it hasn't rained by such or such you would probably destock or move a mob to agistment or sell to keep whatever stock you got on for another three months and then have another time line and then reduce again. The government one … there is no risk management over that one, that is totally over whether you just bite the bullet and hang on or load them onto a truck and take what you can get first available before the effects really filter down through the system. You've got to—whatever happens out of your control—and work back, so it minimises your business risk and your loss in your business at the point in time."*

Producer, QLD:
"At the moment if you sell early, it's a little bit to do with the weather and say there is a decreasing chance of rain and therefore [you're] not going to have the grass to carry your stock through and the money is good at the moment so let's [sell] the mob. You sell them, but there is no tax incentive to sell early. So if you keep them on until you get declared as a drought, then you're back to your tax system that it's a forced sale. So you got 5 years to bring that sale in. The problem is you've damaged your pasture. There is no incentive to look after your pasture. One side says its going to rain....so now if you've got country that's got feed on it you're still eligible for any drought and freight subsides, but as soon as you put agistment on you lose all your eligibility, … then there is a period after that you are still ineligible then once that time passes you become eligible again for subsidies. I'm not a big fan of subsidies, but there has got to be a better system to repay the people that look after their pasture, their country. It's probably a good one to go around [to people] that have flogged their country vs. people that have sold early to see what pastures are recovering - why did they sell early? Did they still have grass left or no grass? We are probably conservative so we would want to sell early, but there is no benefit for selling early, except for the higher price, but in the tax side of things there is no benefit. You've got to work out what's best for your farm. So yeah the weather they sort of intermingle."

In relation to health, the connections between drought risk and business were also highlighted by health professionals working in rural settings:

Community, QLD:
"*… the easy answer would be to say that we definitely see a change in mental health presentations, but I think it is more than that. I think, in addition to undoubtedly seeing formal and less formal or rather indirect mental presentations associated with the drought and then occasional floods, we also see mental health issues presenting associated with the economic damage [and what] that does to the viability of farms and the knock on effect through the communities. So we not only see those presentations from farmers and their families, but from people in the supply chain and people depending on agricultural industry cash flow in the community*…"

Southern WA

Rainfall's importance for agricultural was highlighted by some respondents:

RD & E, south-western WA:
"*… our region has been suffering a strong drying trend; winter rainfall's declined, so we - both biodiversity and agriculture - are suffering potentially because of it and we've seen that in the last 10 or 15 years. But this year's been fantastic and at the same time that's actually lessened some of the issues that we had. Salinity is one of*

greatest environmental threats over here, but because it's been quite dry the last 10 or 15 years, the focus on it sort of went off. So it'll be interesting to see how that responds."

Additional to rainfall, seasonal changes in rainfall and climate were also mentioned as a risk:

RD & E, south-western WA:
"*Rainfall, frosts, unseasonal weather, extreme weather events (hail, wind, heat waves, flooding), pests and weeds. These all affect a landowner's ability to make a profit and survive another year. Rainfall is the biggest factor affecting agriculture in this region and it has become increasingly unpredictable and unseasonal*."

RD & E, south-western WA:
"*The climate in the region has become drier and rainfall has become increasingly unseasonal and unpredictable. As indicated above, landowners have had to become increasingly flexible with their management plans to be able to run with unseasonal rainfall. However this can be stressful and not always successful*."

Northern Victoria

Water was the most frequently mentioned word amongst interviewees from Victoria, and its importance is highlighted in the quotes below:

Community, VIC:
"*Biggest risk has got to be the lack of water.*"

Community, VIC:
"*The main thing that is affecting this risk is less water in the region due to buy backs, water going to other industries (e.g. almonds), government policies and drought*."

Connections between risks, water and business are also highlighted in relation to water markets:

RD & E, VIC:
"*The water market definitely [*is the biggest risk*], but not just the water market in isolation, it's how people use the water market to their advantage or disadvantage.*"

Producer, VIC:
"*Main risk is viability. Access to irrigation water. Being an irrigation farm we need irrigation water at a reasonable price. This area doesn't have enough rainfall to sustain pasture for dairy cattle without irrigation*."

The impact of recurrent drought was also discussed:

> RD & E, VIC:
> *"The main issue with the frequency of droughts is that farmers in the region are getting sick and tired of only having a couple of good years before having bad ones again. It isn't allowing enough recovery time between bad years. It also puts enormous stress on them each time and this wears them out."*

3.3.2 Stakeholder group perspectives on risk and risk management

Across the five stakeholder groups surveyed, the most frequently mentioned words in response to Questions 5 and 6 about risks to business viability and risk management (Fig. 10) also indicate significant differences between and commonalities across the groups for factors of most concern. A common emphasis is apparent amongst producer groups (beef, dairy, sheep, cropping) on weather and climate ('drought', 'rain', 'climate', 'season'), resources ('water', 'feed'), finances ('markets', 'money', 'prices', 'cost', 'dollars') and decision-making ('business', 'change', 'control', 'decision', 'management', 'time'), although there is some variation in the relative importance of these across the groups (Fig. 11). While the community grouping also commonly mentioned climate ('drought') and business issues ('risk', 'control', 'time'), they were more likely to also mention 'health', 'property' and 'town'.

Beef

Market access and the impact of drought were identified as major risks by stakeholders associated with the Australian beef cattle industry.

> Producer, QLD:
> *"There are a number of risks. I guess market access and price received is certainly a risk. Climatic variability is - and climate change - are major risks and major direct risks to the productivity of the land - to pasture growth and hence the ability to run enough stock to make a living".*

> Producer, QLD:
> *"I would say the population has fallen by 70% in the last 20 years. The properties are getting bigger - getting almost semi-abandoned. If you drive up this road, there's still a few people on some of the farms, but almost no livestock at all. It's been hit really hard by this drought".*

Dairy

Within the dairy industry, discussion of business risks and risk management centred on access to water, which is a major issue for the dairy industry where high quality feed and irrigated pasture are important components of the production system:

Producer, QLD:
"Biggest risk is the lack of water; it impacts feed availability and then increase cost of either of purchasing feed or costs of irrigation to grow the feed and whether they have to buy the feed, as a flow-on impact."

Community, VIC:
"The main risk to my business in this region is the shrinking size of the industry in the region (e.g. less farm businesses). During adjustment periods (crisis) it makes me very busy in the short term but in the long term it may lead to less work in the region."

Sheep

In the 'Sheep' industry, many of the ten most frequently mentioned words ('sell', 'drought', 'rain', 'cattle', 'feed', 'risk' and 'climate') were related to risk and risk management (Fig.11c).

Producer, QLD:
"The risks are certainly climate - drought. We've always coped with drought. Until this last episode, basically we've had two droughts. One drought followed by another drought without a break in the middle. Normally, you may completely miss a summer rainfall, but fundamentally we've missed three in a row. We've had no water, and no grass at all so that's a major risk".

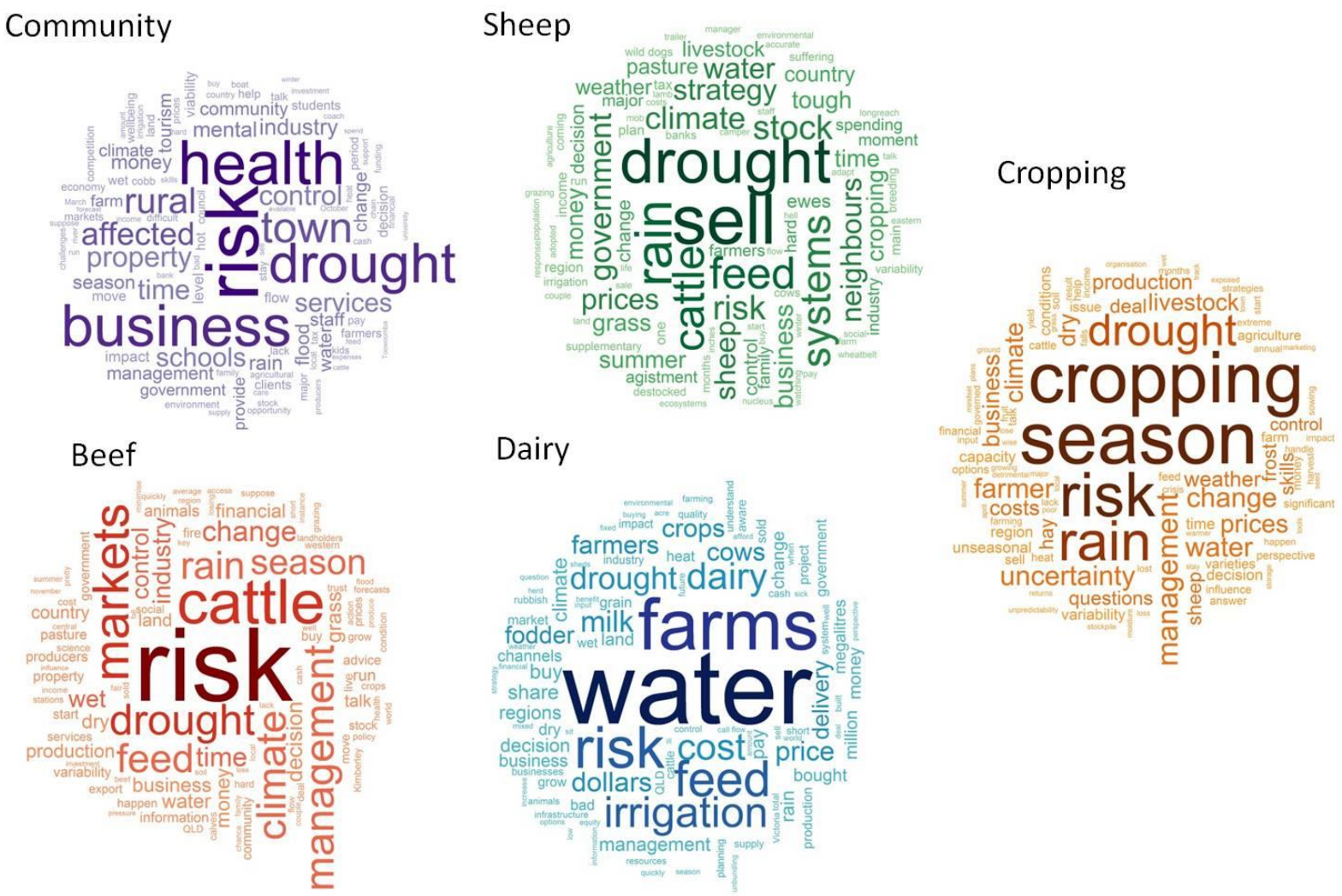


Figure 10. Word cloud for responses to questions about risk and risk management by participant group (text size is proportional to relative frequency of word use).

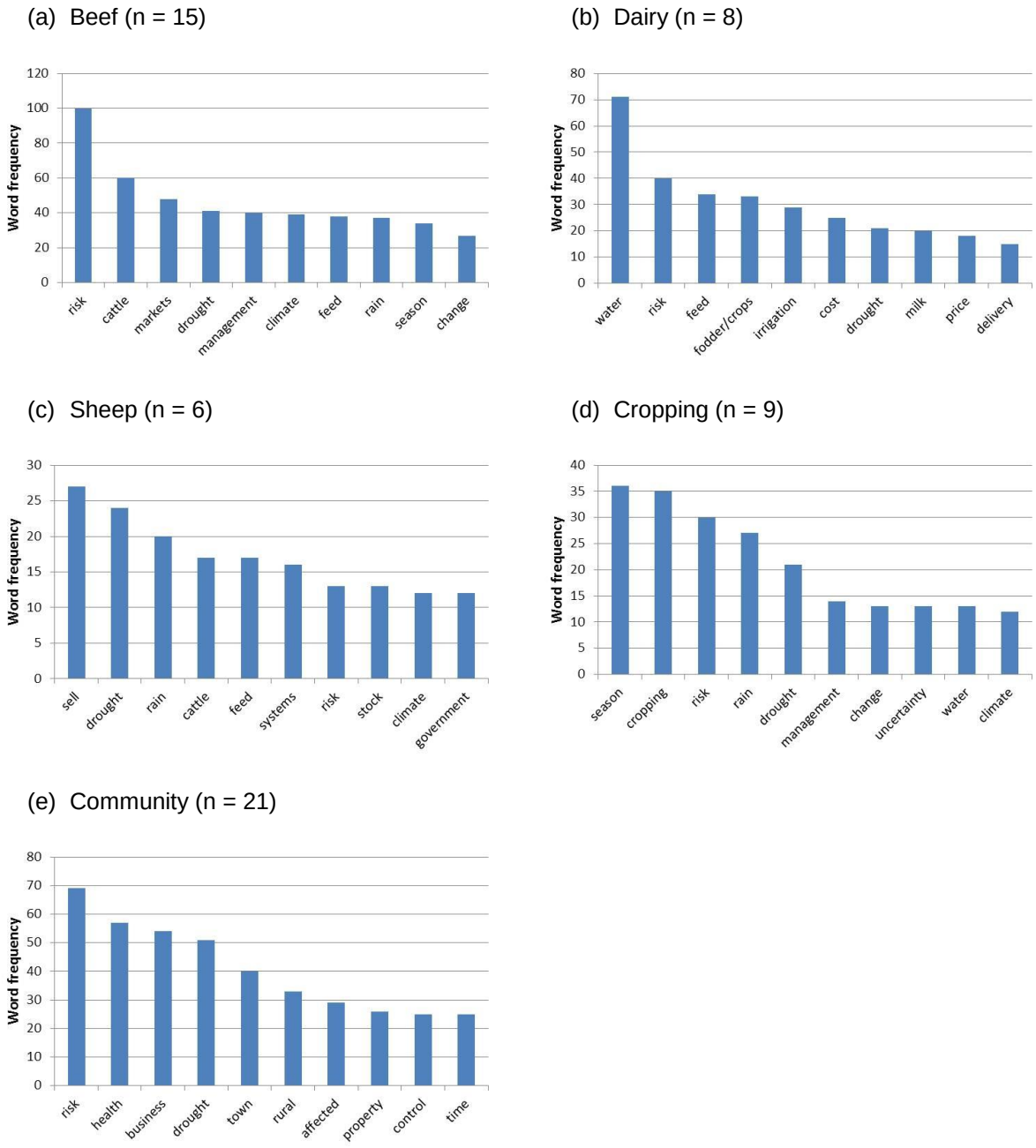


Figure 11. The ten most frequently mentioned words relevant to questions about risk and risk management by participant group: (a) beef producers; (b) dairy farmers; (c) sheep & wool growers; (d) cropping farmers; and (e) community. Please note that the scale in these figures may differ. Common but generic words such as 'farm','farmers' and 'industry' are not included in this figure.

Cropping

Rainfall variability is also a critical concern for crop production systems:

> RD & E, south-western WA:
> *"Rainfall is the biggest factor affecting agriculture in this region and it has become increasingly unpredictable and unseasonal. This has a huge impact on how a farmer can operate and they have had to become more flexible with their seeding and harvest times. At this stage cropping and livestock science is keeping up with this unpredictability e.g. providing crop varieties that can handle dry seeding. However, constant innovations and trials are needed"*.

Community

These production risks and their flow on effects also stood out as important factors in responses from community members and businesses.

> Community, QLD:
> *"… the kids need to … go to school, the bank's chasing the money - all sorts of things happen which influence that. From no farms, no returns, increasing debt, difficulty in providing for family even and it gets to the level which we've seen around mental health, family issue that arise because of that".*

> Community, QLD:
> *"… but in other rural areas where I've worked there's been a really strong tie between the obvious things such as droughts and floods and climatic events and mental health presentations. So for example quite often you find that big events that affect producers will tend to show up in your GP clinics. They may or may not present with a mental health issue as such but usually when you're talking to them sometimes, things [that] ... tends to affect or threaten farm viability tends to reflect directly in the presentation in your practice within the farming community".*

3.3.3 Summary

Key issues highlighted in this analysis include:

- risks associated with climate (drought, rain), technology access and use (internet, mobile phones), finances (markets, money, costs, business decisions) and resource (water, feed) availability are common across regions and stakeholder groups;
- significant business risks at the property level include drought, water, management (e.g. total grazing pressure) and the timing of critical decisions;
- there are significant flow on effects of risk at the property level to the supply chain and businesses in rural towns; and

- there are significant health risks associated with conducting business enterprises in regions when and where climatic variability and market and policy uncertainty prevail, which are often exacerbated by remote location and social isolation.

These issues indicate the need for effective and relevant support to enable better adaptive management—by making appropriate and timely strategic and operational decisions—to minimise exposure to risk and enhance sustainable land management.

3.4 Adoption barriers and drivers

Across all interviewees and regions, the most frequently mentioned words in response to Questions 9 and 10 about barriers to and drivers of adoption of new practices and technologies (Fig. 12) indicate an emphasis on technology and technology access ('technology', 'internet'); other words such as 'business', 'time', 'change', 'adopt', 'money', 'information' and 'solutions' were also relatively common. Few words except 'technology' were consistently associated or co-located with the term 'adopt' (Table 7).

The importance of producer's willingness and capacity to change, as well as the time to learn, adapt and adopt new solutions, technologies and practices, was a notable theme across the surveys:

> RD & E, QLD:
> *"It just comes back to the management skills and determination of the people. I often find that when they are youngish, a couple running a business where they are both engaged, you get that synergy of bouncing ideas off and they can really go somewhere. But if you have one partner - so if you want to be stereotypical, if you've got one guy who is running the farm and his wife/partner is not overly interested or involved or rising kids - I think it is a lot harder for that guy because the wife is not overly sure what questions to ask or when there are danger signs and things like that."*
>
> RD & E, VIC:
> *"Another thing was that people didn't think there was anything wrong with their current management, simply because they didn't know enough about how their business was performing. And/or they didn't know enough about their land condition. So they assumed everything was going along well. They didn't see a need to change. There was also social constraints in terms of peer pressure against changing in some cases. Also, if it involves new infrastructure, people not having the money to put in new fencing or waters to spell country. Most people … you've got to see a need for change. If it's coming from outside, then it's hard to accept that you really need to change. Like a lot of the change that we're pushing on them is really driven by maybe research and the impact on the reef and different changes there and sometimes at a local level they're not seeing that. They hear about it but it's hard to change what's*

working well for you - if you're happy, everyone's poking along. Even when it's not working well for them, there's still that reasoning within the industry that if it'd only come back to good seasons again then we'll be right, so if they can hang on a bit longer through this, it'll start raining again eventually and everything'll be right. I also think part of it's down to not understanding their business well. You know, they're just growing cattle and selling them without too much of an understanding about the decision making processes along the way. It makes it hard to make a change if you're not quite sure where the changes need to be made."

Industry differences were also highlighted in this regard:

RD & E, north-western WA:
"*In the pastoral industry some of the older pastoralists don't want to change and adopt new technologies e.g. emails etc. In the irrigation area, [it] is the exact opposite. They look… for new approaches all the time to get the better edge in the industry and increase the profitability.*"

The importance of technology and difficulties accessing information through the internet, for example, were commonly mentioned:

Community, QLD:
"*the biggest problem we've got out here is internet access.*"

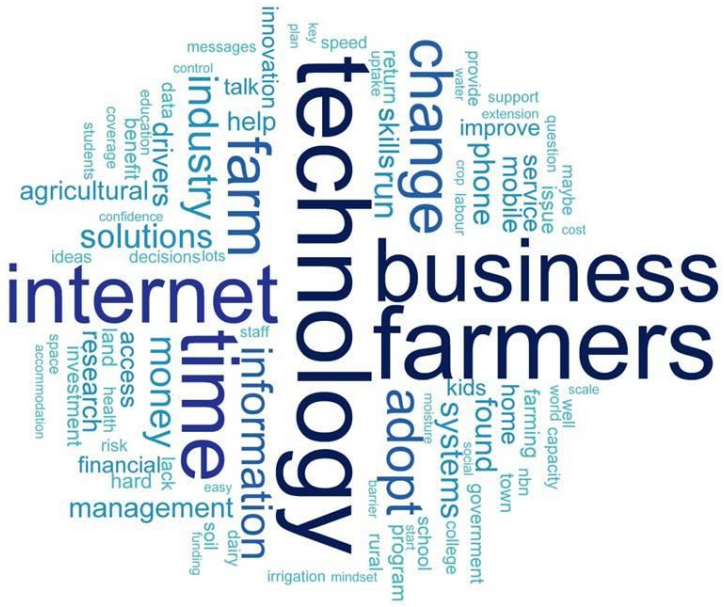
The aspect of time availability to learn and use new technology was also brought up:

Producer, QLD:
"*Time and lack of [time] would change if things turn around and then you can run more stock you'll get more men therefore you can do more of that technology side of things because you've got the time to do it.*"

Table 7. Selected words frequently co-occuring with 'adopt' across all interview questions (frequency count ≥ 2; $G^2 > 5$).

Word	Count	G^2
technology	12	81.79
solution	5	29.97
industry	5	16.28
strategy	4	19.61
innovate	3	10.39
barrier	3	9.56
change	3	8.80
sustainable	3	8.45

(a)



(b)

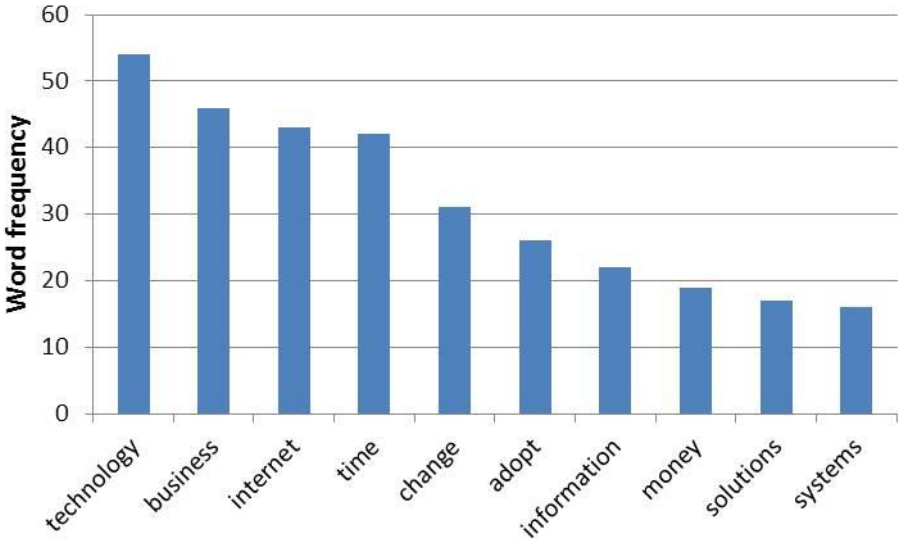


Figure 12. Word frequency in response to questions about barriers to and drivers of adoption of new practices and technologies: (a) word cloud of the 100 most frequently mentioned words (text size is proportional to relative frequency); and (b) ten of the most frequently mentioned words (common but generic words such as ‘farm’,’farmers’ and ‘industry’ are not included in this figure).

3.4.1 Regional perspectives on adoption barriers and drivers

Across the four key regions surveyed, there was a common emphasis on access to technology (‘internet’, ‘mobile’, ‘phone’), finances (‘money’, ‘financial’, ‘costs’, ‘economics’) and time in relation to the barriers and drivers of adaptation (‘adopt’, ‘change’) (Figs. 13 & 14). However, technological issues were less likely to be mentioned in southern WA, while ‘time’ was relatively more commonly used by participants in western Queensland than by participants in other regions.

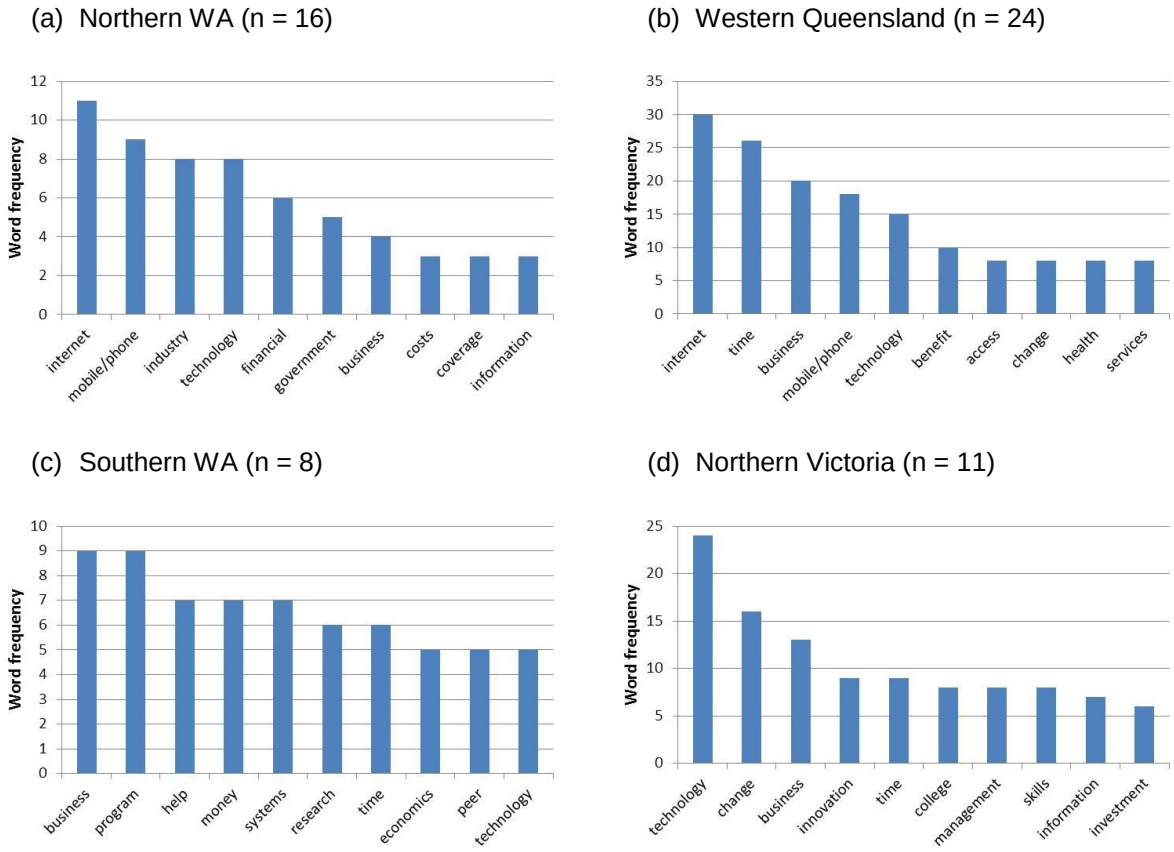


Figure 13. The ten most frequently mentioned words relevant to questions about adoption barriers and drivers by region: (a) northern WA; (b) western Queensland; (c) southern WA; and (d) northern Victoria. Please note that the scale in each of these figures may differ. Common but generic words such as 'farm','farmers' and 'industry' are not included in this figure.

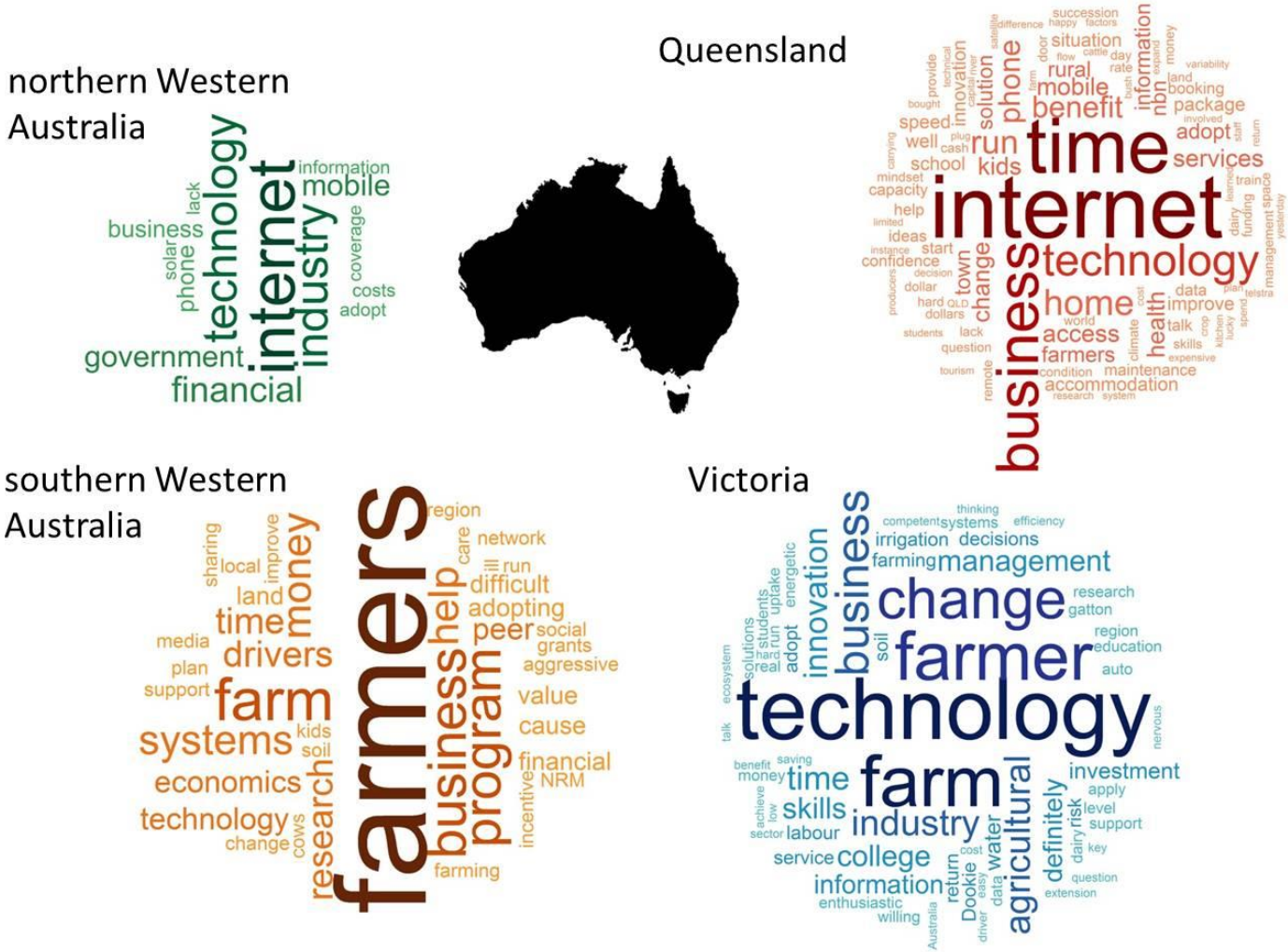


Figure 14. Word cloud for responses to questions about adoption barriers and drivers by survey regions (text size is proportional to relative frequency of word use). These word clouds comprise a total of 168 words mentioned between 3 and 30 times by participants in one or more of the regions.

Northern WA

The internet was frequently mentioned as a barrier to the adoption of new solutions:

> Community, north-western WA:
> *"Slow internet, mobile coverage and the lack of consistence."*

> Community, north-western WA:
> *"The slow internet is an issue."*

> RD & E, north-western WA:
> *"Communication infrastructure: internet, satellites, computers, mobile phone coverage etc*."

Financial constraints and the importance of working with industry were also highlighted:

> RD & E, north-western WA:
> "*Financial constraints and barrier of practice change. New approaches which come out of research need to be commercially road tested before they are adopted by the industry. We often ask the industry to road test the new stuff themselves. They are the ones in the best position to do that and we work side by side with them*."

Limitations of certain technologies in the climate of north Western Australia was also raised:

> Community, north-western WA:
> *"Climate, environment and the heat. Lots of the new technology is designed to work in 28^{o}C and off solar panels. We have 45^{o}C. And other electronic equipment don't work at all. The solar controllers have a heat issue. Mainly in the solar industry are the main issues."*

Western Queensland

Internet was highlighted as a key issue, both as a driver and barrier of adoption, by multiple Queensland respondent:

> Community, QLD:
> "*the biggest problem we've got out here is internet access - but you wouldn't have heard that - that's just - it's just a nightmare really. On the radio driving in, they're saying Kenya has better internet access than we do here*"

> Community, QLD:
> *"Bring the internet - it's coming to those far western places and that will make their lives a lot better out there - that's what you need - great connectivity and access to that."*

Community, QLD:
"You can't adopt new technologies unless the tools are there: telephone & internet. But not every solution has to have a technological focus."

From those in the broader community and those in the health sector the internet was also mentioned:

Community, QLD:
"…internet's not as fast [and] is a common complaint amongst a lot of the resident medical officers here and that does tend to decrease your ability to research particularly in your spare time."

Time, or the lack of it, was talked about as a barrier to the adoption of new solutions, technologies and practices:

Producer, QLD:
"*Energy of the farmers, a lot of them work pretty hard and don't always have enough labour to provide them with time …to allocate to these sort of areas. Once that's finished for the day to day management of the farm plus anything else that is thrown up in their face, usually something breaks down ... so energy.*"

In relation to barriers to new technology uptake, the difficulty with people embracing change was also mentioned:

Community, QLD:
"I think there's always an element of people being afraid of change. And that often reflects on difficulty in uptake of technologies. There's always an element of that's not the way my father did it and that's not the way my grandfather did it."

Southern WA

Farmer characteristics, such as age, were mentioned as both a barrier and driver of adoption:

Community, WA:
"*People's desire and willingness to change from their current and adopted methods. I think the younger brigade of farmers are very adept at that. Grabbing hold of the new technology - and whether that is through Facebook, twitter or whatever - I think they are a fairly aggressive bunch. I think the new breeds of growers are fairly aggressive at adopting new technology. I think some of the middle aged to older folk are a bit slow on the uptake there. I think the information is readily available; it's whether people want to seek it or are financially able to*."

The importance of engaging directly with farmers on the farm was also emphasised:

> RD & E, south-western WA:
> "*all farmers want to see it. They want to see things in action. Tthey want to go out there and kick the dirt, talk to someone that's experienced it, so local trials are incredibly valuable for that and that's where we ... you might say, look someone's done some research in a slightly further away region. "Oh no i don't trust it … I want to see it." So that's I guess one of the barriers - making sure that the economics of what you are suggesting are part … you know what they are, so you know how it fits into the farm business as well as the NRM outcomes."*

Northern Victoria

Technology and the importance of seeing it applied successfully in a commercial sense on the ground was raised:

> Community, VIC:
> "*As well as seeing your neighbours do it, yeah so if they have a near neighbour and someone in the area that has put in this technology, then they will go and have a good look at it and work out how it fits for them. I think actually seeing it in place and in practice and probably being run as a commercially [viable thing] rather than just as research, that's a really big driver, cause some things that are run just as research, they work well under those very controlled situations, but then when you get them into the real world they might not work to quite the same degree*."

As was financial capacity and return on investment:

> Community, VIC:
> *"Access to capital is the biggest one we see on farm."*

> RD & E, VIC:
> *"Direct contribution by external sources (eg government support) definitely helps that - irrigation technology investment by the state government in infrastructure has definitely lead to the uptake of irrigation technology that wouldn't have otherwise been invested in."*

> Community, VIC:
> *"A clear demonstration of return on investment. A lot of farmers I know would rapidly adopt new technologies but it comes down getting a return on that investment."*

The importance of being willing to embrace change, and see clear benefits for doing so, was also mentioned:

> Community, VIC:
> "*I think that mindset of being willing to change as well and just seeing that there is a benefit in doing those changes."*
>
> Community, VIC:
> *"Probably that nervousness of changing from what they have done historically."*
>
> Community, VIC:
> *"Fear of the unknown. Not having the ability to absorb the risk of new practices. Failing to see the benefits of new solutions."*
>
> RD & E, VIC:
> *"What we found is that there is a big gap in the service industry in terms of the people who were able to assist farmers to use them properly and then we found that a lot of the technology in terms of mapping, soil moisture monitoring, variable rate application, was in the cotton industry was really driven by quite skilled service providers who could take that information and put in a way that was directly relevant to what the farm management decisions were, but without that third part it was very difficult for the farmer, unless there was a particular interest or skill set to take on all this information and try and translate for what it means for them."*
>
> RD & E, VIC:
> *"When you keep doing things with same result then probably it suggests that a change is needed because we don't have a choice - necessity does lead to innovation."*

3.4.2 Stakeholder group perspectives on adoption barriers and drivers

Across the five stakeholder groups surveyed, the most frequently mentioned words again indicate commonalities across the groups for factors of most concern (Figs. 15 & 16) with 'finances', 'time' and technology ('technology', 'internet') commonly mentioned in all groups. However, few differences between groups were identified. Given that responses to these questions were comparatively brief, the analysis presented here is indicative more of the broad range of issues than any differences between the groups.

Beef

Willingness to change was mentioned as important:

> Producer, QLD:
> *"… but above all its mindset - I really think most of it is mindset and willingness to change and willingness to try something new*"

RD & E, north-western WA:
"In the pastoral industry some of the older pastoralists don't want to change and adopt new technologies …"

Business succession planning was also frequently highlighted as a factor that influences the uptake of new solutions, technologies and practices:

RD & E, QLD:
"*I push it no end you know and I know there are significant businesses around that have done succession from the time that the kids went to boarding school, where the kids have had a input into the business or whatever; the kids have been asked do they want to be part of the business and over time their thoughts have changed you know - some of them have said no I don't want to be part of the business I want my share though I don't want to be part of it, so that whole plan of the future has changed*."

Dairy

The cost of technology and the importance of getting a good return for investing in new technology were mentioned:

Producer, VIC:
"*Cost is a factor. We have implemented technology through irrigation and modernisation with automation. 90% of the farm is automated. We have to get a good return on these things."*

As was observed in the beef industry, the importance of farmer characteristics were also highlighted:

RD & E, QLD:
"*Farmers themselves, just some people, it could be an age thing, but not always. It just comes back to the management skills and determination of the people*."

Figure 15. Word cloud for responses to questions about adoption barriers and drivers by participant group (text size is proportional to relative frequency of word use). These word clouds comprise a total of 181 words mentioned between 3 and 23 times by participants in one or more of the stakeholder groups across the study.

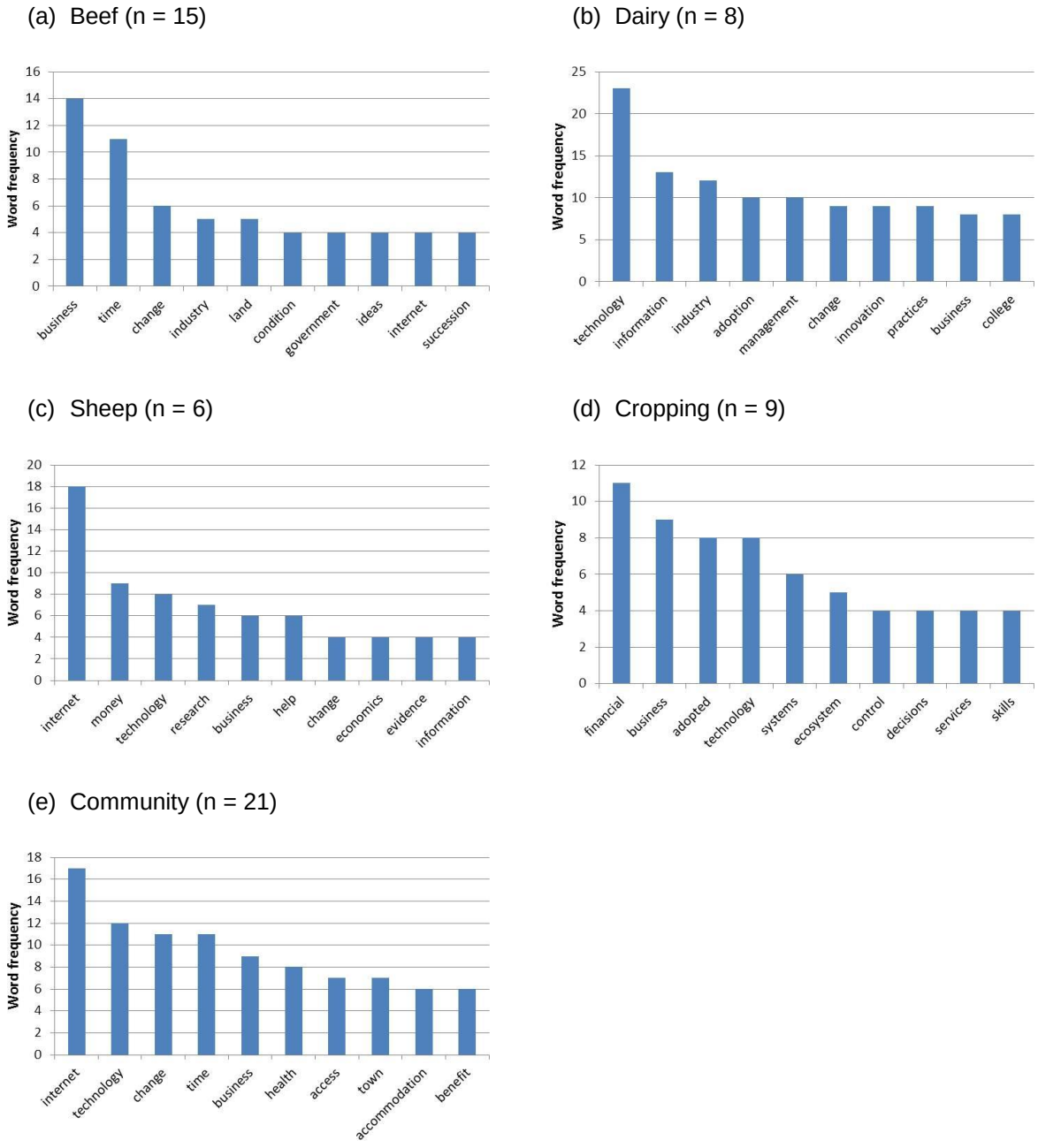


Figure 16. The ten most frequently mentioned words relevant to questions about adoption barriers and drivers by participant group: (a) beef producers; (b) dairy farmers; (c) sheep & wool growers; (d) cropping farmers; and (e) community. Numbers in parentheses are the number of interview participants that were included in the stakeholder group. Please note that the scale in each of these figures may differ. Common but generic words such as 'farm','farmers' and 'industry' are not included in this figure.

Dairy (cont.)

Information and the importance of how it is communicated should also be carefully considered:

> RD & E, QLD:
> "*As scientists, we are always looking at how to get information out of people. These guys are just bombarded with information. It's just crazy and the dairy industry is quite serviced ... subtropical dairy and other groups - they are getting emails all the time. You can't say limited information is a barrier. The information is out there and we have got to package it differently.*"

Sheep

The power that consistent messages can have in driving adaptation was brought up:

> Producer, south-western WA:
> "*I suppose it's the other side of that. … that if you do get consistent messages … that are clear, coming from multiple sources, you know the people are on the same page and they do have that evidence of that it works … from actual places. It's not just a science study but … there are real farmers and real growers out there who've applied it and it's worked in practice.*"

> Producer, south-western WA:
> "*if you're getting a consistent message, it should be … well evidenced that it's profitable, that [if] you put your investment in year one, by the end of year three you've got your investment back plus - and that evidence should come from real farms not just research stations*."

Having enough money to take up new solutions, technologies and practices was also a common theme:

> Producer, south-western WA:
> "*Economics. If the money is not there nothing happens. If the money is not there the focus is on production at the expense of everything else*."

Cropping

Financial constraints and financial drivers were put forward as barriers to and drivers of new solutions, technologies and practices:

> Producer, north-western WA:
> *"Financial constraints and [lack of] exposure to new technologies … our remoteness."*

Producer, north-western WA:
"Financially, to find new strategies to adopt new ideas to make you more financially viable. That's the driver."

Producer, north-western WA:
"Barriers to adoption are financial pressures – not having the financial resources to adopt new technologies."

In relation to technology, the importance of understanding it and being able to effectively use it was also raised:

Producer, VIC:
"*Whether you understand the technology and are able to competently execute it*."

Community

Slow internet was mentioned as a constraint on businesses and as an inhibitor to effective communication by respondents from several of the regions surveyed:

Producer, north-western WA:
"*Spending money to improve the internet for business transaction*."

RD & E, north-western WA:
"*Internet speed is an issue and mobile phone coverage. No NBN so far*."

RD & E, north-western WA:
"*Remoteness is the biggest issue for some. Phone and internet access is the biggest issue. Communication is very difficult."*

In relation to technology, the importance of being able to demonstrate the purpose and benefits of technology was mentioned:

Community, VIC:
"They [farmers] are actually quite good at adopting technology, if they can see a benefit for it."

RD & E, VIC:
"*We found that while people looked at technology or an innovation as a goal, they were limited in uptake - rather than as a mechanism to achieve a goal. So we found that people were focusing on ... if I just adopt this technology, that will lead to more profitability. But instead we have to change the question … how do I become ... I need to [use] less water on my farm; this irrigation technology is a mechanism of doing that ... not just - I need to use this technology*."

Difficulty in embracing change was highlighted:

> Community, VIC:
> "*Probably that nervousness of changing from what they have done historically. There is that mindset of I've never tried this and I'm just too nervous to go ahead and do that. Particularly for a lot of farmers that are introverted to a fair extent. That's probably the big one for them. Just a bit nervous to make those changes. They might know it's the right thing to do, but they are just nervous to implement it and risk capital and the business to do so*."

3.4.3 Summary

Key factors influencing adoption identified through the survey include:

- access to technology (technology, internet, phone), time, information (information, research) and finances (money, cost) are critical issues in the adoption of new information, practices and technologies;
- adoption is linked to producer's willingness and capacity to change, as well as the time to learn, adapt and adopt new solutions, technologies and practices;
- frame of mind (e.g. sorting out financial and health issues first) was seen as a critical factor influencing people's readiness to take on new information;
- business succession planning was frequently highlighted as a factor that influences the uptake of new solutions, technologies and practices;
- the cost of technology and the importance of getting a good return for investing in new technology may be a barrier;
- the importance of peer-to-peer learning and local on-farm examples which show that these work in practice and that returns on investment are there are likely to enhance the rate of adoption of innovations; and
- the importance of packaging information appropriately and providing consistent messages across the industry (i.e. government agencies, agents, advisors, suppliers) was seen as an important factor in generating change/adoption.

3.5 Impact of external factors on business success and sustainability

Questions 11 and 12 asked about external factors influencing (i) the ability to manage business risk and viability; and (ii) the ability to deal with variability and extreme events. Responses included both negative and positive influences.

3.5.1 Positive influences on business success and sustainability

Positive influences included:

- improved forecasts and extension and support for using climate information

  RD & E, QLD:
  "I believe in Queensland now we get better storm warnings albeit that they're only you know better in that we actually get them. Once upon a time, we didn't get them. Now we might get them 6 hours out…"

  RD & E, VIC:
  "Lots and lots of very small initiatives done by agricultural extension officers in the department and grower groups now throughout Australia, which are generally oil rag type projects, small beer, generally worked on a small scale that have really empowered people to make better decisions. They know their local community and worked with them so they knew that would work. Where projects have been shaped from a bottom up bid where it's been a group of farmers and someone who is not necessarily the expert but good understanding at what the farmers issues are and might have good networks in with the experts, pop those together they are generally the most powerful type of projects."

  Producer, QLD:
  "I think an example is what you have been doing. Helping farmers to understand forecasts and climate variability, so I think that is good. I have met a lot of farmers that use the BoM forecasting, the seven day forecasting. I've got others that have looked at the longer term forecast as well to get bit of a guide, but there is less confidence with that. Then I was thinking maybe something like … soil moisture monitoring tools. It's better understanding that, knowing the water use and making decisions about irrigation and fertilisers based on that, rather than just guessing."

  Producer, QLD:
  "I look at the short term forecasts and I look at the long term El Nino–La Nina type things, but they're only a small part of how I asses what I'm going to do in 6 months time. I may plant more country if the forecasts look good but I try not to make too strong a decision on a long range forecast. I'll plan towards that decision or that forecast but I won't spend money til it gets close. I don't like to expose myself to a lot of risk. Look, I'll say, we're growing some oats here for hay this spring to make hay out of so I can probably carry a few more cattle into the summer than I normally would because I'm going to have oaten hay up my sleeve. If the forecast is good and it's correct then I may not need the hay but I know i've got it there. It's very much a case of looking at the known factors and seeing how they may be affected by the forecast."

- improvements in irrigation infrastructure

  Community, VIC:
  "… in northern Victoria there has been 2 billion spent on farming irrigation efficiency that has been a really positive thing off the back of the MDB plan, just to improve their irrigation design and efficiencies, but yeah I think the MDB plan has been the biggest impact in this area and it will be felt for a long time."

- access to grants

  Community, QLD:
  "Our current council which has recently changed appears to be accessing more grants and that type of thing to assist. We can access grants for out there that continue to build our race days. Businesses have benefited from it, particularly your dress shops, your shoe shops, food shops, motels. We got record numbers of 1600, tourist operators benefited."

  Producer, QLD:
  "The topical one out here at the minute is the wild dog exclusion fencing that governments have kicked in a bit of money for. That's designed to stop wild dogs coming into this country. It's not a big impact on us running a cattle operation at this stage, but it's certainly a big impact on those running sheep. We're hoping that, by doing that, there may be more people that get back into sheep, which will mean more shearers, which will mean more people in the bush which will mean more community. That's really what a lot of people out in this country at the minute are hanging their hats on, because these western towns are dying and without people they're going to continue to die. So hopefully we can reverse the trend."

  RD & E, QLD:
  "I do know that from people that I've spoken to and heard reports about who have fenced that they are definitely more able to manage total grazing pressure and that's really about how many kangaroos are around and people who've fenced are then following good practices in terms of mitigation permits - making use of it to manage the population."

  Community, QLD:
  "The big red truck - I don't know if you've heard of it - we're the only school in Queensland that has a b-double that is used for delivering a Certificate II in Kitchen Operations" and "…it's a $2.77 m federal government grant. It's the most wonderful facility when you've got kids in there turning out fabulous food, but it costs $80-100,000 per year to run and I don't get any money to help defray these costs."

- improvements in the live export industry

Producer, north-western WA:
"When the LivEx was banned the people banded together to take the government on. Then it got opened back up and to be honest I haven't seen it any better LivEx. Other people's actions and initiative to take the government on to change the policies is probably better now where we stand."

- mental health support

Producer, QLD:
"… through the drought, there was a lot of support for people from people like the RFDS mental health and Rachel Bock as a financial counsellor."and "… if their head's not in the right place and they need to speak to someone - mental health issues - go to RFDS and speak to someone there or sometimes they just need a bit of a social outlet because they've been that caught up in other stuff …"

- coordinated disaster response

Community, QLD:
"… if we have extreme events and things really go bad here, we have a disaster coordination system and we get help from the state - I've lived a few disasters here so I'm pretty familiar with how that goes, but if you want to relate that to a significant outcome in a health service or problems with communities where a disaster is declared and you have - the local inspector of police is the coordinator and you have a disaster committee - I think they're all pretty well set up."

3.5.2 Negative influences on business success and sustainability

Negative influences identified by respondents included:

- changes in land and water use regimes

RD & E, VIC:
"… the changing land use across the region. So there are different players in the region in terms of horticulture, cotton, rice, that type of thing and we have an increasingly small [amount] of water, so access to water is related to what other industries are doing with water as well."

Community, south-western WA:
"I think corporate purchasing is probably making it harder, maybe not so much in this area, but that will have a flow on effect if big or corporate type farmers want to buy up higher rainfall potentially more viable farming areas and its pushing the price up and if anyone in that area wants to expand its making it a lot more difficult for them to be sustainable perhaps."

Community, VIC:
"… water being purchased and used outside the region. This has meant that the price of securing water has increased to the level that it is no longer viable to many businesses locally. The Murray Darling Basin Plan water buybacks has meant that there is less water for the region, meaning less production profit can be achieved."

Community, VIC:
"Since the MDB plan it's been really a massive one, just because it's just sucked so much water and so much energy out of the community at different times when they have already been struggling and this one has been dumped on top of it."

- markets and commodity pricing

Producer, QLD:
"Just thinking about supermarket dollar a litre milk—they are actually causing risk ...Certainly the reaction to the Victorian milk crisis at the moment has been a great benefit to the QLD industry. QLD has had the problem of people buying supermarket milk for ages; just that Victorian were hurting—they couldn't really [deal with the] problem which was the international market and Murray Goulbourn being idiots, so they say it was supermarkets, so we finally got the benefits of some of that. Hopefully that will flow through to [give] farmers a sustained price, a higher price."

Producer, VIC:
"Globally, the dairy price. Ultimately if the dairy price is no good in the world it will roll over to our business and it affects the next business we buy off. We got to make money and the other people we buy off have to take a cut for their income. So it is just a snowball effect. Then it goes from our community to the outside community. I think this year it will affect a lot of businesses here."

Producer, VIC:
"Certainly world trade has a big impact on the price we get at the farm gate for our produce and has a flow on effect on our profitability. And that has a flow on effect to what we can do in the region and in the local community."

Community, north-western WA:
"Export market. We are dependent what other countries like Indonesia want."

- government policy

RD & E, QLD:
".....you could say government policy helps manage risk and probably poorly by providing different types of drought assistance. Not everyone claims drought assistance, but a lot of people do and sometimes it rewards poor management. But it's a process. There's been plenty of reports of papers of policy saying it's probably

not the best but it still seems to hang around. And it's always in response ... something'll happen and then next minute there'll be a new assistance scheme; they're always (?) policy on the run, responding to a drought and industry and community pressure, to be seen to be doing something. So their initiatives - sometimes they're good, sometimes they can have perverse outcomes."

Community, QLD:
"Policies regarding live export have had a massive impact on north Queensland particularly when live export bans coincided with drought and then we had a critical mass of cattle that couldn't be destocked and people were over stocked and they had no market to sell to that certainly caused a spate of suicides around northern Queensland with several suicides reported a week at times so those sorts of things certainly do have an impact."

RD & E, QLD:
"Everybody up here's going to say the live export ban. X - I think that highlights that risk. I mean that was a specific response, but I think everyone realised the impact that social attitude and the power that one person said ' you're not going to export' and that was it. Hell or high water, it doesn't matter what industry or people saying it's really important to my family ... they're going 'well we don't think that's an acceptable situation to put those animals in - we're going to stop it.' It highlighted that they have to manage that risk. There's been a lot more activity by industry and by organisations around managing social media now because it has to be ... so easy for just one photo to send everything south real quick."

Community, QLD:
"The Queensland government trying to crack down on vegetation management at the minute - those decisions that they make down in the leafy suburbs of Brisbane that are to appease a few people, the Greens - are killing people in the bush. I think people in the bush are the best land managers of anyone - and I know there's the odd cowboy around, but most/99% of people do it for the good of their land and they need to be able to manage the regrowth that happens out here in order to be able to survive."

Producer, north-western WA:
"A good example now, down in the Pilbara, BHP and Rio have a wastewater issue through their mining. So they funded—they had government subsidies I believe to fund some irrigation projects in which they are growing fodder. Now it is common knowledge that they don't need to be profitable within their own right because it is a by-product and need to do something with it by the government to make it happen. And they were able to produce a product without needing to make a profit. That is a subsidy and is an unfair playing field. Some of that is coming out to the Kimberley which effects myself. There has been an impact so far and there will be more as they

learn to become better at it and push harder. But they can govern the price. And they don't need to make a profit. The only thing that is saving us at this point is our distance. They still have a freight component and that is our saviour at the moment."

- biosecurity

  Producer, VIC:
  "It all has [an] enormous impact. I don't know where you start. The latest one.. Russian aphids…that's the latest scourge. It's only happened this year. It started in South Australia and now it's just about here."

  Producer, QLD:
  "There are potential biosecurity risks always lurking in the background. There are risks associated with wild dogs; risks associated with uncontrolled total grazing pressure - so kangaroos, wild goats etcetera."

- research investment issues

  RD & E, north-western WA:
  "The lack of investing into research is having the biggest impact. And coming up with solutions on a regional level."

  Producer, QLD:
  "Things like the risk of climatic variability and climate change—really there's a combination of further research and development and extension that's needed to dampen that risk. I think part of that would look like capturing the experience of the longer term landholders in western Qld before they do exit the industry, for instance. Capturing that hard earned knowledge and skills, and I think there's also an opportunity there to actually export some of that knowledge and skills. There's many places in the world whose climates are becoming much more like western Qld has been for the last 150 years and they stand to be able to learn from us. I think that experiential knowledge needs to be put through an industry filter and also a scientific filter to sort the gems from everything else and equally the research that we do—further research to try and improve our predictive capacity for rainfall, particularly for the longer range forecasts - that also needs to be filtered through a practical pragmatic set of eyes so that it's actually useful on the ground. Or so that industry members know what can't be achieved at the moment through science. I think that's one of things that we often miss is just being able to say, 'look, no, just at the moment we can't achieve something like that. We know that's what you really need but it might take one or two decades before we can even get technology to the point of being able to answer those key questions.'."

- climate forecast uncertainty

Producer, QLD:
"Forecasting would be the biggest one. And that's been gotten wrong so badly so many times in the last few years. Almost to the stage where we've jokingly said a few times at some of our … meetings, 'Strong forecast for good rain this summer. We'd better go and buy some stock feed.' It's just been dead wrong and all the indicators suggest that producers should look longer, pay more attention to long term forecasts and all those things, and if you do and you spend - like some of these wheat farmers around Goondiwindi had a punt on a good forecast and spent a million dollars on seed and fertiliser because their planting windows were closing and if that's wrong that's a huge expense for an enterprise to try and recoup and there's no accountability. So if that forecast is wrong, as it often is, the forecasters just come up with the next forecast. and they're not held accountable for the fact there's 25 wheat producers in Goondiwindi now having very serious discussions with their bank because they've just blown a million bucks."

3.6 Business connectivity

This section reports on interactions between stakeholders and other businesses based on responses to Question 13, which asked 'What other businesses do you interact with while operating your business?'.

We analysed business interactions among various participants to assess whether stakeholders are interacting with each other. To do this, we grouped the 59 survey participants into three main stakeholder groups: producers (15), RD&E professionals (20) and community members (24). We also grouped the businesses and government agencies mentioned by participants into five key groups (Appendix C). The frequency of how often these main stakeholders mentioned they interact with these business groups is shown in Table 8.

Table 8: Index of the frequency of interactions between main stakeholder groups and identified business group. Values are average number of interactions per stakeholder group; colours indicate the relative intensity of interactions (red: limited; yellow: moderate; green: frequent)

Business group	Producer	RD & E	Community
Input/Supply Chain	3.3	1.4	1.0
Agricultural consultants/Education	2.1	1.3	0.6
Government	0.8	1.0	0.2
Finance	0.1	N/A	0.2
Others	1.7	0.8	1.0

While not conclusive, these results indicate that relatively frequent interactions were reported between producers and the 'input/supply chain' and 'agricultural consultant/education' groups', interaction with government agencies (0.8) and the finance

sector (0.1) was reportedly relatively fewer. The RD & E participants reported relatively low levels of interaction with other businesses involved in the agricultural industries and associated rural communities. This was also apparent for the majority of community participants.

The limited range of interactions between the producer stakeholder group and the government and finance sectors, and between both the RD & E and community stakeholder groups and all other groups, suggests that there is potential benefit to be gained in developing greater levels of interaction between the individual and business stakeholder groups—an issue which would be foundational in the co-innovation process.

Examples of cooperative approaches were apparent in a small number of responses; for example:

> RD & E, QLD:
> *"I interact with other private consultants - there are other private consultants who used to work for the department that I work with, and where I think they can better fill a need for … a producer group that I'm working with, well then I'll enlist them to come and provide a service to that group because I think they could provide that to a higher standard, and at the end of the day that's what it's about—providing a quality service. so I also have a bit to do with DAF and ... I do a bit for the ag colleges as well as the major pastoral companies, and private landholders and feed companies and also some of those business houses that also sell products, but I operate on the premise of providing information and services relating to information and I don't get locked in with any business to actually promote their products 'cause that's like selling your soul."*

> RD & E, south-western WA:
> *"What I really see … the value is that their strategy is that … they [the NRM sector] take the time and effort to work with industry, to study the literature, to talk to the experts, to talk to the farmers and their strategy is continuing something that can really combine practice and research. So I like the fact that the NRM sector's I think quite central in that network of researchers, industry, community groups. … interacting with the, not controlling, interacting with them, 'cause NRM is so cross cutting. There's no one-size-fits-all answer. If industry aren't engaged in NRM, then you're not going to achieve the NRM outcomes that you want. There's no way that the government can give us enough money to fund the scale say of revegetation that we need in the wheatbelt unless the ag sector is on board with the types of initiatives that we've put in place."*

3.7 Sources of information

In response to Question 19 regarding sources of information to support decision-making, interviewees mentioned that they engaged with extension programs, other producers and the industry in various ways.

Producers said that they frequently talked with each other,

> Community, QLD:
> *"Everyone, all the producers are always talking to each other .. they have got to know what the prices are and how things are going and how things are operating."*

Numerous respondents also highlighted the importance of engaging with a range of people to get information,

> Producer, QLD:
> *"I interact with my local Stock and Station agent; he and I talk, that's where we get most of the information about livestock. I'm a member of AgForce and I get a lot of information there dealing with vegetation management, fencing and general issues. The media - Country Life - I get information from them. I talk to different government people at DPI (it's probably not called that now) - people involved in that that I've known over a number of years. Generally, through my community, other producers and people around. I pick them because they're people I talk to that I feel are competent people that know what they're talking about."*

> RD & E, QLD:
> *"rural media, leading producers, industry networks (processors, retailers), research networks, NRM groups - multitude of agencies, universities…"*

The importance of the media and government sources of information was also mentioned

> Community, QLD:
> *"I probably get most of my information about the livestock industry - On days off, I usually try and listen to ABC Qld country Hour. I like to get hold of the Qld Country Life when I can. I probably source most of my news from the interne. In terms of rural news that probably comes mainly from the ABC rural pages - tends to be my main source of information. In terms of climatic information, I source most of mine from either the Bureau of Meteorology website or the Long Paddock website with the seasonal forecast."*

Industry events, workshops and show days were also highlighted as important opportunities for some

> Prodcuer, QLD:
> *"Go to as many workshops as possible."*

> Community, VIC:
> *"Certainly I go to a lot of different industry events. Talking to lots of farmers."*

4 Priority R&D issues

This scoping study, involving 59 livestock industry and community members across four regions of mainland Australia, captured a range of issues concerning risks (at the business enterprise and community level), as well as innovation and adaptation barriers, experienced by stakeholders in, and associated with, the Australian livestock industries. Based on these responses and expert input, a number of potential opportunities for research and development investment aimed at building capacity to enhance the sustainability of the industry and regional communities and which could be investigated in detail through R&D for Profit funding Round 3 were identified (Table 9). These include:

- *Pasture management and total grazing pressure* — including aspects of thresholds for pasture quantity and quality and land condition; timing of key decisions; Key indicators for decisions; and development of protocols for monitoring and evaluation of key indicators.

- *Improved seasonal and multi-seasonal climate forecasts to allow producers the confidence and capability to make decisions*—for example, to sell or agist livestock early before pastures degrade, stock lose weight and prices decline; or water market decisions to enhance water secururity (i.e. water buy back decisions). Relevant aspects include multi-year climate forecast systems with skill assessments; forecasts of upper or lower tercile rainfall for the wet season; and forecasts of start and end of wet season.

- *Integrating livestock, finance, economics, business and marketing management* — including whole farm analysis of pasture condition/productivity, environmental factors, herd dynamics, transport and financial position to meet (and compare) different market specifications; and managing change.

- *Building social networks, health and wellbeing* — including tools and support for physical and mental health; planning for the future; peer to peer learning; and the importance of champions or role models to facilitate adoption of new technologies.

- *Innovations for better decision making for drought management and resilience* — for monitoring and reporting drought and drought recovery; monitoring natural resource and pasture conditions; improved financial and business planning; and supporting timely decision-making (i.e. decision support frameworks).

- *Barriers to adoption* — including financial constraints; the need for the benefits of research (including return on investment) to be demonstrated in the commercial world; lack of time; poor internet connection; producers willingness to change; and lack of skills in knowing how to integrate research outcomes into business.

Table 9. Recommended R&D issues (and potential projects) that directly relate to the regional industry-specific risks and issues identified in the scoping study. These projects are outlined by region in Appendix B.

Identified R&D Projects	Northern WA	Western QLD	Southern WA	Northern VIC
1. Pasture management and total grazing pressure - decision support				
Key indicators and thresholds for pasture quantity and quality & land condition	✓	✓	✓	✓
Timing of key decisions and/or decision points based on key indicators	✓	✓	✓	✓
Protocols and tools for monitoring and evaluation of key indicators	✓	✓	✓	✓
Assessing total grazing pressure (livestock & non-domestic herbivores)	-	✓	✓	✓
Assessing/addressing biosecurity threats - BMPs	✓	✓	✓	✓
Tools & support for timely decision-making - decision support framework	✓	✓	✓	✓
Managing total grazing pressure (livestock & non-domestic herbivores) - BMPs	-	✓	✓	✓
2. Forecasts – provide producers with the confidence and capability to sell or agist livestock early before pastures degrade, stock lose weight & prices decline				
Accuracy and lead-time of Nov-Mar rainfall (summer rainfall areas)	✓	✓	-	-
Accuracy and lead-time of Apr-Aug rainfall (winter rainfall areas)	-	-	✓	✓
Skill testing of GCMs at seasonal scale	✓	✓	✓	✓
Testing of multi-year forecast systems	✓	✓	✓	✓
Cyclone forecast systems	✓	✓	✓	-
Forecasts of upper or lower tercile rainfall for the wet season	✓	✓	-	-
Forecasts of start and end of wet season	✓	✓	-	-
Forecasts of unseasonal rain during the dry season	✓	-	-	-
Forecasts of extreme heat periods SOND	✓	-	-	-
3. Integrating livestock, finance, business and marketing management				
Whole farm analysis of pasture condition/productivity, environmental factors, herd dynamics, red meat production, profit, transport and taxation to meet (and compare) different market specifications	✓	✓	✓	✓
BMPs	✓	✓	✓	✓
Engaging better with the marketplace	✓	✓	✓	✓
Managing change in production system (or similar) (e.g. transitioning from dairy to beef)	-	-	✓	✓
4. Building social networks, health & wellbeing				
Tools and support for physical and mental health	✓	✓	✓	✓
Personal/professional development	✓	✓	✓	✓

Identified R&D Projects	Northern WA	Western QLD	Southern WA	Northern VIC
Planning for the future	✓	✓	✓	✓
The role of peer to peer learning and industry champions in facilitating adoption of new technologies and practices	✓	✓	✓	✓
5. Decision making for better management of drought and recovery				
Identifying key drought indicators and thresholds	✓	✓	✓	✓
Seasonal and multi-year forecasts	✓	✓	✓	✓
Water security(e.g. water buy back decisions)	-	-	-	✓
Tools and support for making key economic and environmental decisions - BMPs	✓	✓	✓	✓
Early decision making with confidence	✓	✓	✓	✓
Monitoring and reporting of drought and drought recovery (of natural resource/pasture condition? stock numbers? financial? other?)	✓	✓	✓	✓
Better understanding and application of hydrological, hydro-illogical and hydro-psychological cycles	✓	✓	✓	✓
Different types of pastures or crops to suite the climate situation	✓	✓	✓	✓
6. Assist NBF and PKCA in developing new markets				
New market identification and feasibility	✓	-	-	-
7. Helping meet market specifications for beef within age and seasonal boundaries				
Lot feeding stock for short periods	✓	-	-	-
Selling crops grown in region as beef liveweight	✓	-	-	-
8. Working with Indigenous Land Council & others to increase the productivity of beef on indigenous pastoral leases				
Extension and communication program	✓	-	-	-
9. Importance of biosecurity in maintaining and expanding markets that pay a premium price (plants and animals)				
Extension and communication program	✓	-	-	-

Many of the issues identified in this scoping study apply broadly across the surveyed regions; however, differences in the relative importance of these varies and issues specific to particular regions were also identified. A high degree of interconnectedness at the regional level between the livestock industries and associated regional communities was apparent. All regions surveyed are subject to significant levels of uncertainty in terms of climate variability, market volatility and changing policy regimes. These issues collectively point to the complex and dynamic environment in which the Australian livestock industries operate. Given this, as well as the large spatial extent of Australia's livestock industries and the numbers of institutional stakeholders (federal and state government agencies and industry bodies), it is perhaps not surprising that there is a high level of fragmentation of information and innovation in the industry (Coutts, pers. com).

5 Summary and conclusions

This survey interviewed a range of stakeholders associated with the livestock industries in four regions of Australia to capture the range of issues faced by the industry, current responses to risk and the barriers and drivers of adoption of new innovations (information, technologies, practices). Preliminary analysis of the survey participant responses indicates both common challenges across the industries as well as industry- and region-specific issues.

A number of potential opportunities for research and development investment aimed at building capacity to enhance the sustainability of the industry and regional communities and which could be investigated in detail through R&D for Profit funding Round 3 were identified through this pilot project. Importantly, the information derived from this survey will provide a valuable starting point for a multi-stakeholder co-innovation process aimed at supporting more sustainable practices for increased profitability and resilience by decision makers in the Australian livestock industries.

6 Acknowledgements

We would like to acknowledge the assistance of those individuals who provided us with contacts and assisted in arranging interviews, including Gerry Roberts (Longreach, QLD), Matthew Fletcher (Kimberley, WA), Amy Fay (Project Manager; Murray Dairy, VIC), Dale Miller (AgForce, QLD), Chris Murphy (Dairy Australia, VIC) and Angus Ireland (Australian Wool Innovation), Gordon Stone (Agri-Business Development Institute, QLD) and, in particular, those participating stakeholder who shared valuable insights.

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8 Appendix A: Interview questionnaire

Preamble

This is a preliminary survey that will help us to identify key issues for further research and discussion with stakeholders. The results will be used to inform a larger project on the resilience of the Australian livestock industry.

Part A: Introduction

1. Can you please explain a little about your business/businesses in this region and the current context?

2. What is it that drew you to this business/industry/region – what makes it enjoyable/ worthwhile for you?

3. In your view, what is success in your business/businesses in the region?

4. What is the motivation to do what you do? How do you define success? How does what you do fit in/affect your community?

Part B: About livelihood and climate (drought) risks

5. What are the main risks to the viability of your farm business/businesses in this region/industry?

    i. What affects these risks?

    ii. What effect do these risks have?

    iii. What control/influence/no control do you have over these risks?

    iv. What influences your risk management?

    If climate variability is raised then:

    b. What do you think are the main issues related to climate variability and extreme events for your farm business/this industry/major industries in this region?

        i. What are the main climate risks for you/your industry/main industries in this region? *(Likely to be answered in the general question but could be a summary; specific follow up on farm and other business impacts if needed or to clarify)*

        ii. How have drought and climate events affected your farm/the industry/the region (impacts on production, financial and environmental sustainability)?

6. What actions, if any have you taken to try and manage business risks?
    i. *If none taken, ask*
        1. were there options available? If yes
        2. what made them difficult to put in place?
        3. are you planning to take action in the future?
    ii. *If some taken, ask about the most significant.*
        4. how did you decide what to do?
        5. did it work the way you thought it would?
        6. were they a long term or short term shift in your business?
7. Who do you look for inspiration for managing climate/drought impacts? What have they done differently?
8. What was one of the last big decisions you made in relation to your business and how did you come to the decision you made? (*Please ask what information did you gather, who did you talk and listen to? How long was the decision making process?)*
9. What are range of factors that prevents the adoption of new solutions, technologies and practices?
10. What are range of drivers that helps the adoption of new solutions, technologies and practices?
11. What actions/initiatives/polices have been taken by others that have had an impact on your ability to better manage business risks and help your viability?
12. What factors/decisions outside of your region affect the ability of your business/businesses in this region/industry to be able to deal with this variability and extreme events?
13. What are the most important businesses you interact with and why are they important?

Part C: About you

The questions in this section help us to understand more about you and your business and social situation.

14. Where do you live?
15. How many years have you lived in this location?

16. What is your main form of work/employment?

17. Which of the following (one only) best describes your role in the livestock industry:

    - Producer (owner/operator or business manager)
    - Value adder (manufacturer/processor etc.)
    - Wholesaler
    - Financier
    - Bankers
    - Service provider (Elders etc.)
    - Materials supplier (input providers)
    - Retailer (of inputs or outputs)
    - Researcher
    - Policy maker
    - Policy regulator
    - Educator
    - Health provider
    - Animal health provider
    - Stock worker/farm labour
    - Transporter
    - Others from a particular reference listing roles in the industry?

18. Significance of the livestock industry to your business: can you estimate what proportion of your business income is related the livestock industry?

    - Over 90%
    - 60–90%
    - 30–59%
    - Less than 30%

19. In what ways do you engage with extension programs, other producers or the industry more generally?

    i. In particular, where do you usually get the latest information about the livestock industry?

    ii. Why do you interact with these people/ organisations?

    (*Get an indication of what/ who they seriously take heed of and what who they chat to for more social reasons.*)

20. What are the main goals/aspirations for your farm business/this industry/your region for the next 5 years? Next 10 years?

9 Appendix B: R&D issues by region

Based on information from the surveys, recommended R&D issues (and potential projects) that directly relate to the regional industry-specific risks mentioned above include:

Longreach, Qld

i. Pasture management and total grazing pressure - decision support

- Key indicators and thresholds for pasture quantity and quality & land condition
- Timing of key decisions and/or decision points based on key indicators
- Protocols and tools for monitoring and evaluation of key indicators
- Assessing total grazing pressure (livestock & non-domestic herbivores)
- Assessing/addressing biosecurity threats - BMPs
- Tools & support for timely decision-making - decision support framework
- Managing total grazing pressure (livestock & non-domestic herbivores) - BMPs

ii. Forecasts – provide producers with the confidence and capability to sell or agist livestock early before pastures degrade, stock lose weight & prices decline

- Skill testing of GCMs at seasonal scale
- Testing of multi-year forecast systems
- Cyclone forecast systems
- Forecasts of upper or lower tercile rainfall for the wet season
- Forecasts of start and end of wet season

iii. Integrating livestock, finance, business and marketing management

- Whole farm analysis of pasture condition/productivity, environmental factors, herd dynamics, red meat production, profit, transport and taxation to meet (and compare) different market specifications
- BMPs
- Engaging better with the marketplace

iv. Building social networks, health & wellbeing

- Tools and support for physical and mental health
- Personal/professional development
- Planning for the future
- Peer to peer learning and the importance of champions or role models to facilitate adoption of new technologies

v. Decision making for better management of drought and recovery

- Identifying key drought indicators and thresholds
- Seasonal and multi-year forecasts
- Tools and support for making key economic and environmental decisions - BMPs

- Early decision making with confidence
- Monitoring and reporting of drought and drought recovery (of natural resource/pasture condition? stock numbers? financial? other?)
- Better understanding and application of hydrological, hydro-illogical and hydro-psychological cycles

Kimberley, WA

i. Pasture management and total grazing pressure - decision support

- Key indicators and thresholds for pasture quantity and quality & land condition
- Timing of key decisions and/or decision points based on key indicators
- Protocols and tools for monitoring and evaluation of key indicators
- Assessing/addressing biosecurity threats - BMPs
- Tools & support for timely decision-making - decision support framework

ii. Forecasts – provide producers with the confidence and capability to sell or agist livestock early before pastures degrade, stock lose weight & prices decline

- Skill testing of GCMs at seasonal scale
- Testing of multi-year forecast systems
- Cyclone forecast systems
- Forecasts of upper or lower tercile rainfall for the wet season
- Forecasts of start and end of wet season
- Forecasts of unseasonal rain during the dry season
- Forecasts of extreme heat periods SOND

iii. Integrating livestock, finance, business and marketing management

- Whole farm analysis of pasture condition/productivity, environmental factors, herd dynamics, red meat production, profit, transport and taxation to meet (and compare) different market specifications
- BMPs
- Engaging better with the marketplace

iv. Building social networks, health & wellbeing

- Tools and support for physical and mental health
- Personal/professional development
- Planning for the future
- Peer to peer learning and the importance of champions or role models to facilitate adoption of new technologies

v. Decision making for better management of drought and recovery

- Identifying key drought indicators and thresholds
- Seasonal and multi-year forecasts

- Tools and support for making key economic and environmental decisions - BMPs
- Early decision making with confidence
- Monitoring and reporting of drought and drought recovery (of natural resource/pasture condition? stock numbers? financial? other?)
- Better understanding and application of hydrological, hydro-illogical and hydro-psychological cycles
- Different types of pastures or crops to suite the climate situation

vi. Assist NBF and PKCA in developing new markets

- New market identification and feasibility

vii. Helping meet market specifications for beef within age and seasonal boundaries

- Lot feeding stock for short periods
- Selling crops grown in region as beef liveweight

viii. Working with Indigenous Land Council & others to increase the productivity of beef on indigenous pastoral leases

- Extension and communication program

ix. Importance of biosecurity in maintaining and expanding markets that pay a premium price (plants and animals)

- Extension and communication program

Northern Victoria

i. Pasture management and total grazing pressure - decision support

- Key indicators and thresholds for pasture quantity and quality & land condition
- Timing of key decisions and/or decision points based on key indicators
- Protocols and tools for monitoring and evaluation of key indicators
- Assessing total grazing pressure (livestock & non-domestic herbivores)
- Assessing/addressing biosecurity threats - BMPs
- Tools & support for timely decision-making - decision support framework
- Managing total grazing pressure (livestock & non-domestic herbivores) - BMPs

ii. Forecasts – provide producers with the confidence and capability to sell or agist livestock early before pastures degrade, stock lose weight & prices decline

- Accuracy and lead-time of Nov-Mar rainfall
- Skill testing of GCMs at seasonal scale
- Testing of multi-year forecast systems

iii. Integrating livestock, finance, business and marketing management

- Whole farm analysis of pasture condition/productivity, environmental factors, herd dynamics, red meat production, profit, transport and taxation to meet (and compare) different market specifications
- BMPs
- Engaging better with the marketplace
- Managing change in production system (or similar) (e.g. transitioning from dairy to beef)

iv. Building social networks, health & wellbeing

- Tools and support for physical and mental health
- Personal/professional development
- Planning for the future
- Peer to peer learning and the importance of champions or role models to facilitate adoption of new technologies

v. Decision making for better management of drought and recovery

- Identifying key drought indicators and thresholds
- Seasonal and multi-year forecasts
- Tools and support for making key economic and environmental decisions - BMPs
- Early decision making with confidence
- Monitoring and reporting of drought and drought recovery (of natural resource/pasture condition? stock numbers? financial? other?)
- Better understanding and application of hydrological, hydro-illogical and hydro-psychological cycles
- Water security (e.g. water buy back decisions)

Southern WA

i. Pasture management and total grazing pressure - decision support

- Key indicators and thresholds for pasture quantity and quality & land condition
- Timing of key decisions and/or decision points based on key indicators
- Protocols and tools for monitoring and evaluation of key indicators
- Assessing total grazing pressure (livestock & non-domestic herbivores)
- Assessing/addressing biosecurity threats - BMPs
- Tools & support for timely decision-making - decision support framework
- Managing total grazing pressure (livestock & non-domestic herbivores) - BMPs

ii. Forecasts – provide producers with the confidence and capability to sell or agist livestock early before pastures degrade, stock lose weight & prices decline

- Accuracy and lead-time of Nov-Mar rainfall
- Skill testing of GCMs at seasonal scale
- Testing of multi-year forecast systems

- Cyclone forecast systems

iii. Integrating livestock, finance, business and marketing management

- Whole farm analysis of pasture condition/productivity, environmental factors, herd dynamics, red meat production, profit, transport and taxation to meet (and compare) different market specifications
- BMPs
- Engaging better with the marketplace

iv. Building social networks, health & wellbeing

- Tools and support for physical and mental health
- Personal/professional development
- Planning for the future
- Peer to peer learning and the importance of champions or role models to facilitate adoption of new technologies

v. Decision making for better management of drought and recovery

- Identifying key drought indicators and thresholds
- Seasonal and multi-year forecasts
- Tools and support for making key economic and environmental decisions - BMPs
- Early decision making with confidence
- Monitoring and reporting of drought and drought recovery (of natural resource/pasture condition? stock numbers? financial? other?)
- Better understanding and application of hydrological, hydro-illogical and hydro-psychological cycles

10 Appendix C: Connectivity

Table C1: Business connectivity within the Australian livestock industry and associated rural communities

Businesses	Business group	Producer	RD & E	Community
Agro-economist	Ag consultant/educator	4	2	
Agronomists	Ag consultant/educator	4	7	
Consulting Businesses	Ag consultant/educator	2	1	1
Dairy Industry	Input/supply chain	1	2	2
Education	Ag consultant/educator	1	2	3
Farm Management	Input/supply chain	6	8	2
Farmers	Ag consultant/educator	7	7	5
Feed Companies	Input/supply chain	11	4	3
Fertiliser Companies	Input/supply chain	5	3	3
Financiers	Finance	2		4
Government Agencies	Government	9	16	5
Grain Sellers	Input/supply chain	5	1	
Health Care Services	Other	2	3	6
Helicopter Company	Input/supply chain	2		
Livestock Agents	Ag consultant/educator	11	4	5
Local Businesses	Other	12	5	9
Material Supplier	Input/supply chain	11	6	9
Mechanics	Other	6	4	3
Milk Companies	Input/supply chain	3		2
Mining Companies	Other		1	
Nutritionists	Ag consultant/educator	2	2	1
Researchers	Government	3	4	
Solicitors	Other	1		1
Telecommunication Providers	Other	2	1	1
Tourist Businesses	Other	2	1	5
Trucking Contractors	Input/supply chain	2	2	2
Veterinarian	Input/supply chain	4	1	2