2018 ANNUAL REPORT

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

SOUTHERN REGION

REGIONAL CROPPING SOLUTIONS NETWORK

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GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

2018 Annual Report – Southern Region Regional Cropping Solutions Network
This report outlines some of the local research, development and extension (RD&E) priorities identified by the grain grower, adviser and researcher members of the GRDC Regional Cropping Solutions Network (RCSN), operating across the southern grain-growing region of Australia.

Acknowledgements
Grateful acknowledgement is made for the ideas and time committed to this initiative by the facilitators, growers, advisers and researchers who are part of GRDC's Southern Regional Cropping Solutions Network.

Note
The information presented in this document was current and correct as at November 2018. However, as time progresses information about each of the issues discussed will change as the issue progresses through GRDC RD&E process. This report aims to provide an indicative view of RD&E priorities in the southern grain-growing region, rather than absolute information.

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Cover: RCSN low-rainfall zone member Wade Nickolls inspecting his canola crop near Pinnaroo, SA. Photo: Alistair Lawson.

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1. Foreword

I am pleased to present this fifth annual report of the Southern Regional Cropping Solutions Network (RCSN).

In doing so, I acknowledge the valuable contribution and commitment over the past year of all 38 members, zone leads and the coordinator of the Southern RCSN.

As GRDC settles into its new five-year Research Development and Extension (RD&E) Plan, the role of the Southern RCSN has come to the fore as a crucial initiative for identifying, prioritising and understanding issues affecting Australian grain growers, to inform strategic investment.

Launched in 2012, the Southern RCSN provides a transparent process to ensure all priority grains industry issues are captured and to assist GRDC in the development of targeted investments delivering the knowledge, tools or technology required by growers to facilitate positive on-farm practice change.

The role of the RCSN has evolved from one of primarily contributing to the identification of growers' priority issues and supporting the GRDC Southern Region Panel, to now including a broadened focus on identifying emerging issues, strategic review of existing investments and identifying opportunities to improve the delivery of research outcomes and on-farm adoption.

The evolved role of the RCSN aligns well with GRDC's new RD&E Plan, launched in August 2018.

Enduring grower profitability is the cornerstone of the plan – in parallel with the underlying purpose of the RCSN initiative.

The RD&E Plan's five core objectives – improving yield and yield stability; maintaining and improving price; optimising input costs; reducing post-farmgate costs; and managing risk to maximise profit and minimise losses – are underpinned by 30 Key Investment Targets (KITs) that describe the constraints and opportunities required to be overcome or captured to create enduring profitability for Australian grain growers.

Development of the KITS was undertaken in consultation with growers, researchers and the wider grains industry and a full strategy for the delivery of each KIT will be developed over the period of the new RD&E Plan.

To ensure the plan achieves its objectives, input from the Southern RCSN over the coming years will continue to be incredibly important.

The network comprises growers, researchers, advisers and agribusiness professionals, who liaise closely with, and represent, the wider grains community within their respective zone – low-rainfall zone (LRZ), medium-rainfall zone (MRZ) or high-rainfall zone (HRZ).

Representing a diverse mix of experience, skills and expertise, and breadth of geographical representation, network members bring to GRDC an intimate understanding of the issues impacting most profoundly on our growers. That intelligence – an enormous asset – helps shape GRDC's RD&E investment agenda, ensuring optimum impact for growers.

The Southern RCSN is led by coordinator Jen Lillecrapp, of Struan (South Australia), who supports all three RCSN zones. Supporting Jen are Cam Nicholson of Geelong (Victoria) who is the HRZ lead; John Stuchbery of Donald (Victoria) who is the MRZ lead and is co-leader of the LRZ; and Barry Mudge of Port Germein (SA) who also co-leads the LRZ.

I thank Jen and the leads for their time and efforts in preparing the content of this annual report, the purpose of which is to present the priority issues that the RCSN identified during 2018 and to outline new and current GRDC investments that address those issues. In 2018, the Southern RCSN identified and prioritised a combined total of 211 issues that they considered to be affecting the profitability and productivity of grain growers in the southern region.

I also take this opportunity to recognise the outgoing members of the RCSN: LRZ – Andy Bates, Chris Kelly, Michael Moodie, Keith Pengilley (Panel appointee), Nigel Wilhelm; MRZ – Matt Dare, Mick Faulkner, Mark Modra, Rob Sonogan (Panel appointee); HRZ – Mark Branson, Terry Horan, Rob Norton, Lawrence Richmond. I thank each and every one of these outgoing members for their input and dedication to their roles.

Congratulations are extended to former RCSN members Andrew Russell and Michael Chilvers who are continuing their association with GRDC through their appointments to the GRDC Southern Panel.

On behalf of GRDC and the Southern Region Panel, I again thank all members and support staff of the Southern RCSN for their passion and contribution to grains industry RD&E and I look forward to another year of fruitful collaboration.

LUKE GAYNOR
GRDC Senior Manager – Grower Extension and Communication

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2. Executive summary

Ensuring GRDC's investments are locally and agronomically relevant to growers is crucial for delivering on the organisation's purpose – investing in research, development and extension (RD&E) to create enduring profitability for Australian grain growers.

Since 2013, the Australian grains industry has expanded, growing from an estimated value of $13.9 billion (2012-13) to $17.8 billion (2016-17), underpinned by investment in RD&E to drive profitability. Over the course of the last financial year, GRDC has invested more than $199.8 million in over 750 projects.

Following the launch of GRDC's Five-year RD&E Plan in August 2018, GRDC has been implementing its strategy to achieve this, focusing on the key profit drivers. The plan outlines a flexible and responsive approach to investment that enables GRDC to respond to the constantly evolving operating environments of agricultural systems. An appetite for slightly higher risk, transformational investment opportunities is also reflected in the RD&E Plan.

The key profit drivers of Australian grain production enterprises form the five major objectives of the plan:

- improve yield and yield stability;
- maintain and improve price;
- optimise input costs;
- reduce post-farm-gate costs; and
- manage risk to maximise profit and minimise losses.

Thirty Key Investment Targets (KITs) address the five objectives, and strategies describing how GRDC will invest to overcome or capture these constraints and opportunities are currently under development.

GRDC's Southern Regional Cropping Solutions Network (RCSN) plays an integral role in ground truthing investments, informing GRDC on the key priority constraints and opportunities to improve profitability in each localised area of the high, medium and low-rainfall zones.

Since the establishment of the Southern RCSN in 2012, its members, through their networks and GRDC open forums, have identified;

- 70 issues affecting profitability in the high-rainfall zone;
- 68 issues in the low-rainfall zone; and
- 77 issues in the medium-rainfall zone.

Prioritisation of these issues and further information provided around the motivations, attitudes, knowledge, abilities and technology for each constraint or opportunity has enabled GRDC investments to be highly targeted to the profit-limiting factors in each rainfall zone. Examples of investments that have been driven from RCSN identified priorities and background information include:

- Southern Pulse Extension Project (BWD1709);
- Using seasonal forecast information and tools to manage risk and increase profitability in the southern region (DAV1803-010SAX); and
- Development of the 'Ag Price Guide' (as part of ORM0004 & SFS00020).

The RCSN initiative in the southern region is co-ordinated by Jen Lillecrapp, who is supported by the RCSN leads from each network, Cam Nicholson, John Stuchbery and Barry Mudge. The networks meet twice a year to identify, define and prioritise issues affecting grower profitability in the southern grain-growing region and provide GRDC with detailed information about these issues.

Local forums, along with RCSN meetings and engagement with the GRDC Southern Panel, have enabled GRDC to increase local engagement and better respond to grower feedback.

The RCSN members are an enormous asset in GRDC's ability to deliver value to grain growers through targeted investment, providing the crucial local link to prioritise and drive GRDC's investment agenda within the scope of the KITs.

3. Managing grains RD&E

The Grains Research and Development Corporation (GRDC) is one of the world's leading grains research organisations. Its purpose is to invest in research, development and extension (RD&E) to create enduring profitability for Australian grain growers.

GRDC is a statutory corporation, founded in 1990, under the *Primary Industries Research and Development Act 1989* (PIRD Act), it is subject to accountability and reporting obligations set out in the *Public Governance, Performance and Accountability Act 2013* (PGPA Act).

The functions of GRDC under the PIRD Act include: coordinating or investing in RD&E activities; monitoring, evaluating and reporting on the impact on the grains industry and the wider community; and facilitating the dissemination, adoption and commercialisation of the results of R&D.

Investment in grains RD&E is driven by the needs of Australian grain growers and the regional communities in which they live and work.

Growers and other industry stakeholders can contribute to the development of grains RD&E by:

- direct engagement with representatives of the GRDC including;
  - staff;
  - GRDC Regional Panel Members; and
  - GRDC Regional Cropping Solutions Network (RCSNs) members;
- participating in discussions at GRDC grower events including Grains Research and Farm Business Updates; and
- engagement with GRDC on social media including Facebook (@theGRDC), Twitter (@theGRDC, @GRDCSouth, @NVT_Online), Instagram (thegrdc) and LinkedIn (Grains Research and Development Corporation).

Growers, along with several advisers and researchers have the opportunity to represent their industry as members of RCSNs. They may also be as appointed members of GRDC Regional Panels or the GRDC Board. GRDC has a continuous investment cycle, designed to ensure grain grower levies are invested in RD&E to create enduring profitability for Australian grain growers.

Defining and understanding the causes of an issue

The RCSNs use an analytical approach to understand the causes and factors that contribute to the constraint or opportunity, which is essential to identify a range of effective solutions to address the constraint or capture the opportunity.

What are the motivations, attitudes, knowledge, abilities and tools/technologies (MAKAT) or the lack thereof that cause the issue? This structured approach is referred to as the MAKAT process and identifies the range of causes for the existing issue (constraint or opportunity). Understanding the causes of the issue contributes to the GRDC process to identify a range of solutions to address the cause issue, prioritise regional investment and design investments.

Guided consideration

With hundreds of issues presented and discussed annually, RCSN members work to clearly understand and define constraints or opportunities to grains profitability, and identify perceived gaps in knowledge, skills, tools or technology relating to these issues. The analysis of each issue is structured and the RCSNs assess each issue by considering the following points.

1 Understand the issue. What is the constraint or opportunity and how does it fit within the context of the farm system? How is it limiting production or, more importantly, profit? Is it common to most growers in the district or limited to local areas? What contribution will finding a solution make to individual farm profit and risk management and to the district? How likely is it that the solution will be adopted?

2 What is already known? Have the literature been explored to see if there is already a solution? Are there growers in the district or in similar environments elsewhere who have developed a solution, or at least tried things? Is further work needed or would it be better to share the current knowhow with other scientists and growers?

3 Review what type of work is needed. Does a solution need to be generated through research and are these resources and scientific capability available? Or should someone else with greater experience and skills be engaged? Will the research only provide technical information or can a profitability dimension be added? Or, if there is already a body of knowledge (see step 2), should work concentrate on validating that information in the relevant district, either by a simple plot set-up or larger demonstration strips in grower paddocks? Or should work move straight to extending the known information?

4 What is the value/return of any proposed solution? Having generated a possible technical solution what difference will it make to farm profit? Does it increase farm risk and how can that be managed? Are there any side benefits or downsides? These considerations need to cover the range of farms in the district. What is the district impact? Can it be applied to farms elsewhere in similar environments?

5 Review how growers might adopt the solution. What is the current level of understanding of growers and how does the solution fit their system? What do they need to know? How does the information need to be delivered so that growers are confident to build it into their decision-making? Should demonstrations, field days, grower discussion groups or something else be used? What is the role of the commercial sector in extension (for example private consultants)? How will the level of adoption be measured and how will the reasons why some growers do not adopt (as will inevitably be the case) be understood? How can growers and advisers in areas with similar environments be informed of the results?

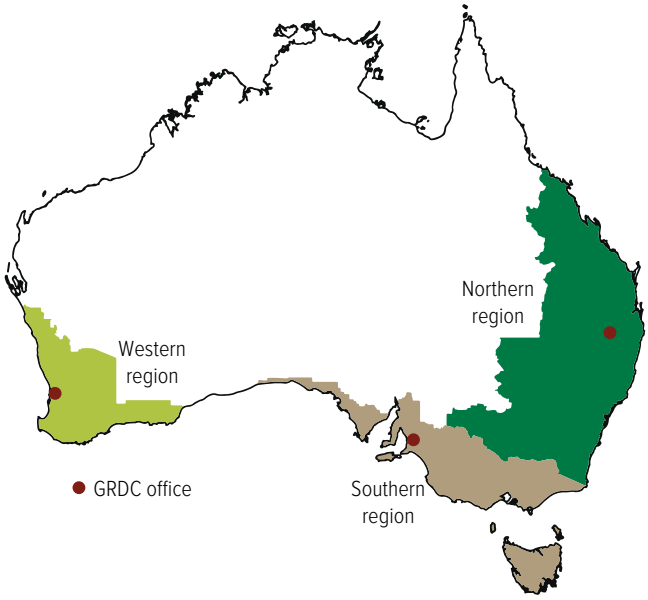
6 Understand the timeframe. Recognising what has been done elsewhere/learning from this. What will be delivered and in what timeframe, and will it require an extension response?

After all issues are considered, the highest-ranking issues undergo another process of structured analysis to identify and define what RD&E is required to address the issue – the process is called program logic.

Local networks

GRDC engages extensively with the grains industry via a wide variety of sources to guide its investment in RD&E. To assist this (RCSNs have been established in each of the three GRDC regions – southern, northern and western (Figure 1).

FIGURE 1 GRDC organises its operations and functions based on three regions, reflecting the distinct grain-growing zones within Australia.



These networks play a critical role in supporting GRDC staff and Regional Panels to set priorities for RD&E. The networks assist in identifying and understanding important profitability constraints and opportunities. The format of each group or network differs between regions, based on historical RD&E management, industry structures and grower needs.

Regional Panels

Recognising the variations in environment, conditions and issues across Australia, three advisory panels based on the grain-growing regions of southern, northern and western Australia (Figure 1) were established in 1990. GRDC Regional Panels ensure market and production realities are considered and reflected in the RD&E investment program. Each region has distinctive features that warrant focused planning and research management in genetic and enabling technologies, applied R&D (including soils, agronomy and farming systems, crop protection, and biosecurity), business and commercial, and communications and extension.

The Regional Panels comprise grain growers, agribusiness representatives, advisers, researchers and GRDC's General Managers.

Each Panel:

- identifies and monitors regional and national grains industry issues relevant to the region;
- interacts with grower groups, research advisory committees and other interested parties in the region to exchange information;
- identifies and develops priorities for RD&E investment and recommends these to the GRDC National Panel;
- keeps growers, advisers and other stakeholders in the region informed about GRDC's strategic direction, investment portfolio and research projects; and
- assists staff in monitoring the effectiveness of the investment portfolio.

The GRDC National Panel is made up of the Chairs of the three Regional Panels, the Managing Director of GRDC and GRDC's General Managers.

The National Panel:

- addresses national RD&E priorities across GRDC's investment portfolio and makes recommendations to the Board; and
- assists the Board to maintain links with grain growers, the Australian Government, state and territory Governments, and research partners.

GRDC is guided by constant two-way communication with growers through its Panels and grower networks.

4. About the Southern Regional Cropping Solutions Network

Purpose

The purpose of the GRDC Southern RCSN is to provide a transparent process for the identification and prioritisation of issues (constraints and opportunities) affecting the profitability of growers across the rainfall zones of the southern region. The RCSNs assist GRDC in the development and strategic review of locally targeted RD&E activities to create enduring profitability for Australian grain growers. RCSNs also interrogate the underlying causes and limitations (motivations, attitudes, knowledge, abilities and technology) around issues to help inform RD&E investments that effectively address constraints and capture opportunities. Structurally, the Southern RCSN is broadly represented through three rainfall-zone-specific RCSN groups – low-rainfall zone (LRZ), medium-rainfall zone (MRZ) and high-rainfall zone (HRZ) – that stretch across Victoria, Tasmania and South Australia (Figure 2).

Functions

The main roles and responsibilities of RCSN members are to:

- liaise with a wide network of stakeholders in their respective regional production zones;
- identify topical seasonal and emerging issues in their local area and potential appropriate responses from GRDC, including communication or extension activities;
- identify and prioritise issues (constraints and opportunities for long-term profitability of grain production systems in the relevant rainfall zone);
- identify factors that cause and affect priority issues as well as RD&E opportunities to address these issues or capture opportunities;
- assist GRDC staff to develop RD&E investments;
- liaise with other growers and industry partners to represent their issues at RCSN level;
- strategically review selected GRDC investments that address priority issues for their relevant production zone;
- increase awareness of GRDC RD&E outcomes, investments and strategic direction to their own network of grain industry stakeholders; and
- provide feedback to GRDC staff and the Southern Panel on emerging issues, current attitudes and activities within the region that are relevant to local issues and the needs of the network.

Membership

Each of the three RCSN zones has up to 13 members and includes growers, advisers, agribusiness/resellers and researchers. The membership comprises a minimum of six growers (four of whom are involved solely in primary production), a minimum of three advisers, plus at least one agribusiness/reseller and one researcher.

The membership of each zone includes three or four members of GRDC's Southern Panel.

GRDC resources the Southern RCSN through an independent facilitator for each rainfall zone, a dedicated coordinator and is supported by GRDC southern region staff.

The knowledge, networks, skills and geographical spread of members are the primary considerations in the recruitment of members.

Expressions of interest for new members were called for the next two-year term of the Southern RCSN commencing 1 November 2018.

FIGURE 2 Zones and member locations of the three RCSNs in the GRDC southern region.

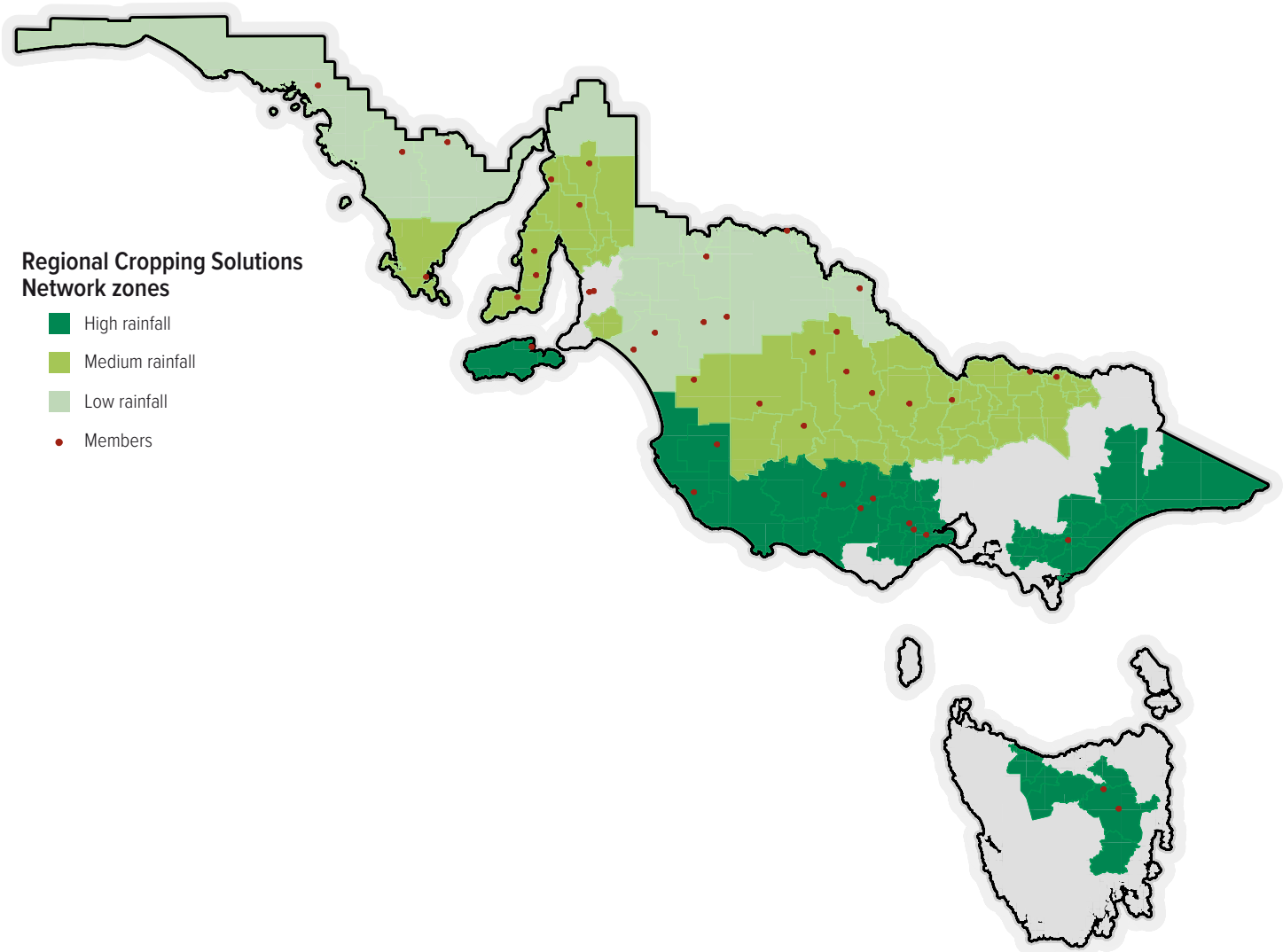


TABLE 1 GRDC Southern Regional Cropping Solutions Network – low-rainfall zone (as at July 2018).

Name	Category	Town	State
Tristan Baldock	Grower	Buckleboo	SA
Andy Bates	Adviser	Streaky Bay	SA
Andrew Biele	Grower	Loxton	SA
Chris Crouch	Grower	Wandearah	SA
Louise Flohr	Adviser	Lameroo	SA
Chris Kelly	Grower	Woomelang	VIC
Peter Kuhlmann^	Grower	Mudamuckla	SA
Brian Lynch	Adviser	Loxton	SA
Tim McClelland	Grower	Birchip	VIC
Michael Moodie	Researcher	Mildura	VIC
Rohan Mott^	Grower	Ninda	VIC
Alistair Murdoch	Grower	Kooloonong	VIC
Wade Nickolls	Grower	Pinnaroo	SA
Nigel Wilhelm	Researcher	Adelaide	SA
Kate Wilson^	Grower	Hopetoun	VIC

^GRDC Southern Panel member

TABLE 2 GRDC Southern Regional Cropping Solutions Network – medium-rainfall zone (as at July 2018).

Name	Category	Town	State
John Bennett^	Grower	Lawloit	VIC
Matt Dare	Grower	Clare	SA
Mick Faulkner	Adviser	Watervale	SA
Andrew Hansen	Grower	Coomandook	SA
Grant Hollaway	Researcher	Horsham	VIC
Sam Holmes	Adviser	Maitland	SA
Steven Jaeschke	Grower	Keith	SA
Mark Modra	Grower	Port Lincoln	SA
Richard Murdoch^	Grower	Warooka	SA
Steve Richmond	Adviser	Jamestown	SA
John Robertson	Adviser	Horsham	VIC
Andrew Russell	Grower	Rutherglen	VIC
Gavin Sait	Grower	Charlton	VIC
Andrew Slater	Grower	Curramulka	SA
Peter Taylor	Grower	Lubeck	VIC
Randall Wilksch^	Grower	Yeelanna	SA

^GRDC Southern Panel member

TABLE 3 GRDC Southern Regional Cropping Solutions Network – high-rainfall zone (as at July 2018).

Name	Category	Town	State
Mark Branson	Grower	Stockport	SA
Michael Chilvers	Grower	Evandale	TAS
Craig Drum	Adviser	Rossbridge	VIC
Brett Gilbertson	Grower	Millicent	SA
Adam Hancock	Adviser	Naracoorte	SA
Terry Horan	Adviser	St Leonards	TAS
Bruce Macague	Grower	Rochester	VIC
Fiona Marshall^	Grower	Mulwala	NSW
Peter McCann	Adviser	Ceres	VIC
Mike McLaughlin^	Researcher	Adelaide	SA
Jon Midwood^	Adviser	Inverleigh	VIC
Rob Norton	Researcher	Horsham	VIC
Rowan Paulet	Grower	Flynns Creek	VIC
Keith Pengilley^^	Grower	Conara	TAS
Lawrence Richmond	Adviser	Newington	VIC
Jenny Stanton	Grower	Kingscote	SA
Jim Zwar	Adviser	Glenthompson	VIC

^GRDC Southern Panel member
^^GRDC Southern Panel member until August 2018

TABLE 4 RCSN support team.

RCSN zone	Role	Name	Telephone	Email
All zones	GRDC Grower Relations Manager – South	Courtney Ramsey	0428 274 018	courtney.ramsey@grdc.com.au
	GRDC Grower Relations Manager – South	Darren Arney	0447 877 178	darren.arney@grdc.com.au
	GRDC Grower Relations Manager – South	Randal Wilksch	0437 769 098	randall.wilksch@grdc.com.au
	Coordinator Southern RCSN	Jen Lillecrapp	0427 647 461	jen@brackenlea.com
Low-rainfall zone	RCSN Lead LRZ	John Stuchbery	0429 144 475	john.stuchbery@agrivision.net.au
	RCSN Lead LRZ	Barry Mudge	0417 826 790	theoaks5@bigpond.com
Medium-rainfall zone	RCSN Lead MRZ	John Stuchbery	0429 144 475	john.stuchbery@agrivision.net.au
High-rainfall zone	RCSN Lead HRZ	Cam Nicholson	0417 311 098	cam@niconrural.com.au

Low-rainfall zone RCSN: (Back, from left) Louise Flohr, Darren Arney (GRDC Grower Relations Manager – South), Chris Couch, Tim McClelland, Nigel Wilhelm, Rohan Mott, Wade Nickolls, Andy Bates, Brian Lynch, Michael Moodie, Chris Kelly, Tristan Baldock. (Front, from left) John Stuchbery (RCSN facilitator), Barry Mudge (RCSN facilitator), Alistair Murdoch, Andrew Biele. Absent: Peter Kuhlmann and Kate Wilson.

Medium-rainfall zone RCSN: (Back, from left) Darren Arney (GRDC Grower Relations Manager – South), Andrew Hansen, Gavin Sait, Sam Holmes, Peter Taylor, Mark Modra, Randall Wilksch (GRDC Grower Relations Manager – South), Craig Ruchs (GRDC Senior Regional Manager – South), Steve Richmond, Richard Murdoch, Grant Holloway, Kate Burke (previous RCSN lead). (Front, from left) Mick Faulkner, Andrew Russell, John Bennett, John Robertson, Andrew Slater, Matt Dare. Absent: Steve Jaeschke.

High-rainfall zone RCSN: (Back, from left) Darren Arney (GRDC Grower Relations Manager – South), Jon Midwood, Cam Nicholson (RCSN facilitator), Pete McCann, Adam Hancock, Lawrence Richmond, Craig Drum, Brett Gilbertson, Keith Pengilley. (Front, from left) Fiona Marshall, Bruce Macague, Terry Horan, Michael Chilvers, Rowan Paulet, Jim Zwar. Absent: Mark Branson, Rob Norton and Jenny Stanton.

5. Activities of the RCSN

Each rainfall zone of the Southern RCSN met for two days in both February and July 2018. At each of the meetings, the RCSN members identified topical, seasonal issues and management challenges faced by growers based on conversations with their own networks of growers and industry stakeholders. Capturing these issues and identifying information requirements has guided GRDC communication products and extension activities.

The RCSN reviewed the prioritised list of issues affecting grower profitability in each rainfall zone at each of the meetings. List review included consideration of issues identified at GRDC local forums or submitted by other growers and industry stakeholders. Prioritised issues for each rainfall zone of the southern region as at July 2018 are listed on pages 14 to 20. Issues are prioritised according to impact, area affected and frequency of occurrence.

GRDC provided feedback on the status of investment/RD&E responses to important issues submitted by the RCSN following each meeting. A list and summary of recent and current GRDC investments addressing these issues was also provided to the network and are available at the GRDC Southern RCSN website (www.regionalcroppingsolutions.com.au/publications-2/grdc-investment-summaries).

Feedback from GRDC to priority issues from each RCSN zone were categorised as "partially or fully addressed by existing investments and further feedback from RCSN requested as priority". At the suggestion of GRDC, each of the rainfall zones of the Southern RCSN undertook a 'deep-dive' of several issues. A deep dive involves an overview of current knowledge, latest research outcomes and objectives of current research from recognised RD&E specialists. The purpose of deep dives is to:

- understand underlying causes;
- describe the desired outcome (where we want to get to);
- review current knowledge, technologies and tools, current RD&E objectives and activities; and
- identify any RD&E gaps and actions required to work toward desired outcomes through strategic investment.

Deep dives of issues undertaken by the Southern RCSN in 2018 are as follows.

Low-rainfall zone:

- Rhizoctonia – economics of fungicides (seed dressings and in-furrow application);
- barley grass and brome grass control; and
- farm business management skills are essential to improve long-term profitability.

Medium-rainfall zone:

- level of knowledge of advisers is critical to the profitability, risk management and/or compliance of farm businesses; and
- stubble retention has increased the risk of economic damage from pests including but not limited to insects (for example, lucerne flea, slugs, snails and mice).

High-rainfall zone:

- methods to reduce reliance on foliar and in-furrow fungicides; and
- management packages for canola diseases (for example, Sclerotinia, blackleg, powdery mildew).

A combined meeting of the LRZ, MRZ and HRZ of the Southern RCSN was held in July 2018. A range of common and important issues identified for all rainfall zones was explored at this meeting and topics are outlined below.

- **Enabling technologies to capture transformational opportunities, including data-driven decisions and management, which have been identified by the RCSN.** Liam Ryan (GRDC Manager of Transformational Technologies) provided insights into the GRDC investment portfolio in technologies and how research activities support commercialisation.
- **The registration of agricultural chemical is recognised as a high priority issue affecting the profitability of grain growers.** Gordon Cumming (GRDC Manager of Chemical Regulation) provided RCSN members with an overview of GRDC investment to support the registration of chemical use patterns including support for minor and emergency-use permits support, label extensions, new products and active ingredients for Australian growers. He also provided an update on any progress to register chemical use patterns, which had previously been identified by the RCSN.
- **Nitrogen (N) is a key driver of yield and N fertiliser is a significant input and therefore has a significant impact on grower profits.** A deep dive was undertaken by the RCSN groups to identify motivations, attitudes, knowledge, tools and technologies associated with the related issues identified in each rainfall zone. Presentations included an overview and written summaries of current and recent RD&E provided by Dr Stephen Loss (GRDC Manager Soils and Nutrition – South). Dr Jeff Baldock (CSIRO) provided a synopsis of the latest the knowledge of N dynamics in modern cropping systems and the findings of a review of N mineralisation and N decision-support tools in cropping systems of south-eastern Australia was presented by Dr Murray Unkovich (University of Adelaide).
- **Objectives and outcomes of GRDC RD&E investments that aim to address a wide range of weed issues identified by the RCSNs.** RCSN members heard and were provided with written summaries from Jason Emms (GRDC Manager Weeds) about GRDC's weeds investment portfolio. Following presentations, each rainfall zone RCSN group further defined issues and identified gaps in knowledge and opportunities to address important weed issues affecting profitability.

Following the deep dive of each issue, priority issues related to each topic were revisited to further interrogate gaps in knowledge and research, with new information provided to GRDC to inform investments. For these topics additional information included: refined issues related to big data, automation, precision agriculture and sensors; issues surrounding chemical use patterns and registration; as well as refined issues related to nitrogen management and the weeds portfolio.

A review of the RCSN Initiative was undertaken at each meeting to evaluate the effectiveness of the process in fulfilling the purpose of the initiative and identify opportunities for continual improvement. An audit of the skills, knowledge, experience, networks and geographical locations of members for the 2018–20 term was undertaken to assist GRDC in the recruitment of new RCSN members.

GRDC local forums

Six GRDC local forums were held across the LRZ, MRZ and HRZ of the GRDC southern region in 2018 from mid June to early July. Further details are outlined below.

Local forums were established to provide local growers and industry stakeholders an opportunity to engage directly with GRDC and RCSNs to identify important constraints and profit growth opportunities, validate issues as described by RCSNs, as well as to learn about, discuss and help shape future RD&E. The local forums also presented an opportunity to reach and build connections with a new audience, to strengthen connections with stakeholders and to explain and provide greater transparency in the investment process and build confidence in the GRDC RCSNs and the Southern Panel.

Six Local forums were held in 2018 that focused on locally relevant topics as indicated in Table 5.

TABLE 5 Locally relevant topics from six local forums held in 2018.

Rainfall zone	Location and district	Focus topic(s)
Low	Pinnaroo, Mallee, SA	Increasing the productivity of sandy soils
	Lalbert, Eastern Mallee, VIC	Understanding any potential risk of herbicide carryover in soils and potential implications for the emergence and productivity of subsequent crops
Medium	Kapinnie, Lower Eyre Peninsula, SA	Managing weeds and herbicide resistance in retained stubble systems
		Managing insects and insecticide resistance in retained stubble systems
	Dookie, North East, VIC	Strategies to optimise yield and profitability of growing canola
High	Derrinallum, South West, VIC	Nutrition to fill the yield gap and optimise return on investment in fertiliser
		Mid-row banding of nitrogen fertiliser
	Sale, Gippsland, VIC	Nutrition strategies to increase production and profitability
		Subsoil amelioration to increase infiltration, water-holding capacity and plant-available water

Evaluation

More than 190 individuals participated in the forums and a summary of evaluation surveys is listed below:

- 85 per cent of respondents rated as good or excellent the effectiveness of forums to enable growers and industry stakeholders to check and identify important issues that affect grower profitability and need to be considered by GRDC;
- 80 per cent of respondents rated as good or excellent the effectiveness of the forum to enable growers and industry representatives to learn about and have input into the future RD&E on the focus topics; and
- 84 per cent of respondents rated as good or excellent the effectiveness of the forums to enable growers and industry stakeholders to hear about a selection of other GRDC RD&E investments.

Constraints and opportunities

Through the delivery of the six GRDC local forums in 2018, a total of 144 issues, important constraints and opportunities for the long-term profitability of grain growers were identified. These issues were considered as part of the Southern RCSN and are categorised below:

- 18 new/additional issues plus five additional issues specific to irrigated cropping enterprises;
- 17 issues were incorporated into existing issues that were re-defined or described;
- 97 issues that have already been captured and therefore validated that these are important issues; and
- 12 issues deemed to be outside the mandate of GRDC (and referred to relevant organisations).

6. Priority issues for the southern region

At each meeting the Southern RCSN reviewed and updated the list of priority issues (constraints and opportunities) affecting grower profitability for each rainfall zone (LRZ, MRZ and HRZ). Additional or emerging issues were captured by RCSN members, direct submissions to the RCSN and GRDC local forums. These issues were prioritised based on a standard set of criteria (area affected, financial impact and frequency) and were included on the prioritised issues list provided to GRDC as listed in Tables 6 to 8.

TABLE 6 Issues (opportunities and constraints) that have the greatest impact on the profitability of growers in the low-rainfall zone (LRZ) of the southern region.

Priority	Issue
1	Potential for external societal influences to affect growers' ability to produce in an effective manner (for example, biased consumer attitudes)
2	Improved pulse varieties to increase the profitability of farming systems in the LRZ
3	The loss of glyphosate as a major tool through either regulation or resistant weed species would significantly impact on the profitability and sustainability of farming systems in the LRZ
4	As the global trend for pesticide regulation based on hazard rather than risk continues, deregistration of affordable active ingredients will cause an increase in pesticide costs and erode profit margins
5	Increased model skill in seasonal forecasting from March to May and better utilisation of seasonal forecasts
5	Potential for climate change to become a significant constraint due to increasing spring heat, shorter growing seasons and possible increased frost incidence
7	Farm business management skills are essential to improving long-term profitability
8	Robotics provide opportunities to increase efficiencies and profitability of farm businesses
9	New and novel methods of weed control (for example, microwaves)
10	The risk (either perceived or real) of herbicide residues accumulating in sandy soils in low-rainfall environments is reducing returns
11	Hard-to-control weeds
11	Limited knowledge, skills and experience of growers and advisers new to pulse growing increases production risk of pulses in the LRZ
13	Opportunities to improve the integration and management of livestock into the farming system with site-specific grazing are impeded by technology cost and state regulation
13	Predicting flowering time and manipulating crop development to reduce exposure during high-risk periods to mitigate impact of frost
15	The sustainable use of cost-effective herbicides and the development of alternative management tools are critical for effective weed control and profitability of cropping systems
16	RD&E capacity in the LRZ is diminished by retraction of public investment in infrastructure and human resources and the exit of experienced professionals
16	Opportunities to improve profit are missed as new practices are not adopted due to a lack of grower trust in small plot results
18	The downside risk of highly leveraged, high-input, high-crop-intensity farming systems threatens the economic viability of low-rainfall farm businesses
18	The strong preference growers demonstrate for peer-to-peer learning via digital communication (Twitter) is an opportunity for effective extension to builds skills and capacity and practice change
20	Economic thresholds for insect control in the LRZ are poorly defined, which causes the over-use of insecticides
20	The opportunity to use big data to improve grower profitability in the LRZ
22	Glyphosate-resistant weed populations are developing on fencelines
22	Nitrogen management decisions – value of legume contribution and cost vs returns
22	Managing insects – forecasts and alerts, new pests, thresholds, new insecticide groups and control of resistant populations
22	Barley grass and brome grass control
26	Phenoxy herbicides – alternatives
27	Easy-to-use decision-support tools would enable better use of objective data and reduce grower financial and production risk
28	Opportunity to improve profitability and long-term management of weeds, diseases and soil fertility through better crop sequencing
29	Seedbanks of problem grass weeds are increasing because harvest weed seed management is not being fully utilised
29	Local data for Russian wheat aphid risk factors (volunteer species, aphid flights) is scant
29	The soil nitrogen supply is declining as crop intensity increases
29	The lack of low-cost open-pollinated canola varieties is contributing to the reduction in canola area in the LRZ
33	Widespread adoption of seed-applied insecticide for Russian wheat aphid control may harm beneficial insects and soil microbes

TABLE 6 *(continued)* Issues (opportunities and constraints) that have the greatest impact on the profitability of growers in the low-rainfall zone (LRZ) of the southern region.

Priority	Issue
33	Sandy soils – crop establishment and growth, cover crops and amelioration strategies
35	Increasing awareness of nitrogen removal and cycling may improve nitrogen management, lower risk and increase profit in the LRZ
36	Fertiliser toxicity
36	Better access to profit and production-focused precision-agriculture (PA) support would increase return on investment in PA
36	Rhizoctonia – economics of fungicides (seed dressings and in-furrow application)
39	Poorly calibrated moisture probes provide incorrect estimations of total available water and plant-available water capacity
39	There is an opportunity to obtain higher return on investment from sulfur fertiliser by understanding of sulfur dynamics in sandy soils and low-rainfall environments
39	Improved integration of livestock – flexibility, economics and animal health
42	A better understanding of seed zone environment and determine the value of vertical furrows
42	Crop establishment under marginal conditions – moisture, stubble, precision seeding, discs, chemicals
44	The nitrogen supply of sandy soils is being over-estimated
45	Populating the Flower Power decision-support tool with varieties and locations relevant to the GRDC southern region will help mitigate frost risk
45	Access to regional soil descriptions would help define management zones in variable soil landscapes
47	Farm efficiencies
48	Spot spraying
48	Control of grasses in cereal-based pastures creates a feed deficit at certain times of the year
48	Growers are concerned that the erosion risk of bare tramlines may outweigh the benefits of reducing compaction in sandy soils
48	Crown rot is increasing with changed farming practices leaving stubble crowns intact and not susceptible to break down
52	Is there an opportunity to increase the productivity and profitability of shallow calcareous soils?
52	There is limited choice of legume pasture species adapted to the LRZ
52	Do more intensive cropping systems require greater micronutrient inputs?
55	Overcoming highly alkaline and saline subsoil constraints would increase rooting depth and access to plant-available water
56	The risk of wind erosion due to inadequate ground cover constrains the use of legumes in low-rainfall environments
56	Is regular use of in-furrow fungicides changing soil microbiology and increasing *Pratylenchus neglectus* populations?
56	There is limited data on the nutrient use efficiency of calcareous soils
56	Mice – improved options that provide effective and long-term control of populations
60	Growers are unaware of recently developed techniques to improve common white snail control and off-label product use is occurring
60	Sodic soils are not profitable in the LRZ
62	Variety specific agronomy for irrigated crops
63	The potential for improved profitability from retaining more stubble by investing in stripper front disc seeder technology needs to be quantified
63	Soaks and seeps
65	Powdery mildew is reducing medic production
66	Milling oats
67	Is there potential to use alternative crops such as safflower as a viable rotation option for the LRZ?
68	Irrigated high-value crops could improve profitability of LRZ growers who have access to water for irrigation

TABLE 7 Issues (opportunities and constraints) that have the greatest impact on the profitability of growers in the medium-rainfall zone (MRZ) of the southern region.

Priority	Issue
1	Developing new food-based markets for pulses to help growers manage price volatility
2	Nitrogen (N) decision-making – technology to measure nitrogen in real-time and improved N budgeting tools, better rules of thumb for N mineralisation, N budgeting and management, improve N use efficiency
3	Evaluation and pre-breeding of canola varieties for tolerance levels to 'dim' herbicide chemistry could lead to improved annual ryegrass control and reduce the risk of crop damage resulting in increased profitability and increased area of canola production
4	Profit-focused cost and productivity management can increase profit
5	High-value pulse and legume varieties (for example, lentils and chickpeas) bred for a wider range of soil types and rainfall zones will improve farm profitability on a broader scale
5	Long-term no-till cropping farms may not have the infrastructure, tools or knowledge to effectively integrate livestock into the business
7	Level of knowledge and skills of advisers, growers and staff is critical to the profitability, risk management and/or compliance of farm businesses
8	Efficacy of glyphosate is declining due to over-use and increased incidence of glyphosate-resistant weeds including fleabane, wild radish, tares, milk thistle and canary grass in addition to annual ryegrass
8	Stubble retention has increased the risk of economic damage from pests including but not limited to insects (for example, lucerne flea, slugs, snails and mice)
8	Access to local spray application training for local operators including in the border areas of Victoria and New South Wales to increase spray efficiency and reduce off-target damage
8	Using soil moisture information to make better decisions; tactical management to optimise the use of plant-available water
12	Variability in seed supply and limited choice of canola varieties, particularly high-yielding, open-pollinated varieties with durable disease resistance increases production risk, compromises weed control and herbicide residue management, and reduces profitability
13	Updated variety specific agronomy packages (VSAPs) to ensure successful adoption and growing of pulse crops
13	Cost-effective, non-chemical weed control systems such as robotic weeders in broadacre crops will prolong the life of important herbicide chemistry such as glyphosate and minimise the economic impact of difficult-to-control weed species such as fleabane
15	The current processes for pesticide legislation and governance within the Australian Pesticides and Veterinary Medicines Authority restrict timely access to pesticides, which negatively impacts crop production and profits
16	Cereal leaf diseases – genetic solutions and integrated management strategies to manage yellow leaf spot, eyespot and *Septoria tritici* blotch
16	Increased seasonal climate variability creates extremely contrasting growing seasons, which require adaptive, agile and flexible management options to optimise yield and maximise profit, including but not limited to a 'menu' of crop species and cultivars
18	Growers cannot easily predict the likelihood of pest and disease incursions, which is important for planning and management
19	The continual breakdown of genetic resistance to blackleg in canola impacts on the yield and profit of growing canola
19	Spatial monitoring of farms using sensor technology and digital platforms may improve crop scouting efficiencies and enable site-specific management including crop nutrition, weed and pest control
21	Which is the more economically sustainable option in high land price areas: a crop rotation dominated by high-value crops or a more balanced rotation with a mix of cereals, pulses and other land-use options?
21	Nitrogen requirements to maximise profitability of wheat and canola in a long-term no-till system are not well understood
21	Over-reliance on chemicals (herbicides, insecticides and fungicides) has reduced sensitivity and increased resistance, which limits cost-effective management options
24	Summer weed spraying in conditions conducive to inversions and/or with inappropriate spray quality (droplet size) creates a high risk of drift and off-target damage
25	Canola variety specific agronomy packages (VSAPs) to optimise yield potential and maximise profit
25	Limited influence on barley variety development, which may lead to a lack of varietal choice
25	Soil residual herbicide used to control weeds on fencelines and 'voids' can damage vegetation if they move through the soil from the target area
25	Increased incidences of fires when harvesting pulses, particularly lentils and/or when harvesters have an in-built seed destruction could have consequences for insurance (for example, exclusions and higher premiums)
29	Subsoil constraints — understanding how acidity, sodicity, nutrients and structure limit yield, quantifying the economic impact of amelioration techniques, management of subsurface and subsoil acidity, genetic advancements, soil amelioration and drainage strategies to reduce the impact of waterlogging
29	Opportunity to improve the mitigation of frost risk via pre-sowing risk assessment, new monitoring tools, better frost identification skills and shared learning
29	Compaction – what is the impact, which soil types are impacted and which soils will be responsive to tillage?
32	Harvester set-up to increase efficiency and effectiveness to reduce losses
32	What are the practical strategies that can make best use of precision-agriculture data and technology to maximise profit by reducing or re-allocating costs and/or increasing yields?
32	Pre-emergent herbicides do not work effectively in heavy stubbles
35	Registration of short residual 'imi' herbicides to control problem weeds in lentils reduces the risk of herbicide residue damage in cereals and the off-label use of other short residual Group B herbicides in lentils
36	Vetch variety improvement and grain market development would enhance the profitability of farms with soil types that are not suitable for growing lentils
36	Profit from cereals sown on early autumn rainfall events could be enhanced by clearly defined management packages that include variety selection, canopy management and crop protection strategies
36	Soil amelioration techniques for specific situations to improve crop establishment, nutrition and production on non-wetting sands resources for growers for soil amelioration – extension and resources for growers

TABLE 7 *(continued)* Issues (opportunities and constraints) that have the greatest impact on the profitability of growers in the medium-rainfall zone (MRZ) of the southern region.

Priority	Issue
39	Growers and advisers cannot make informed decisions about adopting a new variety as non-biased National Variety Trials data is not available or accessible until after a variety is released
40	Succession planning for RD&E expertise and capacity plus building the skills of growers
40	The commercial structure of plant breeding in Australia is leading to monopolies and reducing customer choice in varieties
42	Precision seeding to improve crop establishment and yield and profitability
43	Soil health – increasing organic matter to address declining levels and consequences by understanding the impact of inputs on soil biology and soil health plus understanding the impact of practices such as controlled-traffic farming and growing cover crops
43	Growers can optimise price received by improving their grain marketing knowledge and skills and/or accessing high-quality grain marketing advice
43	Poor understanding of soil water use in pulses leads to poor yield predictions
43	More effective extension of valuable R&D findings to enable adoption and practice change
47	The accumulation of herbicide residues in soils, especially low organic carbon sands over several seasons, may impact crop health and yield and restricts crop options
47	Identify and understand the constraints that limit the yields and profitability of lupins, including black pod syndrome and phomopsis blight
47	Soil acidity is increasing as liming programs and rates are not keeping up with rates of acidification
50	Cover crops, green and brown-manuring crops are options to increase inclusion of legumes and other broadleaf species, which provides the opportunity to increase the diversity and sustainability of farming systems
50	Foliar diseases and poor agronomy of oats reduce hay yields and quality
50	There is a paucity of grazing withholding periods for chemicals that are commonly used on cereals
50	Lack of grass-control options in pulses (faba beans and others)
54	Quantify nutrition (N, P, K, S, Cu, Zn and Mn) responses for a range of crop types including pulses, canola and cereals for a range of diverse environments across the MRZ
54	Conical snails reduce harvest efficiency, contaminate grain and reduce marketability
56	Profitable pulse or grain legume crop options and agronomy packages for sandy soils with a pH <6 or >8
57	The development of integrated strategies that includes bio-control options for the management of *Sclerotinia* in pulses and canola plus a quick test to accurately distinguish sclerotes from *Sclerotinia* from ryegrass ergot to avoid product being unnecessarily downgraded are required
58	The efficacy of zinc phosphide wheat bait on mice at registered rates is not providing adequate control and late-season control strategies are unclear
58	Crop yields are declining on non-wetting sands after several years of no-till cropping
58	Enabling flexible phenology in cereals through chemical application or breeding to match flowering date to emergence date and seasonal conditions would mitigate the risks associated with dry sowing (for example, heat stress or frost)
61	Uncertainty in the rotational break time required for eyespot inoculum breakdown in stubble, reduces confidence and leads to prophylactic fungicide applications in cereals
62	Updated variety specific agronomy packages (VSAPs) to increase durum yields
63	Too much information prevents the message from being received
64	Minimising downside/maximising upside
65	Strategies to stop and manage the increasing area affected by seeps and soaks (dryland salinity and waterlogging)
66	Effectiveness of liquid systems to deliver crop inputs, including granular versus liquid fertiliser delivery
67	High pH subsoils and compaction limits the yield potential of canola crops
68	Solutions including drainage to reduce the impact of waterlogging on trafficability, management and profitability of crops
68	The risk of growing lentils close in an intensive rotation could be reduced with specific and targeted weed, disease and pest management guidelines to address the key risks
70	It is difficult to estimate plant-available water and yield potential of calcareous soils and limestone of rubble subsoils
70	Practical engineering solutions are required to cost-effectively inject animal waste, lime and gypsum at depth to ameliorate subsoils
72	Quantify 'unusual frost' damage in grain-growing areas near wind farms
73	Accuracy and consistency of virus testing in pulse seed
74	Lack of independent product evaluation
75	Growers have difficulty controlling blanket weed (Toadflax) after wet years with standard summer weed control herbicide mixes
76	Multi-peril crop insurance – is it peril or a pearl?
77	Irrigated cropping requires a different set of crop selection criteria to optimise production and maximise profits on/under irrigation
78	Perennial crops – is there a place for these crops (for example, perennial wheat) in broadacre dryland cropping systems?

Case study:

Climate investment sheds light on forecast modelling

Successful Victorian climate and forecast information service *The Fast Break* is being rolled out to South Australia and Tasmania, connecting growers with the latest in climate, rainfall and oceanic activity predictions and observations.

GRDC has invested to expand *The Fast Break* across the southern region in partnership with Agriculture Victoria, recognising the key challenge climate risk poses for growers.

The seasonal outlook products on offer with the project, Using seasonal forecast information and tools to manage risk and increase profitability in the southern region, include:

- *The Fast Break* monthly email newsletter editions for SA, Tasmania and Victoria to be released monthly with updates on seasonal conditions, key climate drivers and the combined seasonal outlook from various global forecast models;
- *The Very Fast Break t*hree-minute monthly videos summarising seasonal conditions, key climate drivers and outlooks for SA and Victoria; and
- using seasonal forecasts in a GRDC South webinar series coaching participants on seasonal risk, model projections for climate drivers and soil moisture conditions to be available to participate in online either live or by viewing the recorded presentation.

Agriculture Victoria seasonal risk agronomist Dale Grey says the free-subscription *The Fast Break* newsletters and *The Very Fast Break* videos would save growers hours of research and simplify potentially conflicting information put out by a range of climate models.

"We're able to explain what the predictions are saying and discuss for growers where there is consensus to give growers more confidence into what might happen for the season ahead or if they need to exercise some risk-management strategies," he says

"Some years the models jump on a prediction quite early and they're right, while sometimes they're quite late making a consensus and it's always an issue that model predictions around autumn are the most problematic.

"Of course this is just when every cropper wants information about what the season is like before they plant but at least with this project we're able to arm them with as much information as possible to make the best decision for their operation."

Mr Grey says grain growers can use The Fast Break and The Very Fast Break services mid-season to make late nitrogen decisions and find guidance on harvest rain events.

"When we've got a prediction in July for the August, September and October period and people are considering top-dressing nitrogen, predictions at that time really can help with that sort of decision-making," he says.

"You wouldn't make this decision in isolation, you'd need to be thinking about how much nitrogen is in the paddocks already, sowing dates and stored soil moisture rather than just doing something because a forecast said it.

"In some years it could give greater confidence on the amount of forward-selling to do mid-season.

"It can give you some guidance as to what's likely to happen during harvest as well, to know if it might be wetter and what's the potential urgency to get the crop off as quick as possible.

"For people who are making export oaten hay or hay in general, these forecasts give you some sort of guidance to spring and whether this is likely to be a good haymaking year or not."

Mr Grey says the newsletters and videos also allow for reflection on weather events, giving growers an insight into what had been happening in their area and why.

In addition to the newsletters and videos, the project will include a series of lunchtime webinars focusing on seasonal risk, model projections for climate drivers and soil moisture conditions for growers across the southern region. The webinars are online and allow participants to ask questions. They will also be recorded to allow people to watch at any time.

Looking towards winter 2018, Mr Grey will update current climatic and soil moisture conditions and outline the oceanic and atmospheric conditions affecting SA, Tasmania and Victoria. He will also discuss the current seasonal outlooks and global model outputs for the coming months.

Agriculture Victoria seasonal risk agronomist Dale Grey is bringing the latest in climate and forecast information to South Australian and Tasmanian growers, building on the successful *The Fast Break* initiative that has been running in Victoria for more than a decade. PHOTO: AGRICULTURE VICTORIA

TABLE 8 Issues (opportunities and constraints) that have the greatest impact on the profitability of growers in the high-rainfall zone (HRZ) of the southern region.

Priority	Issue
1	Reliable supply of canola seed – is F2 canola an option?
2	Identify and develop high-value grain crops to complement existing common crops
3	Opportunity to capitalise on the synergies for livestock and cropping enterprises and increase whole-farm profit
4	Spatially specific (real-time) assessment data to better inform in-season nitrogen decisions in high-rainfall environments
4	Enhanced accuracy of nitrogen management decisions
6	Poor harvester efficiency (including grain loss) is impacting on profitability
7	Risk with limited stock of canola (no seed supplies)
8	Improved management packages for multi-herbicide-resistant annual ryegrass
9	Develop new markets for broad beans and faba beans
10	Determine practices (rotations) to reduce the high input costs required to grow high-yield wheat
11	Ensuring long-term cost-effective management of important HRZ foliar diseases by prolonging the life of fungicide and varietal resistance
12	Disease management package for Sclerotinia, blackleg and powdery mildew in canola
12	Develop harvest and weed seed management techniques to deal with late-germinating annual ryegrass
14	Need to use higher rates of clethodim to control ryegrass in canola
15	Develop new (non-GM) canola varieties
16	Encourage soil testing and how to interpret results (growers and advisers)
17	More accurate weather forecasts
18	Accelerated development of waterlogging-tolerant barley
19	Improved establishment of canola
20	Quantify the optimum yield and inputs to maximise the profit margin (for each grower)
20	Determine how optical sensors can be used profitably to inform decision-making
20	Extracting greater 'value' from spatially referenced data that is already being collected
23	Enable quicker access to long-season, Northern Hemisphere varieties with superior leaf disease resistance
24	Increasing labour demands with cropping systems
25	Improved grain marketing through expanded or differentiated markets (faba beans and cereals) and greater grower marketing skills advice to get a better price
25	Limited choice of linseed varieties, including winter varieties
27	Improving phone/internet services/speeds in rural areas to enable access to services
28	Is the increasing use of neonicotinoids building up residues in the soil?
29	Optimise fertiliser use by applying the 4Rs (right fertiliser source, right rate, right time, right place) at a regional level
30	Maintain and enhance research and advisory capacity so growers can access independent advice
30	Managing grower health
32	Identify the reasons for inconsistent nodulation (and subsequent yield loss) in broad beans and faba beans
32	Determine if cover crops have a profitable impact on soil health
34	Screen potential milling oat varieties that are adapted to the HRZ and available internationally
35	Determine sustainable and profitable management strategies of high-volume stubbles
36	Extension on the use of precision-agriculture tools – which tools are most appropriate for a particular situation (evaluate to remove confusion)?
37	Determine practices to alleviate chronic and acute waterlogging
37	Improving soil water-holding capacity
39	Loss of chemicals and the need for greater grower advocacy around the retention of various herbicides and pesticides
40	Develop a broad bean and faba bean agronomy packages
40	Develop appropriate recovery strategies (mainly nitrogen application) for waterlogged crops
40	Identify the species, varieties and agronomy to grow a profitable summer crop
43	A more integrated pest-management strategy needed to reduce the use of fipronil in canola and on a broadacre scale to kill hard-to-kill pests
44	Gaining faster access to pesticides used in Europe and the US
44	Agronomy and varieties to increase energy in grain (for domestic feed markets)

TABLE 8 *(continued)* **Issues (opportunities and constraints) that have the greatest impact on the profitability of growers in the high-rainfall zone (HRZ) of the southern region.**

Priority	Issue
46	No effective spring control tactics for slugs and snails to reduce harvest contamination and damage to following crops
46	Improved disease (chocolate spot and ascochyta) resistance in faba beans
48	Manage subsurface (5 to 15cm) acidity on land with good surface lime application history
49	Approaches to improve poor water use efficiency (hyper yields and three crops in two years)
50	Early prediction of disease outbreaks in pulse to inform fungicide-management decisions
51	Understand the opportunities for delving or ripping on sandy soils
51	Quality control over data entered into Online Farm Trials
53	Develop practices to reduce electricity costs in irrigation
54	Lack of grower attendance at local events
55	Quantify the impact of powdery mildew on canola yields in the Lower South East of South Australia, Tasmania, and Gippsland, Victoria
56	Identify a 'pillar crop' to build a sustainable and profitable farming rotation
57	Renewable or alternative nitrogen fertilisers
57	Managing animal health issues of livestock grazing annual clovers
59	The pros and cons of disc seeder versus tyne seeders
60	Opportunity to use aerial seeding for relay cropping (for example, aerial sowing millet and/or rape into wheat crops)
60	Carbendazim for snail control – does it work, issues with maximum residue limits , registration of use patterns
62	Enhanced spray application to penetrate and provide coverage of wet and/or bulky crops
63	Potential to use of plant growth regulators for crop management (canopy and grain quality)
64	Development of GM crops for yield and enhanced management options
65	Register existing chemicals for use with shielded sprayers
66	Method to calculate nitrogen loss when soils are above field capacity
67	Understanding how climate change will affect the incidence of waterlogging
68	Improved management of water and including nutrients and chemicals to conserve moisture and limit runoff
69	Value and response of phosphites as a bio-stimulant, which is being used in Europe
70	Managing drainage beyond the farmgate

Nick Poole, FAR presenting to local growers at a hyper-yielding field day and crop walk at Kapinnie, SA.

Case study:

Opportunity to capitalise on the synergies for livestock and cropping enterprises and increase whole-farm profit

There are four things every grower should consider when managing risk: understanding the volatility or range in enterprise prices and yields; understanding the correlation between different enterprises; diversification; and trust in intuition. Grain & Graze regional coordinator for southern Victoria and HRZ RCSN lead Cam Nicholson says Australian growers manage risk each year and that it is a natural and accepted part of farming which can, if managed correctly, help generate increased returns.

However, the information available to help growers determine their level of risk based on actuals is limited.

"Risk management requires knowing how often an event happens (the frequency) and what is the impact (the value) when it does happen," Mr Nicholson says.

"Current communication offerings provide information based on averages: for example, average yields, average price, and average costs. While these convey a value they do not present the extremes, volatility or the frequency which they occur, and therefore they don't show the risk."

Recognising the information gap, GRDC invested in the Grain & Graze projects, where Mr Nicholson and the Grain & Graze team investigated the historic and real-time ranges in yields, volatility and prices. The team generated a new online guidance tool, plus a range of tips to help growers better manage risk.

UNDERSTAND THE VOLATILITY OR RANGE IN PRICES AND IN YIELDS

Growers should investigate historic information and analyse the patterns in price and volatility within and between commodities. The key drivers of profit in agriculture, namely yield, prices and some costs have a range of values within and between production periods. If averages are used for analysis, it usually overestimates the profits and hides the volatility in those profits.

"Managing risk is not about the middle or the average, it is the opposite. It is appreciating what happens at the extremes, the size or value of these extremes and how often they occur," Mr Nicholson says.

"Take the time to consider what history tells us about price volatility. Look at the weekly prices for your chosen crop and consider how often you actually get various price points. Compare the weekly prices across a range of commodities such as lentils, oilseeds or wheat. While this sounds like a simple tip, it can be quite complicated to decipher actual trends."

An outcome of a GRDC investment was the development of the Ag Price Guide (http://agprice.grainandgraze3.com.au). This free tool allows growers to apply individual information on price to generate a personalised graph that defines the amount or value of each specified commodity and how often this occurs. If similar ranges are created by using historic yield information, then the volatility in farm income can be represented.

"This reflects what happens in real life," Mr Nicholson says. "For example, there may be high yield but poor prices, so gross income is about average. Less often there will be poor yields and poor prices and conversely we occasionally get high yields and high prices."

UNDERSTAND THE CORRELATION BETWEEN ENTERPRISES

How strongly yields or prices move in relation to each other are referred to as correlations. Understanding the correlation between different commodity prices and the yields of different crops is essential in understanding and managing risk.

"Using the Ag Price Guide tool, growers can investigate the correlation between commodities," Mr Nicholson says.

"This can be interesting, for example in some cases when the price of wheat is high the price of barley is generally high, and when prices for wheat are low then barley tends to be low. Other commodities correlate differently, for example the price of lentils is often not strongly correlated to the wheat, barley or oilseed price. We found that when prices are correlated you get bigger swings. They tend to be all up at one time or all down at another time."

"If growers wish to manage volatility, they should consider how their enterprises are correlated and choose some commodities that are not strongly correlated, then one can be up when the other is down. They might choose to consider more livestock, given that livestock and cropping prices are not strongly correlated. It smooths out the roller-coaster ride."

DIVERSIFY

Along with considering a range of crop or livestock types that are not generally correlated, growers can diversify their enterprise – a tried and true practice, according to Mr Nicholson.

"Production risk can be managed by diversification in crop and pasture type, enterprise mix, targeting multiple markets and property location," he says.

TRUST YOUR INTUITION AROUND RISK

Insights from the Grain & Graze program suggest growers mainly inform their decisions around risk, based on past experience and intuition or instinct.

"Doing the 'sums' to understand the likelihood and consequence is much less common because the information has been hard to come by," Mr Nicholson says

"The fact of the matter is growers have been managing risk well for years. They should not simply throw out using intuition to analyse risk. Rather, they should keep this as part of the strategy but use the tool to validate their gut instincts."

Grain & Graze southern region coordinator Cam Nicholson has developed an online tool to assist growers in their efforts to manage on-farm risk.

PHOTO: ALISTAIR LAWSON

7. Description of priority issues and relevant GRDC investments

A description of priority issues that affect the long-term profitability of grain growers identified by the RCSN and a list of and recent and current GRDC investments that aim to address or contribute to addressing the issues are presented in Tables 9 to 74.

Low-rainfall zone projects

TABLE 9 Issue No. 2 – Improved pulse varieties to increase the profitability of farming systems in the LRZ.	
Description	The development of high-value pulse varieties, especially lentils and chickpeas, which are better adapted to low-rainfall environments and farming systems would increase the area sown to pulse crops and thereby increase long-term profitability. Improved varieties of pulses for situations where high-value pulses are not suited would also increase in the area sown to pulses and thereby enduring profitability of growers in the LRZ. Identified issues and traits of improved varieties include, lupins tolerant of free lime and high-residue field peas that provide protection of soils from wind erosion.
Current and recent GRDC investment addressing this issue	Pulse Breeding Australia – Lentil Breeding Program (DAV00119) Pulse Breeding Australia – Chickpea Breeding (DAN00212) Understanding the implications of new traits on adaptation, crop physiology and management of pulses in the southern region (DAV00151) Improving weed management in pulse crops through herbicide tolerance (DAS00131) Collection, phenotyping and exploitation of wild *Cicer* genetic resources for chickpea improvement (CSP00185) Identifying low-pH tolerance and effective rhizobia for wild *Cicer* to improve adaptation to acid sandy soils (UMU00044) Improving the profitability of pulse production through local validation of research outcomes in the southern region Building capacity, skills and knowledge for the pulse industry in the southern region: Supporting expansion of high-value pulses into new areas and ensuring sustained profitability of all key pulse crops in existing areas Validating recent research on break crop options in the LRZ to determine the best options for the different climate, soil type and biotic stress situations (DAS00162-A) Lupin Breeders Toolbox – A resource for Lupin Genetics (CSP1806 -009RTX) Development, characterisation and incorporation of novel herbicide-tolerance traits in pulse crops (DAS1802-001BLX)

TABLE 10 Issue No. 3 – The loss of glyphosate as a major tool through either regulation or resistant weed species would significantly impact on the profitability and sustainability of farming systems in the LRZ.	
Description	Our farming systems are heavily reliant on the use of glyphosate, both as a crop establishment knockdown and for fallow weed control, pasture topping and crop topping of canola, feed barley and sometimes wheat. The loss of this chemical would substantially impact the farming systems in low-rainfall areas. While the withdrawal of regulatory support is considered unlikely, loss of efficacy, through increased resistance, poses a significant threat. It raises the question of whether it is possible to farm without glyphosate and what techniques would be required. The pressure on glyphosate in the European Union was behind the question about ongoing regulatory support.
Current and recent GRDC investment addressing this issue	GRDC Australian Glyphosate Sustainability Working Group (ARN0001) GRDC – Bayer Crop Science Herbicide Innovation Partnership (HIP00001) WeedSmart (UWA001724) Benchmarking and managing soil herbicide residues for improved crop production (DAN00180) Mechanisms, evolution and inheritance of resistance (UA00158) Improving IWM practice of emerging weeds in the southern and western regions (UA00149) Locally important weeds (DAW00257) A simple and innovative test for real-time detection of resistance in weeds (UWA1807-001AWX) (Refer also to Issue no. 9 (LRZ) – New and novel methods of weed control)

TABLE 11 Issue No. 4 – As the global trend for pesticide regulation based on hazard rather than risk continues, deregistration of affordable active ingredients will cause an increase in pesticide costs and erode profit margins.	
Description	In the LRZ, pest and weed management is often based on the use of low-cost generic products. Several of these are under threat or are about to be deregistered. The application of the precautionary principle (hazard-based assessment) may restrict access to commonly used cost-effective chemicals with the need then to use more expensive options. There is the need to advocate for the protection of growers' interests in any attempt to deregister active ingredients.
Current and recent GRDC investment addressing this issue	Advocacy is not within the GRDC mandate as this is a policy matter dealt with through both the Australian Pesticides and Veterinary Medicines Authority (APVMA) and government legislation, which is managed by the Department of Agriculture and Water Resources. Policy issues need to be channelled through grain grower representative groups such as Grain Producers Australia and Grain Growers Limited. GRDC may provide scientific comment on APVMA documents and does so where there are documents for public comment such as registration public release summaries (PRS), chemical reviews and trade advice notices (TANs). GRDC co-invests with the agrochemical industry to provide greater crop protection options to growers where: a) there is market failure; and b) the investment will address specific identified data deficiencies identified in any review (for example, working with Syngenta on the CODEX paraquat review of omethoate and dimethoate where no investment was required as the relevant registrants, Arista and FMC, where addressing the requirements). Pathways to registration: • minor use applications (AKC00006); • AgVet Access grants; • ag chemical priority forum (cross-RDC project); and • practical and applied workshops and communications to promote key messages and resources to maximise the effectiveness of spray applications in the southern region (BWD1803-005SAX).

TABLE 12 Issue No. 5 – Increased model skill in seasonal forecasts provided from March to May and better forecast utilisation by growers and advisers presents an opportunity to improve decision-making and management of risk more effectively.	
Description	In low-rainfall areas, there can be considerable benefits in adopting alternative seeding plans depending on where the season is heading. It would be highly advantageous to have access to more skilful seasonal outlook forecasts at the time of planting. Coupled with this is the need for improved methodology for utilising forecasts of varying skills in effective decision-making.
Current and recent GRDC investment addressing this issue	Impacts of climate on low-rainfall and marginal areas (CSA00053) Assessing and managing heat stress in cereals (MCV00006) Improving forecast accuracy, especially with improved Indian Ocean initialisation (MCV00008) Rural R&D for Profit – seasonal forecasting Using seasonal forecast information and tools to manage risk and increase profitability in the southern region (DAV1803-010SAX)

TABLE 13 Issue No. 7 – Farm business management skills are essential to improving long-term profitability.	
Description	Improved farm business management skills will improve long-term profitability of grain growers in the LRZ. Identified farm business skills that are essential to enduring profitability include: risk management; economics of machinery investment; understanding the trade-off between investment in machinery and labour; tools and skills for better farm decision-making; people management; assessing farm business performance; business planning; farm business succession; farm business models; and pathways for entry into farming. Peer grower learning groups are seen as an effective vehicle for improving farm business management skills.
Current and recent GRDC investment addressing this issue	The integration of technical data and profit drivers for more informed decisions (RDP00013) GRDC Farm Business Updates – southern region (ORM00015) Practical financial figures for farm business management – aka Ag Profit (APR00001) National Paddock Survey Initiative (BWD00025) Rural R&D for Profit – seasonal forecasting Identifying the key production and profitability drivers using commercial paddocks (POO0001) Stubble Initiative – BCG (BDW00024) – Milestone 34 Extension of knowledge and resources to manage risk and exploit opportunities to improve whole-farm profit through successful integration of cropping and livestock enterprises in the GRDC southern region (AEA1803-002SAX) Grain & Graze III – Extension and deliver on mixed farm benefits in the southern region (SFS00028) Grain & Graze II – Farm business logic application (NR00009)

TABLE 14 Issue No. 8 – Robotics provide opportunities to increase efficiencies and profitability of farm businesses.	
Description	The technology of robotics is advancing rapidly and offers a greater level of automation, which may provide significant opportunities to increase efficiencies and profitability of farm businesses.
Current and recent GRDC investment addressing this issue	Future Farm – Theme 1, Review phase: Intelligent sensing – Improving grower confidence in targeted N management through automated sensing (CSP00201) Future Farm – Agricultural Automation and Robotic Management, Theme 3: Intelligent Infrastructure (USQ00022)

TABLE 15 Issue No. 9 – New and novel methods of weed control (for example, microwaves).	
Description	There is a need to develop alternatives to herbicides to control weeds where control with herbicides is no longer effective, and to prolong the life of existing herbicides.
Current and recent GRDC investment addressing this issue	Development of new non-chemical weed control technologies – microwave control of weeds (UM00053) Improving IWM practice of emerging weeds in the southern and western regions (UA00149) Surveillance of herbicide resistant weeds in Australian grain cropping (UCS00024) Weed management in the southern region mixed-farming systems – strategies to combat herbicide resistance (UCS00020) New uses for existing chemistry (UQ00080) Harvest weed seed control for the southern region (SFS00032) Emerging weeds (UA00156) Australian Herbicide Resistance Initiative – Phase V (UWA00171) WeedSmart (UWA00172) Genetically improving wheat's ability to outcompete weeds (CSP00182) Mechanisms of weed suppression by early vigour and other novel wheat genotypes (USC00022) Locally important weeds (DAW00257) Cultural Weed Management (UAO1711-005RTX) Grains Industry Research Scholarship – David Hall (QUT): Automated Weed and Plant Recognition for Agricultural Applications (GRS10926) Stealth plow: Mechanical control of hard to kill weeds with minimum soil disturbance (NDF1806-001AWX) Intelligent Robotic Non-Chemical Weeding (UOS1806-002AXW) Development., characterisation and incorporation of novel herbicide-tolerance traits in pulse crops (DAS1807-013BLX) A simple and innovative test for real-time detection of resistance in weeds (UWA1807-001AWX)

TABLE 16 Issue No. 10 – The risk (either perceived or real) of herbicide residues accumulating in sandy soils in low-rainfall environments is reducing returns.	
Description	Herbicide residues appear to be persisting longer than label indications, particularly on sandy soils. The evidence for this is anecdotal and creating uncertainty. There may be low-level yield losses and reduction in returns or on the other hand, the perceived risk may be leading to decisions that reduce returns. The situation needs to be clarified.
Current and recent GRDC investment addressing this issue	Benchmarking and managing soil herbicide residues for improved crop production (DAN00180) Management of residual herbicides in broadacre cropping (THA00001) Increasing production on sandy soils in low and medium-rainfall areas of the south (CSP00203)

TABLE 17 Issue No. 11 – Hard-to-control weeds.	
Description	Growers have observed an increase and/or ingression of 'hard-to-kill' weed species in low-rainfall districts. It is suggested that this may be attributed to several factors including seasonal conditions, changes in rainfall and temperatures, modern farming systems and practices, selection and shifts in weed ecology. Important hard-to-kill weeds include fleabane, feathertop Rhodes grass, windmill grass, button grass, Gazania and statice. These weeds are not well controlled with blanket sprays. Understanding the ecology and cost-effective management practices for low-rainfall farming systems is required to reduce the impact of hard-to-kill weeds.
Current and recent GRDC investment addressing this issue	Locally important weeds (DAW00257) Emerging weeds (seedbank biology) (UA00156) Mechanisms, evolution and inheritance of resistance (UA00158) Stubble Initiative – Upper North Farming Systems (UNF0002) – Output #12 – Weed management. New biocontrol solutions for sustainable management of weed impacts (RnD4Profit-115-02-005) A simple and innovative test for real-time detection of resistance in weeds (UWA1807-001AWX) (See also Issue no. 9 – New and novel methods of weed control (for example, microwaves))

TABLE 18 Issue No. 11 – Limited knowledge, skills and experience of growers and advisers new to pulse growing increases production risk of pulses in the LRZ.	
Description	The expansion of lentils and chickpeas into new areas and further into the LRZ in the past five years has boosted profitability. Pulses are complex to manage, and poorly managed crops pose a risk to profitability of inexperienced growers. Field peas and lupin areas have also expanded. There is a lot of interest in growing pulses in low-rainfall areas but knowledge, skills and experience are limiting the ability of growers to successfully grow profitable pulse crops in the LRZ. There is also the need to refine pulse management techniques from higher-rainfall areas to make them more relevant for quicker finishing and less-reliable rainfall districts. The interest in pulses is leading to increased plantings so growers are intending to plant them while lacking knowledge, skills and experience, which is likely to result in reduced returns.
Current and recent GRDC investment addressing this issue	Understanding the implications of new traits on adaptation, crop physiology and management of pulses in the southern region (DAV00150) Profitable crop sequencing in the low-rainfall areas of south-eastern Australia (DAS00119) Building capacity, skills and knowledge for the pulse industry in the southern region: Supporting expansion of high-value pulses into new areas and ensuring sustained profitability of all key pulse crops in existing areas (9275825) Profitable crop sequencing in the low-rainfall areas of south-eastern Australia (DAS00119) Legume Management for Economic Nitrogen Production in the Low-Rainfall Areas of North West Victoria (VIS00002) Pulse Chemical Stewardship Program (PAL1809-001SAX)

TABLE 19 Issue No. 13 – Opportunities to improve the integration and management of livestock into the farming system with site-specific grazing are impeded by technology cost and state regulation.	
Description	Access to virtual fencing could provide substantial advantages for grazing the large expanses common in low-rainfall areas. Technology is currently uneconomic, but it is not possible to do local research given that virtual fencing is currently illegal in SA and Victoria. It would also help with managing variable soil types within large paddocks (for example, prevent over-grazing of sand hills and the subsequent increase in erosion risk).
Current and recent GRDC investment addressing this issue	Extension knowledge and resources to manage risk and exploit opportunities to improve whole-farm profit through integration of cropping and livestock enterprises in the GRDC southern region (AEA1803-002SAX) Advocacy on legislative reform does not fall within GRDC's mandate; however, legislative reform and the development of this technology are being undertaken by several government agencies and commercial companies.

TABLE 20 Issue No. 13 – Predicting flowering time and manipulating crop development to reduce exposure during high-risk periods to mitigate impact of frost.	
Description	The ability to predict flowering time and the risk of frost (and heat stress) given sowing date for different locations across the southern region would mitigate the risk of losses caused by frost. A greater understanding of the effectiveness of techniques to manipulate development, flowering and maturity of varieties, which can reduce exposure to high-frost-risk periods.
Current and recent GRDC investment addressing this issue	GRDC National Frost Initiative Screening of frost tolerance in cereals (UA00162) Identification of wheat frost tolerance loci using a combination of genetics, biochemistry and molecular approaches (CSP00202) Determining yield under frost – one degree at a time (DAW00234) Advancing profitable farming systems – frost risk management (DAW00260) Spatial temperature measurement and mapping tools to assist growers, advisers and extension specialists manage frost risk at a farm scale (CSP00198) National Frost Initiative – knowledge and communication manager (SKC00008) Advancing profitable farming systems – frost risk management (DAW00241/260) Management of wheat and barley cultivars in WA (DAW00224) Frost Treatment (IMT1806-001AWX) – Establish the legitimacy and bounds of performance of a chemical frost protection treatment for cereals Applying Technology Solutions for Improved Frost Detection, Diagnostics and Precision Management Decisions (FMO1806-002AWX) National Phenology Initiative (ULA00011)

TABLE 21 Issue No. 15 – The sustainable use of cost-effective herbicides and the development of alternative management tools are critical for effective weed control and profitability of cropping systems.	
Description	The over-reliance on Group B herbicides for grass and broadleaf weed control, increasing herbicide resistance in broadleaf weeds such as Indian hedge mustard and sowthistle, and the selection for resistance in a range of other weeds as a consequence of exposure to herbicides will continue to limit cost-effective chemical weed control and the profitability of growers. The development of a range of alternative chemical and non-chemical weed-control strategies, such as new or additional herbicide tolerance for a greater range of crop options and varieties and develop new and novel cultural technologies.
Current and recent GRDC investment addressing this issue	Weed management in the southern region mixed-farming systems – strategies to combat herbicide resistance (UCS00020) Surveillance of herbicide-resistant weeds in Australian grain cropping (UCS00024) WeedSmart (UWA00172) Australian Herbicide Resistance Initiative – Phase V (UWA00171) Mechanisms, evolution and inheritance of resistance (UA00158) GRDC – Bayer Crop Science Herbicide Innovation Partnership (HIP00001) New uses for existing chemistry (UQ00080) Emerging weeds (UA00156) Improving IWM practice of emerging weeds in the southern and western regions (UA00149) Locally important weeds (DAW00257) Mechanisms of weed suppression by early vigour and other novel wheat genotypes (USC00022) Genetically improving wheat's ability to outcompete weeds (CSP00182) Cultural Weed Management (UAO1711-005RTX) Development of new non-chemical weed control technologies – microwave control of weeds (UM00053) Regional Agronomy SA – Improving weed management in high break crop intensity farming (DAS00168-BA) Mechanisms, evolution and inheritance of resistance (UA00158) A simple and innovative test for real-time detection of resistance in weeds (UWA1807-001AWX) (See also Issue no. 9 – New and novel methods of weed control)

TABLE 22 Issue No. 16 – RD&E capacity in the LRZ is diminished by retraction of public investment in infrastructure and human resources and the exit of experienced professionals.	
Description	There has been a steady decline in the RD&E capacity across agriculture, particularly in low-rainfall areas, which may not be highly attractive areas of work and careers against other alternatives. Included is the need for a mentoring program to support staff at remote research facilities.
Current and recent GRDC investment addressing this issue	GRDC–SARDI Strategic Partnership (DAS00165-169) GRDC–DEDJTR strategic partnership: Improving practices and adoption through strengthening RD&E capability and delivery in the southern region – Regional Research Agronomists (DAV00143)

TABLE 23 Issue No. 16 – Opportunities to improve profit are missed as new practices are not adopted due to a lack of grower trust in small plot results.	
Description	Growers tend to be suspicious of the results from small-scale trials and would like to see results on a larger paddock scale before adopting the technologies.
Current and recent GRDC investment addressing this issue	Statistics for the Australian Grains Industry (SAGI) – this investment provides biometric data analysis including multi-environment analysis to ensure scientific results are rigorous and stand up to real work use GRDC recognises the need for paddock-scale trials around specific practices and examples where this has been integrated include through Integrated Weed Management investments and GRDC Stubble Initiative (various projects).

TABLE 24 Issue No. 18 – The downside risk of highly leveraged, high-input, high-crop-intensity farming systems threatens the economic viability of low-rainfall farm businesses.	
Description	A risk-management feature of traditional low-rainfall farm businesses has been the adoption of mixed-farming practices, in part to minimise the financial impact of poor seasons. High-cropping-intensity systems adopted from higher-rainfall districts can expose low-rainfall businesses to higher risk. There is the need to improve the identification, development and quantification of practices that better balance the multiple goals of maximising profit, reducing risk and increasing business resilience.
Current and recent GRDC investment addressing this issue	GRDC Farm Business Updates – southern region (ORM00015) Over-dependence on agrichemicals (CWF00020) The integration of technical data and profit drivers for more informed decisions (RDP00013) Practical financial figures for farm business management – aka Ag Profit (APR00001) National Paddock Survey Initiative (BWD00025) Grain & Graze III – Extension and deliver on mixed farm benefits in the southern region (SFS00028) Grain & Graze II – Farm business logic application (NRS00009) Rural R&D for Profit – Seasonal forecasting Using seasonal forecast information and tools to manage risk and increase profitability in the southern region Legume management for economic nitrogen production in the low-rainfall areas of north-west Victoria (VIS00002) Identifying the key production and profitability drivers using commercial paddocks (POO0001) Stubble Initiative – BCG (BDW00024) – Milestone 34 Validating recent research on break crop options in the low-rainfall zone to determine the best options for the different climate, soil type and biotic stress situations (DAS00162-A) Stubble Initiative – Component No. 1 – Research – CSIRO – various milestones Extension of knowledge and resources to manage risk and exploit opportunities to improve whole-farm profit through successful integration of cropping and livestock enterprises in the GRDC southern region Grain & Graze III – Extension and deliver on mixed-farm benefits in the southern region (SFS00028) Grain & Graze II – Farm business logic application (NR00009) Boosting profit and reducing risk on mixed farms in low and medium-rainfall areas with newly discovered legume pastures enabled by innovative management methods – southern region (DAS1805-003RMX).

TABLE 25 Issue No. 18 – The strong preference growers demonstrate for peer-to-peer learning via digital communication (Twitter) is an opportunity for effective extension to builds skills and capacity and practice change.	
Description	This issue recognises the current and developing importance of social media in agricultural extension and seeks to explore mechanisms by which this can be further enhanced.
Current and recent GRDC investment addressing this issue	eXtensionAUS – trial (EXF00001) GRDC participates in a range of online forums including Twitter, YouTube, Facebook, Instagram and LinkedIn as well as generating webinar, podcast and video content to enable learning via digital and peer-to-peer platforms. Opportunities for peer-to-peer and participatory learning are also considered throughout GRDC's investment portfolio.

TABLE 26 Issue No. 20 – Economic thresholds for insect control in the LRZ are poorly defined, which causes the over-use of insecticides.	
Description	Growers want to reduce the use of insecticides but require evidence or thresholds (for pest and beneficial species) to be confident to only use insecticides when required. Current knowledge and economic thresholds are not relevant for the low-rainfall environments where there is a sharp finish to the season finishes and temperatures. The use of insecticidal strategies that minimise impact on beneficial insects are also seen as important for the integrated management of pests and long-term profitability.
Current and recent GRDC investment addressing this issue	Predicting insect pest issues in Australian grain crops (UM00054) Improving Plant Pest Management Through Cross Industry Deployment of Smart Sensors, Diagnostics and Forecasting (Rural R&D for Profit) The iSPY manual, which was an output of the National Invertebrate Pest Initiative (NIPI) (CSE00058) Economic thresholds for the major pests reducing profitability in the Australian grains industry (DAQ1711-001RMX) Opportunities for SMART surveillance for biotic threats in the Australian grains industry (9176028) The development of economic thresholds for the management of Russian wheat aphid across rainfall zones of the Australian grain industry (9176535) Supporting the sustainable use of insecticides and local on-farm implementation of integrated pest management strategies in the GRDC southern region (BWD1805-006SAX)

TABLE 27 Issue No. 20 – The opportunity to use big data to improve grower profitability in the LRZ.	
Description	Growers are unsure of what constitutes big data and if this provides opportunities to improve productivity and profitability in the LRZ.
Current and recent GRDC investment addressing this issue	GRDC recognises the importance of a strategic approach to data-driven agriculture. This is why data and analytics form one of the new five-year RD&E Plan's four core frameworks underpinning all RD&E investments. Under the five-year RD&E plan each of the Key Investment Target strategies is being developed in line with the data and analytics framework.

TABLE 28 Issue No. 22 – Glyphosate-resistant weed populations are developing on fencelines.	
Description	Repeated spraying of fencelines with glyphosate-based mixes is placing high selection pressure on weeds for resistance to glyphosate. While the threat and occurrence of glyphosate resistance in annual ryegrass is recognised, there is a threat of glyphosate resistance developing in other species that are potentially more difficult and costly to control. This could the increase cost and complexity of weed management in the LRZ.
Current and recent GRDC investment addressing this issue	GRDC Australian Glyphosate Sustainability Working Group (ARN0001) GRDC – Bayer Crop Science Herbicide Innovation Partnership (HIP00001) Australian Herbicide Resistance Initiative (AHRI) – Phase V (UWA00171) WeedSmart (UWA001724) Benchmarking and managing soil herbicide residues for improved crop production (DAN00180) Mechanisms, evolution and inheritance of resistance (UA00158) Locally important weeds (DAW00257) (See also Issue no. 8 (MRZ) and Issue no. 3 (LRZ))

TABLE 29 Issue No. 22 – Nitrogen management decisions – value of legume contribution and cost vs returns.	
Description	In the low and variable-rainfall environment of the LRZ, growing pulses and applying nitrogen fertiliser increases costs, which could result in reduced returns in poor seasons. Quantifying the nitrogen contribution of pulses and the benefit to subsequent crops will enable growers to include the value of the nitrogen contribution when assessing the overall economic benefit of growing pulses. This knowledge can be combined with improved decision-making tools to better match nitrogen applications to requirements, reducing the risk of losses when nitrogen is applied when it is not required, and increasing profitability when a return from nitrogen application is likely.
Current and recent GRDC investment addressing this issue	Real time evaluation of soil nitrate using ion exchange technology (EPF00002-A) Managing legume and fertiliser nitrogen in the southern region (UA00165) More Profit from Crop Nutrition Initiative – Phase II (MPCN II) Re-assessing the value and use of fixed nitrogen (CSA00037) Optimising nitrogen fixation of grain legumes – southern region (DAS00128) Updated nutrient response curves in the northern and southern regions (UQ00082) Benchmarking wheat yield against nitrogen use (DAS000147) Improving profit and reducing risk by managing nitrogen in wheat and extreme temperature in pulses (DAS00166-BA) Scoping study – Reviewing mechanisms and magnitude of nutrient mineralisation in Australian grain-producing soils (CSP00207) More nitrogen from pulse crops for growers in the southern region (MSF1806-002SAX) In field assessment of selected soil properties and plant N contents using IR spectroscopy (ASO1806-002AWX) Using soil and plant testing data to better inform nutrient management and optimise fertiliser investments for grain growers (ASO1806-001RTX)

TABLE 30 Issue No. 22 – Managing insects – forecasts and alerts, new pests, thresholds, new insecticide groups and control of resistant populations.	
Description	Due to logistical considerations, prophylactic applications of insecticide on a broad scale are common when managing insects but there are concerns about resistance, the effect on beneficial insects and the environment. Management of insects could be improved with better forecasts and alerts, thresholds and knowledge and tools to manage resistant populations.
Current and recent GRDC investment addressing this issue	Predicting insect pest issues in Australian grain crops (UM00054) Improving Plant Pest Management Through Cross Industry Deployment of Smart Sensors, Diagnostics and Forecasting (Rural R&D for Profit) The iSPY manual, which was an output of the National Invertebrate Pest Initiative (NIPI) (CSE00058) Economic thresholds for the major pests reducing profitability in the Australian grains industry (DAQ1711-001RMX) Opportunities for SMART surveillance for biotic threats in the Australian grains industry (9176028) The development of economic thresholds for the management of Russian wheat aphid across rainfall zones of the Australian grain industry (9176535) Supporting the sustainable use of insecticides and local on-farm implementation of integrated pest management strategies in the GRDC southern region (BWD1805-006SAX)

TABLE 31 Issue No. 22 – Barley grass and brome grass control.	
Description	Selection pressure for later germination and the development of herbicide resistance have caused barley and brome grass to become significant weeds that constrain the profits of growers in low-rainfall areas.
Current and recent GRDC investment addressing this issue	Australian Herbicide Resistance Initiative – Phase V (UWA00171) Crop competition for weed management and maintenance of crop yield Surveillance of herbicide-resistant weeds in Australian grain cropping (UCS00024) Validation of the persistence of common residual herbicides in LRZ (DAS00162-B) GRDC Stubble Initiative – BCG (BDW00024) – Milestone 19 GRDC Stubble Initiative – Component No. 1: Research – CSIRO (CSP00186) Emerging weeds (seebank biology of emerging weeds) – UA00156 New uses for existing chemistry – UQ00080 Weed management in the southern region mixed-farming systems – strategies to combat herbicide resistance – UCS00020 Mechanisms, evolution and inheritance of resistance – UA00158

TABLE 32 Issue No. 36 – Rhizoctonia – economics of fungicides (seed dressings and in-furrow application).	
Description	Growers and advisers have a good understanding and skills in implementing husbandry techniques that manage rhizoctonia damage to seminal roots early in the season, but have less awareness that infection of crown roots later in the season is causing yield loss in some situations. There is no knowledge of husbandry techniques to manage infection of crown roots. It has been demonstrated that in furrow applications of fungicides can reduce damage and provide yield response but the situations where this will provide a return is not defined. Growers and advisers do not use technology as they are uncertain of getting a return on investment.
Current and recent GRDC investment addressing this issue	Fungicide control of rhizoctonia – Part A (DAS00125) Fungicide control of rhizoctonia – Part B (DAS00123) Fungicide control of rhizoctonia – Part B (DAS00122) Strategies to provide resistance to the economically important fungal pathogen *Rhizoctonia solani* (UWA00154) Innovative approaches to resistance to necrotrophic pathogens and sap-sucking insect pests (UWA00145) Continuation of fungicide control of rhizoctonia (DAS00125) Increasing symbiotic nitrogen fixation for the benefit of following crops (9176601) Validation investment proposed for 2019

Medium-rainfall zone

TABLE 33 Issue No. 1 – Developing new food-based markets for pulses to help growers manage price volatility.	
Description	Pulse commodity price is highly influenced by demand in the Middle East (for example, faba beans) and the Subcontinent (for example, lentils). Developing new markets through novel food uses for pulses or gaining market through greater market access of trade agreements may reduce price volatility of pulses.
Current and recent GRDC investment addressing this issue	Market Intelligence for Theme 1 (AEG00006) Victorian Department of Economic Development, Jobs, Transport and Resources (DEDJTR) Pulse Breeding (DAV00143) Pulse Chemical Stewardship Program (PAL1809-001SAX)

TABLE 34 Issue No. 2 – Nitrogen (N) decision-making – technology to measure nitrogen in real-time and improved N budgeting tools, better rules of thumb for nitrogen mineralisation, N budgeting and management, improve N use efficiency.	
Description	This issue emerges each year as a high-priority concern and was again raised at the 2017 open meetings. Growers and advisers find making in-season N management decisions difficult because there is uncertainty about the amount if N available in the soil (mainly due to low uptake of deep soil N testing), the amount of N required by the crop (yield potential) and the financial risk associated with meet crop N demand if there is a dry spring or a frost or heat-stress event.
Current and recent GRDC investment addressing this issue	Real-time evaluation of soil nitrate using ion exchange technology (EPF00002-A) and (UA00165) Tools for rapid, real-time measurement of nutrients (CSO00045) Soil spectroscopy capability (CSO00045) Nitrogen inputs by free living nitrogen fixing bacteria – Grower messages (CSP00191) Regional soil testing guidelines for the southern region (DAN00168) Proximal soil sensing for profitable and sustainable farming (CSA00048) Extension and training – southern region (BWD00021) Organic matter and nutrient availability (UQ00079) Updated nutrient response curves in the northern and southern regions (UQ00082) Managing legume and fertiliser nitrogen in the southern region (UA00165) Optimising nitrogen fixation of grain legumes – southern region (DAS00128) Re-assessing the value and use of fixed nitrogen (CSA00037) Benchmarking wheat yield against nitrogen use (DAS00147) Improving nitrous oxide abatement in higher-rainfall cropping systems and developing nitrogen response curves (DAV00125) Nutrient performance indicators (IPN00003) Strategies to better synchronise nutrient supply and crop demand (UM00023) Nitrogen and water interactions (DAS00157) Understanding how waterlogging affects water and nitrogen use by wheat (DAV00151) MPCN II – Managing micronutrient deficiencies in cropping systems of eastern Australia (DAS00146) Understanding Biological Farming Inputs (CSO00044) Increasing the effectiveness of nitrogen fixation in pulse crops through development of improved rhizobial strains, inoculation and crop management practices (DAS1805-004RTX) Using soil and plant testing data to better inform nutrient management and optimise fertiliser investments for grain growers (ASO1806-001RTX)

TABLE 35 Issue No. 3 – Evaluation and pre-breeding of canola varieties for tolerance levels to 'dim' herbicide chemistry could lead to improved annual ryegrass control and reduce the risk of crop damage resulting in increased profitability and increased area of canola production.	
Description	In states where Roundup Ready® canola technology is not available, options for managing herbicide-resistant annual ryegrass are limited and tolerance to higher rates of dim chemistry (butroxydim or clethodim) are a useful tool. However, tolerance of varieties and herbicide damage varies across environments and seasons. The risk, damage and impact are higher for less-tolerant canola varieties. Knowledge of tolerance levels would enable growers to avoid damaging sensitive cultivars at current label rates. The information could also be used to support label rate variations on specific tolerant varieties and support pre-breeding programs for improved tolerance to dim herbicide chemistry.
Current and recent GRDC investment addressing this issue	Pilot study undertaken as part of the National Variety Trials.

TABLE 36 Issue No. 4 – Profit-focused cost and productivity management can increase profit.	
Description	Many farm businesses are not aware of their own drivers of financial or production performance and therefore do not understand what drives profit in their business. Farm business potential is being constrained by decisions influenced by perceptions of what drives profit rather than intimate business knowledge. There are unrealised gains in production and profits in the southern region that can be achieved with minimal impact on business risk. Evidence from GRDC project RDP00013 suggests the average business is performing at half the profit level of the top 20 per cent performers. Solutions include initiatives that empower growers to better understand the drivers of revenue, costs and therefore profit at the individual farm level, supported by an understanding of the qualitative traits and management strategies that lead to improved profit.
Current and recent GRDC investment addressing this issue	GRDC Farm Business Updates – southern region (ORM00015) The integration of technical data and profit drivers for more informed decisions (RDP00013) Practical financial figures for farm business management – aka Ag Profit (APR00001) National Paddock Survey Initiative (BWD00025) Rural R&D for Profit —Seasonal forecasting GRDC 'Opportunity for Profit' workshops (RDP1802-001WSX)

TABLE 37 Issue No. 5 – High-value pulse and legume varieties (for example, lentils and chickpeas) bred for a wider range of soil types and rainfall zones will improve farm profitability on a broader scale.	
Description	There is an opportunity to expand and intensify the production of high-value (>$600/t) lentil and chickpea crops and increase the profitability of farm businesses. The development and adoption of improved varieties and agronomic packages are essential to capitalise on this opportunity.
Current and recent GRDC investment addressing this issue	Pulse Breeding Australia – Lentil Breeding Program (DAV00119) Pulse Breeding Australia – Chickpea Breeding (DAN00212) Understanding the implications of new traits on adaptation, crop physiology and management of pulses in the southern region (DAV00150) Improving weed management in pulse crops through herbicide tolerance (DAS00131) Collection, phenotyping and exploitation of wild *Cicer* genetic resources for chickpea improvement (CSP00185) Development, characterisation and incorporation of novel herbicide tolerance traits in pulse crops (DAS1807-013BLX) Tailoring an integrated solution to effectively address subsoil constraints by incorporation of chemically-balanced nano-amendments (DAN1806-002AWX)

TABLE 38 Issue No. 5 – Long-term no-till cropping farms may not have the infrastructure, tools or knowledge to effectively integrate livestock into the business.	
Description	Many no-till grain growers recognise the advantages of integrating livestock into their farming system to provide income diversity, reduce input costs and increase profits. Paddock size, fencing and water points are often inadequate to manage grazing without causing damage to the soil resource. A range of new and modern tools may offer potential solutions that would allow growers to capture this opportunity.
Current and recent GRDC investment addressing this issue	Grain and Graze II – Farm business logic application (NR00009) Grain and Graze III – Extension and deliver on mixed-farm benefits in the southern region (SFS00028) Extension of knowledge and resources to manage risk and exploit opportunities to improve whole-farm profit through successful integration of cropping and livestock enterprises in the GRDC southern region (AEA1803-002SAX)

TABLE 39 Issue No. 7 – Level of knowledge and skills of advisers, growers and staff is critical to the profitability, risk management and/or compliance of farm businesses.	
Description	Growers depend on the skills, knowledge and recommendations of advisers, which guide their decisions and contribute to the management of their farm businesses. Therefore, the knowledge and abilities of advisers and agronomists may inadvertently be limiting the profitability, risk management and/or compliance of farm businesses. Growers and staff new to grain growing require learning opportunities to upskill in all technical, operational and business aspects of grain growing. Extension methodology research and recent evaluation of discussion groups for inexperienced growers indicates that peer discussion groups are the preferred and most effective learning method for growers.
Current and recent GRDC investment addressing this issue	GRDC Farm Business Updates – southern region (ORM00015) GRDC Research Updates – southern region (ORM00014) GRDC Grower and Adviser Development Program GRDC Stubble Initiative – Yeruga Crop Research – Output No. 3 Assessing the economic value of precision agricultural tools for grain farming businesses in the southern region Supporting the sustainable use of insecticides and local on-farm implementation of integrated pest management strategies in the GRDC southern region Extension of knowledge and resources to manage risk and exploit opportunities to improve whole-farm profit through successful integration of cropping and livestock enterprises in the GRDC southern region (AEA1803-002SAX) Grain & Graze III – Extension and deliver on mixed farm benefits in the southern region (SFS00028) Grain & Graze II – Farm business logic application (NR00009) GRDC 'Opportunity for Profit' workshops (RDP1802-001WSX)

TABLE 40 Issue No. 8 – Efficacy of glyphosate is declining due to over-use and increased incidence of glyphosate-resistant weeds including fleabane, wild radish, tares, milk thistle and canary grass in addition to annual ryegrass.	
Description	Glyphosate has multiple and ever-increasing use patterns – knockdowns, fenceline hygiene summer weed control, in-crop weed control in Roundup Ready® crops and spraytopping. The extent and number of weed species developing glyphosate resistance is also rapidly increasing. The efficacy of glyphosate is quickly declining. Glyphosate resistance threatens the viability of no-till systems. It is the key non-selective tool used to manage weeds during fallow periods. Therefore, there is an urgent need to develop alternative tools and systems to manage weed without glyphosate.
Current and recent GRDC investment addressing this issue	GRDC Australian Glyphosate Sustainability Working Group (ARN0001) GRDC – Bayer Crop Science Herbicide Innovation Partnership (HIP00001) Australian Herbicide Resistance Initiative (AHRI) – Phase V (UWA00171) WeedSmart (UWA001724) Benchmarking and managing soil herbicide residues for improved crop production (DAN00180) Mechanisms, evolution and inheritance of resistance (UA00158) Locally important weeds (DAW00257) (See also, other glyphosate-related issues)

TABLE 41 Issue No. 8 – Stubble retention has increased the risk of economic damage from pests including but not limited to insects (for example, lucerne flea, slugs, snails and mice).	
Description	Crop establishment is increasingly being affected by a range of pests that proliferate in retained stubble farming systems. The pest spectrum has shifted and not only includes traditional stubble loving foes such as lucerne flea, snails and mice, but also includes slaters, millipedes, earwigs and slugs. There are few products registered for use on the emerging pests and limited knowledge on successful management strategies.
Current and recent GRDC investment addressing this issue	GRDC Stubble Initiative: • Maintaining profitable farming systems with retained stubble research support – insects; • Maintaining profitable farming systems with retained stubble – farming systems: • Victoria and Tasmania; • Upper Eyre Peninsula and Lower Eyre Peninsula; • South-East and Kangaroo Island; • Yorke Peninsula and Mid North; • Riverine Plains; and • Mallee. New knowledge to improve the timing of pest management decisions in grain crops (CSE00059) Improved management of snails and slugs (DAS00134) Predicting insect pest issues in Australian grain crops (UM00054) Economic thresholds for the major pests of grain crops (being contracted) Current invertebrate pest-management options (ICN00020). Management of invertebrate pests on farms (CSE00059) Supporting the sustainable use of insecticides and local on-farm implementation of integrated pest management strategies in the GRDC southern region National coordination of invertebrate pest research and insecticide resistance management (UM00048) Improved surveillance and management options for mice in Australian grain crops MouseAlert Surveillance of mouse populations across the grainbelt of Australia (IAC00002) Historical investments in the impact and control of mice including: • zinc phosphide bait technology development; • biological control projects; • mouse sterilisation; • numerous communication and extension programs that include information to growers and modelling populations; • zinc phosphide OH&S package; and • mouse immuno-contraception projects. Understanding mouse biology and ecology in zero and no-till cropping systems to inform best-practice crop production and mouse management practices (CSP1806-015RTX) Improved surveillance and management options for mice in crops (CSP1806-001SAX)

TABLE 42 Issue No. 8 – Using soil moisture information to make better decisions; tactical management to optimise the use of plant-available water.	
Description	Plant-available soil water drives crop yield and the risk associated with crop choice and management decisions. Real-time knowledge of soil water status, including spatial variability across the farm, creates an opportunity to more effectively monitor yield potential as the season evolves and then make better decisions including crop choice at sowing time, nitrogen and disease management.
Current and recent GRDC investment addressing this issue	Measuring and managing soil water in Australian agriculture (CSP00170) New tools to measure and monitor soil moisture (USQ00014) Using soil and plant testing data to better inform nutrient management and optimise fertiliser investments for grain growers (ASO1806-001RTX) Methods to predict plant-available water capacity (CSP00210) Future Farm Initiative (Phase 1) Future Farm – Phase 2: Improving grower confidence in targeted N management through automated sensing and decision support Understanding plant-available soil water and implications for crop management (RPI00009) Soil Water App maintenance (CSP 1803-004SAX)

TABLE 43 Issue No. 12 – Variability in seed supply and limited choice of canola varieties, particularly high-yielding, open-pollinated varieties with durable disease resistance increases production risk, compromises weed control and herbicide residue management, and reduces profitability.	
Description	The relatively low cost of open-pollinated (OP) varieties and the opportunity to retain seed compared with hybrid varieties reduces the production cost and financial risk of growing canola. Seed supplies of OP varieties have been unreliable. Added to this is the dominance of hybrid canola systems and the unreliable seed supply and high-cost structure. Currently, there is only a single company breeding OP varieties for Australia. Growers require continued access to a range of OP canola varieties for a range of environments with a range of robust blackleg and sclerotinia resistance and a range of herbicide-tolerance systems.
Current and recent GRDC investment addressing this issue	National Brassica Germplasm Improvement Program

TABLE 44 Issue No. 13 – Updated variety specific agronomy packages (VSAPs) to ensure successful adoption and growing of pulse crops.	
Description	Updating and dissemination of key pulse agronomy and disease management strategies is essential. Information is required as new varieties are adopted and inexperienced advisers and growers may not have the level of knowledge required to effectively manage pulse crops in variable soils types and seasonal conditions.
Current and recent GRDC investment addressing this issue	Understanding the implications of new traits on adaptation, crop physiology and management of pulses in the southern region (DAV00150) Building capacity, skills and knowledge for the pulse industry in the southern region: supporting expansion of high-value pulses into new areas and ensuring sustained profitability of all key pulse crops in existing areas.

TABLE 45 Issue No. 13 – Cost-effective non-chemical weed control systems such as robotic weeders in broadacre crops will prolong the life of important herbicide chemistry such as glyphosate and minimise the economic impact of difficult-to-control weed species such as fleabane.	
Description	The over-use and reliance on herbicide strategies increases the rate at which resistance develops and reduces the efficacy of herbicides. This has resulted in an increase in the number and distribution of 'hard-to-kill' weeds. Adoption of integrated weed management packages that include non-chemical strategies may be re-energised by developing novel technologies and tools to identify and implement targeted control of hard-to-kill weeds.
Current and recent GRDC investment addressing this issue	Development of new non-chemical weed control technologies – microwave control of weeds (UM00053) Improving integrated weed management (IWM) practice of emerging weeds in the southern and western regions (UA00149) Surveillance of herbicide-resistant weeds in Australian grain cropping (UCS00024) Weed management in the southern region mixed-farming systems – strategies to combat herbicide resistance (UCS00020) New uses for existing chemistry (UQ00080) Harvest weed seed control for the southern region (SFS00032) Emerging weeds (UA00156) Australian Herbicide Resistance Initiative – Phase V (UWA00171) WeedSmart (UWA00172) Genetically improving wheat's ability to outcompete weeds (CSP00182) Mechanisms of weed suppression by early vigour and other novel wheat genotypes (USC00022) Locally important weeds (DAW00257) Cultural Weed Management (UAO1711-005RTX) Grains Industry Research Scholarship – David Hall (QUT) Automated Weed and Plant Recognition for Agricultural Applications (GRS10926) Development, characterisation and incorporation of novel herbicide-tolerance traits in pulse crops (DAS1807-013BLX) Pulse Chemical Stewardship Program (PAL1809-001SAX) Intelligent Robotic Non-Chemical Weeding (UOS1806-002AXW)

TABLE 46 Issue No. 15 – The current processes for pesticide legislation and governance within the Australian Pesticides and Veterinary Medicines Authority restrict timely access to pesticides, which negatively impacts crop production and profits.	
Description	The current regulatory process for the registration of new and/or an extension of chemical use patterns is lengthy, which limits access to tools that growers require to cost-effectively manage risks. A lack of registered products and timely permit renewals impacts on product supply, the management of weeds, pests and disease and resistance. Growers perceive that regulators do not fully comprehend the financial impact of restricted or delayed access to chemicals (for example, fungicides).
Current and recent GRDC investment addressing this issue	Advocacy is not within the GRDC mandate as this is a policy matter dealt with through both the Australian Pesticides and Veterinary Medicines Authority (APVMA) and government legislation, which is managed by the Department of Agriculture and Water Resources. Policy issues need to be channelled through grain grower representative groups such as Grain Producers Australia and Grain Growers Limited. APVMA legislative timeframes are shorter than its counterparts in Canada, the US, the European Union, New Zealand and the UK GRDC may provide scientific comment on APVMA documents and does so where there are documents for public comment such as registration public release summaries (PRS), chemical reviews and trade advice notices (TANs). Pathways to registration: • minor use applications (AKC00006); • AgVet Access grants; and • ag chemical priority forum (cross-RDC project).

TABLE 47 Issue No. 16 – Cereal leaf diseases – genetic solutions and integrated management strategies to manage yellow leaf spot, eyespot and *Septoria tritici* blotch.	
Description	The risk of fungal pathogens developing pathotypes with resistance to commonly used fungicides is increasing. An opportunity exists to mitigate this risk through development of genetic solutions and integrated management strategies for the major cereal foliar diseases.
Current and recent GRDC investment addressing this issue	Improving grower surveillance, management, epidemiology knowledge and tools to manage crop disease in Victoria (DAV00129) Improving grower surveillance, management, epidemiology knowledge and tools to manage crop disease in South Australia (DAS00139) Improving grower surveillance, management, epidemiology knowledge and tools to manage crop disease in New South Wales (DAN00177) Germplasm enhancement for yellow leaf spot resistance in wheat (DAW00206) Yield loss response curves for host resistance to leaf, crown and root diseases in wheat and barley (DAW00245) Centre for Crop and Disease Management (CUR00023) National pathogen management modelling and delivery of decision-support (DAW00228) Benchmarking resistance and managing *Septoria tritici* blotch and leaf rust (FAR00004A) Regional Agronomy SA – Improving disease management through improved agronomic practices (DAS00167-BA) National improved molecular diagnostics for disease management (DAS00137) Effective genetic control of *Septoria tritici* blotch (DAN00203)

TABLE 48 Issue No. 16 – Increased seasonal climate variability creates extremely contrasting growing seasons, which requires adaptive, agile and flexible management options to optimise yield and maximise profit, including but not limited to a 'menu' of crop species and cultivars.	
Description	The MRZ experiences a high level of variability. Being able to quickly adapt from one season to the next is difficult. For example a decile 1 season requires vastly different management tactics for crop and variety choice, in-season crop nutrition, weed, pest and disease management than a rainfall decile 7 season. Supporting growers to be adaptive and agile for each season type will enable yield and profit optimisation while managing risk. This can be done with decision-support tools and extension tailored to specific agro-ecological zones within the southern region.
Current and recent GRDC investment addressing this issue	Improving forecast accuracy, especially with improved Indian Ocean initialisation (MCV00008) Assessing and managing heat stress in cereals (MCV00006) Impacts of climate on low rainfall and marginal areas (CSA00053) Using seasonal forecast information and tools to manage risk and increase profitability in the southern region Optimised Canola Profitability (CSP00187) Evaluating the potential of long-term fallowing to reduce whole-farm production costs while maintain profit margin (UHS11009) Optimising the yield and economic potential of high input cropping systems in the HRZ (DAV00141) Management of early-seeded wheat (ULA91750) SARDI Strategic Partnership – MRZ project (9175938) GRDC Stubble Initiative – Riverine Plains Individual research component (RPI0000) Sustaining wheat yield and quality under increasing atmospheric CO2 (DAV00121) Accelerating wheat genetic gain by establishing a high-throughput spike phenotyping platform (UOA1806-013AWX) National Phenology Initiative (ULA00011)

TABLE 49 Issue No. 18 – Growers cannot easily predict the likelihood of pest and disease incursions, which is important for planning and management.	
Description	Understanding and being aware of the risk of a range of pests and diseases (for example, Russian wheat aphid, beet western yellows virus) would enable growers and advisers to better plan and implement timely strategies to proactively and more effectively manage identified risks. This could be achieved by modelling and communicating climate conditions, which are generally the major precursors that influence the risk of disease and insect incursions. This information could be used to assess the risks and provide an early-warning system to enable growers and advisers to develop and implement strategies to cost-effectively manage insect and diseases.
Current and recent GRDC investment addressing this issue	Predicting insect pest issues in Australian grain crops (UM00054) Improving grower surveillance, management, epidemiology knowledge and tools to manage crop disease in South Australia (DAS00139) Centre for Crop and Disease Management (CUR00023) – Research Program 1A – Early detection and management strategies for fungal diseases and Program 9 –*Sclerotinia* management Improving Plant Pest Management Through Cross Industry Deployment of Smart Sensors, Diagnostics and Forecasting (Rural R&D for Profit) Economic thresholds for the major pests of grain crops (mouse) MouseAlert Improved surveillance and management options for mice in crops (CSP1806-001SAX)

TABLE 50 Issue No. 21 – Which is the more economically sustainable option in high land price areas: a crop rotation dominated by high-value crops or a more balanced rotation with a mix of cereals, pulses and other land-use options?	
Description	Growers perceive that it is more profitable to generate income and achieve an acceptable return on investment on highly valued land by growing high-value crops such as lentils in close rotation than having a more balanced rotation that manages weeds, disease, pest and chemical residues. Increasing grower understanding of the impact of crop choice on risk and return may lead to more informed crop choice decision-making.
Current and recent GRDC investment addressing this issue	SARDI Strategic Partnership – MRZ project (9175938) Benchmarking and validating the yield gap in each agro-ecological zone (CSA00055) Identifying the key production and profitability drivers using commercial paddocks – Victorian Mallee (P0000001) Understanding the implications of new traits on adaptation, crop physiology and management of pulses in the southern region (DAV00150) Victorian Strategic Partnership

High-rainfall zone

TABLE 51 Issue No. 1 – Reliable supply of canola seed – is F2 canola an option?	
Description	The issue has evolved from one of general seed supply (accepting that Australian demand is at the end of the global seed supply, so are partially dictated by what the seed suppliers have left available) to a question of using F2 hybrid canola if new seed is not available. There is some evidence seed grading and other agronomy can lessen the impacts of sowing F2 hybrid seed. Is F2 canola an option and if so under what agronomy package will it work?
Current and recent GRDC investment addressing this issue	Testing retained sowing seed of hybrid canola in a range of rainfall zones (YCR00001) Optimised Canola Profitability – understanding the relationship between physiology and tactical agronomy management (CSP00187) Australian canola germplasm enhancement program (DAV00085) A novel mutation-based strategy to increase seed yield in canola (US00068)

TABLE 52 Issue No. 2 – Identify and develop high-value grain crops to complement existing common crops.	
Description	Most traditional crops grown in the HRZ are bulk commodities that compete with other high-volume suppliers around the world. The introduction of new high-value grain crops, including pulses (for example, chickpeas, soybeans peanuts), oilseeds (linseed, safflower, evening primrose and sunflower) and other options would have a positive impact and be applicable to most growers across the HRZ. The direct benefit would be increased profit, with wider gains through diversification of rotations potentially enabling alternative options for weed control, nitrogen accumulation, disease break, soil amelioration and water use. Depending on the crop, new beyond-farmgate industries may emerge in handling and processing.
Current and recent GRDC investment addressing this issue	Southern Pulse Agronomy (DAV00150) Improving the profitability of pulse production through local validation of research outcomes in the southern region Building capacity, skills and knowledge for the pulse industry in the southern region: supporting expansion of high-value pulses into new areas and ensuring sustained profitability of all key pulse crops in existing areas. N fixing break-crops and pastures for high-rainfall zone acid soils (DAN00191) Waterlogging and acid soil screening of pulses (UT00021) Increasing the effectiveness of nitrogen fixation in pulse crops through development of improved rhizobial strains, inoculation and crop management practices Identifying low-pH tolerance and effective rhizobia for wild *Cicer* to improve adaptation to acid sandy soils (UMU00044) Collection, phenotyping and exploitation of wild *Cicer* genetic resources for chickpea improvement (CSP00185) The potential of the pearl lupin (*Lupinus mutabilis*) for southern Australia (UWA00043) Hyperyielding cereals – a feed grain initiative (FAR00003) Tailoring an integrated solution to effectively address subsoil constraints by incorporation of chemically balanced nano-amendments (DAN1806-002AWX)

TABLE 53 Issue No. 3 – Opportunity to capitalise on the synergies for livestock and cropping enterprises and increase whole-farm profit.	
Description	There is an understanding of the work that has been done in the Grain & Graze program over the past decade. While the program has improved knowledge and awareness of things such as grazing crops and stubble and use of pastures in the rotation, the more difficult question of synergies, integration and whole-farm impact remain. It is a complex area and probably requires some different thinking to the extension approach that has been used in the past.
Current and recent GRDC investment addressing this issue	Grain & Graze II – Farm business logic application (NR00009) Grain & Graze III – Extension and deliver on mixed-farm benefits in the southern region (SFS00028) Extension of knowledge and resources to manage risk and exploit opportunities to improve whole-farm profit through successful integration of cropping and livestock enterprises in the GRDC southern region Building the resilience and profitability of cropping and grazing growers in the high-rainfall zone of southern Australia (9176969) Boosting profit and reducing risk on mixed farms in low and medium-rainfall areas with newly discovered legume pastures enabled by innovative management methods – southern region. (DAS1805-003RMX)

Case study:

Southern Pulse Agronomy

The Southern Pulse Extension Project is arming growers and advisers with the knowledge to diversify into new pulse crops in non-traditional production areas of Victoria and South Australia.

The three-year GRDC investment follows significant expansion of the area sown to pulses in the southern region in recent years and recognition that growers outside the medium-rainfall zone (MRZ) are seeking higher-value pulse options.

GRDC's manager of systems and agronomy for the southern region, Andrew Etherton, says information generated by the ongoing Southern Pulse Agronomy program is providing content for a range of first-time and experienced growers and advisers.

"The area sown to lentils in SA's low-rainfall zones has grown from 3800 hectares in 2013 to an estimated 27,000ha in 2017. Chickpea plantings have increased from 3100 to 13,800ha over the same period," he says.

Mr Etherton says pulses can provide high returns in good years, as well as offering agronomic benefits. "These legume crops fix nitrogen, so growers don't have to buy as much fertiliser; there are different herbicide packages for weed control; they can provide a break from cereal diseases; and they are a good break crop for soil health," he says.

"There is a need to change the mentality of pulses from being a one-year cash crop to include them as an entire farming systems approach looking at following rotations. Growers are encouraged to consider the entire picture and benefits of pulses beyond the single-year financial returns."

Southern Pulse Extension steering committee chair Bill Long says extension to connect growers with each other and the latest research is vital to improve productivity.

"This project will enable growers to have the confidence to grow pulses in areas where they haven't been grown before," he says.

"In addition, Pulse Check groups are being run in several regions where pulse production is significant and where there are different sets of challenges, such as disease and weed management issues due to a close pulse crop sequence.

"The investment in Pulse Check groups is based on a fundamental principle around how growers learn. Primarily, growers learn from other growers, so getting groups together to discuss how to grow a crop in a supportive environment is very effective."

The Pulse Check groups, which are being run across the region throughout the three-year investment, are complemented in the Southern Pulse Extension Project by events, workshops, technical content development and agribusiness capacity-building efforts.

As work continues to accommodate low-rainfall and high-rainfall zone pulse options, the extension project will form mechanisms to educate the industry, Mr Etherton says.

Southern Pulse Agronomy has trial sites spread throughout SA and Victoria, but most of these are located in established pulse-production areas. Mr Etherton says this is changing to include non-traditional zones and working towards variety development for all growers.

Pulse Australia chief executive officer Nick Goddard says the industry needs pulses as a break crop option beyond canola but, without experience, pulses can be a risky option.

"The purpose of the extension project is really to build capability among the wider field of growers," Mr Goddard says.

"Farming practices have changed over time and breeding has improved, which has enabled pulses to be grown into areas that were not quite as attractive as before due to drier conditions. But, of course, you also need the industry to follow and there needs to be a critical mass of any crop to make it viable from a receiver point of view."

He says a coordinated region-by-region approach to upskill growers will ensure that the wider industry will be able to support new pulse-growing areas and allow growers to understand pulse price volatility and the agronomic benefits of growing pulses.

Members of the Southern Pulse Extension team: (back, from left) Southern Pulse Extension steering committee member and facilitator Tony Craddock, Rural Directions; Southern Pulse Extension monitoring and evaluation consulting Jamie Allnut, ENFAC Consulting; (front, from left) Pulse Australia and Southern Pulse Extension communications coordinator Rebecca Freeman; Southern Pulse Extension manager Pru Cook; and Southern Pulse Extension content development and technical review coordinator Katherine Hollaway, Astute Ag. PHOTO: ALISTAIR LAWSON

TABLE 54 Issue No. 4 – Spatially specific (real-time) assessment data to better inform in-season nitrogen decisions in high-rainfall environments.	
Description	Nitrogen (N) management is a key driver of yield and profitability of all non-legume crops in most seasons within the HRZ. Improved technologies and tools to accurately and rapidly measure in-crop N status would enable better in-season tactical N decisions. It would also enable more intensive and frequent measurement of N, which would provide the information required to customise N management. Customised and variable-rate N applications would increase N use efficiency, return on investment and profit.
Current and recent GRDC investment addressing this issue	Real-time evaluation of soil nitrate using ion exchange technology (EPF00002-A, UA00165) Tools for rapid, real-time measurement of nutrients (CSO00045) Soil spectroscopy capability (CSO00045) Nitrogen inputs by free-living nitrogen fixing bacteria – Grower messages (CSP00191) More Profit from Crop Nutrition (MPCN) II – Regional soil testing guidelines for the southern region (DAN00168) Proximal Soil Sensing for Profitable and Sustainable Farming (CSA00048) Updated nutrient response curves in the northern and southern regions (UQ00082) Using soil and plant testing data to better inform nutrient management and optimise fertiliser investments for grain growers (ASO1806-001RTX)

TABLE 55 Issue No. 4 – Enhanced accuracy of nitrogen management decisions.	
Description	The key nitrogen (N) management decisions are amounts/rates and timing of applications. A range of N budgeting tools that calculate N fertiliser requirements given N demand based on target yield and protein less N supply from mineralisation currently exist. However, the amount of N supplied through mineralisation is highly variable. Therefore, the calculated amount of required N fertiliser can only be considered a 'guide'. Crop models have not been calibrated for regional conditions in the region, which limits the accuracy and reliability of using normalised difference vegetation index (NDVI) information as a tool to estimate N requirements. The development of technologies and tools to measure N rather than rely on estimates of N would increase the accuracy of N management decisions. Improved seasonal forecasts and crop models would also enable growers to adapt tactical N management based on potential yield given seasonal conditions.
Current and recent GRDC investment addressing this issue	Real-time evaluation of soil nitrate using ion exchange technology (EPF00002-A, UA00165) Managing legume and fertiliser nitrogen in the southern region (UA00165) More Profit from Crop Nutrition Initiative – Phase II (MPCN II) Re-assessing the value and use of fixed nitrogen (CSA00037) More Profit from Crop Nutrition Initiative – Phase II (MPCN II) Benchmarking wheat yield against nitrogen use (DAS00147) Soil spectroscopy capability (CSO00045) Proximal Soil Sensing for Profitable and Sustainable Farming (CSA00048) Improving nitrous oxide abatement in higher-rainfall cropping systems and developing nitrogen response curves (DAV00125) Re-assessing the value and use of fixed nitrogen (CSA00037) Evaluation of late nitrogen applications to achieve yield potential and increased protein in wheat (SFS00025) Nutrient performance indicators (IPN00003) Strategies to better synchronise nutrient supply and crop demand (UM00023) Nitrogen and water interactions (DAS00157) Understanding how waterlogging affects water and nitrogen use by wheat (DAV00151) Optimising nitrogen fixation of grain legumes – southern region (DAS00128) Updated nutrient response curves in the northern and southern regions (UQ00082) Using soil and plant testing data to better inform nutrient management and optimise fertiliser investments for grain growers (ASO1806-001RTX)

TABLE 56 Issue No. 6 – Poor harvester efficiency (including grain loss) is impacting on profitability.	
Description	The set up and operation of the header can have an impact on throughput and how much grain is 'lost' during harvest. Variability in machines, operator skill, crop moisture, canopy structure and weather conditions all impact of harvest efficiency. Setting and adjusting machinery to maximise grain capture while operating at optimum machine performance is a skill. Providing expert advice to growers and contractors would enhance profit by ensuring the maximum amount of grain is captured for the costs incurred, both in expenditure to grow the crop but also to get the crop off in a timely manner.
Current and recent GRDC investment addressing this issue	GRDC Stubble Initiative Halving canola harvest losses (PLN1803-001SAX)

TABLE 57 Issue No. 8 – Improved management packages for multi-herbicide-resistant annual ryegrass.	
Description	Surveys have shown very high levels of herbicide resistance in annual ryegrass (ARG) is widespread across the HRZ. ARG populations in the HRZ have developed resistance to multiple groups of herbicides. The long growing season in HRZ results in large populations of herbicide-resistant ARG that can germinate very late in the season (September to November) after in-crop herbicides have lost their efficacy. The ongoing population of ARG reduces yields, limits crop options and less effective and/or increased input costs for weed control, which is significantly limiting the profitability of farming systems. Improved management packages that provide season-long control of ARG in the HRZ are required.
Current and recent GRDC investment addressing this issue	Australian Herbicide Resistance Initiative – Phase V (UWA00171) WeedSmart (UWA00172) Harvest weed seed control for the southern region (SFS00032) Mechanisms, evolution and inheritance of resistance (UA00158) Surveillance of herbicide-resistant weeds in Australian grain cropping (UCS00024) Weed management in the southern region mixed-farming systems – strategies to combat herbicide resistance (UCS00020) Cultural Weed Management (UAO1711-005RTX) Technical Workshops – southern region: Herbicide resistance management (ARN00002) Weed management in the southern region mixed-farming systems – strategies to combat herbicide resistance (UCS00020) Understanding and management of weed resistance to glyphosate (UA00088) Development, characterisation and incorporation of novel herbicide tolerance traits in pulse crops (DAS1807-013BLX)

TABLE 58 Issue No. 10 – Determine practices (rotations) to reduce the high input costs required to grow high-yield wheat.	
Description	Increasing investment in weed, pest and disease control, along with nutrition has become an accepted requirement to grow higher-yielding wheat crops. Growers (and some advisers) are now beginning to question the sustainability of this approach. Increasing direct input increases downside financial risk, because most of the costs are upfront before the final yield is known and the expenditure is often 'sunk' (it cannot be recovered in the next crop if yields are below expectation). Understandably growers are wondering if there are other means of supplying these inputs at lower cost, while not limiting the upside potential when growing conditions are favourable. Seeking smarter ways to manage and provide the inputs is prudent farm management. It is accepted that farming systems, rotations and individual practices strongly influence weeds, pests, diseases and nutrients. In turn this influences the inputs that are required to grow high-yielding wheat crops. Identifying farming systems and strategies that will reduce costs and optimise wheat yields would enable growers manage financial risk and increase profits.
Current and recent GRDC investment addressing this issue	N-fixing break crops and pastures for high-rainfall acid soils (DAN00191) Optimising yield and economic potential of high-input cropping systems in the HRZ (DAV00141) National Paddock Survey Initiative (BWD00025) Agronomy to support expansion of feed grain production in Tasmania (FAR00003) More Profit from Crop Nutrition Initiative – Phase II (MPCN II), re-assessing the value and use of fixed nitrogen (CSA00037) Management of high-rainfall cropping to improve water quality and productivity (DAV00059) Genotype and management combinations for highly productive cropping systems in the HRZ of southern Australia (DAV00161) Rooty: A root ideotype toolbox to support improved wheat yields (UOQ1804-002RTX) Boosting profit and reducing risk on mixed farms in low and medium-rainfall areas with newly discovered legume pastures enabled by innovative management methods – southern region. (DAS1805-003RMX)

TABLE 59 Issue No. 11 – Ensuring long-term cost-effective management of important HRZ foliar diseases by prolonging the life of fungicide and varietal resistance.	
Description	The reliance, prophylactic and repeated use of a limited number of fungicide groups has increased the risk and rate of development of fungicide resistance. The development and adoption of integrated approaches and informed decisions to disease management are required to reduce the reliance and over-use of fungicides as the only means of control. The integrated approach will require a three-pronged approach. 1. Genetic resistance to reduce the reliance on fungicides to manage diseases. The ongoing development of new varieties that provide improved resistance to a range of important diseases is required. 2. The adoption of non-chemical control strategies that reduce inoculum levels prior to fungicide applications to (reduce selection pressure). 3. More judicious use of fungicides, based on an established need rather than a prophylactic approach.
Current and recent GRDC investment addressing this issue	Centre for Crop and Disease Management (CUR00023) • CCDM Program 1 – Project A – Early detection and management strategies for fungal diseases • CCDM Program 1 – Project B – Best management practices for fungal disease control • CCDM Program 1 – Project C – Economics of disease management and capacity development • CCDM Program 2 – Extension and engagement • CCDM Program 3 – *Septoria nodorum* blotch biology • CCDM Program 4 – Tan (yellow) spot • CCDM Program 5 – Net form of net blotch functional genomics • CCDM Program 6 – *Sclerotinia* stem rot of canola and lupins • CCDM Program 6 – Ascochyta blight of pulses • CCDM Program 8 – Durable resistance to powdery mildew • CCDM Program 9 – Fungicide resistance Benchmarking resistance and managing *Septoria tritici* blotch and leaf rust (FAR00004A) Improving grower surveillance, management, epidemiology knowledge and tools to manage crop disease in New South Wales (DAN00177) Crown Rot Resistance – a range of investments Rust Resistance – a large number of investments Nematode Resistance – a range of investments Multiple Resistances – numerous investments Virus Resistance – various investments

TABLE 60 Issue No. 12 – Disease management package for Sclerotinia, blackleg and powdery mildew in canola.	
Description	Conditions in high-rainfall environments favour the infection and spread of foliar diseases in canola crops. Recently growers, agronomist and advisers have encountered an increase in the range of diseases and levels of infection. The main foliar diseases include: • blackleg – flower, stem and pod infections; • sclerotinia; • powdery mildew. The current heavy reliance on low-cost, simple fungicides strategies may jeopardise the long-term control of fungal diseases in canola and a more diverse, integrated approach may be required.
Current and recent GRDC investment addressing this issue	National canola pathology program (UM00051) Upper Canopy Blackleg Infection (SFS00034-B) Centre for Crop and Disease Management (CUR00023) – research program 6 – Sclerotinia stem rot of canola Improving grower surveillance, management, epidemiology knowledge and tools to manage crop disease (DAW00229) Emerging foliar diseases of canola (UWA00170) Blackleg National Variety Trials ratings (MGP00004)

TABLE 61 Issue No. 12 – Develop harvest and weed seed management techniques to deal with late-germinating annual ryegrass.	
Description	The high levels of resistance and longer growing seasons in the HRZ means that growers do not have herbicide options to effectively control the staggered and late germinations of annual ryegrass (ARG), which cause seedbanks to increase. Weed seed-set and harvest weed seed tactics for ARG are required to enable growers to effectively prevent the build-up of ARG weed seedbanks and reduce ARG numbers.
Current and recent GRDC investment addressing this issue	Harvest weed seed control for the southern region (SFS00032) Cultural Weed Management (UAO1711-005RTX) Weed management in the southern region mixed-farming systems – strategies to combat herbicide resistance (UCS00020) Harvest weed seed control for the southern region (SFS00032) Australian Herbicide Resistance Initiative – Phase V (UWA00171) Chafflining – a new, cost-effective harvest weed seed control tool (PLN1802-002SAX)

TABLE 62 Issue No. 15 – Develop new (non-GM) canola varieties.	
Description	Growers require access to a range of improved canola varieties with a range of traits that are adapted to high-rainfall environments. Regulations in South Australia and Tasmania prevent the growing of GM varieties. As a consequence, growers in key high-rainfall production areas in these states do not have access to GM varieties with a range of improved traits (for example. herbicide resistance, pod strength to reduce shattering).
Current and recent GRDC investment addressing this issue	National Brassica Germplasm Improvement Program

TABLE 63 Issue No. 17 – More accurate weather forecasts.	
Description	Seasonal conditions are the greatest determinant of yield, which has a significant impact on profit. Improved skill of weather forecasts and seasonal outlook forecasts would provide growers with the powerful tools that would enable growers to make better-informed plans and decisions that will increase profits.
Current and recent GRDC investment addressing this issue	Using seasonal forecast information and tools to manage risk and increase profitability in the southern region (DAV1803-010SAX) Improving forecast accuracy, especially with improved Indian Ocean initialisation (MCV00008) Rural R&D for Profit – Seasonal forecasting Assessing and managing heat stress in cereals (MCV00006)

TABLE 64 Issue No. 18 – Accelerated development of waterlogging-tolerant barley.	
Description	Large areas of the HRZ are prone to waterlogging, which limits yields and profitability. Barley is less tolerant of waterlogging than other cereal crops. GRDC has invested in research undertaken by the Tasmanian Institute of Agriculture that has identified a major gene controlling the tolerance of waterlogging in barley. Further research is required to develop molecular markers, which would accelerate the introduction of this gene and the breeding of varieties with greater waterlogging tolerance.
Current and recent GRDC investment addressing this issue	Adapted barley germplasm with waterlogging tolerance (TBA) Genotype and management combinations for highly productive cropping systems in the HRZ of southern Australia (DAV00161)

TABLE 65 Issue No. 19 – Improved establishment of canola.	
Description	Poor establishment of canola crops in high-rainfall environments, particularly when sown into heavy stubble loads limit yield and profit of growing canola. Key opportunities that could improve the establishment of canola crop include stubble management starting with prior harvest, sowing systems (tyne and discs), row spacing, seed row placement, seeding rates, soil ameliorants and fertiliser inputs and placement.
Current and recent GRDC investment addressing this issue	Optimised Canola Profitability (CSP00187) GRDC Stubble Initiative and participating RD&E delivered by grower groups including: • BCG • Central West Farming Systems • MacKillop Farm Management Group • Riverine Plains • Yeruga Crop Research Optimising the yield and economic potential of high-input cropping systems in the HRZ (DAV00141) Optimising plant establishment, density and spacings to maximise crop yield and profit in the southern and western regions (UOA1803-009RTX) Optimising plant establishment, density and spacings to maximise crop yield and profit in the southern and western region (9176134) – Will replace (UOA1803-009RTX)

TABLE 66 Issue No. 20 – Quantify the optimum yield and inputs to maximise the profit margin (for each grower).	
Description	The HRZ has potential to grow high-yielding crops; however, to achieve this it commonly requires significant inputs. There is potential for large returns, but because of the inputs required also comes with a high level of risk. The most common type of production response in agriculture diminishes as inputs are increased. If starting from a low point, each additional input provides a return much greater than the cost of the input (a large marginal return for the investment). As inputs increase further, a positive response still occurs but it becomes less than the response from the previous input (it is diminishing or becomes more marginal). If investment continues, there is a point where further investment becomes greater than the additional response achieved. Given most growers have limited resources available, knowing the optimum yield and inputs to maximise this margin (at an acceptable level of risk) is essential.
Current and recent GRDC investment addressing this issue	GRDC Farm Business Updates – southern region (ORM00015) The integration of technical data and profit drivers for more-informed decisions (RDP00013) Practical financial figures for farm business management – aka Ag Profit (APR00001) Grain & Graze III – Extension and deliver on mixed farm benefits in the southern region (SFS00028) Grain & Graze II – Farm business logic application (NR00009) National Paddock Survey Initiative (BWD00025) Rural R&D for Profit – Seasonal forecasting Development of a grower and industry based GRDC Farm Business Management Manual in hard copy and e-book format (PTP00001) Assessing the economic value of precision agricultural tools for grain farming businesses in the southern region (RDP1805-002RTX) Using soil and plant testing data to better inform nutrient management and optimise fertiliser investments for grain growers (ASO1806-001RTX) Optimising the yield and economic potential of high input cropping systems in the HRZ of SW Victoria (DAV00141)

TABLE 67 Issue No. 20 – Determine how optical sensors can be used profitably to inform decision-making.	
Description	Optical sensors, which use specific wavelengths to collect a range of reflectance data measurements, are becoming cheaper and more common. While they can be shown to collect and differentiate images, the value of the data to inform decision-making is unclear. There are suggestions it could be used to inform summer weed control, crop establishment and damage, variable-rate nitrogen, validate areas of waterlogging and where drainage is required, crop disease prevalence and crop maturity to determine timing of desiccation or windrowing. None of these suggestions have been well developed. On the surface there appears to be lots of opportunities to use sensor data, but just what this is and importantly how it can be used to improve decisions and profit is unclear. The people promoting the technology are enthusiastic, and growers and advisers are curious but the application (and proof it is profitable) is yet to be established. The risk of leaving it to the market is: a) the sensor technologists will assume what growers need – and may not get this right; and/or b) individuals pursue the potential but then do not share with the wider industry (market failure). This is costly to the individual and the wider grains industry.
Current and recent GRDC investment addressing this issue	Future Farm Theme 1: Intelligent Sensing (CSP00201) Spatial temperature measurement and mapping tools to assist growers, advisers and extension specialists manage frost risk (CSP00198) Hyperspectral data for estimating leaf biochemistry (GRS 9165910) Direct comparison between selected field infrared instruments for the prediction of soil properties in grain cropping soils (CSO00045) Assessment of N and water co-limitations by remote sensing as a tool to improve wheat and canola profitability and manage risk (DAS00165-BA) Applying technology solutions for improved frost detection, diagnostics and precision management decisions (FMO1806-002AWX)

TABLE 68 Issue No. 20 – Extracting greater 'value' from spatially referenced data that is already being collected.	
Description	An enormous amount of data is being captured by growers and their contractors, either consciously (drones, soil testing, EM) or because technology now enables this to happen (yield monitors, satellites). This data includes soil pH, elevation, normalised difference vegetation index (NVDI), yield and grain quality. Most of the data collected is geo-referenced, potentially enabling different interventions in different parts of a paddock. Extracting 'value' from this data is in its infancy, but on the surface it appears to have great potential to improve profitability. For example, collected information could be used to assess the impact of diseases and nutrition or provide the opportunity to measure and quantify the financial value of treatments, therefore enabling greater value from on-farm trials to be obtained. Typically the data collection is driven by those at the technology end (sensors and data capture) rather than by the end user (data user and decision-maker). There is a need to understand what data would be valuable to inform the decision-maker and then examine what data that is already being collected could meet these needs.
Current and recent GRDC investment addressing this issue	Data-driven agriculture is a core framework underpinning RD&E investment within GRDC's new five-year RD&E Plan. Precision-agriculture technology and analytics will enable grain growers to gain an improved understanding of the yield, cost and risk components of their production systems. GRDC is building its digital agriculture portfolio and is a unique position to invest in the science that is necessary to enable growers to realise greater value from the data that is already being captured. Assessing the economic value of precision-agricultural tools for grain farming businesses in the southern region (RDP1805-002RTX) Future Farm Initiative (Phase 1) – Program for improving grower confidence in targeted N management through automated sensing, decisions and intelligent infrastructure Future Farm – Phase 2: Improving grower confidence in targeted N management through automated sensing and decision support Understanding plant-available soil water and implications for crop management (RPI00009) Spatial variability of soil acidity and response to liming in cropped land of the Victorian HRZ (DAV00152) Victorian Department of Economic Development, Jobs, Transport and Resources (DEDJTR) Regional Agronomist (DAV00143) Soil Water App maintenance (CSP1806-004SAX)

TABLE 69 Issue No. 23 – Enable quicker access to long-season, Northern Hemisphere varieties with superior leaf disease resistance.	
Description	RCSN members believe there are important and desirable improved long-season wheat, barley, canola and faba beans trait and varieties from the Northern Hemisphere that would increase the profitability of growing these crops in the HRZ. These opportunities include long-season varieties with mid to late maturity, waterlogging tolerance, improved grain quality, higher yields, greater leaf disease resistance and improved straw to reduce the risk of lodging and head retention. In particular, superior genetics that offer leaf disease tolerance is needed, given that current varieties lack resistance to the leaf major diseases (for example, *Septoria tritici* blotch, barley yellow dwarf virus and leaf rust). Facilitating quicker access to Northern Hemisphere material would be of benefit to high-rainfall growers.
Current and recent GRDC investment addressing this issue	Hyperyielding cereals – a feed grain initiative (FAR00003)

TABLE 70 Issue No. 25 – Improved grain marketing through expanded or differentiated markets (faba beans and cereals) and greater grower marketing skills advice to get a better price.	
Description	Farm profit is influenced by the price received for a commodity. There is a belief that profit could be improved if: a) there was greater differentiation in markets, especially with cereals and faba beans; and b) growers had improved grain selling skills (either themselves or in partnership with a grain marketer). Differentiated markets may also encourage growers to introduce some more novel crops in the rotation, thereby helping manage disease, pest and nutrition (having markets and favourable prices influences rotation choices).
Current and recent GRDC investment addressing this issue	GRDC Farm Business Updates – southern region (ORM 1505-002SAX) Market Intelligence for Theme 1 (AEG00006) Victorian Department of Economic Development, Jobs, Transport and Resources (DEDJTR)Pulse Breeding (DAV00143) Rural Business Support (9176026)

TABLE 71 Issue No. 32 – Identify the reasons for inconsistent nodulation (and subsequent yield loss) in broad beans and faba beans.	
Description	It is widely recognised that the nodulation of broad beans and faba beans in the HRZ is poor and unreliable. This has major implications for growers relying on these pulses, both in direct yield but also the nitrogen fixation achieved. Identifying the causes of inconsistent nodulation is the first step to developing effective strategies to improve both the level and consistency of nodulation to improve nitrogen fixation and yields. This is unlikely to be a simple task because product, handling regimes, chemical and rotation history, soil types and the wider farming system are all likely to be contributing factors.
Current and recent GRDC investment addressing this issue	Increasing the effectiveness of nitrogen fixation in pulse crops through improved grower and adviser awareness and knowledge of inoculation and crop management practices in the southern region (MSF1806-002SAX) Increasing the effectiveness of nitrogen fixation in pulse crops through development of improved rhizobial strains, inoculation and crop management practices (DAS1805-004RTX) Nitrogen-fixing break crops and pastures for HRZ acid soils (DAN00191) Poor nodulation of faba beans on Kangaroo Island (AKI00001) Extension of N fixation to end users (South) (UA00138) Managing legume and fertiliser nutrition (UA00165)

TABLE 72 Issue No. 32 – Determine if cover crops have a profitable impact on soil health.	
Description	Cover cropping is a relatively new practice that is being tested in some cropping systems. A cover crop is defined as a three to nine-month crop that is grown primarily for biomass (not grain but may or may not be grazed). It could be a monoculture or include multiple species, including nitrogen-fixing species. It is not necessarily a summer crop. The primary objective of introducing a cover crop is to enhance soil biota. It is assumed improved soil biodiversity will lead to greater resilience and greater profit. Enhancements in soil composition (biodiversity, structure and nutrients) are thought to be derived from increased carbon sequestration, having longer periods of active material for soil biota to feed on, moderating soil temperature, enhancing soil structure and building soil nitrogen. In some locations and farming systems, the cover crop is also seen as a way of controlling summer weeds, extracting soil moisture (to reduce subsequent waterlogging periods) and utilising excess water by growing more annual biomass. In theory the benefits of cover cropping are attractive and the proposition 'make sense' at a general level. However, there is very little information to understand what changes cover cropping will have on soil composition (and then ultimately to the flow-on effects to other parts of the business, impact on financial performance and risk in the farming business).
Current and recent GRDC investment addressing this issue	Cover crops for no-till farming systems in the western region (WAN00013) Cover crop and stubble management systems for the central and southern NSW (CWC00003) Quantifying the effectiveness of cover crops as a means of increased water infiltration and reduced evaporation in the northern region (DA00211) Warm and cool season mixed cover cropping for sustainable farming systems in south-eastern Australia (GRANT-NLP-9175786)

TABLE 73 Issue No. 35 – Determine sustainable and profitable management strategies of high-volume stubbles.	
Description	The quest for higher yields has an undesirable legacy – heavy stubble loads. These heavy stubbles create real challenges, in the establishment of subsequent crops, disease and pest carry over herbicide efficacy. The grains industry has been active in trying to find approaches that minimise the negative impacts of high stubble loads, while trying to retain the benefits of retained stubble (ground cover, extra carbon and nutrients). Row spacings, inter-row sowing, no grazing, harvest height, baling, machinery modification, incorporation are some of the tactics being employed. Burning is another tactic that, although practised less often that decades ago, is still used because it 'solves many problems' easily and quickly (for example, removes the stubble, kills disease, pest harbour, reduce weed seeds). The challenge is to enable growers and advisers to put together several tactics into a strategy that is, on balance, are appropriate for the time and the situation. The package of tactics is likely to change from region to region, year to year and even between paddocks with the same year. There is no recipe.
Current and recent GRDC investment addressing this issue	GRDC Stubble Initiative – Maintaining profitable farming systems with retained stubble in South Australia, Victoria and Tasmania including high-rainfall districts: • Maintaining profitable farming systems with retained stubble of the south-east and Kangaroo Island (MFM00006) • Maintaining Profitable Farming Systems with retained stubble in the SFS HRZ area (BWD00024) • GRDC Stubble Initiative – research component, CSIRO et al (CSP00186) Using soil and plant testing data to better inform nutrient management and optimise fertiliser investments for grain growers (ASO1806-001RTX)

TABLE 74 Issue No. 40 – Develop broad bean and faba bean agronomy packages.	
Description	The HRZ desperately needs a pulse in the cropping rotation. Gowers and advisers currently dabbling with pulses are finding them often unreliable and not profitable. Yet they believe there is opportunity with pulses, especially with the test yields being reported of newer varieties. Part of their optimism stems from a feeling they are under prepared (need more knowledge, skills, confidence) to apply the right agronomy to realise the potential of the varieties available (it is not the plant that is the limitation or a desire to use it, rather it is how growers manage it that is the limitation).
Current and recent GRDC investment addressing this issue	GRDC Faba bean southern region – GrowNotes™ Understanding the implications of new traits on adaptation, crop physiology and management of pulses in the southern region (DAV00150) Building capacity, skills and knowledge for the pulse industry in the southern region: Supporting expansion of high-value pulses into new areas and ensuring sustained profitability of all key pulse crops in existing areas. Improving the profitability of pulse production through local validation of research outcomes in the southern region (DAV00150 – validation component)

2017–2019 Southern Regional Cropping Solutions Network (RCSN)

The RCSN initiative was established to identify priority grains industry issues and desired outcomes and assist the GRDC in the development, delivery and review of targeted RD&E activities, creating enduring profitability for Australian grain growers. The composition and leadership of the RCSNs ensures constraints and opportunities are promptly identified, captured and effectively addressed. The initiative provides a transparent process that will guide the development of targeted investments aimed at delivering the knowledge, tools or technology required by growers now and in the future. Membership of the RCSN network comprises growers, researchers, advisers and agribusiness professionals. The three networks are focused on farming systems within a particular zone – low rainfall, medium rainfall and high rainfall – and comprise 38 RCSN members in total across these zones.

REGIONAL CROPPING SOLUTIONS NETWORK SUPPORT TEAM

SOUTHERN RCSN CO-ORDINATOR: JEN LILLECRAPP

Jen is an experienced extension consultant and partner in a diversified farm business, which includes sheep, cattle, cropping and viticultural enterprises. Based at Struan in South Australia, Jen has a comprehensive knowledge of farming systems and issues affecting the profitability of grains production, especially in the high rainfall zone. In her previous roles as a district agronomist and operations manager, she provided extension services and delivered a range of training programs for local growers. Jen was instrumental in establishing and building the MacKillop Farm Management Group and through validation trials and demonstrations extended the findings to support growers and advisers in adopting best management practices. She has provided facilitation and coordination services for the high and medium rainfall zone RCSNs since the initiative's inception.

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LOW RAINFALL ZONE CO-LEAD: BARRY MUDGE

Barry has been involved in the agricultural sector for more than 30 years. For 12 years he was a rural officer/regional manager in the Commonwealth Development Bank. He then managed a family farming property in the Upper North of SA for 15 years before becoming a consultant with Rural Solutions SA in 2007. He is now a private consultant and continues to run his family property at Port Germein. Barry has expert and applied knowledge and experience in agricultural economics. He believes variability in agriculture provides opportunities as well as challenges and should be harnessed as a driver of profitability within farming systems. Barry was a previous member of the Low Rainfall RCSN and is current chair of the Upper North Farming Systems group.

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John is a highly experienced, business-minded consultant with a track record of converting evidence based research into practical, profitable solutions for grain growers. Based at Donald in Victoria, John is well regarded as an applied researcher, project reviewer, strategic thinker and experienced facilitator. He is the founder and former owner of JSA Independent (formerly John Stuchbery and Associates) and is a member of the SA and Victorian Independent Consultants group, a former FM500 facilitator, a GRDC Weeds Investment Review Committee member, and technical consultant to BCG-GRDC funded 'Flexible Farming Systems and Water Use Efficiency' projects. He is currently a senior consultant with AGRIvision Consultants.

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HIGH RAINFALL ZONE LEAD: CAM NICHOLSON

Cam is an agricultural consultant and livestock producer on Victoria'sBellarine Peninsula. A consultant formore than 30 years, he has managed several research, development and extension programs for organisations including the GRDC (leading the Grain and Graze Programs), Meat and Livestock Australia and Dairy Australia. Cam specialises in whole-farm analysis and risk management. He is passionate about up-skilling growers and advisers to develop strategies and make better-informed decisions to manage risk – critical to the success of a farm business. Cam is the program manager of the Woady Yaloak Catchment Group and was highly commended in the 2015 Bob Hawke Landcare Awards.

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Notes

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Map depicting GRDC Southern Region

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