

2014-15 ANNUAL REPORT



GRDC

REGIONAL CROPPING
SOLUTIONS NETWORK

SOUTHERN REGION



REGIONAL CROPPING SOLUTIONS NETWORK

Southern Region

Annual Report: Regional Cropping Solutions Network, 2014–15

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.

Author

Andrew Rice, former manager regional grower services – south, GRDC

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Note

The information presented in this document was current and correct as at December 2016. RD&E investments since this date and not captured here may mean information relating to each of the issues discussed may have changed since this date. 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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GRDC contact:

Ms Maureen Cribb
GRDC Publishing Manager
PO Box 5367
KINGSTON ACT 2604

T: 02 6166 4500

E: maureen.cribb@grdc.com.au

W: <https://grdc.com.au/About-Us/Our-Grains-Industry/Region-Cropping-Solutions-Networks>

Editorial coordination, additional writing and editing:

Lucy Kealey, Kealey Clark P/L

Design and production: Coretext, www.coretext.com.au

Cover: Rebecca Jennings

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Foreword

Since its launch in 2012, the Regional Cropping Solutions Network (RCSN) initiative of the Grains Research and Development Corporation (GRDC) has enabled growers and industry stakeholders to influence the GRDC's investment portfolio and enhance the local delivery of research, development and extension.

The RCSNs were established to provide advice to GRDC staff and the Southern Panel and they have been successful in enhancing the GRDC's appreciation of region-specific challenges and its ability to respond in a timely and appropriate manner.

The GRDC footprint of engagement within the industry is now the largest it ever has been, giving the panel a much greater insight into the important issues affecting growers and allowing it to make the right investments that will best address these issues and result in the adoption of improved farming practices.

The network groups currently consist of 42 growers, agronomists, consultants and researchers who have strong connections with growers and other grains industry stakeholders and are supported by skilled and experienced facilitators. The panel is also represented on the RCSNs.

Each RCSN is focused on farming systems in a particular production zone – low rainfall, medium rainfall, high rainfall and irrigation – and members liaise with the wider grower community in their respective zone.

From mid-2016, in alignment with the GRDC's regional boundary and operational changes, irrigation priorities will be captured both within the three remaining Southern RCSN groups (high, medium or low rainfall zones) and also by the GRDC northern region, as part of a larger irrigation area which will encompass the irrigated cropping areas of Queensland and New South Wales.

The composition of the low, medium and high rainfall RCSN groups will also transition to reflect the new GRDC boundaries whereby southern NSW is incorporated into the GRDC's northern region.

In future, the three southern RCSN groups will comprise members from Victoria, South Australia and Tasmania – the three states which now make up the GRDC southern region.

This document is the second annual report of the GRDC southern region RCSN. Its purpose is to present the priority issues that the RCSNs identified for the 2014-15 investment cycle, and outline the actions taken by the GRDC in response to each priority issue.

For 2014-15, the southern region RCSN identified 31 priority issues that they believed required RD&E investment. The Southern Panel identified a further 26 priority issues, which are also included in this report. Of the issues identified, many were addressed directly by new investments in the 2015-16 investment plan, or by broader or ongoing GRDC investments. The remaining issues are acknowledged as important but more information is required before they are 'investment ready'.

It is rewarding for RCSN members to now realise their efforts resulting in funded projects that have on-farm impact. Members will monitor and evaluate the progress and outputs from these projects.

On behalf of the Southern Panel and the GRDC, I thank members of the southern region RCSN groups for their ongoing enthusiasm, commitment and contribution.



Keith Pengilley
Chair, GRDC Southern Panel

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1. Executive summary

The Grains Research and Development Corporation (GRDC) is committed to investing in research, development and extension (RD&E) to benefit Australian grain growers. To assist the GRDC in maintaining strong connections with growers and identify locally specific RD&E priorities, the Regional Cropping Solutions Network was established in the grain-growing regions of southern Australia in 2012.

In 2014-15 there were four RCSN groups within the GRDC southern region, representing the key grain production zones: low rainfall, medium rainfall, high rainfall and irrigation. Each network comprises growers, researchers, representatives of farming systems groups, consultants and other grains industry stakeholders. The networks are led by facilitators and supported by the GRDC's Southern Panel and the GRDC manager regional grower services – south.

The RCSN groups meet several times each year to identify the priority issues facing growers in the southern grain-growing region and to provide the GRDC with detailed information about the issues. This information helps the GRDC to plan and determine its annual RD&E investments to achieve maximum effectiveness of RD&E levies at a local, regional and national scale.

With hundreds of issues identified annually, the RCSN plays a critical first step in 'sorting the wheat from the chaff'. Each RCSN reviews the issues arising in its zone, taking into account the regional impact and significance of the issue to local growers and the practice change(s) required to address the issue. After consideration of each issue, using a formal 'program logic' process, the RCSN identifies the priority issues to be presented to GRDC staff and the GRDC Southern Panel. The panel then assists with determining the significance of the issue in the context of the broader grains industry, and using its knowledge of current GRDC investments to help determine the need for further investment in RD&E to address the issue.

In 2014-15, the RCSN and the Southern Panel identified 57 priority issues that they believed were not being addressed by current investments and were affecting the profitability and sustainability of growers in the southern region. The resulting information was presented to the GRDC through the panel for consideration in the 2014-15 investment planning cycle. The 57 priority issues are described in Section 4 of this report, along with a summary of the actions required to address the issue and the GRDC's response to the issue in terms of consideration of existing investments and new investments.

Some of the issues identified by the RCSNs were addressed through the GRDC's 'fast track' investment pathway. Fast track projects were designed to give the industry an opportunity to

be responsive to localised, seasonal and tactical issues, which would best be addressed with timely, small-scale, small-budget projects. The projects are generally in-season, delivered within a short timeframe (usually no longer than 12 months) and set up where the speed of response is critical to meeting industry needs.

Since their establishment, the southern region RCSNs have instigated and seen the completion of 10 fast track projects, which have successfully delivered results in a timely, highly accessible and cost-effective manner. The close involvement of RCSN members in project design and approval also ensures a credible approach to local RD&E. While the RCSN groups recognise that not all issues can be addressed by a fast track project, a small number of issues have effectively been addressed through this process.

To date, fast track projects have included investigation into issues spanning:

- **herbicide resistance** – herbicide resistance surveys in the low and medium rainfall zones of NSW and Victoria;
- **disease** – evaluation of fungicide efficacy for control of eyespot in wheat and extension of cost-effective management strategies;
- **pests** – evaluation of integrated slug control strategies in the high rainfall zone, precision agriculture technology to increase efficacy of slug control, improvement in spreading of bait to increase snail control;
- **nutrition** – evaluation of late nitrogen applications to achieve yield potential and increased protein content in wheat;
- **pulse crops** – investigation of the barriers to adoption of faba beans as a break crop in irrigated systems; and
- **canola** – testing retained sowing of hybrid canola seed in a range of rainfall zones.

Outcomes from a number of the fast track projects became the basis of longer-term and integrated investments in RD&E within the southern region. Work undertaken in the low rainfall zone on the 'underperformance of sandy soils' has been used to guide the development of a five-year RD&E investment set to commence in 2016-17.

The southern region RCSN groups identified 29 new priority issues in 2014-15 that they believed required RD&E investment. The RCSNs also re-presented two issues identified in 2013-14 but additional information was requested by the GRDC to support proposed RD&E investments. In total, the RCSNs presented 31 issues for consideration of RD&E investment in 2014-15.

In 2014-15, the Southern Panel identified a further 26 priority issues for RD&E investment. These issues were developed and included in this annual report. Further, some issues were similar to issues raised by the RCSNs and therefore developed and presented as an RCSN issue.

In total, 57 priority issues were identified as affecting grain growing and grain growers in the southern region. The issues are presented in detail in Section 4 of this report. The outcomes of RD&E consideration of the issues by the GRDC are summarised in Section 5 of this report.

Among the issues identified for the 2014-15 investment cycle that were subsequently addressed by the GRDC investments were:

- increasing awareness, knowledge and capacity for industry to tackle herbicide resistance; advancing and extending knowledge of the behaviour of major weed species for better implementation of integrated weed management in the southern region;
- increased understanding of the impact and management strategies for foliar diseases – white leaf spot, blackleg pod infections, sclerotinia, powdery mildew and alternaria – in high potential canola crops for the high rainfall zone;
- improved understanding to manage emerging pests – millipedes, slaters and earwigs – in retained heavy stubble loads;
- specific knowledge to develop effective strategies to manage the small conical snail to avoid grain contamination;
- more sustainable and diverse farming systems through an increased inclusion of legumes in farm systems;
- development of a viable legume (crop or pasture; annual or phase) for acidic and alkaline soils in the high rainfall zone;
- improved nitrogen budgeting and management;
- better understanding of the impact of climate change on low rainfall agriculture;
- improved crop production on sandy soils in the low rainfall zone; and
- understanding of subsoil constraints (acidity, sodicity, nutrient, structure) and potential products and machines for amelioration.

To discuss any content in this report please contact:

Chair, GRDC Southern Panel

Keith Pengilley

kgpengilley@bigpond.com

0448 015 539

Low Rainfall Zone RCSN facilitators

Nigel Wilhelm

0407 185 501

nigel.wilhelm@sa.gov.au

Naomi Scholz

0428 540 670

naomi.scholz@sa.gov.au

Medium Rainfall Zone RCSN facilitators

Jen Lillecrapp

0427 647 461

hrznetwork@bigpond.com

Tony Craddock

0417 809 317

tcraddock@ruraldirections.com

High Rainfall Zone RCSN facilitators

Jen Lillecrapp

0427 647 461

hrznetwork@bigpond.com

Trent Potter

0427 608 306

trent@yeruga.com.au

Former Irrigation Zone RCSN facilitators

Rob Fisher

0428 545 263

vicc@dragnet.com.au

Bree Laughlin

0409 529 883

bree.laughlin@irrigatedcroppingcouncil.com.au

2. Managing grains RD&E

The Grains Research and Development Corporation (GRDC) was established under an Act of Parliament in 1990. Its charter is to plan, facilitate and oversee the investment of funds in research, development and extension (RD&E) to improve the production, sustainability and, ultimately, the profitability of the Australian grains industry. The GRDC manages more than \$195 million worth of investment in grains RD&E, which is the combined research investment of grain growers and the Australian Government.

The investment of funds into grains RD&E is a complex process that is driven by the needs of grain growers and the regional communities in which they live and work. At the ground level, a grower can contribute to the development of grains RD&E by:

- participating in and contributing to discussions at GRDC grower events and grower updates;
- discussing issues and making suggestions and comments directly to representatives on the GRDC Regional Cropping Solutions Network (RCSN) and Grower Solutions Groups (GSGs);
- discussing issues and making suggestions and comments directly to GRDC staff or representatives on the GRDC regional panels;
- making comments and suggestions about RD&E on the GRDC website (www.grdc.com.au/About-Us/Contribute); and
- making comments and suggestions about RD&E through social media by following the GRDC on Facebook and Twitter (@theGRDC).

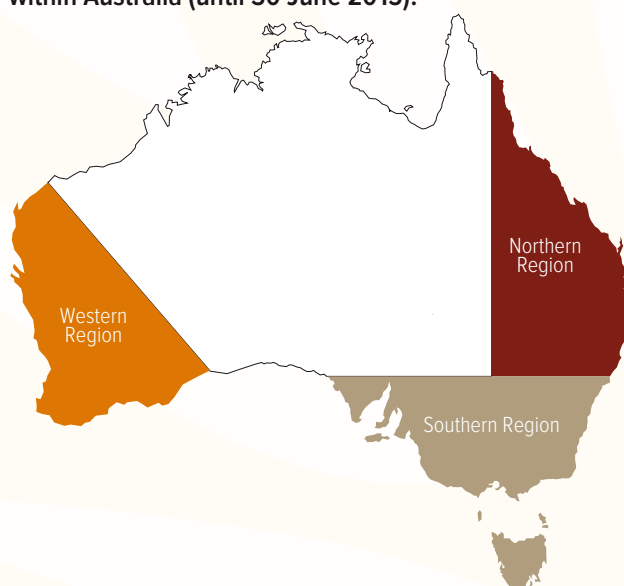
At the decision-making level, grain growers have the opportunity to represent their industry as members of RCSNs, GSGs or as appointed members of regional panels or the GRDC Board.

The GRDC has a rigorous investment planning process designed to ensure that the GRDC levy is managed so it can be the best investment a grower can make to improve their business. Additionally, the GRDC must ensure accountability for monies invested, which are essentially public funds.

Local networks

The GRDC engages extensively with the grains industry and uses a wide variety of information sources to guide its investment in RD&E. Grower groups or networks have been established in each of the three GRDC regions: northern, southern and western (Figure 1).

FIGURE 1 The GRDC organises its operations and functions based on three regions, reflecting the distinct grain-growing zones within Australia (until 30 June 2015).



These groups or networks play a critical role in supporting GRDC regional panels to help set priorities for RD&E (Figure 2). The groups or networks also have access to funds to address immediate local research priorities in the short term.

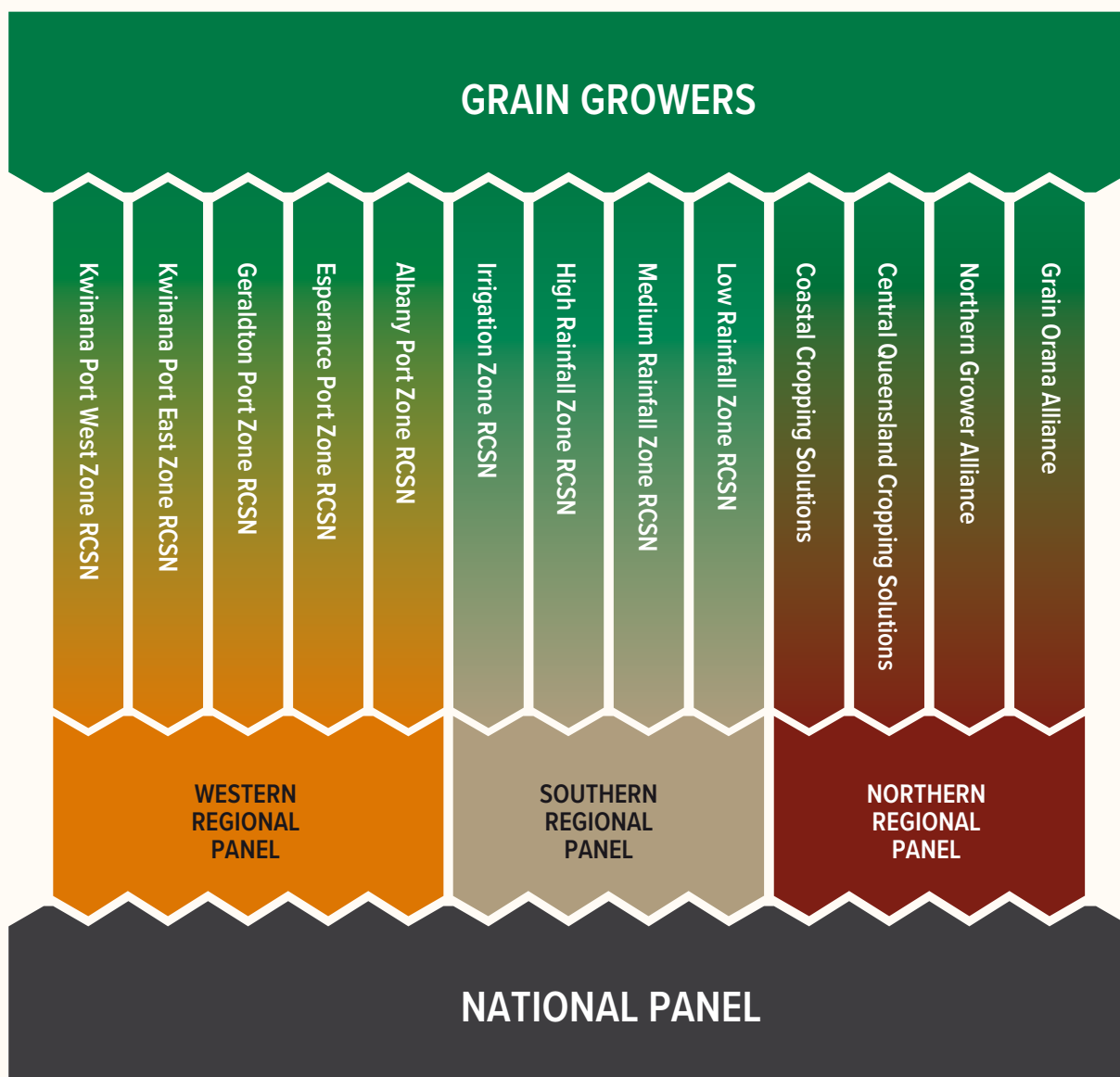
The format of each group or network differs between regions, based on historical RD&E management, industry structures and grower needs.

GRDC WESTERN AND SOUTHERN REGIONS

There are nine GRDC RCSNs across the western and southern grain-growing regions of Australia. Each network comprises up to 16 members representing growers, agronomists, agribusiness, researchers and representatives from the relevant GRDC regional panel, and is coordinated by an independent facilitator. The RCSNs were established in the western region in 2011 and the southern region in 2012.

The RCSN initiative was developed to provide a vital role in the GRDC's effort to understand and address priority issues in the western and southern regions. The initiative was also seen as a way for the GRDC to work with growers to help accelerate the on-farm adoption of new varieties, practices and technologies. Creating a forum to involve growers and their advisers in the GRDC investment process is also an important role of the RCSNs.

FIGURE 2 Grower involvement in the GRDC decision-making process for RD&E investments (until 30 June 2015).



The RCSN initiative grew out of feedback from major stakeholders of the GRDC indicating that:

- growers want more effective delivery of RD&E that drives growth in their productivity, profitability and sustainability;
- growers continue to face a broad spectrum of demands on their time and resources;
- the grains industry operates in the context of increasing consolidation of public sector resources, most critically in development and extension services;
- Australia's competitiveness in global grain markets will increase if the time between development, field testing and ultimate adoption is accelerated; and
- the GRDC's delivery of development and extension must continue to adapt to changing physical and operational environments to meet the priorities of stakeholders.

The development of the RCSN initiative was aligned closely with the vision of the Primary Industries Ministerial Council. This vision included a national restructuring of RD&E resources, which aimed to foster greater cooperation between the Commonwealth and the states, avoiding unnecessary duplication, and maximising benefits from the investment in RD&E.

The objectives of the RCSN initiative are to:

- create and manage knowledge;
- build regional development and extension capacity among growers and advisers;
- proactively respond to regional industry issues in a timely manner; and
- provide enduring links between growers, advisers and the GRDC.

The primary goal of the southern and western RCSNs is to provide feedback to GRDC staff and the GRDC regional panels on local issues affecting growers, which are specific to production zones, to assist the panels in prioritising issues for investment in RD&E. The RCSNs enable the GRDC to develop a detailed understanding of what is important to growers and determine where there are gaps in current RD&E, with a specific focus on issues affecting grower profitability. The local knowledge of the RCSNs helps build essential on-ground linkages between growers, farming systems groups, agribusiness representatives and researchers.

As well as influencing investment at a regional and national scale, the RCSNs were able to determine and initiate fast track projects, where significant local issues can be addressed in a short timeframe with a relatively small budget.

The RCSN initiative complements the National Grains Industry RD&E Strategy (2011). The strategy is focused on coordination and collaboration to improve the continuity of investment and improvement of the efficacy and efficiency of investment in RD&E. The RCSNs play a role in ensuring greater industry engagement in setting priorities for RD&E and ensuring that outputs from national research programs are adapted and delivered into the regions with local development and extension activities of greatest benefit to growers.

Regional panels

Recognising the variations in environment, conditions and issues across the nation, when the GRDC was established in 1990, it implemented three advisory panels based on the grain-growing regions of northern, southern and western Australia. The regional panels ensure that different 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 plant breeding, farming systems, soil, grain storage and handling, product development, market opportunities and technology marketing.

The regional panels are composed of grain growers, agribusiness representatives, researchers and the GRDC's executive managers. Each panel:

- identifies and monitors regional and national grains industry issues that are 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 and advisers in the region informed about the GRDC's strategic direction, investment portfolio and research projects; and
- assists staff in monitoring the effectiveness of the investment portfolio.

The GSGs and RCSNs provide information on priority issues to the GRDC's regional panels. The regional panels also consider information provided by less formal structures than the networks, such as direct communication with grower groups, government research and extension agencies, private research and extension organisations, and industry organisations.

The regional panels work with the GRDC National Panel to ensure that GRDC investments are directed towards the interests of all grain industry stakeholders and to deliver relevant products and services in each grain-growing region.

The GRDC National Panel is made up of the chairs of the three regional panels, the managing director of the GRDC and the GRDC's executive managers. The National Panel:

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

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

Research themes*

(up until 30 June 2015)

To ensure that RD&E funds are used efficiently, bring optimal benefit to the grains industry and achieve the greatest return to growers, the GRDC organises its RD&E across six strategic themes (Figure 3). These themes align directly with the key issues that confront growers in the planning and operation of their farm businesses.

Meeting market requirements is about uncovering market opportunities and developing the crops, varieties and production methods to meet them.

Improving crop yield is about higher potential yields, better tolerance of drought, more of the right grain for a given area and seasonal conditions.

Protecting your crop is about defending the crop's yield and quality against losses from pests, weeds and disease, and doing it sustainably and efficiently.

Advancing profitable farming systems generates the knowledge and tools for growers to plan strategically and respond tactically to markets, climate, seasons and risks.

Improving your farm resource base covers protecting, managing and enhancing the natural assets growers use.

Building skills and capacity is about better leadership, research capability and adoption of research outcomes.

FIGURE 3 The GRDC focuses its RD&E investment on six strategic themes (until 30 June 2015).



Investment pathways

(up until 30 June 2015)*

The investment of funds in grains RD&E involves a rigorous investment planning process to ensure the best possible investment of grower levies and government funds. The process involves formal and informal analysis of each issue, as well as analysis of trends, current activities (including internationally), opportunities and threats around priority issues, to help the GRDC make fully informed judgements about where to invest RD&E funds.

There are three main investment processes or 'pathways' used by the GRDC, which recognise that issues raised by growers will vary in many ways and one pathway alone may not suit all issues. Following the principle that 'one size does not fit all', the RCSNs and regional panels play a central role in determining which pathway will be most effective to address individual issues.

PATHWAY 1 – FAST TRACK INVESTMENT

In the GRDC southern and western regions, the 'fast track' investment pathway provides a means for in-season, small-scale projects to be carried out at a local level, where the speed of response is critical to meeting industry needs. Fast track projects are delivered in a short timeframe (usually less than 12 months) and best suited to issues that would benefit from immediate investigation, development and/or extension, such as addressing the impact or management of a crop disease.

The budgets for fast track projects are generally small and require only minimal administration.

Opportunities for developing fast track projects are identified and developed by RCSNs.

The fast track project concept was successful in delivering results in a timely, highly accessible and cost-effective manner. The transparent nature and collective approach to approval ensured it was also a credible way of instigating some types of RD&E. The fast track process had provided a pathway of investment that enabled particular issues to be addressed effectively with significant return for a relatively small investment, however this process was not appropriate for all issues.

*The GRDC undertook a restructure of the organisation which included the rearrangement of RD&E areas.

PATHWAY 2 – STANDARD INVESTMENT

The standard investment pathway is the main method by which most RD&E investments were made to address priority issues. A decision to award funding was made after identifying and assessing issues nationwide and, after consideration of all issues, deciding which best serve the ongoing profitability and sustainability of the grains industry. Details of the steps of the standard investment pathway are presented in Table 1.

The RCSNs participated in the standard investment pathway by submitting a list and description of their priority issues and ideas for RD&E to tackle these issues to the GRDC regional panels in March and August of each year, as part of the GRDC's previous annual investment planning cycle.

PATHWAY 3 – INTENSIVE INVESTMENT

An intensive process of assessment could also be undertaken to determine the nature of investment required to address an issue. This process entails a thorough investment analysis, which may span more than one investment cycle. While not required for every issue, the intensive process is best suited to those issues where complex RD&E investments are needed to address an issue, or a range of related issues. It was generally used for longer-term investments, where people outside the GRDC may have the insight, tools and/or capabilities to add to the rigour of the investment analysis, or where the final project is complex, or the planned response is more important than the speed of the response.

TABLE 1 The steps of the decision process for the standard investment pathway.

What	How	When
1. Identify priorities	Investment priorities are identified through: interaction with growers, advisers and other industry participants; through Regional Grower Networks and grower events; in consultation with regional panels, Grain Producers Australia (GPA), researchers, farming organisations and national agribusiness reference group; and in consideration of the Australian Government's national Research Priorities and Rural R&D Priorities.	Throughout the year
2. Plan investments	GRDC managers and regional panel members discuss issues and projects that address identified RD&E gaps and align with investment strategies. Indicative budgets across the six GRDC themes are established and new projects to address gaps in investment strategies are proposed. The proposals are ranked by regional panels with input from GRDC managers. The GRDC National Panel recommends a high-level budget for investment proposals grouped by theme, which form the basis of the GRDC investment plan. Recommendations for funds allocation are provided to the GRDC Board, GPA and state farming organisations for comment.	July–August
3. Call for tenders	Project proposals that are suitable for competitive tender are published. Tenders are evaluated against specific selection criteria to determine the preferred research partner(s). In any one year, about half of the new investments are directly negotiated with a research provider, where there is limited expertise in a research area and/or a need for ongoing access to co-owned intellectual property.	August–September
4. Award contracts	Contracts are awarded for projects for the next financial year.	September onwards
5. Review process	Progress on development of new investments is reviewed and strategic gaps are addressed.	February–March
6. Assess progress	Project progress is reported on an annual basis in March, and progress payments are made after assessment of the report. Final reports are submitted in September following completion of the project. Project findings are communicated to grain growers and other industry members.	March for annual reports September for final reports

PHOTO:GRDC



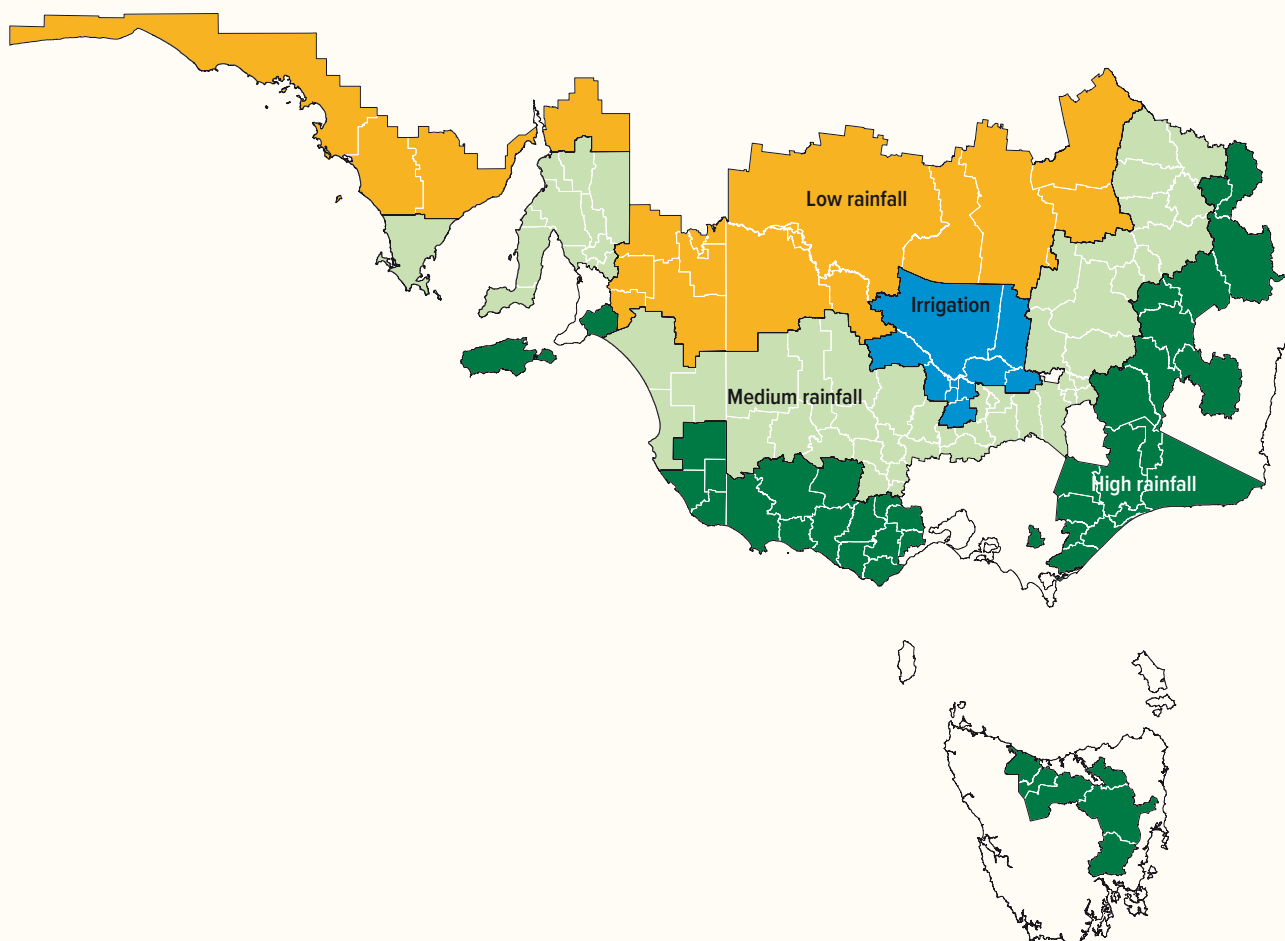
Yarrawonga grower Adam Inchbold (left) with researcher Nick Poole during a Riverine Plains Inc. spring crop walk.

3. Grower-driven decision-making

Four Regional Cropping Solutions Network (RCSN) groups were established in the southern grain-growing region of Australia in 2012, to help guide the GRDC investment planning process by providing an on-ground and local perspective of grower issues. The members of the RCSNs have contributed to the RD&E investment planning process by working together to:

- identify and track regional issues facing growers in the southern grain-growing region of Australia – issues identification can be through the networks, feedback, observation or experience;
- provide on-the-ground insights into priority issues requiring industry research and development attention;
- gather intelligence on regional grain production constraints and opportunities;
- provide support and advice to the GRDC's Southern Panel on regional issues; and
- drive, with the GRDC Southern Panel, the fast track projects that are aimed at improving grain growers' productivity, profitability and sustainability.

FIGURE 4 The zones of the four RCSN groups of the GRDC southern region.



Production-based zones

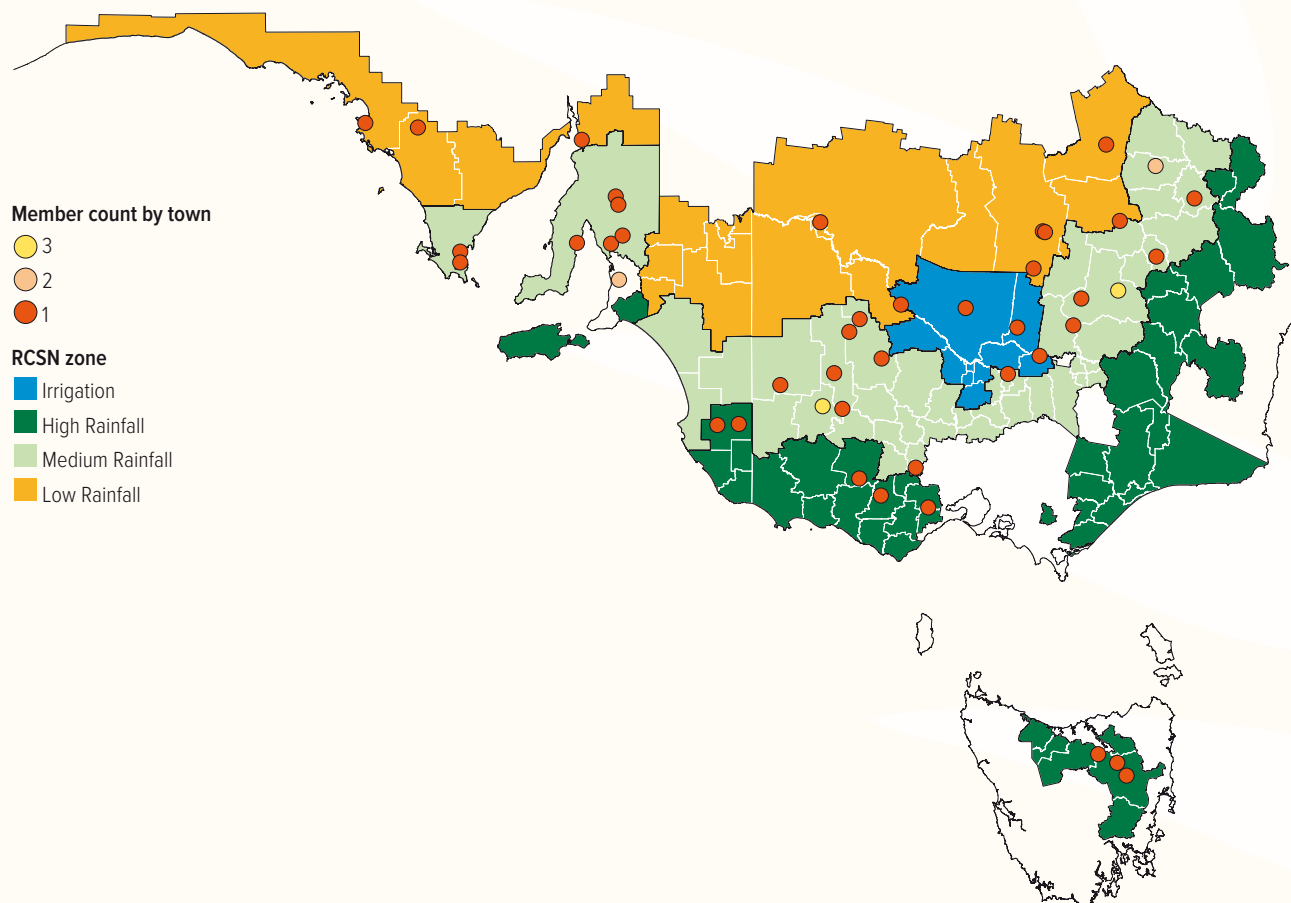
The RCSN groups were formed to bring together growers, advisers and researchers working in similar production environments. Rainfall has been used as the distinction between production environments for each of the RCSN groups. The network represents the low, medium and high rainfall zones of south-eastern Australia. A specific network that represented irrigated cropping had previously operated in the southern region. The areas previously covered by each network are shown in Figure 4.

Local representatives

The members of the four southern RCSN groups are growers, advisers and researchers. The distribution of network members across south-eastern Australia is shown in Figure 5 and the membership of each network is listed in Tables 2 to 5.

The members of each RCSN group are selected to contribute the range of skills and regional knowledge required for the successful operation of the network and to provide geographic coverage of the zone. The networks, along with the GRDC Southern Panel, form a critical part of the GRDC's industry engagement on the planning and management of investments in grains RD&E.

FIGURE 5 The distribution of RCSN members across the GRDC southern region.



Low Rainfall Zone RCSN

The Low Rainfall Zone RCSN has 12 members comprising five growers, five researchers and two advisers. All members have strong farming, advisory and/or research backgrounds; extensive networks in their district or profession; and are located throughout the zone, from Streaky Bay on the west coast of South Australia to Condobolin in the central west of New South Wales. The network is facilitated by Dr Nigel Wilhelm and Naomi Scholz.

The membership of the Low Rainfall Zone RCSN at end of June 2015 is shown in Table 2. There has been some turnover of membership since the inception of the RCSNs, reflecting the need of individual members to balance their workloads or as a result of changes to the GRDC Southern Panel. Replacement members for the network are appointed as required. One of the original appointments to the low rainfall network, Scott Vaessen, a grower from Griffith, NSW, retired during 2014-15 due to business commitments. A RCSN recruitment process to fill the mid-term vacancy resulted in Roger Bolte, a grower from West Wyalong, NSW, being appointed to the RCSN.

The Low Rainfall Zone RCSN met face-to-face three times during 2014-15 to identify and discuss issues affecting grain growers. The high level issues for the low rainfall zone included the need for profitable and low-risk break crop options for cereals, and management strategies to maintain sound weed and pest control with less reliance on herbicides and pesticides. The network also identified the need for resources to assist growers to proactively manage emerging weed and herbicide-resistance problems and to improve productivity on impoverished sandy soils.

Specific issues raised as a priority for the Low Rainfall Zone RCSN included:

- **weed management** – developing systems that are less reliant on chemical inputs for maintaining fertility and controlling weeds, pests and diseases;
- **succession planning** – training and mentoring of the next generation of RD&E specialists;
- **improved integration** of livestock and cropping enterprises;
- **climate change** – understanding the impact on low rainfall agriculture;
- **proactive weed science** – to better manage weeds in cropping systems before they become a problem; and
- **improved crop production** – better systems and management for cropping on impoverished sandy soils.

TABLE 2 Members of the Low Rainfall Zone Regional Cropping Solutions Network (at 30 June 2015).

Member	Occupation	Location
Russell Amery	Grower	Wycheproof, Victoria
Andy Bates	Adviser (consultant)	Streaky Bay, SA
Roger Bolte	Grower	West Wyalong, NSW
Danny Conlan	Adviser (consultant)	Sea Lake, Victoria
Neil Fettell*	Researcher (University of New England)	Condobolin, NSW
Barry Haskins	Adviser (consultant)	Griffith, NSW
Bruce Heddle	Grower	Minnipa, SA
Chris Kelly	Grower	Woomelang, Victoria
Rick Llewellyn	Researcher (CSIRO)	Adelaide, SA
John Minogue*	Adviser (consultant)	Barmedman, NSW
Michael Moodie	Adviser (consultant)	Mildura, Victoria
Barry Mudge	Grower	Port Germein, SA

* GRDC Southern Panel member 2013–15

Constraints to crop production on sandy soils

Underperforming crops on sandy soils was an issue identified by the Low Rainfall Zone RCSN, highlighting growers' desire to improve grain production. In response, a review of potential constraints and possible solutions to crop production in the low rainfall zone was commissioned and undertaken by CSIRO. Key findings of the review are summarised as follows.

Coarse-textured (sandy) soils, which by definition have a very low clay content, represent approximately 30 per cent of cropping soils in south-eastern Australia. These low-fertility soils typically occur in low rainfall areas. Opportunities to increase crop production on these soils are probably substantial because crop yields appear to be well below the water-limited potential.

The primary solutions to address the issue are likely to come about from a better understanding of soil-water extraction by crop roots and the effect of water movement on nutrients within the crop root zone. Crop nutrition and crop rotations will also play a key role in improving crop root growth, thereby increasing total crop water and nutrient use. Soil compaction, either natural or traffic-induced may be a significant limitation to crop production, and the extent and causes need to be ascertained. If these opportunities can be realised then soil organic matter may be raised on sandy soils, providing significant whole-of-system benefits.

The critical challenges on coarse-textured soils in low-rainfall environment of south-eastern Australia are to ensure that:

- crops have deep rooting capacity and deep rooting opportunity;
- nutrients are accessible within the crop rooting zone;
- crop rotations include more frequent broadleaf species;
- movement of water and nutrients down the soil profile is understood to the extent that it can be predicted;
- the extent of non-wetting and high soil resistance to root growth is better defined;
- the specific causes of high soil resistance to root growth are identified; and
- soil organic matter is increased, thereby improving chemical, biological and physical fertility.

Further opportunities, including the application of novel soil amelioration practices, involving additions and incorporation of clay and organic matter, have been trialled and offer the possibility of a more elevated crop yield plateau. Considerable research would be required to provide predictive capacity with respect to the efficacy of these practices and thus the returns on the substantial investment required to deploy these practices on-farm.

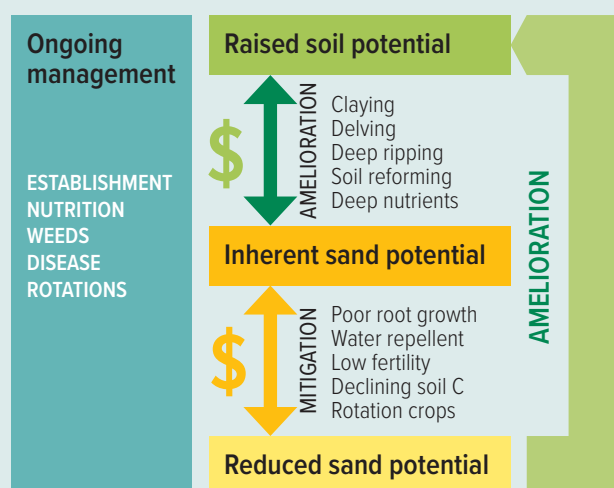
In the meantime the challenges listed above can be progressed

with a combination of basic, strategic and applied research, and adaptation and extension of existing technology from elsewhere in Australia.

For each of the challenges, it is important that research questions are carefully framed, and relevant material thoroughly examined, prior to any experimental work being planned. Much can be learnt and adapted from Western Australian research into water-repellency on sands and extended to low-rainfall south-eastern Australia. Many of the other questions can be answered with specifically targeted research, rather than large-scale programs incorporating many treatments and few measurements.



The Low Rainfall Zone RCSN commissioned a review of production constraints and potential solutions on soils where crop growth is poor, such as this sandy soil in the South Australian mallee.



Opportunities for mitigating current constraints and bringing crop yields closer to water limited yield potentials on sandy soils, and for soil reformation through more radical amelioration strategies.

SOURCE: MJ UNKOVICTORIAH

GRDC Project Code: MSF00004

More information: Rick Llewellyn, CSIRO, 0429 690 861, rick.llewellyn@csiro.au

Full story:

<http://www.msfp.org.au/a-review-of-the-potential-constraints-to-crop-production-on-sandy-soils-in-low-rainfall-sa>

Medium Rainfall Zone RCSN

The Medium Rainfall Zone RCSN comprises seven growers, two researchers and three advisers, located in an area from Port Lincoln on the Eyre Peninsula of South Australia to Wagga Wagga in southern New South Wales.

The Medium Rainfall Zone RCSN was facilitated by Felicity Pritchard until June 2014. Since July 2014, the RCSN has been co-facilitated by Tony Craddock and Jen Lillecrapp.

The membership of the Medium Rainfall Zone RCSN at June 2015 is shown in Table 3. Inaugural members Adam Inchbold and Colin McMaster retired during 2014-15. An audit of skills, knowledge and stakeholder networks was undertaken to guide a mid-term RCSN recruitment process to fill the vacancies, and Rohan Brill and Andrew Russell were appointed. Rohan Brill is a research and development agronomist with the NSW Department of Primary Industries based in Wagga Wagga. Andrew Russell is a grower from the Browns Plains district of Victoria, and is a committee member of Riverine Plains Inc. grower group.

Over three formal meetings, the Medium Rainfall Zone RCSN prioritised, described and developed investment proposals for seven issues that were subsequently submitted for consideration at the GRDC's major investment planning week.

The high level issues for the Medium Rainfall Zone RCSN were:

- **capacity building** – mentoring the development and retention of skilled advisers;
- **emerging challenges for managing weeds** – advancing and extending knowledge of the behaviour of major weed species to improve the adoption of effective and integrated weed management;
- **soil moisture management** – improving tools and the use of soil moisture information over the whole production system for better decision-making;
- **yellow leaf spot** – understanding of the economic impact and the management of yellow leaf spot;
- **growing and manuring legumes** – developing more sustainable and diverse farming systems that include the growing and manuring of legume species;
- **pesticide longevity** – reducing reliance on and use of pesticides to increase product longevity by creating greater awareness of pesticide resistance and developing innovative non-chemical strategies; and
- **robotic technologies** – identifying, understanding and adapting robotic technology (including drones) for the grains industry.

TABLE 3 Members of the Medium Rainfall Zone Regional Cropping Solutions Network (at 30 June 2015).

Member	Occupation	Location
Matt Dare	Grower	Clare, SA
Mick Faulkner	Adviser (consultant)	Watervale, SA
Roy Hamilton	Grower	Rand, NSW
Mark Harris	Adviser (consultant)	Wagga Wagga, NSW
Julia Hausler	Grower	Warracknabeal, Victoria
Jeff Hoffmann	Grower	Lockhart, NSW
Grant Hollaway	Researcher (Victorian DEPI*)	Horsham, Victoria
Glenn McDonald	Researcher (University of Adelaide)	Glen Osmond, SA
Mark Modra	Grower	Port Lincoln, SA
Peter Taylor	Grower	Lubeck, Victoria
Adam Inchbold (Feb 2012–Jul 2014)	Grower	Yarrawonga, Victoria

*Department of Environment and Primary Industries



Improving effectiveness of snail baiting

The Medium Rainfall Zone RCSN instigated a snail bait distribution trial on Yorke Peninsula in 2013 to test several types of spreaders and baits.

Snails cause significant problems by damaging young and emerging crops and contaminating grain at harvest. Snail baiting by spreading molluscicides over the planted area is a common way to control snails, along with cultural methods such as cabling, rolling or burning.

While general snail-control information exists and can be found in the GRDC's Snail Management Fact Sheet (www.grdc.com.au/GRDC-FS-SnailManagement), growers were finding that control measures were not as effective as they expected. The most common method of spreading snail baits on the Yorke Peninsula was using a fertiliser spreader. Ute spreaders were also used, particularly along fence lines, but were not as effective.

In response, the Medium Rainfall Zone RCSN instigated a fast track project in 2013 to investigate the effectiveness of a range of spreaders to distribute several types of snail bait. The project involved a series of trials on the Yorke Peninsula of South Australia, and was conducted by the Yorke Peninsula Alkaline Soils Group and the South Australian Research and Development Institute (SARDI).

The aim of the trial was to find the best settings for each spreader, not to find a best spreader–bait combination.

The trial demonstrated that commonly used equipment for applying snail bait did not provide the bait coverage that growers expected, and spreader settings had to be adjusted to ensure a more uniform distribution of bait to achieve effective control.

The trial, conducted in August 2013 at Urania, tested four types of spreaders with four different brands of snail bait: Amazone, Bogballe, Kuhn and Vicon spreaders, with Meta®, Metarex®, Slugger® and Slugout® baits. The trial involved running each

spreader–bait combination three times, perpendicular to a row of 50 trays placed at one-metre intervals across the potential width of the spread bait. The number and mass of baits per tray was recorded and analysed.

Each spreader x bait combination was tested with a number of different spreader settings, with the best settings compared with other combinations. Results of this trial showed that each spreader was capable of distributing bait in a way that snails would receive a lethal dose but the spreader must be used at the correct settings.

The key findings of the trial were:

- the size and density of a bait pellet determined the distance it was spread;
- spreaders are designed for use with fertiliser therefore snail and slug bait was not spread as widely as growers may expect;
- fragmentation of baits can occur, reducing the number of effective baits;
- growers must calibrate their spreaders especially for snail bait to achieve optimal bait coverage; and
- ute-mounted spreaders provided an uneven distribution of snail and slug bait.

A fact sheet presenting details of trial results can be found on the GRDC website (see below).

GRDC Project Code: YPA00002

More information: Greg Baker, SARDI, 08 8303 9544, greg.baker@sa.gov.au

Full story: www.grdc.com.au/Resources/Factsheets/2015/01/Snail-Bait-Application

High Rainfall Zone RCSN

The High Rainfall Zone RCSN has 14 members, comprising seven growers, four researchers and three advisers, who are located in an area from Lucindale in south-east South Australia, to Cootamundra in southern New South Wales and Carrick in northern Tasmania. The High Rainfall Zone RCSN is co-facilitated by Trent Potter and Jen Lillecrapp.

The membership of the High Rainfall Zone RCSN at June 2015 is shown in Table 4. Neil Vallance was the only member who did not seek a second term on the RCSN. An audit of skills, knowledge and networks of industry stakeholders was undertaken to guide the targeted recruitment of members to fill the vacancy. Tony Geddes, a grower from the Holbrook district and chairman of the Holbrook Landcare Network, was appointed to the RCSN in late 2014.

Over three formal meetings, the High Rainfall Zone RCSN prioritised, described and developed investment proposals for 12 issues that were subsequently submitted for consideration at the GRDC's major investment planning week. The high level issues for the High Rainfall Zone RCSN were:

- **integrated weed management** – identifying cultural control options to manage a range of weeds with resistance to multiple herbicide groups;
- **emerging invertebrate pests** – improving understanding to manage a range of emerging pests, including millipedes, slaters and earwigs, in retained heavy stubble loads;
- **small pointed conical snails** – addressing specific knowledge gaps to develop effective strategies to manage the small conical snail to avoid grain contamination;
- **increasing canola yields** – developing specific agronomy packages for winter and spring canola types to increase yields;
- **new and emerging diseases of canola** – understanding

the impact and management strategies for a range of foliar diseases in high potential canola crops, including white leaf spot, blackleg pod infections, sclerotinia, powdery mildew and alternaria;

- **viable legume options** – evaluating and developing regional guidelines for the management of suitably adapted crop and pasture legumes for acid and alkaline soils;
- **plant growth regulators** – compiling specific data on key interactions and to fill the gaps in registrations;
- **optimum sowing time and agronomy** – developing agronomy packages to increase crop yields in the high rainfall zone;
- **nitrogen budgeting and management** – developing and validating technologies and tools to improve information that will support decision-making;
- **subsoil constraints** – understanding how acidity, sodicity, nutrients and structure limit yield; and evaluate amelioration and management practices;
- **international knowledge** – facilitating the transfer of knowledge of agronomic research and systems from overseas that can be adapted to local high rainfall environments and farming systems; and
- **capacity building** – improving the skills and specific expertise to support the development of improved farming practices.

A range of additional issues were also explored by the High Rainfall Zone RCSN during the meetings that were convened in 2014-15 and these included:

- a physiological perspective of crop growth, yield, water use efficiency and nutrient use efficiency;
- recommendations for developing the high rainfall National RD&E Strategy; and

TABLE 4 Members of the High Rainfall Zone Regional Cropping Solutions Network (at 30 June 2015).

Member	Occupation	Location
John Bennett	Grower	Lawloit, Victoria
Phil Bowden	Adviser (Murrumbidgee Landcare, formerly NSW DPI)	Cootamundra, NSW
Mark Branson	Grower	Stockport, SA
Michael Chilvers	Grower	Nile, Tasmania
Philip Hawker	Adviser (agribusiness)	Derrinalum, Victoria
Terry Horan	Adviser (agribusiness)	Carrick, Tasmania
Jon Midwood	Researcher (farming systems group)	Inverleigh, Victoria
Rob Norton	Researcher (International Plant Nutrition Institute)	Horsham, Victoria
Lawrence Richmond	Grower	Ballarat, Victoria
Lachlan Seears	Grower	Lucindale, SA
Neil Vallance (February 2012 - July 2014)	Grower	Lake Bolac, Victoria
Tony Geddes (appointed November 2014)	Grower	Holbrook, NSW
Chris Blanchard*	Researcher (Charles Sturt University)	Wagga Wagga, NSW
Mark Stanley*	Adviser (consultant)	Port Lincoln, SA
Susan Findlay Tickner	Grower*	Horsham, Victoria

* GRDC Southern Panel member 2013-15

- septoria in wheat – reporting the distribution, potential yield loss and emerging issues for management and control (including the potential for the development of fungicide insensitivity) and RD&E needs. This information

was submitted to the GRDC to guide the development of a proposal that would enable resources to be allocated to address the identified issues and needs.

PHOTO: MICHAEL NASH



Sunflowers planted in October 2014 as part of the High Rainfall Zone Regional Cropping Solutions Network (RCSN) fast track project. On the left side of the image is slug bait applied at sowing and on the right is slug bait applied five days after sowing, which resulted in reduced plant numbers.

when they sowed a sunflower crop. Mr Pilkington says he was pleased with early results.

“We used a precision planter to sow the sunflowers, which had boxes on the back for the application of granular insecticide, which are used in corn crops,” he said.

Using precision agriculture for targeted control of slugs

By Alistair Lawson, Ag Communicators

Slugs are an all-too-familiar problem for growers in the high rainfall zone of south-eastern Australia – something that has been recognised by the GRDC and the High Rainfall Zone RCSN.

While burning and cultivating stubble might be effective cultural control methods for the slimy pest, the advent of stubble retention, no-till and zero-till cropping means that growers must rely heavily on baits to control slugs.

With that in mind, Compass Agribusiness Management – with the help of South Australian Research and Development Institute (SARDI) senior researcher entomology Michael Nash and the Victorian No-Till Farmers Association (VNTFA) – were engaged by the GRDC to undertake a fast track project for the High Rainfall Zone RCSN, that investigated if precision agriculture tools could improve the efficacy of baits to control slugs.

The project began in May 2014 with canola sown using a disc seeder on 380-millimetre row spacing with two-centimetre accuracy. A day later, the same disc seeder and configurations were used to place different treatments of slug bait on top of the crop rows.

Compass Agribusiness consultant Tim Pilkington says they found it hard to get accurate bait placement in their first attempt.

“We found even with RTK 2cm auto steer and using the same machine for both sowing and baiting the slight inaccuracies of each pass meant that we weren’t able to achieve the exact placement we were hoping for,” he said.

“We also had issues with preventing the airflow in the seeder blowing the lighter baits off target and stubble impeding the bait placement making it harder for slugs to find the baits.”

But all was not lost and after a period of refining their planning and engineering, the team had another go in late September

“We used that to apply the slug bait directly above the crop row at seeding.

“We were able to guarantee accuracy of bait placement because it was applied in the same pass at seeding. We achieved good accuracy for bait placement, with it all in a 10cm band above the crop row.”

Mr Pilkington believes the application at sowing made a huge difference to bait placement accuracy and the residue managers on the precision planter helped with putting baits onto clear ground for the slugs to find.

“The residue managers were clearing a path about 15cm wide, which means all the baits sat up on top of the row and weren’t obstructed by straw, so I was very happy with that application,” he said.

The key message to come out of the 2014 research was despite the product used or how it was applied, timing and rate were critical. Bait must be applied at sowing to protect germinating seed. The trial continued in 2015 on another canola crop.

Additional funding from the GRDC enabled Southern Farming Systems to conduct a small, targeted project in conjunction with the VNTFA to explore and trial the practicalities of using unmanned aerial vehicle (UAV) technology to monitor canola establishment and slug damage at the critical early stages of crop development.

This technique could potentially provide a more cost-effective means of crop monitoring to identify areas of crop damage across a paddock, which would enable more targeted and cost-effective baiting and pest management more generally.

GRDC Research Codes: SAM00001, SFS00030

More information: Michael Nash, SARDI, 08 8303 9537, michael.nash@sa.gov.au

Full story: www.grdc.com.au/Media-Centre/Media-News/South/2015/05/Merging-precision-ag-and-slug-control

Irrigation Zone RCSN

The Irrigation Zone RCSN has 11 members, comprising five growers, two researchers and four advisers. The members represent the irrigation cropping areas of south-east South Australia, northern Victoria, southern New South Wales and Tasmania. The network is facilitated by Rob Fisher and Bree Laughlin.

The membership of the Irrigation Zone RCSN at June 2015 is shown in Table 5. Throughout the 2014-15 year the membership remained the same, with all members continuing in their roles. The most recent addition to the RCSN, just prior to this reporting year, was Peter Johnson, who took on the position following the appointment of Geoff McLeod to the GRDC Southern Panel.

The Irrigation Zone RCSN met face-to-face three times during 2014-15, as well as engaged in teleconferences and email discussions to further examine issues raised. The RCSN also toured the irrigation areas of the south-east SA in February 2015 to further understand the challenges faced under different environmental conditions.

In 2014-15, the network remained up to date with projects underway as a result of its initial 'issues identification' process and investigated further issues, which it believed growers in the irrigation zone would want addressed as a matter of priority. The following high level priority issues were identified.

- **Plant growth regulators** – the effectiveness of plant growth regulators needs to be examined in an irrigated environment, as well as contributing to joint assessment of the issue across all RCSNs.
- **Irrigated durum production** – durum is a high value crop with potential to be integrated in irrigated cropping systems. However, marketing (including delivery, bulk handling and storage), susceptibility to the disease (especially crown rot) and limited knowledge of agronomic management (especially nitrogen management) to ensure durum quality is achieved have limited adoption of the crop.
- **\$ per ML return on water** – increasing the capacity for irrigated grain growers to make informed decisions in terms of irrigation water use to maximise whole-farm profitability. The importance of this issue increased as the water price increased throughout 2014-15.
- **Best management practice for irrigated barley** – the shorter growing season with dry conditions in 2014 prompted renewed interest in barley, and the need to identify best management practices for barley under irrigation.
- **Irrigated faba bean production** – high prices for faba beans in 2014 triggered renewed interest to evaluate genetic material under irrigation, and to identify agronomic practices to improve the consistency of the crop in terms of profitability and contribution to following crops.
- **Managing glyphosate resistance** – a best management practice guide specifically for the irrigation zone is needed, which fits within the overall strategy of the GRDC's response to glyphosate resistance.
- **Improved irrigation layouts** – examining the effectiveness of new and improved layouts for irrigation farms; and in particular understanding the interaction between crop types and different layouts. This issue developed at a rapid rate during 2014, fuelled by the growth of the cotton industry in southern NSW.

TABLE 5 Members of the Irrigation Zone Regional Cropping Solutions Network (at 30 June 2015).

Member	Occupation	Location
David Brown	Adviser (consultant)	Naracoorte, SA
Luke Gaynor	Researcher (NSW Department of Primary Industries)	Wagga Wagga, NSW
Anthony Hamilton	Grower	Forbes, NSW
Adrian Hayes	Adviser (agribusiness)	Coleambally, NSW
Michael Hughes	Grower	Morago, NSW
Damien Jones	Researcher (Irrigated Cropping Council)	Kerang, Victoria
Kieran O'Keeffe	Adviser (Cotton Info)	Griffith, NSW
Peter Johnson	Agribusiness (Auswest Seeds)	Forbes, NSW
Craig Reynolds	Grower	Congupna, Victoria
Geoff McLeod*	Grower	Finley, NSW
Keith Pengilly*	Grower	Conara, Tasmania

* GRDC Southern Panel member 2013-15

Irrigated faba beans – a profitable crop for irrigators

Grain growers in the irrigation zones of southern Australia have the opportunity to grow two crops over a 12-month period. However, the success of this approach depends on the right selection of crops and varieties, and carefully managed establishment, input and irrigation practices.

Faba beans were identified by growers as a crop with high potential for irrigated double-cropping systems. A realistic and achievable yield for irrigated faba beans in the Riverina is five tonnes per hectare, which means they should be a very profitable crop to grow. While some in the industry consider faba beans a more risky and less profitable option than wheat, their input costs are considerably less because the crop produces its own nitrogen. Faba beans also benefit the entire crop rotation by providing a disease break and net gain of residual nitrogen. While pulses make up only four per cent of crop production in irrigated areas, growers believe faba beans could be a way to make their farming systems more profitable and sustainable.

The Irrigation Zone RCSN instigated a fast track project that funded a scoping study of the faba bean industry in 2013-14, which was carried out by the NSW Department of Primary Industries (DPI). A literature review of previous published and unpublished literature was conducted and 34 growers, agronomists, marketers and a faba bean breeder were surveyed. NSW DPI also worked closely with Pulse Australia to review market opportunities. The information gathered led to a set of recommendations for future RD&E for growing irrigated faba beans.

The key findings of the study were as follows.

- Price is the major driver for growers to produce irrigated faba beans.
- Market potential was identified to be 58,000 tonnes of production in the Murrumbidgee and Murray valleys.
- Water allocation was the major limitation to crop production, with growers choosing crops based on returns per megalitre rather than profitability. Faba beans were competing against wheat (or canola) as a winter crop.
- Two marketers in the region have developed stable long-term markets supplying faba beans to the processing trade and aquaculture. Their major difficulties were a volatile market environment and developing acceptable contracts with growers before sowing instead of at harvest.
- Growers and regional buyers have the potential to develop long-term relationships to encourage increased and consistent production.

- Agronomy practices have improved compared with 10 to 20 years ago, and a management package could be updated quickly with current available experience.
- On-farm research priorities have not changed markedly over the past 10 to 20 years.
- Most growers rely on commercial agronomists for advice and co-learning with other growers. Support to drive production increase is needed, and a dedicated independent agronomist is required to coordinate on-farm research, development and extension (RD&E).

The recommendations from the study were provided to the Irrigation Zone RCSN for consideration of future priorities and research.

The four major RD&E issues that were prioritised by industry were:

- 1 Plant breeding to focus on yield, disease resistance and standing ability under irrigated situations.
- 2 Agronomy research to focus on better management practices and dealing with soil constraints under various irrigation systems (furrow, border check, spray).
- 3 A team of agency and industry members to drive R&D and support production increases, which should include dedicated agronomists to coordinate activities, information development and research.
- 4 Updated biannual publications focusing on agronomy and marketing, potentially distributed by Pulse Australia, state agencies and grower groups, such as the Irrigation Research and Extension Committee.

The results of the study were also presented to pulse growers and grower groups in the southern irrigation areas and a variety of private discussions were held with key faba bean growers. The final report will be distributed to faba bean marketers and other interested growers.



PHOTO: ALISTAIR LAWSON

Irrigated faba bean crop.

Go to NSW DPI website for more information on irrigated faba beans:

http://www.dpi.nsw.gov.au/_data/assets/pdf_file/0004/157729/faba-bean-pt1.pdf

GRDC Project Code: DAN00183

More information: Luke Gaynor, NSW DPI, 0428 260 156, luke.gaynor@dpi.nsw.gov.au

Full story: <http://finalreports.grdc.com.au/DAN00183>

RCSN facilitators

The GRDC appointed regional facilitators during 2011-12 to facilitate the four RCSNs in the southern region.

Each facilitator (or facilitator team) ensures the effective operation of their network and that maximum benefit is gained from the input of the network's members. The role of the RCSN facilitator is to:

- facilitate interactive meetings with the RCSN to enable priority issues to be identified and explored, to identify practice changes required to address these issues, determine what is preventing such practice change currently (for example lack of motivation, knowledge or technologies) and then what activities need to be undertaken to achieve the desired practice change;
- work with farming systems groups and local advisers to contribute to and support the identification and prioritisation of local production issues;
- establish, link, support and develop a regional development and extension network of regional farming systems groups, local agribusiness and research and development organisations;
- identify and facilitate fast track projects that focus on local issues, where progress can be made with a short-term, targeted and relatively small investment;
- provide an effective interface between the RCSN and the GRDC; and
- provide feedback to the GRDC and its regional panels on emerging issues and current attitudes and activities within the region that are relevant to local production issues and the needs of the networks.

The facilitators of the RCSNs in the GRDC southern region for 2014-15 were:

- Dr Nigel Wilhelm and Naomi Scholz – Low Rainfall Zone;
- Felicity Pritchard – Medium Rainfall Zone;
- Jen Lillecrapp and Tony Craddock – Medium Rainfall Zone;
- Jen Lillecrapp and Trent Potter – High Rainfall Zone; and
- Rob Fisher and Bree Laughlin – Irrigation Zone.

RCSN operations

NETWORK MEETINGS

Each of the RCSNs meet in person three times a year, with one of the meetings convened over two days. At least one teleconference is held between the face-to-face meetings. The meetings are scheduled according to the GRDC investment planning process, enabling the RCSNs to provide timely and relevant information to the GRDC as it considers RD&E investments for the coming year.

A face-to-face meeting is held in February of each year to finalise the list of priority issues for the region as identified by RCSN members, and to write up the issues to provide information to the Southern Panel for its investment planning meeting in March of that year. The write-ups of issues are the initial contribution of the RCSNs to the investment planning cycle.

In July each year, there is a combined meeting for all RCSN members from the four production zones. The purpose of the July meeting is to share information on priorities across production zones and identify potential solutions that could be applied across the southern region.

Preliminary feedback from the GRDC about the priority issues determined by the RCSNs in February is also provided at the July meeting. The feedback included information about potential new investments and other responses, including the potential to modify existing investments to address identified issues.

At the July meeting, individual RCSNs also took the opportunity to identify new and emerging issues impacting growers and commenced work to develop ideas to tackle these priority issues for the next investment cycle. In July 2014 issues were identified and discussed to start the process of priority identification for the 2015-16 investment cycle. The starting point of this part of the meeting considered those issues from the previous year that were not addressed by the GRDC. Commonly, this was due to an incomplete understanding of the issue and while the importance of the issue may have been conveyed, the actions required to address the issue have not been adequately developed or effectively communicated. These issues were further considered by the RCSNs to better understand and identify the investment that is required to address the issue.

FIGURE 6 RCSN facilitators.



(From left) Nigel Wilhelm, Naomi Scholz, Jen Lillecrapp, Tony Craddock, Trent Potter, Rob Fisher and Bree Laughlin.

NETWORK APPOINTMENTS

The combined meetings of the RCSNs in July 2014 marked the end of the first term for RCSN members appointed in 2012, or since 2012 due to vacancies arising in the network. To maintain continuity and build on the experience that has been established over the start-up phase of the RCSN initiative, each member of the RCSNs was offered the opportunity to continue their participation in the RCSNs.

Opportunities for new members to join the RCSNs will arise when the second term of the RCSNs expires. At that time,

as with the GRDC regional panels, at least one-third of the membership of each network will be filled by new members. The vacancies on the networks will be extensively advertised and promoted, and applications will be sought from all areas of the grains industry. Appointments will be made on the basis of knowledge and skills (first order consideration) and geographic representation (second order consideration). Appointments will be made by the Chair of the GRDC Southern Panel (on behalf of the panel) and the manager regional grower services – south. Current members will be entitled to re-apply for a position on their network.

PHOTO: JEN LILLECRAPP



At a combined meeting of the RCSNs are (from left) Lachie Seears of Lucindale (SA), Rob Norton of Horsham (Victoria), Bill Long of Ardrossan (SA) and Phil Bowden of Cootamundra (NSW).

PHOTO: JEN LILLECRAPP



At a meeting of the High Rainfall Zone RCSN are Victorian members (from left) – Neil Vallance of Lake Bolac, Phil Hawker of Derrinallum, Susan Findlay-Tickner of Horsham, and John Bennett of Lawloit.

4. Priority issues for the southern region

Over time, the list of grain-growing issues that could be addressed by research, development and extension (RD&E) is limitless. The Regional Cropping Solutions Network (RCSN) groups provide a process where growers and advisers can identify the priority issues currently impacting grain growers. Additionally, the RCSNs provide local insight to the Grains Research and Development Corporation (GRDC) on the potential solutions that could be delivered through investment in grains RD&E. Essentially, the RCSNs play a critical first step in the investment planning process by prioritising the relative importance of the issues and developing ideas to tackle these issues.

The RCSNs, GRDC staff and the GRDC Southern Panel work closely together to determine what is currently important to grain growers in terms of RD&E. This includes determination of:

- the regional impact and significance of the issue to the grains industry, and provide guidance to the regional panel on investment priorities;
- the change in practices required to address the issue; and
- the knowledge and/or extension that is required to bring about practice change.

With guidance from the GRDC Southern Panel, the RCSNs assess how gaps in knowledge/extension for each issue are being addressed by the current GRDC investment program and what further RD&E, at a local or national scale, would assist growers to address the issue.

The process to analyse and develop ideas for RD&E takes place over several meetings of individual RCSNs and concludes with a combined meeting of all the networks in July of each year to determine the top priority issues for the southern region.

After consideration of each issue, using a formal 'program logic' process, the RCSNs identify the top priority issues to be presented to the GRDC Southern Panel, ensuring that each issue aligns with one of the six research themes core to the GRDC's strategic plan. The program logic process used by the RCSNs is described in detail in Appendix A.

The information generated by the issues analysis process is presented to the GRDC Southern Panel for consideration in the investment planning cycle of the GRDC.

Each RCSN has two or three panel members as part of its membership. Some of the grain-growing issues raised by the RCSNs are common to more than one RCSN production zone. For those issues that are common to more than one RCSN, the panel combines the perspectives from across the RCSNs and develops priority issues following the same process used by the RCSNs.

The southern region RCSNs identified 29 new priority issues in 2014-15 that they believed required RD&E investment. The RCSNs also re-presented two issues identified in 2013-14 but additional information was requested by the GRDC to support these proposed RD&E investments. In total, the RCSNs presented 31 issues for consideration of RD&E investment in 2014-15.

The Southern Panel identified a further 26 priority issues for RD&E investment, which are also included in this annual report. Additional priorities raised by the panel were often similar to RCSN issues, and therefore developed and jointly presented.

For 2014-15, the southern RCSNs and the Southern Panel identified 57 priority issues, which they believed were not fully addressed by current investments and were affecting the profitability and sustainability of grain growers in the southern region. These issues are listed in Table 6.

A description of each priority issue, a description of the RD&E required, and an explanation of current or planned actions by the GRDC to address the issue as at 30 June 2016 are presented in this section in Tables 7 to 63.

The outcomes of GRDC's consideration of the 57 issues are summarised in Section 5 of this report.

GRDC PROJECT CODES

Where applicable the GRDC project code is included with project titles for those projects associated with priority issues. This code can be used to access additional information from the GRDC website. Enter the project code into the 'search' facility on the website. Alternatively, contact the GRDC directly and quote the project code.

PHOTO: JEN LILLECRAPP



TABLE 6 Priority issues affecting grain growers, as identified by the southern region RCSN groups and the Southern Panel in 2014–15. The issues are grouped according to GRDC research themes.

#	ISSUE	ORIGINATING ZONE
THEME 1 – MEETING MARKET REQUIREMENTS		
1	Grain classification systems	Southern region
2	Independent market information on grain quality	Southern region
3	Agronomy for durum grain quality	Southern region
4	Grain marketing training	Southern region
THEME 2 – IMPROVING CROP YIELD		
5	Access to well-adapted canola varieties	Southern region
6	Crop varieties and management for late autumn breaks	Southern region
7	More accurate assessment of longer-season wheat varieties	Southern region
8	Increasing the area sown to pulse crops	Southern region
THEME 3 – PROTECTING YOUR CROP		
9	Weed science is under-resourced and reactive	Low rainfall
10	Advancing and extending knowledge of the behaviour of major weed species for better implementation of integrated weed management in the GRDC southern region	Medium rainfall
11	An understanding of the economic impact of yellow leaf spot	Medium rainfall
12	A farming systems challenge to increase the longevity of crop protection chemicals and reduce the resistance risk	Medium rainfall
13	Management of a range of weeds with resistance to multiple herbicide groups	High rainfall
14	Improved understanding to manage emerging pests – millipedes, slaters and earwigs – in retained heavy stubble loads	High rainfall and southern region
15	Effective strategies to manage the small conical snail to avoid grain contamination at harvest	High rainfall
16	Glyphosate resistance on irrigation farms	Irrigation
17	White grain disorder	Southern region
18	'New' fallow weeds	Southern region
19	Efficacy of propyzamide on trifluralin-resistant ryegrass	Southern region
20	Improved management of barley grass	Southern region
21	Improved management of net blotch in barley	Southern region
22	Improved management of rhizoctonia	Southern region
23	Extending the knowledge from the GRDC western region on herbicide-resistance management	Southern region
THEME 4 – ADVANCING PROFITABLE FARMING SYSTEMS		
24	More profitable and less risky ways to manage nutrition, pests, weeds and diseases following cereals	Low rainfall
25	Poorly integrated livestock and cropping enterprises	Low rainfall
26	Identifying, understanding and adapting robotic technology (including drones) for agriculture	Medium rainfall and southern region
27	Brown manuring – an option to increase inclusion of legumes for more sustainable and diverse farming systems	Medium rainfall
28	Applying soil moisture knowledge over the whole production system	Medium rainfall
29	Agronomic packages to increase yields of canola	High rainfall
30	Understanding the impact and management strategies for foliar diseases in high yield potential canola crops	High rainfall
31	A viable legume phase or crop for the high rainfall zone on acidic and alkaline soils	High rainfall
32	Plant growth regulators – compiling specific data on key interactions and filling the gaps in registrations	High rainfall
33	Optimum time of sowing and agronomy packages to increase crop yields in the high rainfall zone	High rainfall
34	Nitrogen budgeting and management	High rainfall
35	Best management practice for irrigated barley	Irrigation
36	Irrigated durum wheat production	Irrigation
37	Increasing faba bean yields in the irrigation zone and growing them consistently	Irrigation

TABLE 6 CONTINUED PAGE 28

TABLE 6 (CONTINUED) Priority issues affecting grain growers, as identified by the southern region RCSNs and the Southern Panel in 2014–15. The issues are grouped according to GRDC research themes.

#	ISSUE	ORIGINATING ZONE
38	Holistic approach to the management of pests, weeds, diseases and nutrition	Southern region
39	Refining the practice of brown manuring	Southern region
40	Refining the use of soil nitrogen testing for improved nitrogen management	Southern region
41	Nitrogen management in seasons with high yield potential	Southern region
42	Reliable break crop options for low rainfall crop environments	Southern region
43	Variety specific agronomy packages (VSAP) for pulses	Southern region
THEME 5 – IMPROVING YOUR FARM RESOURCE BASE		
44	Uncertainty about how climate change will impact on low rainfall agriculture	Low rainfall
45	Poor productivity of sandy soils	Low rainfall
46	Understanding of subsoil constraints and the evaluation of machines and alternate substrates	High rainfall
47	Making informed decisions about irrigation layouts to maximise returns from water applied	Irrigation
48	Examining the effectiveness of new layouts for irrigation set-ups	Irrigation
49	Digitising soil maps of the Murrumbidgee Irrigation Area	Irrigation
50	Modifying soils to increase productivity and profitability	Southern region
51	Management of non-wetting soils in no-till farming systems	Southern region
52	Management of drainage and waterlogging	Southern region
THEME 6 – BUILDING SKILLS AND CAPACITY		
53	Mentoring for the development and retention of skilled advisers	Medium rainfall
54	Transfer of agronomic (research and systems) knowledge from overseas to local high rainfall zone conditions and farming systems	High rainfall
55	Improving skills and expertise to support the development of improved farming practices in the high rainfall zone	High rainfall
56	Governance skills for farming systems groups	Southern region
57	Trial design and evaluation skills for farming systems groups	Southern region

Theme 1 – Meeting market requirements

TABLE 7 Issue 1 – Grain classification systems.

The issue	The Australian Wheat Classification system underpins the marketing of grains into both domestic and international markets. The system allows growers to be rewarded for growing grain that meets specific quality parameters rather than the general 'fair average quality' (FAQ) system that existed previously. For the current system to remain, an independent body is required to assess new varieties to determine the appropriate quality classification they fall into based on the quality parameters they achieve in different environments. This function was previously undertaken by AWB Ltd, however, since deregulation, this role has been undertaken by Wheat Quality Australia (WQA). It was envisaged that WQA would be co-funded by the GRDC and industry partners. However, there has been reluctance by industry to co-invest. Also, the staffing of WQA has been unstable since its inception, which has reduced the ability of WQA to be effective.
RCSN/panel prioritising this issue	Southern Panel
What is needed to address the issue	An investment is needed to review the current effectiveness of WQA and identify possible funding models into the future. It would also be timely to review the current wheat classification system to ensure that it delivers optimum value to growers.
RD&E actions in regards to this issue	The activities required to address this issue fall outside the direct responsibilities of the GRDC. While there will not be GRDC projects developed to address this issue, the GRDC will continue to work with industry partners in regards to this issue.
GRDC projects addressing this issue	RD&E in this field is facilitated by other grains industry organisations

TABLE 8 Issue 2 – Independent market information on grain quality.

The issue	<p>The grains industry lacks accessible, general and independent grain market information. Information about the markets that purchase grain, why grain is purchased (is it price or quality, or a combination of both?), the volume that goes to each market annually, the time period and pattern of sales, and the volumes of different grades and how they are processed and into what products.</p> <p>Up-to-date, accessible information would help growers to make strategic decisions about grain production and grain marketing.</p> <p>Researchers and plant breeders also need access to relevant and independent grain marketing information to ensure crop breeding programs are aligned with market requirements. Breeders also use grain marketing information to guide pre-breeding programs.</p>
RCSN/panel prioritising this issue	Southern Panel
What is needed to address the issue	An industry scoping study is required initially to determine key information requirements for growers and researchers.
RD&E actions in regards to this issue	Up-to-date information on independent market information on grain quality is required by the GRDC Investment Theme 1 by the project listed below. However, a new investment is required to collate and provide access to up to date information.
GRDC projects addressing this issue	Current project <i>Market intelligence for Theme 1 (AEG00006)</i>

TABLE 9 Issue 3 – Agronomy for durum grain quality.

The issue	<p>Growers require information on agronomic and harvest management practices that will result in reliable production of durum wheat that meets required grain quality standards.</p> <p>Seasons with dry finishes, such as low spring rainfall, highlight the limitations of current varieties and agronomic practices.</p>
RCSN/panel prioritising this issue	Southern Panel
What is needed to address the issue	Improved knowledge of durum wheat production is required in regards to agronomic and harvest management, and greater understanding of the impacts of disease and adverse seasonal conditions on durum grain quality is also required.
RD&E actions in regards to this issue	There are several existing projects that, in part, address this issue. Additional RD&E needs are yet to be prioritised for additional investment by the GRDC, and these needs will be explored with the South Australian Durum Growers Association.
GRDC projects addressing this issue	Current projects Various agronomy investments under Theme 4 (DAS00144, DAN00163, ICA00012, CIM00020, NCA00012, USQ00013)

TABLE 10 Issue 4 – Grain marketing training.

The issue	<p>Many growers in the GRDC southern region lack the skills and confidence to make informed decisions about marketing their grain.</p> <p>As markets become more sophisticated and the options for marketing grain become greater, there is an increasing gap between growers' marketing knowledge and the knowledge and skills required for effective marketing. Feedback from past GRDC grain marketing workshops has highlighted a lack of knowledge in grain marketing terminology, options, grain storage, contracts and legal terms, and global grain markets.</p> <p>Marketing skills can make a significant difference to farm business profitability.</p>
RCSN/panel prioritising this issue	Southern Panel
What is needed to address the issue	The development and delivery of independent grain marketing training is required.
RD&E actions in regards to this issue	<p>The GRDC has identified a wide range of grower training needs.</p> <p>In response, the GRDC plans to become the source, strategic driver and coordinator for the supply and delivery of new and existing knowledge for grain growers. This requires the development and implementation of a strategy that matches growers' needs for finding information and acquiring new knowledge, so that their skills in crop production techniques and non-technical farm-related management are continually enhanced. This training will result in growers confidently managing their businesses using superior crop management practices and being readily able to deal with challenges and opportunities to sustain production and profit.</p> <p>Grain marketing is outside the role of the GRDC and as such, grower-related grain marketing issues are addressed by other industry organisations. However, the GRDC recognises the need to better understand the broader needs of grain growers and work will be undertaken by the GRDC to address this issue.</p>
GRDC projects addressing this issue	Project commencing 2015-16 <i>Understanding grower needs for access to knowledge – data collection and formation of a GRDC strategy (DER00021)</i>

Theme 2 – Improving crop yield

TABLE 11 Issue 5 – Access to well-adapted canola varieties.

The issue	<p>Growers require access to a range of canola varieties that are well-adapted to their production environments.</p> <p>Increasingly, growers are adopting new hybrids when choosing a canola variety. In 2010, it was estimated that 40% of canola seed sales in Australia were hybrid varieties¹. Hybrid seed sales have continued to increase in market share, accounting for 53% of total seed sales in 2014.</p> <p>Recent data supplied to the GRDC by bulk handlers shows that 70–90% of total canola receivals were open-pollinated (OP) varieties. The higher proportion of OP varieties in receivals compared with seed sales was attributed to the practice of farm-retained seed.</p> <p>With one of the few remaining specialist OP canola breeding programs (Canola Breeders Western Australia) ceasing operations in 2013 and the increasing use of hybrid canola, growers have expressed concerns about the ongoing access to OP canola varieties in Australia.</p> <p>In medium and low rainfall production zones, growers are increasingly retaining canola seed on-farm for planting the next season. Historically, this was not considered best practice due to the potential for poor seed quality, low germination and vigour, and weed contamination. However, improvements in selection of seed production areas (low weed density and good fertility), and sizing and cleaning of retained seed have alleviated these risks. The relatively lower cost of retained seed compared with purchased ‘fresh’ seed has enabled growers to reduce the costs of growing canola. When added to the flexibility attributable to the practice, this has enabled many growers to keep canola in their crop rotations.</p> <p>Seed of OP varieties is commonly retained as OP varieties are considered best suited to this practice. Retained seed from hybrid varieties shows increased variability in the second generation in terms of plant growth and disease resistance, resulting in generally lower grain yields than crops derived from the original seed^{2,3}. Field trials in 2012 showed that the additional cost of purchasing hybrid canola seed rather than retaining seed was recouped by the additional yield and oil, and generally crops grown from purchased seed were more profitable.</p> <p>In some regions in the low and medium rainfall areas, seed retailers currently estimate that 70–80% of the total canola area is planted with farmer-retained seed.</p> <p>The retail price of canola seed for planting (in 2013) ranged from \$13.00 per kilogram to \$29.00/kg. Seed prices varied depending on type (OP vs hybrid) and herbicide tolerance. For example:</p> <ul style="list-style-type: none"> • conventional OP variety such as AV-Garnett⁴ – \$13.00/kg; • triazine tolerant (TT) OP variety such as ATR-GEM – \$17.00/kg; • Clearfield® hybrid varieties ranged from \$22.00/kg to \$26.00/kg; and • Roundup Ready® (RR) hybrid varieties ranged from \$28.00/kg to \$29.00/kg. <p>With sowing rates commonly varying between two and four kilograms of seed per hectare, seed costs can be up to \$116 per hectare (based on above prices).</p> <p>By comparison, the cost of retained seed is relatively low. The value (opportunity cost) of untreated retained seed is generally about \$500 per tonne (\$0.50/kg). Seed cleaning, treatment with fungicide for blackleg and insecticide treatment costs about \$2.50/kg to \$3.00/kg. Therefore the total cost of seed retained on farm is about \$3.00/kg to \$3.50/kg.</p>
RCSN/panel prioritising this issue	Southern Panel
What is needed to address the issue	Continued grower access to OP canola varieties across the range of herbicide tolerance systems.
RD&E actions in regards to this issue	<p>Consult with commercial canola breeders and pre-breeders to understand strategic direction for breeding programs and ensure alignment with grower needs.</p> <p>Consider options to ensure that breeding and commercial availability of OP varieties are maintained. A possible option is implementing end point royalties (EPR) on OP lines, to ensure returns to breeders in light of the practice of retained seed.</p> <p>GRDC to investigate if there is justification for additional investment in canola breeding and how this could be best targeted to encourage breeding companies to develop additional OP varieties.</p> <p>Future GRDC investments in pre-breeding for 2016-17 to be guided by the outcomes of the above activities.</p>
GRDC projects addressing this issue	<p>Current projects</p> <p><i>National Brassica Germplasm Improvement Program</i> (NBGIP); 7 years, \$7.16 million (DAN00108, DAV00085, DAN00117)</p> <p><i>Optimised canola profitability – understanding the relationship between physiology and tactical agronomy management</i>, will involve physiological and agronomic research across nine cropping zones in the GRDC southern and northern regions (CSP00187)</p> <p>New projects</p> <p><i>Canola Strategy Workshop</i> (June 2014) with representatives from major commercial breeders and pre-breeders (including Bayer CropScience, Cargill Oilseeds, Nuseed, Pacific Seeds, Pioneer, University of Melbourne and NSW DPI)</p> <p><i>National Brassica Germplasm Improvement Program</i> (NBGIP-II); 5 years, \$8.35 million partnering with NSW DPI, DEDJTR and UWA (DAN00108, DAN00208, UM00045, DAV00085, GRS10695)</p>

¹ www.grdc.com.au/GRDC-FS-GrowingHybridCanola

² www.australianoilseeds.com/_data/assets/pdf_file/0017/7424/Effect_of_retained_hybrid_canola_FP.pdf

³ www.finalreports.grdc.com.au/YCRO0001

TABLE 12 Issue 6 – Crop varieties and management for late autumn breaks.

The issue	<p>Growers and advisers believe that late autumn breaks are becoming more common in the GRDC southern region. This is supported by a 2012 CSIRO study⁴ that shows a trend for drier autumns over the previous 17 years.</p> <p>Farming systems have developed on the basis of a late-April to early-May seasonal break. Consequently, the later sowings and/or shorter growing seasons associated with later breaks may result in significant yield penalties and lower profitability.</p> <p>The current high levels of adoption of dry sowing reduces the grower's capacity to respond to a delayed start to the growing season as variety, fertiliser and weed management decisions have already been made on the expectation of rain occurring in early to mid-May.</p> <p>Grower response to a delayed start would ideally include a review of the crop type and variety sown, fertiliser rate applied, herbicide strategy used and forward-marketing strategies.</p> <p>While drier autumns have become more common over the past 17 years, in contrast, February to March rainfall has not declined, and in some areas has increased⁵. This rain can provide sufficient stored soil moisture on which to sow crops, rather than sowing after the traditional autumn break. This early sowing system uses long-season winter wheats to capitalise on stored soil moisture, and is well developed and supported by ongoing research to develop agronomy management packages.</p> <p>Currently there is also significant and ongoing RD&E investment into understanding how variety selection and sowing time of available varieties could be modified to capitalise on elevated moisture levels in the seedbed as a result of February to March rainfall. This investment involves sowing currently available varieties at times earlier than the traditional winter crop sowing window of late April through to early May.</p>
RCSN/panel prioritising this issue	Southern Panel
What is needed to address the issue	<p>Review the options, if any, which are available for growers in seasons with late autumn breaks, including both crop type and varieties, taking into consideration crop sequence issues and economic performance.</p> <p>Evaluate performance of current crop varieties in seasons with late autumn breaks.</p> <p>Assess and develop appropriate alternative practices to optimise productivity with late autumn breaks.</p>
RD&E actions in regards to this issue	The issue is addressed by a range of past, current and new GRDC projects, and it was determined that a specific new investment was not required.
GRDC projects addressing this issue	<p>Current projects</p> <p>Various variety evaluation and agronomy, including variety specific agronomy, investments (CSP00178, WAN00021, DAW00204, DAN00167, HCP00001)</p>

4 Cai W, Cowan T, Thatcher M (2012) Rainfall reductions over Southern Hemisphere semi-arid regions: the role of subtropical dry zone expansion. *Nature Scientific Reports* 2.

5 Hunt JR, Kirkegaard JA (2011) Re-evaluating the contribution of summer fallow rain to wheat yield in southern Australia. *Crop & Pasture Science* 62, 915-929.

TABLE 13 Issue 7 – More accurate assessment of longer-season wheat varieties.

The issue	<p>Late autumn breaks are becoming more common in the GRDC southern region. This is supported by a 2012 study⁶ that showed a trend for drier autumns over the previous 17 years. In contrast, February–March rainfall has not declined and in some areas it has increased⁷. This rain can provide sufficient stored soil moisture on which to sow crops, rather than sowing after the traditional autumn break. This early sowing system uses long-season winter wheats to capitalise on stored soil moisture, and is well developed and supported by ongoing research to develop agronomy management packages.</p> <p>Growers require accurate, independent and timely information about the performance of long-season wheat varieties, which are sown in trials at times appropriate for long-season wheats. This information is not being reliably generated from the National Variety Trials. For example, in NSW in 2013, there were 23 trials sown in the early sowing series. However, of these, only one was sown in April (on 30 April), and 13 were sown after the 15 May, so little useful information about early sowing was obtained in that season. In 2012, of the 25 trials in the series only one trial was sown in April and four were sown in late May.</p> <p>There can be a number of reasons for the delay of sowing the variety trials. Late supply of seed, unsuitable sites with limited fallow water storage, inadequate machinery capacity for sowing quickly and on limited moisture, or very dry seasons.</p>
RCSN/panel prioritising this issue	Southern Panel
What is needed to address the issue	This issue will be addressed by engaging contractors for the National Variety Trials (NVT) with the capacity to increase the proportion of early sown (longer season) trials in the NVT program in NSW, which are actually sown on time (mid-April). The program also requires support to enhance seed supply logistics and guarantee spray irrigation capacity (pivot, linear) for a limited number of sites, to assist timely sowing.
RD&E actions in regards to this issue	GRDC contracts a range of organisations to deliver NVT program across the southern region. NVT provides comparative crop variety testing with standardised trial management, data generation, collection and dissemination.
GRDC projects addressing this issue	Various NVT Service Agreements

⁶ Cai W, Cowan T, Thatcher M (2012) Rainfall reductions over Southern Hemisphere semi-arid regions: the role of subtropical dry zone expansion. *Nature Scientific Reports* 2.

⁷ Hunt JR, Kirkegaard JA (2011) Re-evaluating the contribution of summer fallow rain to wheat yield in southern Australia. *Crop & Pasture Science* 62, 915-929.

TABLE 14 Issue 8 – Increasing the area sown to pulse crops.

The issue	<p>The area sown to pulse crops as a proportion of the total crop area in the GRDC southern region is considered well below what is necessary for balanced, sustainable crop production. Canola–wheat rotations are common but are not considered sustainable due to the prevalence of crop disease and nitrogen fertility decline.</p> <p>While most growers recognise the benefit of including pulse crops within their rotations, they choose not to grow them. The reasons often cited include poor crop yield or the risk of low crop yield, perceived and/or low crop profitability, lack of ready access to markets, variable marketing opportunities and fluctuating commodity prices.</p> <p>There continues to be a significant investment in the breeding of major pulse crops for south-eastern Australia. The return on this investment will only be achieved if the varieties are adopted over a wider area.</p>
RCSN/panel prioritising this issue	Southern Panel
What is needed to address the issue	To increase the area sown to pulse crops, support needs to be provided to growers to select the most suitable pulses for their production environment and to employ the crop agronomy required to optimise crop yield and profitability.
RD&E actions in regards to this issue	The issue is addressed by a range of past, current and new GRDC projects. However, a range of specific new investments are required to address ongoing needs related to this issue.
GRDC projects addressing this issue	<p>Current projects A range of projects currently exists addressing some aspects of this issue.</p> <p>Project commencing 2015-16 <i>A better understanding of the sociological factors influencing the adoption of break crop research</i> (DER00020)</p> <p>Proposed projects for 2015-16 The following GRDC proposed investments did not proceed due to competing higher priorities for funds; proposals will be held over for future potential investment.</p> <p><i>Chickpeas with increased cold tolerance at flowering</i> (GRDC Proposed Investment 2015.02.09)</p> <p>Crop Rotations Initiative</p> <ul style="list-style-type: none"> • <i>Identification and development of new crop or forage legume options for use in medium and low rainfall cropping systems</i> (GRDC Proposed Investment 2015.04.04A09) • <i>Region specific management packages</i> (GRDC Proposed Investment 2015.04.04B09) • <i>Economic analysis</i> (GRDC Proposed Investment 2015.04.04C09) • <i>Fodder and forage legume rotational strategies</i> (GRDC Proposed Investment 2015.04.05A09) • <i>Economic analysis of the benefits of including legume fodder and forage crops in rotational strategies in the medium and high rainfall zone</i> (GRDC Proposed Investment 2015.04.05B09) • <i>Crop rotation/sequencing triggers</i> (GRDC Proposed Investment 2015.04.0909)

Theme 3 – Protecting your crop

TABLE 15 Issue 9 – Weed science is under-resourced and reactive.

The issue	The behaviour of weeds and the types of weeds present on farms continues to change as farming systems evolve. Current support for the industry in the areas of weed ecology and management is thin and very much focused on herbicide resistance. There needs to be an ongoing resource for the industry to monitor not only the incidence of herbicide resistance, but also the ecology of weeds and their integrated management, so that new weeds or 'old weeds behaving differently' can be detected early and a wide range of control strategies rapidly developed.
RCSN/panel prioritising this issue	Low rainfall zone
What is needed to address the issue	Ultimately, growers in the low rainfall zone need to be able to manage weeds to an acceptable level with a wide range of integrated tools and techniques. For this to occur, a weed ecologist/management specialist needs to be appointed, to focus on new and emerging weed management issues. Additionally, cost-effective cultural options to manage weeds need to be developed. With greater specialist focus and farmer knowledge, emerging weed issues will be detected promptly.
RD&E actions in regards to this issue	<p>There is a large number of past and current investments that address this issue. Weeds are a significant ongoing issue for the Australian grains industry, as a result there are large ongoing investments nationally and regionally to address weeds.</p> <p>Coordination and long-term strategic thinking are key requirements to address this issue. As such long-term, national investments that draw together key RD&E providers, advisers and agribusinesses are required. This is being undertaken in the WeedSmart Initiative (see below).</p> <p>Additional regional investments required to meet specific regional issues need to coordinate and integrate with national activities.</p>
GRDC projects addressing this issue	<p>Current projects</p> <p><i>National Coordination of Weeds Research (RDP00011)</i></p> <p><i>Phase III of the WeedSmart Initiative (PNS00013) commencing 2014-15 (\$663,000 over 3 years, www.weedsmart.org.au/app)</i></p> <p><i>Improving IWM practice in the southern region – emerging weed issues (UA00134)</i></p> <p><i>Australian Herbicide Resistance Initiative - Phase 4 (UWA00146)</i></p> <p><i>Weed management in the southern region mixed farming systems - strategies to combat herbicide resistance (UCS00020)</i></p> <p><i>Improving integrated weed management in conservation farming systems in the southern region (UA00113)</i></p> <p><i>Improved herbicide efficacy and longevity in southern no-till farming systems (UA00144)</i></p> <p>Projects commencing 2015-16</p> <p><i>Awareness and extension of herbicide resistance and IWM (RDP00015)</i></p> <p><i>Surveillance and biosecurity strategies for herbicide resistance management (UCS00024)</i></p> <p><i>Mechanisms, evolution and inheritance of resistance (UWA00171 & UA00158)</i></p> <p><i>Chemical management options for herbicide resistant weeds (UQ00080, THA00001, AUE00001, ICN00022)</i></p> <p><i>Physical management options for herbicide resistant weeds (SFS00032 & UWA00171)</i></p> <p><i>Cultural management options for herbicide resistant weeds (DAQ00197)</i></p> <p><i>Seedbank biology of emerging weeds in Australian grain production – a literature review (UA00156)</i></p>

TABLE 16 Issue 10 – Advancing and extending knowledge of the behaviour of major weed species for better implementation of integrated weed management in the GRDC southern region.

The issue	<p>Weed species can persist in farming systems in two ways: tolerance/resistance of control methods (for example, herbicides); or avoidance of control methods (for example, delayed germination through increased dormancy).</p> <p>While information is readily available regarding the herbicide-resistance status of a range of weed species, access to information about dormancy characteristics, life cycles and longevity (decline in seedbank) of weeds in modern farming systems is relatively limited. Information is limited and not packaged as 'ready for use', and information for some weed species may not apply to modern farming systems, which largely are based on continuous cropping with minimum or no till systems.</p> <p>The shift towards the use of pre-emergent herbicides and the discovery of changes in the dormancy of a number of important weeds have increased the complexity and challenge for developing effective integrated weed management (IWM) strategies. Growers and advisers do not have adequate knowledge to understand how individual weed species will respond to different IWM strategies, limiting their ability to strategically and tactically manage the important weeds in cropping systems.</p> <p>The Weed Seed Wizard is a useful tool that enables growers and advisers to use paddock management information to predict immediate and future weed emergence and crop losses. However, this tool has limitations given that it is not yet fully comprehensive and does not address all the above identified issues.</p>
RCSN/panel prioritising this issue	Medium rainfall zone
What is needed to address the issue	<p>Growers require knowledge and better understanding about the life cycle, dormancy characteristics and longevity of the most important weed species for the southern region, so that integrated and effective weed management strategies can be developed or refined.</p> <p>A review of published research and development (R&D) is required to identify the knowledge gaps in the life cycle, dormancy characteristics and longevity of the most important weed species in the southern region. Substantial research has been undertaken worldwide, therefore it is important to collate and review available literature to determine knowledge gaps. It is essential that this information is presented as a useful resource for weed scientists and in a user-friendly format to guide growers and advisers with weed management.</p> <p>With knowledge gaps identified and new knowledge gained, further or ongoing R&D is required to address knowledge gaps and to develop and improve IWM strategies to enable the effective management of the important weeds in modern cropping systems.</p> <p>New or updated information about the life cycle, dormancy characteristics and longevity of the most important weed species in the southern region needs to be collated and extended.</p> <p>Extension activities and products for integrated and effective weed management strategies for the important weed species in the southern region need to be developed and delivered. These weed management strategies should be based upon a range of considerations, including knowledge about the life cycle, dormancy characteristics and longevity.</p>
RD&E actions in regards to this issue	There is a range of past, current and projects that address this issue. This reflects the ongoing and evolving nature of the issue.
GRDC projects addressing this issue	<p>Past projects</p> <p><i>Developing management systems for brome grass, a serious threat to production systems on fragile sandy textured soils in southern Australia</i> (UA00060)</p> <p><i>Emerging weeds in changing farming systems</i> (UA00105)</p> <p><i>Improving integrated weed management in conservation farming systems in the southern region</i> (UA00113)</p> <p><i>Improving IWM practice in the southern region – Emerging weed issues</i> (UA00134)</p> <p><i>Weed Seed Wizard – A validation and improvement of a weed management decision support tool</i> (UWA00125)</p> <p><i>Impact of weeds on Australian grain production and adoption of no-till cropping practices</i> (CSA00043)</p> <p>Current projects</p> <p><i>Development of new non-chemical weed control technologies – microwave control of weeds</i> (UM00053)</p> <p><i>Improving IWM practice of emerging weeds in the southern and western regions</i> (UA00149)</p> <p><i>Weed management in the southern region mixed farming systems</i> (UCS00020)</p> <p><i>WeedSmart</i> (UWA00164)</p> <p><i>Weeds instructional videos, online version of the IWM manual, online web content updates and e-learning content, and 3 weeds webinars</i> (ICN00013)</p> <p><i>GRDC support for the Australian Glyphosate Sustainability Working Group</i> (ARN00001)</p> <p><i>BCG – Broadleaf herbicide resistance targeted survey of Victorian Wimmera-Mallee</i> (Fast track project BWD00023) – increase grower and adviser awareness of the increasing incidence of herbicide resistance in broadleaf weeds, particularly wild radish (<i>Raphanus raphanistrum</i>) and capture the extent of resistance in the Victorian Wimmera-Mallee region.</p> <p>Projects commencing 2015-16</p> <p><i>Herbicide resistance management</i></p> <p><i>Surveillance of herbicide resistant weeds in Australian grain cropping</i> (UCS00024) – regional resistance surveys are crucial for monitoring the development of herbicide resistance and to inform the approaches and strategies for managing this problem.</p>

TABLE 16 CONTINUED PAGE 34

TABLE 16 (CONTINUED) Issue 10 – Advancing and extending knowledge of the behaviour of major weed species for better implementation of integrated weed management in the GRDC southern region.

GRDC projects addressing this issue	<p><i>Chemical management options for herbicide resistant weeds</i></p> <p><i>Integration of residual herbicides into IWM</i> (UQ00062) – best management packages for the use of pre-emergent residual herbicides for different cropping and regional scenarios.</p> <p><i>New uses for existing chemistry</i> (UQ00080) – development of a suite of new and diverse chemical double-knock strategies to manage resistant weeds.</p> <p><i>Physical management options for herbicide resistant weeds</i></p> <p><i>Targeted tillage</i> (UWA00171) – development and validation of targeting tillage equipment that can control weeds in fallow and in-crop with minimal soil disturbance that can be integrated with weed identification systems.</p> <p><i>Harvest weed seed control for the southern region</i> (SFS00032) – develop and validate harvest weed seed control techniques for the higher rainfall and irrigation areas of the southern grain cropping region of Australia.</p> <p><i>Cultural management options for herbicide resistant weeds</i> (DAQ00197) – literature review and meta-analysis of existing data on weed competitive cultural practices for all major crops in all regions that would include a gap analysis to identify future research priorities. Based on the gap analysis this investment will then design field trials suitable for each grain region to address the gaps identified for each region.</p> <p><i>Emerging weeds</i> (UA00156) – document current knowledge on seed dormancy, life cycles and longevity, assess the relevance of this data to contemporary farming systems, and identify knowledge gaps for the major emerging weed species and identify knowledge gaps and RD&E needs.</p> <p><i>Managing weed seed and disease banks and capturing nitrogen benefits to the cropping systems in medium and high rainfall regions</i> GRDC Proposed Investment 2016.04.02) – did not proceed</p>
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TABLE 17 Issue 11 – An understanding of the economic impact of yellow leaf spot.

The issue	<p>Yellow leaf spot (YLS) is the most widespread disease of wheat across the southern cropping region. It is particularly prevalent where wheat is grown in a close rotation and where stubbles are retained. Prevalence has been exacerbated across significant areas where susceptible to very susceptible wheat varieties are grown.</p> <p>Despite the widespread occurrence of YLS, yield loss (quantum and occurrence) is not well understood. Preliminary studies by the Victorian DEDJTR[*] suggest that yield losses may be around 10–15% in susceptible cultivars. However, this estimate of yield loss is based upon limited data and requires further validation.</p> <p>In some instances, growers are not adopting newer, higher-yielding varieties based upon YLS susceptibility and instead, choosing often older, lower-yielding varieties with greater YLS resistance. The alternative varieties most often have a greater susceptibility to stripe rust, which is a disease that can be effectively managed with the use of fungicides, unlike YLS.</p> <p>Growers are applying fungicides in an effort to control YLS infections despite the lack of data and evidence on which to base these decisions.</p> <p>Historically, pathogenic variability within YLS isolates was not considered an important issue. However, cereal pathologists have become increasingly concerned that there may have been changes in the pathogenic variability within the YLS population which should be further investigated.</p>
RCSN prioritising this issue	Medium rainfall zone
What is needed to address the issue	<p>Growers and advisers need a better understanding of the economic impact of YLS to enable cost-effective management of the disease. It is essential that integrated disease management for YLS includes a range of strategies including crop rotation, stubble management, genetic resistance and potentially foliar fungicides.</p> <p>Quantifying the yield loss caused by YLS is critical so that the economic impact of YLS can be understood.</p> <p>Evaluating the efficacy of fungicides to control YLS is required to provide a basis for developing cost-effective management strategies.</p> <p>Further investigation is required to understand any changes in the pathogenic variability within the YLS population.</p> <p>Breeding varieties with improved resistance is considered to be the most effective strategy for managing YLS. It is therefore important that continued investment is provided for germplasm enhancement which would provide a greater range of resistance genes and associated markers for wheat breeders.</p> <p>Development and extension are required so that growers and advisers understand the economic impact of YLS and can cost-effectively manage the disease using a range of integrated strategies, such as crop rotation, stubble management, crop (genetic) resistance and potentially foliar fungicides.</p>
RD&E actions in regards to this issue	There is a range of past and current projects that address this issue, which have developed as the issue and the associated RD&E needs have emerged.
GRDC projects addressing this issue	<p>Current projects</p> <p><i>Improving grower surveillance, management, epidemiology knowledge and tools to manage crop disease in Victoria</i> (DAV00129)</p> <p><i>Improving grower surveillance, management, epidemiology knowledge and tools to manage crop disease in southern NSW</i> (DAN00177)</p> <p><i>Improving grower surveillance, management, epidemiology knowledge and tools to manage crop disease in South Australia</i> (DAS00139)</p> <p><i>Germplasm enhancement for yellow leaf spot resistance in wheat</i> (DAW00206 and DAW00245)</p> <p><i>National pathogen management modelling and delivery of decision-support</i> (DAW00228)</p> <p><i>Centre for Crop and Disease Management – research programs</i></p> <ul style="list-style-type: none"> • <i>Yellow Leaf Spot of wheat</i> • <i>Improved farming systems</i> • <i>Bio-informatics</i> <p>Yellow leaf spot screening within National Variety Trials across WA, Victoria, SA, NSW and Queensland.</p>

^{*}Victoria Department of Economic Development, Jobs, Transport and Resources

TABLE 18 Issue 12 – A farming systems challenge to increase the longevity of crop protection chemicals and reduce the resistance risk.

The issue	<p>Greater awareness is required of the need to reduce the reliance on crop protection chemicals to delay development of resistance, and ultimately increase the effective life of crop protection chemicals.</p> <p>Weeds, pests and diseases are estimated to cost the grains industry around \$4.8 billion per year. Combined with a range of other important issues, this cost will drive the development and adoption of new and innovative approaches to management of weeds, pests and diseases.</p> <p>Identified motivations for change include increasing cost of crop inputs, diminishing margins, increasing challenges and complexity of farming systems, increasing levels of chemical resistance, and the threat of removal of registration on products or uses, the lack of new chemical modes of action, as well as evidence and greater confidence in the use of new or innovative non-chemical control practices.</p> <p>The grains industry needs to create a greater awareness of these issues, otherwise growers face the consequences of a smaller range of products and therefore fewer options to manage weeds, pests and diseases. It is also important that the industry takes a very proactive approach to this threat and facilitates the development of innovative ideas through a novel extension project.</p>
RCSN prioritising this issue	Medium rainfall zone
What is needed to address the issue	<p>The proposed novel extension project would involve conducting an innovative three-year competition or ‘challenge’ between teams of grower groups and collaborators, including universities, state government agencies and agribusiness.</p> <p>The purpose of the challenge would be to encourage the strategic use of chemicals and then communicate key messages and outcomes to the wider industry. The intention would be for teams to use a range of potential tools, including genetic, biological, cultural and more targeted chemical options.</p> <p>As well as increasing the longevity of chemicals, an information or decision-support package would be an important output from this proposed project.</p> <p>The success of the project would be measured and evaluated based upon changes in the attitudes and the development of knowledge and skills of growers. The project would also facilitate and encourage collaboration and knowledge transfer between key stakeholder groups. The project would be an important strategy for building the capacity within the grower groups. It is estimated that an investment of \$20,000 per annum for each participating growers group would be required.</p>
RD&E actions in regards to this issue	<p>There is a wide range of current RD&E activities within integrated weed, pest and disease management projects. Each incorporates novel and innovative approaches to extension in partnership with industry. A new investment will be made to address ongoing needs for extension associated with herbicide resistance management.</p>
GRDC projects addressing this issue	<p>There are various projects that incorporate innovative extension activities, e.g. WeedSmart (www.weedsmart.org.au/)</p> <p>Project commencing 2015-16</p> <p><i>Awareness and extension of herbicide resistance and IWM (RDP00015)</i></p>

TABLE 19 Issue 13 – Management of a range of weeds with resistance to multiple herbicide groups.

The issue	The extent and severity of herbicide resistance tends to increase more rapidly in the high rainfall zone than other zones, due to the long growing season for weeds, resulting in high weed populations. Resistance to a range of herbicide groups in multiple weed species will mean that growers will lose the use of effective chemical weed control options. The consequences of this include reduced yields, limited crop options and rotations, and less effective and/or increased input costs for weed control; with a cumulative impact of the profitability of the farming system declining significantly.
RCSN prioritising this issue	High rainfall zone
What is needed to address the issue	<p>Strategies are required to manage annual ryegrass, wild radish, wild oats and brome grass where there is multiple resistance to the herbicide groups of A, B, C, K, I and M in the high rainfall zone. The increasing development of glyphosate resistance is of particular concern.</p> <p>Growers will need to use a range of cultural methods for the control of herbicide resistant weed species. The major barriers to the adoption of cultural practices is the lack of effective cultural weed-seed set control options and the relative cost when compared with chemical control options. The loss of effective herbicide options will be the driver for attitudinal changes and motivate the use of cultural control options.</p> <p>The desired outcome is for sustainable and profitable cropping systems in the presence of herbicide resistance in a range of weeds, using cultural weed control techniques. Identified RD&E actions required to achieve this outcome include:</p> <ul style="list-style-type: none"> • identify the extent and level of herbicide resistance through surveys; • continue to increase awareness and update growers and consultants about current and predicted extent and level of herbicide resistance, and potential impacts; • improve knowledge of growers and consultants about the ecology, biology, behaviour and effective integrated weed management strategies for the major weed species; • promote the use of cultural control strategies (this is a critical action); • promote the use of decision-support tools to understand the impact of crop sequence and a range of practices on weed seedbanks and populations; • develop innovative and effective weed-seed set control tools; • continue and expand the extension of the results and key findings from the IWM trials at the Southern Farming Systems Lake Bolac site with on-farm demonstrations and grower case studies to motivate and support on-farm practice change; • learn from the experiences and gain knowledge from peers in WA who are managing herbicide resistance in wild radish; • increase awareness and educate growers, advisers and land managers (of roadsides and railway easements) more generally, to promote the adoption of improved IWM packages to reduce the reliance on glyphosate in order to prolong the use and efficacy of glyphosate development, as well as delay the development of glyphosate resistance; and • facilitate registration for the use of paraquat for seed set control in canola at windrowing to provide an alternative option and herbicide group and therefore reduce the use of glyphosate.
RD&E actions in regards to this issue	<p>While there have been surveys for resistance in the past, there remain gaps in terms of geography and weed species covered. Further field surveys are required to identify the extent and level of herbicide resistance in key weeds: wild oats, brome grass and wild radish (all herbicide groups) and annual ryegrass (Group M only).</p> <p>While there are considerable extension activities nationally and regionally, additional activities are required to meet the specific needs of high rainfall zone. Extension is required to improve the knowledge of growers and consultants about the ecology, biology, behaviour and effective integrated weed management strategies for the major high rainfall zone weed species.</p>
GRDC projects addressing this issue	<p>Current projects</p> <p><i>Weeds instructional videos, online version of the IWM manual, online web content updates and e-learning content, and 3 weeds webinars (ICN00013)</i></p> <p><i>WeedSmart (UWA00164)</i></p> <p><i>GRDC support for the Australian Glyphosate Sustainability Working Group (ARN00001)</i></p> <p><i>Australian Herbicide Resistance Initiative phase 4 (UWA00146)</i> – includes cost breakdown fact sheets for comparing harvest weed seed control (HWSC) technologies; decision-support tools allow for scenario-based cost-benefit analysis of management options.</p> <p><i>Weed management in the southern region mixed farming systems (UCS00020)</i> – strategies to combat herbicide resistance.</p> <p><i>Improving IWM practice in the southern region – emerging weed issues (UA00134)</i></p> <p><i>Improved herbicide efficacy and longevity in southern no-till farming systems (UA00144)</i></p>

TABLE 19 CONTINUED PAGE 39

TABLE 19 (CONTINUED) Issue 13 – Management of a range of weeds with resistance to multiple herbicide groups.

GRDC projects addressing this issue	<p>Current projects</p> <p>Projects commencing 2015-16</p> <p><i>Herbicide Resistance Management (2015.03.02)</i></p> <ul style="list-style-type: none"> • <i>Surveillance (UCS00024)</i> – regional resistance surveys are crucial for monitoring the development of herbicide resistance and to inform the approaches and strategies for managing this problem. • Farm hygiene – improve the uptake and regular practice of good farm hygiene to reduce the spread of herbicide resistant weed populations (GRDC Proposed Investment 2015.03.02B). • Tools for measuring seedbanks – tools to quantify and monitor weed seedbanks and populations to support targeted management (GRDC Proposed Investment 2015.03.02C) – did not proceed due to competing higher priorities for funds; held over for future potential investment). <p><i>Chemical management options for herbicides resistant weeds (2015.03.04)</i></p> <ul style="list-style-type: none"> • <i>Integration of residual herbicides into IWM (THA00001)</i> – best management packages for the use of pre-emergent residual herbicides for different cropping and regional scenarios. • <i>New uses for existing chemistry (UQ00080)</i> – develop of a suite of new and diverse chemical double-knock strategies to manage resistant weeds. <p><i>Physical management options for herbicide resistant weeds (2015.03.06)</i></p> <ul style="list-style-type: none"> • <i>Harvest weed seed control for the southern region (SFS00032)</i> – develop and validate harvest weed seed control techniques for the higher rainfall and irrigation areas of the southern grain cropping region of Australia. • Targeted tillage – development and validation of targeting tillage equipment that can control weeds in fallow and in-crop with minimal soil disturbance that can be integrated with weed identification systems (GRDC Proposed Investment 2015.03.06A) – did not proceed due to competing higher priorities for funds; held over for future potential investment. • Strategic tillage validation of weed seed decline after mouldboard ploughing – evaluate the best intervals for mouldboard ploughing to control herbicide resistant weeds (GRDC Proposed Investment 2015.03.06B) – did not proceed due to competing higher priorities for funds; held over for potential future investment. • Strategic tillage – gap analysis – review the state of the science of soil disturbance as an IWM tool for long term weed control and document both the advantages and disadvantages of the use of strategic tillage (GRDC Proposed Investment 2015.03.06C) – did not proceed due to competing higher priorities for funds; held over for future investment. <p><i>Cultural management options for herbicide resistant weeds (DAQ00197)</i> – literature review and meta-analysis of existing data on weed competitive cultural practices for all major crops in all regions that would include a gap analysis to identify future research priorities. Based on the gap analysis, design field trials suitable for each grain region to address the gaps identified for each region.</p> <p><i>Emerging weeds (UA00156)</i> – document current knowledge on seed dormancy, life cycles and longevity, assess the relevance of this data to contemporary farming systems, and identify knowledge gaps for the major emerging weed species and RD&E needs.</p> <p><i>Managing weed seed and disease banks and capturing nitrogen benefits to the cropping systems in medium and high rainfall regions – fodder and forage legume rotational strategies (GRDC Proposed Investment 2015.04.05 06C)</i> – did not proceed due to competing higher priorities for funds; held over for future investment.</p>
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TABLE 20 Issue 14 – Improved understanding to manage emerging pests – millipedes, slaters and earwigs – in retained heavy stubble loads.

The issue	<p>The extent, severity and frequency of damage in crops during early crop establishment is increasing due to a range of ‘emerging’ invertebrate pests including earwigs, millipedes and slaters. While these invertebrates have been present in crop systems for some time, they have not traditionally been considered as pests.</p> <p>Broadleaf crops (canola and pulses) are especially prone to damage from these emerging pests. Impacts are primarily on crop establishment, however some issues have arisen with earwig contamination of canola at harvest.</p> <p>Earwigs, millipedes and slaters have emerged as significant invertebrate pests in minimum and no-till farming systems with high stubble loads. Stubble retention, reduced tillage and increased soil organic matter are thought to have provided a more favourable environment for these pests to survive and reproduce and therefore the size of these populations has continued to increase. There is a need to understand the interaction between stubble load and stubble management strategies on pest numbers.</p> <p>Currently there are no effective target-specific chemical control options to manage these pests. Current management generally relies upon the application or repeated applications of non-specific insecticides while these pests are thought to be feeding on crops. The effectiveness of this practice is highly variable and is not considered sustainable given the impact on beneficial species and the potential development of insecticide resistance.</p>
RCSN prioritising this issue	High rainfall zone and GRDC Southern Panel
What is needed to address the issue	<p>The development of an integrated pest management (IPM) strategy specifically designed for emerging pests is needed. The strategy should enable or include:</p> <ul style="list-style-type: none"> • an understanding of the specific biology, life cycle and behaviour of each pest – currently this is a key knowledge gap limiting the development of effective IPM strategies; • monitoring tools for growers and advisers to correctly identify presence of pests in crops, quantify pest numbers and the level of crop damage. Monitoring tools that are currently available include pitfall and refuges traps. Catches in these traps have not been correlated to pest densities feeding on crops and levels of crop damage. These pests regularly occur in combination and it is often difficult to identify and attribute crop damage to an individual pest or the combinations of these pests and other invertebrates such as slugs. Hence, the development of monitoring tools is required to enable an accurate identification of the damage caused by each of the individual pest species and an assessment of the relative levels of damage; • development of economic thresholds for pest species to guide growers and advisers with decisions on pest control; • a suite of cultural control tactics to manage pest populations to limit crop damage and economic losses to growers. For example, burning and tillage, which reduce stubble loads and available refuges, are considered to be effective strategies that can reduce the numbers of these pests. It is therefore important to better understand and evaluate how stubble retention and other cultural control strategies influence the population dynamics of these pests and the level of damage caused to establishing crops; and • a suite of chemical control tactics to manage pest populations to limit crop damage and economic losses to growers by identifying, evaluating and, if applicable, registering target-specific options for emerging pests.
RD&E actions in regards to this issue	While there is a range of RD&E activities underway to address pests, there is a need to incorporate a greater focus on emerging pests in these activities.
GRDC projects addressing this issue	<p>Current projects</p> <p><i>Stubble Initiative</i> – maintaining profitable farming systems with retained stubble, comprising research support (CSP00186), coordination and communication support (DAS00145) and component farming systems projects with specific focus on pests (EPF00001, CSP000174, LEA00002, MFM00006, MSF00003, RPI00009, UNF00002 and YCR00003).</p> <p>Projects commencing 2015-16</p> <p><i>Management of invertebrate pests on farms</i></p> <ul style="list-style-type: none"> • <i>Current invertebrate pest management options</i> (ICN00020) – a risk matrix across all grain crops on current invertebrate pest management options identifying vulnerabilities by pest and crop. • <i>Management of invertebrate pests on farms</i> (CSE00059) – further the knowledge of the life cycle and biology of grain pests and beneficial species in the southern and western regions, with a focus on the systems approach.

TABLE 21 Issue 15 – Effective strategies to manage the small conical snail to avoid grain contamination at harvest.

The issue	<p>The small pointed conical snail (<i>Prietocella barbara</i>) is a major pest in the high rainfall zone that causes significant crop damage to emerging and establishing crops and is a contaminant of grain. The extent and impact of this species of snail continue to increase.</p> <p>The use of an integrated management approach that includes a range of cultural practices and baiting is generally considered to be effective for the management of the two round snail species and the larger pointed conical snails. However, these strategies are not effective for managing the small pointed conical snail. This was confirmed by recent research that evaluated the efficacy of current strategies to manage <i>P. barbara</i> numbers.</p> <p>The climate, soil types, farming system and landscapes in the high rainfall zone favour the development of this snail species and are the key factors that limit the effectiveness of the current control strategies. It is thought that these conditions enable this species to survive and continue to reproduce over the summer period. Furthermore, current baiting options and practices are not effective.</p> <p>Investment is required to contain or limit the outbreak of the small pointed conical snail.</p>
RCSN prioritising this issue	High rainfall zone
What is needed to address the issue	<p>Research is required to gain an improved understanding of the specific biology, life cycle and breeding and feeding behaviours of <i>P. barbara</i>. Specific knowledge gaps include understanding the environmental conditions that trigger feeding activity and favour breeding and egg-laying of this species.</p> <p>Developing and evaluating strategies that will improve the effectiveness of current control strategies is also required. It is critical to understand why current management, particularly chemical (baiting) control, is ineffective and to investigate opportunities to increase the effectiveness of baiting. Further research and development is also required to identify and evaluate new and alternative control options.</p> <p>Extension to share knowledge and experiences in harvest and post-harvest strategies to exclude and remove <i>P. barbara</i> from grain is required in those areas where the small pointed conical snail is a relatively new pest.</p>
RD&E actions in regards to this issue	While there has been considerable RD&E in relation to slugs and other snail species, RD&E specific to the small pointed conical snail is required, and this will be addressed by existing GRDC investments.
GRDC projects addressing this issue	<p>Past project <i>Snail and slug control scoping study</i> (DAS00127)</p> <p>Current project <i>Improved management of snails and slugs</i> (DAS00134)</p> <p><i>Stubble Initiative – maintaining profitable farming systems with retained stubble - maintaining profitable farming systems with retained stubble in the south East and KI regions</i> (MFM00006)</p> <p>Projects commencing 2015-16 <i>Management of invertebrate pests on farms</i> (2015.03.10)</p> <ul style="list-style-type: none"> • <i>Current invertebrate pest management options</i> (ICN00020) – a risk matrix across all grain crops on current invertebrate pest management options identifying vulnerabilities by pest and crop. • <i>Management of invertebrate pests on farms</i> (CSE00059) – further the knowledge of the life cycle and biology of grain pests and beneficial species in the southern and western regions, with a focus on the systems approach.

TABLE 22 Issue 16 – Glyphosate resistance on irrigation farms.

The issue	<p>There has been increasing pressure on glyphosate-based herbicides in irrigated grains production in recent years, in terms of volume applied and frequency of application. On irrigation farms, non-production areas associated with farm infrastructure (e.g. channels, drains and roadways) present a larger proportion of the total farm area than on dryland grain farms.</p> <p>These non-cropped areas on irrigation farms are generally uneven in topography and prone to erosion with soil disturbance, therefore the only suitable control mechanism at present is the use of glyphosate herbicides.</p> <p>While there are residual herbicides that can be used to control weeds in non-production areas, their use is limited due to potential residues that can move with irrigation water into crop production areas. There is a wide range of layouts being used and sensitive crops being grown under irrigation. Hence the risk with herbicide residues.</p> <p>The regular and widespread use of glyphosate on irrigation farms raises concern about the potential development of glyphosate resistant weeds.</p>
RCSN prioritising this issue	Irrigation zone
What is needed to address the issue	<p>An understanding of the extent of glyphosate resistance on irrigation farms is required, in order to establish best management practices for its use in irrigated grain production. This will require:</p> <ul style="list-style-type: none"> • assessment of the level of glyphosate resistance of weeds in non-production areas of irrigation farms; • development of a best management practice (BMP) guide for weed control in non-production areas; and • assessment of the level of glyphosate resistance of weeds in crop areas of irrigated farms. <p>With an understanding of the extent of the problem, and growers' current approach, best management practices for glyphosate can be tailored to suit irrigation farms, and the information extended to growers through a BMP package for each crop type where glyphosate resistant weeds occur.</p>
RD&E actions in regards to this issue	While there is a wide range of ongoing RD&E to address herbicide resistance in grains production, it is largely targeted at dryland farms. While irrigated grain production has not been excluded, it has not been a specific focus. There are opportunities for targeted activities to address RD&E needs for irrigated grains within existing GRDC investments.
GRDC projects addressing this issue	<p>Current project</p> <p><i>Understanding and management of resistance to Group M, Group L and Group I herbicides (UA00124)</i></p> <p><i>Understanding and management of weed resistance to glyphosate (UA00104)</i></p> <p>Australian Glyphosate Sustainability Working Group</p>

TABLE 23 Issue 17 – White grain disorder.

The issue	<p>There is potential for lower returns to growers with downgrading or rejection of wheat grain due to market confusion between white grain disorder and fusarium head blight, the latter being a disease associated with harmful mycotoxins. Growers, advisers and researchers lack knowledge of the impact and management of white grain disorder.</p> <p>White grain disorder is typically associated with years of high annual rainfall. It causes bleached spikelets and white shrivelled grain. Wet periods after maturity will cause the grain to turn grey and then black due to formation of fruiting bodies. White grain disorder symptoms bear similarities to fusarium head blight or 'tombstone grain' caused by <i>Fusarium graminearum</i>, which produces a number of harmful mycotoxins. Consequently, bulk handlers are downgrading and rejecting grain deliveries based on visual assessment and uncertainty of the grain's safety for human and animal consumption.</p> <p>White grain disorder was first detected in Queensland and northern NSW in 1999 and, at that time, the causal agent was identified as <i>Botryosphaeria zeae</i>. Since 1999, white grain disorder has continued to occur sporadically in Queensland and NSW, sometimes at infection levels of 50% or more. In 2011, over 174,000 tonnes of wheat affected by white grain disorder were delivered to South Australian silos, with infection rates as high as 27%. Wheat affected by white grain disorder was first detected in Western Australia in 2013.</p> <p>It is now believed that more than one species can cause the disorder.</p>
RCSN/panel prioritising this issue	Southern Panel
What is needed to address the issue	<p>Growers and advisers require risk ratings for Predicta® B tests to be established for white grain disorder, to quantify how inoculum levels in the soil relate to disease expression. Growers and advisers also require new knowledge on white grain disorder from field trials that includes information on disease development and management options such as: use of fungicides; impact and effect of rotations, paddock preparation, and grain harvesting and handling. This knowledge needs to be coupled with information on how inoculum levels and environmental factors predispose a crop to the development of the disorder.</p> <p>Wheat breeders and bulk handlers require a reliable phenotyping ('quick test') method to differentiate white grain disorder from fusarium head blight, which includes a validated artificial inoculation method, for white grain disorder.</p>
RD&E actions in regards to this issue	New investment required
GRDC projects addressing this issue	<p>Project commencing 2015-16</p> <p><i>White grain disorder in wheat (DAS00154)</i></p>

TABLE 24 Issue 18 – ‘New’ fallow weeds.

The issue	Over recent years a number of ‘new’ fallow weeds have become prominent in the GRDC southern region. A significant number of these weeds have been common to grain-growing regions but traditionally limited to the northern region. The weeds that have spread south include fleabane, barnyard grass, windmill grass and feathertop Rhodes grass. A number of these weeds (fleabane, windmill grass and feathertop Rhodes grass) are particularly hard to control due to their natural tolerance of commonly used fallow herbicide glyphosate.
RCSN/panel prioritising this issue	Southern Panel
What is needed to address the issue	A review of the herbicides currently used to control these ‘northern weeds’ is required to ensure that all southern states have current herbicide registration. If the southern states are not covered then a project would need an additional component to commission work to facilitate herbicide registration. An education package needs to be developed for growers and advisers providing information on the biology, ecology, herbicide resistance status, northern region control methods and non-chemical control methods. This would provide additional detail to the GRDC fact sheets. A number of case studies could be included along with economic modelling of the cost of summer weeds to the following crop.
RD&E actions in regards to this issue	The issue is addressed in part by a range of past, current and new GRDC projects, however a specific new investment is required to address ongoing needs for this issue.
GRDC projects addressing this issue	Past project <i>Emerging weeds in changing farming systems</i> (UA00105) Current project <i>Improving IWM practice of emerging weeds in the southern and western regions</i> (UA00149) Project commencing 2015-16 <i>Emerging weeds – seedbank biology of emerging weeds</i> (AU00156)

TABLE 25 Issue 19 – Efficacy of propyzamide on trifluralin-resistant ryegrass.

The issue	The pre-emergent herbicide propyzamide is widely used as an alternative to trifluralin to control annual ryegrass (<i>Lolium rigidum</i>) in canola and pulse crops. Propyzamide is currently registered for use only in canola. Registration in pulse crops is expected. Concerns have been raised with the potential for cross resistance in annual ryegrass to trifluralin and propyzamide. Initial suggestions were that 10–20% of annual ryegrass populations resistant to trifluralin would also be resistant to propyzamide. If this proved to be the case, the effectiveness of rotating herbicides to propyzamide would be significantly limited for many growers.
RCSN/panel prioritising this issue	Southern Panel
What is needed to address the issue	The level of cross resistance in annual ryegrass needs to be defined across all major grain-growing regions in the southern and western GRDC regions where canola and pulses are the major non-cereal crops grown. The likely evolution of cross resistance between trifluralin and propyzamide needs to be understood to determine the useful life of propyzamide. Management guidelines for the use of propyzamide need to be developed to extend its useful life.
RD&E actions in regards to this issue	The issue is addressed by a range of current GRDC investments, therefore no new investments are required. Recent GRDC-supported research ⁸ has confirmed that there is: <ul style="list-style-type: none"> • no cross resistance between trifluralin and propyzamide in annual ryegrass; and therefore • it is possible to rotate between these herbicides, along with a third group (Sakura®, Boxer Gold® and Avadex®) from year to year in a 3-year rotation.
GRDC projects addressing this issue	Past projects <i>Review of the potential use and role of propyzamide for registration in pulse and oilseed production</i> (SGA00005) <i>Managing the risks of trifluralin and Group B resistance in no-till cropping systems</i> (UA00121) Current project Optimising the effectiveness of herbicides (UA00124, UA00144, UCS00020)

⁸ www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2015/02/Why-the-obsession-with-the-ryegrass-seed-bank

TABLE 26 Issue 20 – Improved management of barley grass.

The issue	<p>Barley grass has become a significant weed in some parts of the GRDC southern region. In order to improve the management of barley grass, a greater understanding of its ecology and the factors driving development of herbicide resistance is required.</p> <p>Selection pressure applied by current cropping systems is resulting in the development of significant populations of barley grass that germinate later in the season. This creates staggered germination throughout the season making it difficult for control strategies to be effective.</p> <p>Group A herbicide resistance has developed in many populations of barley grass. Some growers are reporting herbicide failure after only as few as three applications of Group A herbicide targeted at barley grass. The increasing prevalence of staggered germination is likely to exacerbate the development of resistance.</p>
RCSN/panel prioritising this issue	Southern Panel
What is needed to address the issue	<p>Improved understanding of the triggers for seed germination and establishment of barley grass in cropping systems in southern Australia is required.</p> <p>Integrated weed management control options for barley grass in cereals, canola and pulse crops need to be identified.</p>
RD&E actions in regards to this issue	The issue is addressed in part by a range of past, current and new GRDC projects, however specific new investments are required to address ongoing needs related this issue.
GRDC projects addressing this issue	<p>Past and current projects</p> <p>Various</p> <p>Projects commencing 2015-16</p> <p><i>Australian Herbicide Resistance Initiative - Phase 5 (UWA00171)</i></p> <p><i>Awareness and extension of herbicide resistance and IWM (RDP00015, Grain Weeds Advisory Committee)</i></p> <p><i>Surveillance of herbicide resistant weeds in Australian grain cropping (UCS00024)</i></p> <p><i>Mechanisms, evolution and inheritance of resistance (UA00158)</i></p> <p>Chemical management options for herbicide resistant weeds</p> <ul style="list-style-type: none"> • <i>Management of residual herbicides in broadacre cropping (THA00001)</i> • <i>New uses for existing chemistry (UQ00080)</i> • <i>Review of recent research on the use of residual herbicides (ICN00022)</i> <p><i>Widening the use pattern on diuron in Queensland broad acre cropping (AUE00001)</i></p> <p><i>Harvest weed seed control for the southern region (SFS00032)</i></p> <p><i>Cultural management options for herbicide resistant weeds (DAQ00197)</i></p> <p><i>Emerging weeds (seedbank biology of emerging weeds) (UA00156)</i></p>

TABLE 27 Issue 21 – Improved management of net blotch in barley.

The issue	<p>Two forms of the fungal disease net blotch exist in the GRDC southern region: 'net form' and 'spot form'.</p> <p>The net form of net blotch is regarded as one of the most damaging diseases of barley and in susceptible varieties can cause yield losses up to 80%.</p> <p>The spot form of net blotch historically has been considered to be less damaging than the net form. However, recent preliminary trials showed grain yield losses of up to 44% and significant reductions in grain plumpness where the disease was severe.</p> <p>Following are current observations with respect to both forms of the disease:</p> <ul style="list-style-type: none"> • the ability of growers and advisers to accurately identify disease symptoms varies widely and often misdiagnosis occurs; • new virulent strains have placed pressure on genetic resistance to the disease in some common barley varieties; • widespread cultivation of susceptible varieties places further pressure on genetic resistance and increases the level of disease pressure; and • there is reliance on fungicides for control of the disease. <p>Currently, resistant barley varieties and foliar fungicides are the most effective management options for both forms of the disease.</p> <p>Preliminary studies have identified different performance and relative strengths of various fungicide products. New fungicide types (SDHIs) require evaluation against existing formulations. A new seed-applied fungicide is showing potential for suppression of the spot form of net blotch and scald; however, disease suppression was better when combined with a foliar fungicide application of a different fungicide type.</p> <p>With respect to both forms of the disease, further RD&E is required to provide growers with:</p> <ul style="list-style-type: none"> • barley varieties with durable resistance to the disease; and • knowledge and information to enable informed decisions on barley variety selection and crop protection strategies to manage the disease.
RCSN/panel prioritising this issue	Southern Panel
What is needed to address the issue	<p>New barley varieties with durable resistance to both forms of the disease are required.</p> <p>R&D is required to refine the use in current farming systems of:</p> <ul style="list-style-type: none"> • foliar fungicide for control of both forms for the disease; and • new seed-applied fungicide for the spot form of net blotch.
RD&E actions in regards to this issue	<p>The issue is addressed in part by a range of past, current and new GRDC projects, however specific new investments are required to address ongoing needs related this issue.</p>
GRDC projects addressing this issue	<p>Current projects</p> <p><i>DEDJTR Pathology</i> (DAV00129)</p> <p><i>SARDI Pathology</i> (DAS00139)</p> <p>Centre for Crop and Disease Management – research programs:</p> <ul style="list-style-type: none"> • <i>Net Blotch of barley</i> • <i>Fungicide resistance</i> • <i>Improved farming systems</i> <p>Project commencing 2015-16</p> <p>Durable resistance to net form net blotch (GRDC Proposed Investment 2015.03.1509) – did not proceed due to competing higher priorities for funds; held over for future potential investment.</p> <p>Determining yield loss caused by spot form net blotch (GRDC Proposed Investment 2015.03.06D09) – did not proceed due to competing higher priorities for funds; held over for future potential investment.</p>

TABLE 28 Issue 22 – Improved management of rhizoctonia.

The issue	<p>Rhizoctonia root rot is an important disease of cereals in both the southern and western GRDC regions. The disease is caused by <i>Rhizoctonia solani</i>, a fungus that grows on crop residues and soil organic matter and is adapted to dry conditions and low-fertility sandy soils.</p> <p>Losses due to the fungal disease rhizoctonia in the GRDC southern region are estimated to be \$82 million⁹. Up to 50% of yield may be lost within individual paddocks in the region.</p> <p>Rhizoctonia is hard to control because:</p> <ul style="list-style-type: none"> • it is soil borne; • it has a wide host range that limits rotational control options; • it can grow and survive in the soil on organic residues without a live plant host (it is a saprophyte); and • there is no known resistance in crops grown in the GRDC southern region. <p>The frequency and severity of rhizoctonia appears to have increased in the last 10 years or so. This is attributed to a run of dry seasons. Dry seasons reduce the breakdown of the organic residues, thereby increasing the inoculum due to the saprophytic ability of the fungus. Less frequent rainfall events and the increased use of subsoil moisture to grow crops exacerbate the disease.</p> <p>The widespread adoption of reduced cultivation and no-till cropping systems has promoted the disease due to less breakdown of crop residues and disturbance of the fungus.</p> <p>Nutrient decline with intensification of cropping has also promoted the disease. Lower-fertility soils result in crops that are more prone to disease.</p>
RCSN/panel prioritising this issue	Southern Panel
What is needed to address the issue	Integrated RD&E is required to refine and extend a range of chemical and cultural control strategies for rhizoctonia.
RD&E actions in regards to this issue	The issue is addressed in part by a range of past, current and new GRDC projects, however a specific new investment is required to address ongoing needs related to this issue.
GRDC projects addressing this issue	<p>Past projects</p> <p><i>Better prediction and management of rhizoctonia disease risk in cereals</i> (CSE00048)</p> <p><i>Management of soil-borne rhizoctonia disease risk in cereal crops</i> (CSP00150)</p> <p><i>Fungicide control of rhizoctonia Part A</i> (DAS00125)</p> <p><i>Fungicide control of rhizoctonia Part B</i> (DAS00123)</p> <p><i>Fungicide control of rhizoctonia Part C</i> (DAS00122)</p> <p>Current projects</p> <p><i>Strategies to provide resistance to the economically important fungal pathogen, Rhizoctonia solani</i> (UWA00154)</p> <p><i>Innovative approaches to resistance to necrotrophic pathogens and sap-sucking insect pests</i> (UWA00145)</p> <p>Project commencing 2015-16</p> <p><i>Continuation of fungicide control of rhizoctonia</i> (DAS00125)</p>

⁹ Murray G and Brennan J (2009), *The current and potential costs of diseases of wheat in Australia*, GRDC, Canberra.

TABLE 29 Issue 23 – Extending the knowledge from the GRDC western region on herbicide-resistance management.

The issue	<p>As the GRDC reviews the current phase of the Australian Herbicide Resistance Initiative (AHRI) and looks to move forward into the next phase, consideration needs to be given to increasing the awareness of growers in the GRDC southern region of the seriousness of the herbicide resistance story in Western Australia.</p> <p>There is a consensus among many in the industry (growers and advisers) that the development of herbicide resistance in the eastern states is approximately 10 years behind WA.</p> <p>Thus growers and advisers need to be aware of the strategies used to combat herbicide resistance in WA, both chemical and non-chemical. Equally important is to know what herbicides are still working and what adjustment has been made to the management of herbicides to prolong their useful life.</p>
RCSN/panel prioritising this issue	Southern Panel
What is needed to address the issue	<p>A review of current WA weed control practices is required and the current level of knowledge among growers in the GRDC's southern region needs to be assessed.</p> <p>Extension experts from the GRDC's western region could be engaged to deliver information about the latest research and experience in practical management of herbicide resistance.</p> <p>An evaluation is required of non-chemical control practices currently used in the western region to combat herbicide resistance, such as chaff carts and the Harrington seed destructor, to understand the reasons for limited (or non) adoption of these technologies in the southern region.</p> <p>Case study information about how resistance developed on some farms in WA would assist eastern states growers and advisers make more informed choices on crop and herbicide rotations.</p>
RD&E actions in regards to this issue	The issue is addressed in part by a range of past, current and new GRDC projects, however specific new investments are required to address ongoing needs related this issue.
GRDC projects addressing this issue	<p>Projects commencing 2015-16</p> <p><i>Australian Herbicide Resistance Initiative – Phase 5</i> (UWA00171)</p> <p><i>Awareness and Extension of herbicide resistance and IWM</i> (RDP00015: Grain Weeds Advisory Committee)</p> <p><i>Surveillance of herbicide resistant weeds in Australian grain cropping</i> (UCS00024)</p> <p><i>Improved herbicide efficacy and longevity in southern no-till farming systems</i> (UA00144)</p> <p><i>Mechanisms, evolution and inheritance of resistance</i> (UA00158)</p> <p>Chemical management options for herbicide resistant weeds</p> <ul style="list-style-type: none"> • <i>Management of residual herbicides in broadacre cropping</i> (THA00001) • <i>New uses for existing chemistry</i> (UQ00080) • <i>Review of recent research on the use of residual herbicides</i> (ICN00022) <p><i>Widening the use pattern on diuron in Queensland broadacre cropping</i> (AUE00001)</p> <p><i>Harvest weed seed control for the southern region</i> (SFS00032)</p> <p><i>Cultural management options for herbicide resistant weeds</i> (DAQ00197)</p>

Theme 4 – Advancing profitable farming systems

TABLE 30 Issue 24 – More profitable and less risky ways to manage nutrition, pests, weeds and diseases following cereals.

The issue	Modern farming systems are heavily reliant on chemical inputs for fertility and for pest, weed and disease control. However, the price of fertilisers is expected to increase as reserves diminish and the price of all agrichemicals will also increase as petrochemicals become more expensive. Increasing incidence of resistance in weeds and pests to agrichemicals is making them less effective. Farming systems in the future must be less reliant on chemical inputs for maintaining fertility and controlling weeds, pests and diseases. The low rainfall zone has the opportunity to address the problem early – there are lessons to be learned from the other zones. Further, there is increasing community pressure against extensive use of agrichemicals in industrial agriculture.
RCSN prioritising this issue	Low rainfall zone
What is needed to address the issue	Improved cultural practices to be less reliant on chemical inputs to maintain fertility and control weeds, pests and diseases are required. This will be achieved primarily through extension of suitable cultural practices. In addition, there is scope for a ‘blue sky’ component in addressing this issue through novel strategies. The low rainfall zone has the opportunity to deal with the problem early by taking heed of lessons learnt in other zones. ‘I didn’t know’ cannot be an excuse when ‘solutions in a can’ become ineffective. Further, inexpensive pesticides have changed the spectrum of pests present; they have removed the easy-to-kill pests but others have taken their place. Therefore new practices are required to replace current management strategies.
RD&E actions in regards to this issue	A new investment specifically designed to address this issue has been developed by the GRDC. The project led by Central West Farming Systems (CWFS) involves a collaboration between three low rainfall farming systems groups (CWFS, Birchip Cropping Group and Mallee Sustainable Farming), SARDI and the Graham Centre at Wagga Wagga.
GRDC projects addressing this issue	Current projects <i>Over-dependence on agrichemicals (CFW00020)</i>

TABLE 31 Issue 25 – Poorly integrated livestock and cropping enterprises.

The issue	Most farm businesses in the low rainfall zone manage crop and livestock enterprises in an integrated system; however, over the past three decades livestock management skills and infrastructure have declined. This was initially due to poor profits from livestock following the removal of the floor price for wool, followed by less interest by the new generation of growers who are not familiar with livestock. As a result, profitability of livestock enterprises is low and key indicators of performance, such as weaning percentages, are generally low in the zone. Note: this issue is not seen as an issue necessarily for the GRDC but it is still important to the zone, nevertheless.
RCSN prioritising this issue	Low rainfall zone
What is needed to address the issue	Management skills for running livestock in low rainfall cropping areas need to be improved to lift the profitability of livestock enterprises. Further, well-managed grazing can improve the outcomes for cropping, as demonstrated by the ‘carbon paddock’ at Minnipa Ag Centre (Eyre Peninsula), Waite Research Institute and FarmLink (Lachlan Valley). Both research and extension are required to better integrate livestock and cropping enterprises in the low rainfall zone. Growers need information about, and demonstration of, more flexible livestock enterprises, modern technologies and appropriate infrastructure to manage livestock. Such information will enable growers to make better-informed investment and management decisions about livestock enterprises.
RD&E actions in regards to this issue	A range of new projects that address key elements of this issue commenced in 2014-15 as part of the GRDC’s investment Theme 4 – Advancing Profitable Farming Systems. While addressing a broader range of issues, these projects also have been designed specifically to address key RD&E gaps in relation to the better integration of livestock and cropping enterprises in the low rainfall zone.
GRDC projects addressing this issue	Current projects <i>Grain & Graze 3 – Extension and delivery on mixed farm benefits in the southern region</i> which is being delivered by a number of organisations including Southern Farming Systems (SFS), Birchip Cropping Group (BCG), Mallee Sustainable Farming (MSF), Ag Excellence Alliance (AEA) and Eyre Peninsula Agricultural Research Centre (EPARC)

TABLE 32 Issue 26 – Identifying, understanding and adapting robotic technology (including drones) for agriculture.

The issue	<p>The use of robotic and automation technology, including the use of drones, is being developed in other agricultural industries, but it appears not to be widely utilised in the Australian grains industry.</p> <p>Farm robotics and automation have the potential to reduce labour costs, provide labour (equivalent) units where there is a limited workforce, and improve the capability and capacity for data collection and management. There is considerable potential for automation of repetitive and laborious tasks, such as soil sampling and scouting for pests, weeds and diseases.</p> <p>Currently in Australia there is limited use of drones by a small number of growers and advisers to survey paddocks to assist in the management of weeds.</p> <p>Drones are also being used in North America to manage nitrogen in corn crops. This technology has the potential to provide a platform for the use of alternative (non-chemical) pest, weed and disease control measures. However, currently in the Australian grains industry drones are mainly being used for monitoring.</p> <p>It is considered that there is a diverse range of knowledge and isolated development in the use of agriculture-related robotic technology. The industry has not drawn together the combined knowledge of experts from agriculture and other relevant industries to explore potential developments that would benefit the Australian grains industry.</p> <p>The development of drones is more advanced than other types of robotic and automation technologies within the grains industry. However, growers and advisers are unaware of technological developments and applications, and their lack of knowledge and skills is an identified barrier to the development and adoption of this technology.</p> <p>The medium rainfall zone RSCN would like to see the identification and cost-effective adaption of robotic technology for use in broadacre agriculture in the medium to longer-term. The GRDC Southern Panel has also had input into the development of this issue.</p>
RCSN prioritising this issue	Medium rainfall zone and GRDC Southern Panel
What is needed to address the issue	<p>Robotic technology and automation for use in broadacre agriculture need to be identified and cost-effectively adapted.</p> <p>Growers and their advisers need to be provided with the knowledge and tools to understand and identify the opportunities and risks associated with adopting these technologies.</p> <p>Opportunities are required for growers, advisers and researchers to bring together all existing ideas and developments, through seeking out overseas technology, identifying who is developing it and possibly employing a key 'driver' to identify the opportunities and risks associated with adopting this technology.</p>
RD&E actions in regards to this issue	There is a range of GRDC investments that links to this issue. Some investments in crop protection (pest, weed and disease) and nutrition have key elements that are linked to the development of potential robotic and automation technology. While new investment is not required, the potential for robotic and automation technology needs to be considered in all applicable current and new investments.
GRDC projects addressing this issue	<p>Current projects</p> <p><i>Active implements for precision seed and fertiliser placement</i> (UNS00002)</p> <p><i>The use of drones to detect slug damage</i> (SFS00030)</p> <p>GRDC partnership with Cooperative Research Centre for National Plant Biosecurity (CRCNPB) – development of lightweight, on-the-go sampling devices (e.g. fungal spore traps) that could be mounted on autonomously controlled aircraft or unmanned aerial vehicles (UAVs).</p> <p>New project</p> <p>Automatic crop nutritional deficiency detection using aerial spectral images in wheat (GRDC Proposed Investment PFS45) did not proceed due to competing higher priorities for funds; held over for potential future investment.</p>

TABLE 33 Issue 27 – Brown manuring – an option to increase inclusion of legumes for more sustainable and diverse farming systems.

The issue	<p>Growing more legumes is critical for the sustainability of crop rotations and will make farming systems more sustainable and diverse. There is significant and growing interest in the potential of brown manuring legumes in continuous cropping systems across the medium rainfall zone of the southern cropping regions.</p> <p>Interest in and the practice of brown manuring is driven mainly by the need to manage herbicide-resistant weeds. An equally important and specific motivation for brown manuring of legumes is the desire to increase organic nitrogen in the soil, reducing the use and reliance on fertiliser nitrogen. Organic sources of nitrogen are less prone to denitrification and leaching, and support a more sustainable farming system. An additional driver for adoption is that legumes provide a break crop effect, which is important for managing diseases.</p> <p>Growers are generally unaware of the broad range of legume options in crop rotations and the relative benefits and potential disadvantages of each. The GRDC crop sequencing projects across the southern and western regions (CSP000146) have created awareness about opportunities for the increased use of legumes species in some regions and cropping systems. However, it is important to further expand this awareness to all regions and cropping systems and provide best management practice packages for brown manuring of legumes.</p> <p>Increased brown manuring of legumes in continuous cropping systems is anticipated to address declining nitrogen levels in cropping soils and provide an additional tool to manage herbicide resistant weed populations. Increased inclusion of legumes has the potential to increase the sustainability and diversity of farming systems.</p>
RCSN prioritising this issue	Medium rainfall zone
What is needed to address the issue	<p>RD&E is required to address a number of identified knowledge gaps in regards to brown manuring, including:</p> <ul style="list-style-type: none"> • crop or pasture options and species based on environment; • green versus brown manuring; • management of residues; • short-term annual legume versus a biennial or perennial phase of pasture legumes; • grazing management; and • use and timing of cultivation techniques. <p>It is essential that this research and development quantifies the impact that the management options listed will have on nitrogen levels and availability, weed seedbanks or populations, and disease levels.</p> <p>A wide range of legume options, including winter grazing followed by brown manuring of annual pasture legume species, needs to be demonstrated in the field, especially in areas not considered as 'premium' pulse growing areas, e.g. southern NSW, north-east and north central Victoria, and the lower Eyre Peninsula.</p> <p>In addition to field demonstrations, the range of options should be promoted by documenting the findings and using a range of extension methods.</p> <p>A comparison between nitrogen inputs from brown manured legumes, where residue is left on the soil surface, brown manured legumes, which are lightly incorporated, and green manured legumes is required to understand and potentially quantify the benefits of different options.</p> <p>A cost-benefit analysis is required to quantify the economic impact of growing legumes for manuring. This analysis should include the effects on the rotation, production and financial risk management.</p> <p>Extension activities are required, including field demonstrations across the identified targeted areas, to promote the opportunities of non-harvested legumes and effective management strategies and understanding of the risks and constraints of the different practices.</p> <p>Regionally specific best practice guidelines for growers and advisers need to be documented and published; and advisers require training in the benefits and methods of brown manuring.</p>
RD&E actions in regards to this issue	This issue will be addressed in a range of current pulse and legume projects. See also RD&E actions for related high rainfall issue (see Table 37, Issue 31).
GRDC projects addressing this issue	<p>Past project <i>Facilitating increased on-farm adoption of broadleaf species in crop sequences to improve grain production and profitability (CSP000146)</i></p> <p>Current project <i>Expanding the use of pulses in the southern region (DAV00113)</i></p>

TABLE 34 Issue 28 – Applying soil moisture knowledge over the whole production system.

The issue	<p>Knowledge of soil moisture is critical for growers to make decisions about crop options, inputs and grain marketing to manage both production and financial risks. However, less than one quarter of Australian dryland growers is monitoring soil water.</p> <p>There is ongoing work to increase the number of soils that has been ‘characterised’ in terms of plant available water capacity (PAWC). This information is accessible in SoilMapp. Soil characterisation data is an essential input to run the APSIM crop model which is the basis of the decision-support tool Yield Prophet® used by growers and their advisers.</p> <p>Soil characterisation includes both the drained upper limits (DUL) and crop lower limits (CLL) of the soil. DUL is defined as the amount of water that a particular soil holds after drainage has practically ceased. CLL is defined as amount of water that a particular soil holds after the crop reaches permanent wilting point (cannot extract any more moisture) or the extent to which a particular crop can extract water from a particular soil type. While the DUL of soils are not crop specific, the CLL are both crop and soil specific. Both DUL and CLL are required for accurate predictions of crop growth and yield in APSIM. Currently the majority of information on CLL is for wheat, with CLL information for other crops on many soils yet to be established. Due to the limited number of soil types characterised and CLL information for crops other than wheat, the usefulness of APSIM and Yield Prophet® to growers and their advisers is limited.</p> <p>Relatively new devices are available that enable continual measurement of soil moisture. Whilst none of these are 100% accurate, the capability to take repeated measurements over time makes them potentially valuable tools for monitoring changes in soil moisture. Therefore these devices can provide additional information to support and improve decision-making processes to manage crop production and financial risks, and identify opportunities. However, as there is a range of soil water monitoring devices available, there is confusion about which devices to use.</p> <p>It is also critical that growers and advisers have access to training to develop the required knowledge and skills to interpret and use information from soil moisture monitoring devices. Currently it is believed that soil moisture monitoring information is not fully utilised by growers to support and improve their crop management decisions.</p>
RCSN prioritising this issue	Medium rainfall zone
What is needed to address the issue	<p>Growers and advisers need improved soil water knowledge across the whole farming system (beyond wheat) so that they are able to make better-informed, tactical and crop-specific agronomy and marketing decisions.</p> <p>It is suggested that a ‘think tank’ or review of soil moisture knowledge would be a useful first step.</p> <p>Research and development is required to determine CLL for a greater range of crops (including pulses and canola) and pastures. It is important that these lower limits are determined over a number of seasons (a minimum of two) and at a number of sites to ensure that estimates are reliable.</p> <p>Further research and development is required to fill the gaps in the soil characterisation for key soil types across the medium rainfall zone.</p> <p>More extension, through training and support, is required to enable growers and advisers to make informed decisions for choosing both soil moisture monitoring equipment and decision-making tools, as well as interpreting and applying the information gathered.</p>
RD&E actions in regards to this issue	<p>There is ongoing investment to increase the number of soil types characterised, with CLL for crops in addition to wheat a key focus for GRDC.</p> <p>In addition, associated extension and training in the use of soil plant available water capacity (PAWC) and soil moisture monitoring are needed to assist growers and advisers with making more profitable crop management decisions.</p>
GRDC projects addressing this issue	<p>Current projects</p> <p><i>Measuring and managing soil water in Australian agriculture (CSP00170)</i></p> <p><i>New tools to measure and monitor soil moisture (USQ00014)</i></p>

TABLE 35 Issue 29 – Agronomic packages to increase yields of canola.

The issue	<p>Recent research has demonstrated the value of longer-season spring and winter canola genotypes to growers. Autumn sowing of longer-season spring canola offers growers the potential to either harvest for grain or to graze at the vegetative stage and still obtain significant grain production. Research and commercially grown crops have demonstrated that winter canola varieties can be sown in late spring or early summer, grazed over the summer and autumn period and then harvested for grain in the following summer. However, the best management agronomic packages are yet to be determined for the new genotypes.</p> <p>Based on the area sown to canola in 2006 (Australian Bureau of Statistics, 2006), if superior long-season spring types and winter types had been planted, an additional 40,000 and 17,000 tonnes of canola grain, respectively, could have been produced. Based on the five-year average canola price of \$486/t, this equates to an additional \$27.7 million per year in production. Selected European late spring and winter canola varieties have been evaluated in the high rainfall zone of southern Australia. However, complete agronomic and management packages that will maximise yield potential are yet to be determined.</p>
RCSN prioritising this issue	High rainfall zone
What is needed to address the issue	<p>To develop agronomy packages specifically for the high rainfall zone, so growers can achieve canola yields that are at least 60% of wheat yields, a range of RD&E is required.</p> <p>Further evaluation of a range of new late spring and winter canola varieties is needed.</p> <p>Research is required to gain an improved understanding of the phenological development patterns for a range of late spring and winter canola varieties, as well as the physiological responses to the environment of southern Australia to maximise grain yield and quality.</p> <p>Knowledge of the relationship between crop growth and nitrogen uptake to green leaf area index is also required. This will enable the use of in-crop nitrogen-sensing tools to provide real-time measurements of nitrogen availability, enabling more accurate decision-making for nitrogen management.</p> <p>R&D is also required to gain an understanding of the role and use of growth regulators in canola production in the high rainfall zone to reduce losses caused by lodging.</p> <p>Economic analysis is required to quantify the additional financial value to a farm business that incorporates grazing in the canola production systems.</p>
RD&E actions in regards to this issue	This issue is addressed by a range of RD&E investments by the GRDC spanning breeding, varietal evaluation (National Variety Trials) and agronomy. To complement these activities, there is a specific investment to address the needs of high rainfall growers in the southern region, as described below.
GRDC projects addressing this issue	<p>Current projects</p> <p><i>Stepping up grain production in the high rainfall zone of southern Australia</i> (DAV00116) – increasing crop production in the high rainfall zone through the identification of wheat and canola traits, including optimum phase duration in the crop life cycle and canopy architecture.</p> <p><i>Optimised canola profitability – understanding the relationship between physiology and tactical agronomy management - physiological and agronomic research across nine cropping zones in the GRDC southern and northern regions</i> (CSP00187)</p>

TABLE 36 Issue 30 – Understanding the impact and management strategies for foliar diseases in high yield potential canola crops.

The issue	<p>Foliar diseases are considered to be a significant factor limiting yield potential of canola crops in the high rainfall zone. The main foliar diseases include white leaf spot, blackleg pod and stem infections, sclerotinia, powdery mildew and alternaria. Infection and spread of these diseases in canola crops are promoted within the high rainfall zone as a consequence of increased humidity levels in crops (high rainfall, mild temperatures and high levels of vegetative growth) during the spring period.</p> <p>In recent years, anecdotal information suggests that there has been an increase in the range of diseases and levels of infection in canola crops across the high rainfall zone.</p> <p>A brief chronology of key canola foliar disease ‘events’ in the high rainfall zone is presented below.</p> <ul style="list-style-type: none"> • 2011: high amounts of powdery mildew were observed; • 2013: white leaf spot was seen to be much greater than in any previous year and significant yield losses were measured in trials; • 2011–13: alternaria and sclerotinia occurred regularly in crops when conditions were favourable for the development of the diseases; • 2013: seed loss due to pod splitting occurred in crops infected with alternaria. In addition, the disease also affected the quality of seed that was harvested from those infected crops; and • 2013: blackleg infection was more prominent than usual, with infections occurring on stems, branches and flowers. High levels of pod infection with blackleg also were noted in isolated higher rainfall districts – these are of concern given the potential ramifications for market access. <p>Growers in the high rainfall zone wish to be able to optimise canola yields in a production environment that is not limited by foliar diseases.</p>
RCSN prioritising this issue	High rainfall zone
What is needed to address the issue	<p>R&D specific to canola foliar diseases for the high rainfall zone is required to:</p> <ul style="list-style-type: none"> • evaluate the epidemiology of white leaf spot and determine the impact of the disease on grain yield and determine optimal control strategies; • determine the epidemiology of powdery mildew and the potential yield loss it can cause and determine cost-effective chemical control measures for late infections; • determine the potential grain yield loss from downy mildew and whether chemical control measures are warranted; • determine possible control measures for stem, flower, branch and pod infection of canola by blackleg; and • determine the epidemiology of alternaria and identify potential management strategies for the disease and/or to maintain the seed quality in affected crops. <p>In general, further R&D is required to identify and evaluate the effectiveness of specific disease management strategies, including the role and use of foliar fungicides. At an industry level, there is an identified knowledge gap that currently limits the ability to quantify yield responses to fungicide strategies.</p> <p>Integrated disease management (IDM) packages and decision-support tools are also required.</p>
RD&E actions in regards to this issue	<p>There is a range of existing and new investments in canola pathology and disease management. Based on a developing understanding of the increasing importance to high rainfall production zones, increased activity will be directed in areas of epidemiology and management of foliar diseases.</p>
GRDC projects addressing this issue	<p>Current projects</p> <p><i>National canola pathology program including new molecular knowledge, pathogen evolution and control technologies (UM00051)</i></p> <p><i>Improving grower surveillance, management, epidemiology knowledge and tools to manage crop disease in southern NSW (DAN00177)</i></p> <p>Centre for Crop and Disease Management – research programs</p> <ul style="list-style-type: none"> • <i>Sclerotinia stem rot of canola</i> <p>Project commencing 2015-16</p> <p><i>Emerging foliar diseases of canola (UWA00170)</i></p>

TABLE 37 Issue 31 – A viable legume phase or crop for the high rainfall zone on acidic and alkaline soils.

The issue	<p>Growers require profitable options for a nitrogen-fixing break crop or pasture that are suited to acid (<pH 6) and alkaline (>pH 7.5) soils in a high rainfall environment.</p> <p>The inclusion of a legume phase (either pulse crop, forage or pasture) is needed to manage herbicide-resistant weed populations, increase nitrogen fixation to reduce production, financial and environmental risks, reduce reliance on nitrogen fertilisers, and reduce the disease risk and pressure as a consequence of a cereal and canola rotation.</p> <p>Pulse crops grown on acid or alkaline soils are generally considered to be not as productive and profitable as wheat or canola. While there are pasture legumes options for high rainfall environments, the challenge is how to integrate these species practically and profitably into cropping systems.</p>
RCSN prioritising this issue	High rainfall zone
What is needed to address the issue	<p>The factors that currently limit pulse crop production need to be identified and potential strategies to overcome these factors need to be identified and evaluated.</p> <p>It is also important to identify and evaluate a range of legume species and varieties on acid and alkaline soils that could be adapted to high rainfall zone environments, including options for annual or short-term and phase or ley systems.</p> <p>The impact of the range of legume options and management strategies on weed seedbanks or populations of the key weed species needs to be quantified.</p> <p>Research is required to determine the capability of species to produce nitrogen and to understand the effect of different management strategies on nitrogen fixing and economics. This would also help to quantify the environmental benefits of growing legumes to produce organic nitrogen, including reducing nitrate contamination of waterways and groundwater.</p> <p>The feed value of legume forages and pasture options needs to be better understood to determine the value of these species to the livestock enterprise(s) or fodder products of the farming system.</p> <p>Adoption of legumes would be enhanced with identification of opportunities for use and markets for alternative pulse crops and pasture legume products.</p> <p>A cost–benefit analysis is required to quantify and compare rotational benefits of a range of options, and the role and uses of legume break crops in the farming system and business.</p> <p>Variety specific agronomy and management packages are required for the different legume species to optimise production, nitrogen fixation and the reduction of weed seedbank and populations of key weed species. The management strategies must include a comparison of a range of roles and options for pasture species in the farming system, including green or brown manuring, forage production (silage and hay), and grazing (annual and short-term phases of pasture).</p> <p>The benefits and options of a viable legume phase need to be determined and described so that the information can be demonstrated and extended to growers and advisers through a range of activities and products including trials/demonstrations, crop walks/field days, GRDC updates and grower case studies.</p> <p>Ultimately, the profitability and growing of legume crops and pastures will depend upon the development of new or alternative market opportunities for pulses and fodder.</p>
RD&E actions in regards to this issue	There has been a range of RD&E investments (past and current) with partial coverage of this issue. To address the gaps a specific new investment has been developed by the GRDC in response to this issue (see below).
GRDC projects addressing this issue	<p>Current projects</p> <p><i>Nitrogen fixing break crops and pastures for HRZ acid soils (DAN00191)</i></p> <p>Project commencing 2015-16</p> <p><i>Viable crop and pasture legumes for alkaline soils in the high rainfall zone (MFM0007)</i></p> <p><i>Poor nodulation of beans on Kangaroo Island (AKI00001)</i></p>

TABLE 38 Issue 32 – Plant growth regulators – compiling specific data on key interactions and filling the gaps in registrations.

The issue	<p>Plant growth regulators (PGRs) are a tactical management tool used to reduce the risk of losses caused by lodging in crops with high yield potential. The risk and frequency of crop lodging is higher in the high rainfall zone given high vegetative growth in crops arising from early sowing times, higher nitrogen inputs and extended growing season. Lodging causes significant yield loss, reduces grain quality, increases harvest losses and increases the cost of harvesting. PGRs reduce the stem height of the crop plants and therefore reduce crop lodging.</p> <p>PGRs have also been reported to enhance yield by improving the proportion of crop dry matter that is partitioned into grain yield. Limited data also suggest that the application of PGRs can increase root growth and therefore improve the potential ability of a crop to exploit and extract soil water and nutrients.</p> <p>Delayed sowing, and the timing and/or rates of nitrogen application are cultural strategies that reduce the risk of lodging. However, measures to reduce lodging (delayed sowing, later nitrogen applications and lower nitrogen rates) can significantly reduce yield potential. PGRs offer an alternative strategy to reduce lodging, as well as provide an opportunity for earlier sowing times and increased and timely nitrogen applications, which are key drivers of yield.</p> <p>However, results from the use of PGRs are highly unreliable and inconsistent and can be influenced by a number of factors and interactions. Anecdotal information from growers and advisers suggests that PGRs are being applied for many reasons other than just to reduce the potential risk and losses associated with lodging. It is considered that these perceived (tangible and intangible) benefits have not yet been adequately recognised or substantiated.</p>
RCSN prioritising this issue	High rainfall zone
What is needed to address the issue	<p>Research and development is required to better understand and predict the effects of PGRs on a range of agronomic parameters beyond yield and quality, including harvest index, nitrogen fixation, competitiveness against weeds, canopy and disease management, green leaf area retention, harvestability, and yield, grain and hay quality. Based on data generated from the research described, complete a cost–benefit analysis for the use of PGR application strategies for canola, wheat and barley, given a range of situations, including variable seasonal conditions and potential yields. This data will be valuable in providing evidence on which to base and promote the use of PGRs. This can then be used to further develop and improve a range of variety specific agronomy packages (VSAPs).</p> <p>A number of PGR products are already registered or have pending registrations for use in cereal crops. However, there are identified gaps including chlormequat (Cycocel®), which is currently only registered for use in wheat but it is expected to be potentially useful for barley as well. Use in barley is currently off label and requires work for registration to become an option for growers.</p> <p>It is necessary for PGR product registrations to include withholding periods for grazing of crops and stubbles (including straw), maximum residue limits (MRLs) and export slaughter intervals (ESIs). These details are important for producers and processors of grain and animal products in both domestic and export markets. Use of PGRs reduces the value and income that can be derived from grazing or agistment of stubbles and/or the sale of straw to intensive livestock producers and processors.</p> <p>Improving the accuracy of seasonal forecasts is critical as this information is the basis on which growers and advisers estimate yield potential, nitrogen requirements and thus the potential for lodging and therefore the use of PGRs.</p>
RD&E actions in regards to this issue	<p>A scoping study was conducted in 2013-14 to prepare a situation and needs analysis for the role of PGRs (UT00028). This investment will provide valuable information that will identify future research, development and extension needs.</p> <p>Two specific issues that fell outside the terms of reference for the scoping study were:</p> <ul style="list-style-type: none"> • the need to compile existing data to improve understanding and knowledge about the interaction between varieties, PGRs and nitrogen applications; and • gaps in product registrations, including: <ul style="list-style-type: none"> • chlormequat (Cycocel®) is currently only registered for use in wheat but may be suitable for barley; and • the need to establish and then include within the PGR products registrations withholding periods, maximum residue limits (MRLs) and export slaughter intervals (ESIs) for livestock grazing on straw and in stubble. <p>Future investments in RD&E are yet to be determined by the GRDC.</p>
GRDC projects addressing this issue	<p>Past investments</p> <p><i>Scoping study to provide GRDC with a situation and needs analysis relating to the current and future role(s) of PGRs (UT00028)</i></p>

TABLE 39 Issue 33 – Optimum time of sowing and agronomy packages to increase crop yields in the high rainfall zone.

The issue	<p>Crop yields in the high rainfall zone are limited by time of sowing and current agronomic practices.</p> <p>Time of sowing is a key factor that sets up the potential yield of winter crops in the southern region. Sowing time is specific to each variety as it determines the timing of the key development stages (particularly flowering), and their interaction with climatic stresses, including frost, water and heat. R&D has confirmed that given the range of environmental stresses across a growing season, earlier sowing of longer-season wheat varieties increases yield.</p> <p>The phenological development (timing of growth stages) of wheat varieties grown in the high rainfall zone is wide ranging and variable, and even more so where suitable varieties include both winter and spring types, which respond to either a vernalisation or photoperiod or a combination of the two.</p> <p>Capturing the opportunity and benefits of earlier sowing to increase yield and profits requires the adoption of specific agronomy packages to exploit the advantages and manage the adverse consequences of earlier sowing times.</p> <p>The adoption of variety specific agronomy packages (VSAPs) and therefore changes to current management practices for individual varieties will require a change in growers' attitude to perceived risk. Growers currently over-estimate the risk of high input cropping and frost but underestimate the impact of water and heat stress. Both water and heat stress risk increase with later sowing. Fundamental knowledge gaps are limiting the development of the required agronomy packages to capture this opportunity.</p>
RCSN prioritising this issue	High rainfall zone
What is needed to address the issue	<p>Information on the phenology of a range of crop varieties grown across the high rainfall zone is required and should be integrated with local climatic information to identify optimum windows for sowing.</p> <p>The development of VSAPs would provide integrated agronomy packages that are specific to an individual variety based upon local conditions.</p> <p>Trials and demonstrations, along with economic analysis that compares the VSAP approach to current 'district' practices, will be important to quantify and demonstrate the potential benefits of earlier sowing times and other management strategies, and thus provide the motivation for practice change.</p> <p>Gaps in knowledge and the availability of decision-support tools are also barriers to the implementation of practice change. Knowledge gaps identified include phenology data for major wheat varieties and the availability of localised climatic data.</p> <p>Other key knowledge gaps relate to the management of weeds, diseases (particularly wheat <i>Septoria triticii</i> and rusts), and pest species in early sown varieties and plant growth regulators.</p> <p>More knowledge about nitrogen management is required, as is an accurate nitrogen management decision-support tool.</p> <p>A lack of awareness of where to access relevant varietal information has also been identified. VSAP information must be developed to support the release of new varieties.</p> <p>Improving the capacity and skills of advisers and growers will be important to enable the adoption of VSAPs. More frequent and intensive crop monitoring and a higher level of management are also required to achieve higher yields.</p> <p>Further expand the network of soil moisture monitoring information and develop the skills of growers and advisers to interpret and apply this information to improve decision-making processes.</p>
RD&E actions in regards to this issue	The issue is addressed by a range of past, current and new GRDC projects.
GRDC projects addressing this issue	<p>Current projects</p> <p><i>Increasing yield and reducing risk through early sowing in the southern grains region – Part 2: National expansion (CSP00178)</i></p> <p><i>Stepping up grain production in the high rainfall zone of southern Australia (DAV00116)</i></p> <p><i>Variety specific agronomy packages for southern, central and northern NSW (DAN00167)</i></p> <p><i>Management of barley and barley cultivars for the southern region (DAN00173)</i></p> <p><i>Expanding the use of pulses in the southern region variety specific agronomy packages (DAV00113)</i></p> <p>Projects commencing 2015-16</p> <p><i>Agronomy to support expansion of feed grain production in Tasmania (FAR00003)</i> – variety specific management programs for the best lines, expanded to other high rainfall zone grain zones including the adaptation of best practice developed for high yielding crops such as targeted use of PGRs and nitrogen use efficiency.</p> <p><i>Nitrogen and water interactions (DAS00157)</i> – understand the interaction between soil moisture, seasonal forecast and soil nitrogen and its impact on nitrogen fertiliser decision-making.</p>

TABLE 40 Issue 34 – Nitrogen budgeting and management.

The issue	<p>Nitrogen management is a key driver of yield and profitability of all non-legume crops in most seasons within the high rainfall zone.</p> <p>Nitrogen budgeting remains an inaccurate science that can only be considered a 'best estimate' given that current decision-support tools rely upon a number of underlying assumptions and averages to estimate nitrogen inputs and losses.</p> <p>Improved knowledge and the development of technologies and tools that can accurately measure and calculate nitrogen requirements would significantly improve nitrogen management.</p> <p>In turn, better nitrogen management would lead to increased crop yields and/or quality because nitrogen inputs are progressively and efficiently matched to seasonal crop requirements.</p>
RCSN prioritising this issue	High rainfall zone
What is needed to address the issue	<p>Growers and consultants need to use a range of improved tools to more accurately and objectively budget and manage nitrogen to optimise yield and increase profitability.</p> <p>Growers and advisers need to be able to more accurately measure and quantify nitrogen requirements, inputs (mineralisation) and losses (denitrification, leaching, drainage and volatilisation). More accurate base information will significantly improve the accuracy of current nitrogen budgeting tools.</p> <p>Development of technology and tools that enable accurate, rapid and real-time measurements of in-crop nitrogen (status and availability) is needed. A tool that can measure nitrogen availability in real time is considered to be more effective than relying upon models and estimates.</p> <p>Nitrogen information then can be linked to soil–water data, which would be another step to significantly improve nitrogen management. Further development and calibration of integrated in-crop soil nitrogen to soil–water decision-support systems is also required.</p> <p>While there are tools and models to determine nitrogen requirements, such as nitrogen rich strips and crop sensors, more calibration is required to support the interpretation and application of the information collected.</p> <p>Development and extension is required to build and improve the skills of growers and advisers in understanding, interpreting and applying nitrogen and soil water crop models and decision-support tools.</p> <p>Expanding soil characterisation and crop rooting depth information for a range of soil types across the high rainfall zone will enable advisers and growers to have confidence to use crop models to better understand the movement of nitrogen.</p> <p>Further development is also required to improve the accuracy of seasonal climatic forecasts. The accuracy of forecasts is fundamental because seasonal weather conditions are the most important factor determining crop requirements and the economics (risk versus reward) of nitrogen fertiliser inputs. Seasonal forecasts will inform and influence the decisions of growers and advisers in determining rates, products and timing of nitrogen fertiliser applications.</p>
RD&E actions in regards to this issue	The issue is addressed by a range of past, current and new GRDC projects.
GRDC projects addressing this issue	<p>Past project <i>Evaluation of late nitrogen applications to achieve yield potential and increased protein content in wheat</i> (Fast track project SFS00025)</p> <p>Current projects <i>More profit from crop nutrition (MPCN) II – Improving nutrient use efficiency in wheat</i> (CSA00032) <i>MPCN II – Re-assessing the value and use of fixed nitrogen</i> (CSA00037) <i>MPCN II – Benchmarking wheat yield against nitrogen use</i> (DAS00147) <i>MPCN II – Improving nitrous oxide abatement in higher rainfall cropping systems and developing N response curves</i> (DAV00125) <i>Optimising the yield and economic potential of high input cropping systems in the HRZ</i> (DAV00141)</p> <p>Proposed projects for 2015-16 The following component projects of the Nutrient Initiative (GRDC Proposed Investment 2015.04.01) did not proceed due to competing higher priorities for funds; proposals will be held over for future potential investment.</p> <ul style="list-style-type: none"> • Nutrient performance indicators – benchmark the partial factor productivity, partial nutrient balance and agronomic efficiency of nitrogen, phosphorus, potassium and sulfur (GRDC Proposed Investment 2015.04.01C) • Organic matter and nutrient availability – understand and validate the estimates of nitrogen losses, in-season nitrogen mineralisation and nutrient performance indicators (GRDC Proposed Investment 2015.04.01D) • Regional tillage practices and the availability and uptake of phosphorus, nitrogen, potassium and sulfur – understand the impact of regional tillage practices on the availability and uptake of phosphorus, nitrogen, potassium and sulfur (GRDC Proposed Investment 2015.04.01E)

TABLE 40 CONTINUED PAGE 59

TABLE 40 (CONTINUED) Issue 34 – Nitrogen budgeting and management.

	<ul style="list-style-type: none"> • Nutrient stratification and sub-surface soil testing – define the strategies required to manage nutrient stratification in the northern and southern grains regions (GRDC Proposed Investment 2015.04.01F) • Nitrogen and water interactions – understand the interaction between soil moisture, seasonal forecast and soil nitrogen and its impact on nitrogen fertiliser decision-making (GRDC Proposed Investment 2015.04.01I) • Phosphorus requirements to accompany high nitrogen fertiliser levels – understand the interaction between nitrogen and phosphorus, in particular, the effect of soil phosphorus levels on optimum yield responses in wheat and canola to high rates of nitrogen fertiliser (GRDC Proposed Investment 2015.04.01J) • Tools for rapid, real-time measurement of nutrients – understand the feasibility and accuracy of tools for rapid, real-time measurement of nutrients and estimation of crop requirements (GRDC Proposed Investment 2015.04.01K) • Case studies – methods of nutrient application – seeks to understand and document the innovative use of nutrition application strategies, tools and technologies (GRDC Proposed Investment 2015.04.01M) • N, P, K & S fertiliser placement – aims to understand the impact of nitrogen, phosphorus, potassium and sulfur fertiliser placement on germination, seedling vigour, root growth, disease levels and soil nutrient levels in a range of crop types (cereals, canola and pulses) (GRDC Proposed Investment 2015.04.01N) • Deep placement of nutrients – aims to understand the yield and quality response of nutrient placement at depth (GRDC Proposed Investment 2015.04.01P) • Regional crop nutrition publications – develop a series of regionally specific electronic publications synthesising current crop nutrition knowledge for growers and advisers (GRDC Proposed Investment 2015.04.01R) • Managing legume and fertiliser nitrogen in the southern grains region – will develop a manual for southern grain growers explaining soil nitrogen, nitrogen cycling, fertiliser nitrogen and legumes in farming systems (GRDC Proposed Investment 2015.04.01S)
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TABLE 41 Issue 35 – Best management practice for irrigated barley.

The issue	There is renewed interest in irrigated barley, which was promoted by the shorter winter-crop growing season experienced in many irrigation areas in 2014. While tactical agronomy and crop sequencing have been well developed and extended for irrigated wheat, this is not the case for irrigated barley.
RCSN prioritising this issue	Irrigation zone
What is needed to address the issue	<p>Existing knowledge and information of best management practices for irrigated barley need to be reviewed to identify knowledge gaps that need to be updated in line with recent changes to irrigation layouts and new barley varieties.</p> <p>A series of trials is needed across the irrigation zone to evaluate new barley varieties under a range of irrigation management systems.</p> <p>Management practices for foliar diseases in barley need to be developed for irrigation farming systems. This could be achieved by adapting information from the high rainfall zone regarding the relationship between foliar fungicide and grain yield and quality.</p>
RD&E actions in regards to this issue	Existing projects partially cover this issue, however additional RD&E needs are yet to be prioritised for additional investment by the GRDC.
GRDC projects addressing this issue	Current projects <i>Management of barley and barley cultivars for the southern region (DAN00173)</i>

TABLE 42 Issue 36 – Irrigated durum wheat production.

The issue	Durum wheat has the potential to be a profitable option in irrigated cropping rotations. However, production is limited due to a lack of knowledge of crop agronomy specific to irrigated environments to optimise yield and meet durum wheat quality requirements. Further, a greater understanding of durum markets by growers is required to encourage the adoption of durum wheat within irrigated farming systems.
RCSN prioritising this issue	Irrigation zone
What is needed to address the issue	<p>Research is required to understand nitrogen and sulfur requirements of durum wheat under irrigation; and to understand nutritional management more broadly. There needs to be an understanding of the potential nitrogen input by legume/high nitrogen input rotations prior to durum wheat, as well as understanding nitrogen application rates, methods and timing, and what form of nitrogen to apply.</p> <p>From a disease management perspective, better understanding is required of the potential negative effects of carryover of disease from one cereal crop to another in intensive cereal rotations, and the potential for break crops to manage disease. Due to the susceptibility of durum wheat to crown rot, this is especially important.</p> <p>Research, demonstration and grain evaluation of existing varieties are required to understand the influence of the irrigated environment on grain quality, and the required variety specific management so growers consistently meet market specifications. Quality issues of particular note include hard vitreous kernels, gluten index and mixograph peak time and breakdown. Some of these characteristics may be influenced by soil type, therefore testing across a range of soil types common to the irrigation areas is important.</p> <p>For durum wheat to become a feasible option in irrigated cropping rotations, market analysis is required to understand the size of the market, variety performance in regards to market specifications, where durum wheat is being produced, and where current and future receival sites may be located in South Australia, southern NSW and northern Victoria.</p>
RD&E actions in regards to this issue	There are existing projects that partially address this issue, however these are not conducted in irrigation farming systems. Additional RD&E needs are yet to be prioritised for further investment by the GRDC. Further advice is required from the Irrigation Zone RCSN as to the requirement and nature of an irrigation-specific investment.
GRDC projects addressing this issue	No projects at the time of reporting

TABLE 43 Issue 37 – Increasing faba bean yields in the irrigation zone and growing them consistently.

The issue	<p>Renewed interest in irrigated faba beans has been promoted by high prices for faba beans in 2014.</p> <p>Faba beans potentially have a good fit in irrigated cropping rotations, however there is little knowledge about suitable faba bean varieties or crop agronomy for irrigated crop production.</p> <p>In 2014-15 there was only one site in the southern region that focused on irrigated varietal evaluation (UA00127), which was located at Kerang and hosted by the Irrigated Cropping Council. Unlike pulses in dryland production systems, there is no coordinated approach to the development of agronomy practices and extension regarding faba beans in irrigated production systems.</p>
RCSN prioritising this issue	Irrigation zone
What is needed to address the issue	A coordinated program of evaluation, information development and extension is needed across the irrigation zone. A suggested approach would be to establish variety trials at several locations across the zone, and have local grower groups undertake extension of the findings.
RD&E actions in regards to this issue	A fast track project was completed in 2014 as a scoping study (DAN00183) to compile a report of the current status of irrigated faba beans and identify current or expected limitations of the crop under irrigated farming systems based on previous reports, trials and discussions with key stakeholders. The Irrigation Zone RCSN is undertaking further consultation with industry to develop a proposed investment to address this issue and further advice is required by the GRDC from the Irrigation Zone RCSN as to the nature of an irrigation-specific investment.
GRDC projects addressing this issue	<p>Past project</p> <p><i>Irrigated faba beans – a profitable break crop for irrigators in southern regions</i> (Fast track project DAN00183)</p>

TABLE 44 Issue 38 – Holistic approach to the management of pests, weeds, diseases and nutrition.

The issue	<p>To reduce the reliance on purchased inputs (chemicals and fertilisers) and the development of resistance to crop protection products (in pests, weeds and diseases), there is a need to develop holistic approaches to input management.</p> <p>There is increasing interest from growers in holistic management systems that integrate both crops and livestock and focus on soil health.</p>
RCSN prioritising this issue	Southern Panel
What is needed to address the issue	<p>This issue requires the application of a farming systems approach to RD&E.</p> <p>For example, weed seed capture using chaff carts and resultant chaff heaps offer the potential to increase the viability of mixed farming enterprises. Chaff heaps have significant benefits to the livestock enterprise and to soil health. Chaff provides a source of feed during traditional late summer/autumn feed gap periods, whilst grazing offers the advantage of spreading the nutrient value of the chaff from a concentrated area to across the paddock. This practice offers options to address nutrient decline and drought-proof the livestock enterprise component of the business. There is potential for cost-effective options that provide multiple benefits for farm businesses.</p>
RD&E actions in regards to this issue	The issue is addressed by a range of past, current and new GRDC projects, and it was determined that a specific new investment was not required.
GRDC projects addressing this issue	<p>Current projects</p> <p>Various pest, weed and disease management projects.</p> <p><i>Stubble Initiative</i></p> <ul style="list-style-type: none"> • <i>Maintaining profitable farming systems with retained stubble in Victoria and Tasmania</i> (BWD00024) • <i>Maintaining profitable farming systems with retained stubble in Central West NSW</i> (CWF00018) • <i>Maintaining profitable farming systems with retained stubble on Upper Eyre Peninsula</i> (EPF00001) • <i>Maintaining profitable farming systems with retained stubble in NSW South West Slopes and Riverina</i> (CSP00174) • <i>Maintaining profitable farming systems with retained stubble on Lower Eyre Peninsula</i> (LEA00002) • <i>Maintaining profitable farming systems with retained stubble in the South-East and KI regions</i> (MFM00006) • <i>Maintaining profitable farming systems with retained stubble in the Mallee</i> (MFS00003) • <i>Maintaining profitable farming systems with retained stubble in the Riverine Plains region</i> (RPI00009) • <i>Maintaining profitable farming systems with retained stubbles in Upper North SA</i> (UNF00002) • <i>Maintaining profitable farming systems with retained stubble on Yorke Peninsula and the mid North of South Australia</i> (YCR00003) <p><i>Centre for Crop and Disease Management – research programs</i></p> <ul style="list-style-type: none"> • <i>Septoria nodorum blotch of wheat</i> • <i>Yellow leaf spot of wheat</i> • <i>Pulse Pathology and Genetics</i> • <i>Net blotch of barley</i> • <i>Powdery mildew of barley</i> • <i>Sclerotinia stem rot of canola</i> • <i>Fungicide resistance</i> • <i>Improved farming systems</i> • <i>Bio-informatics</i> <p>Projects commencing 2015-16</p> <p><i>Australian Herbicide Resistance Initiative – Phase 5</i> (UWA00171)</p> <p><i>Harvest weed seed control for the southern region</i> (SFS00032)</p> <p><i>Cultural management options for herbicide resistant weeds</i> (DAQ00197)</p>

TABLE 45 Issue 39 – Refining the practice of brown manuring.

The issue	<p>Brown manuring of legumes (pasture legumes or pulse crops) is a practice being adopted increasingly by growers, especially in southern NSW. The practice is considered one way for growers who have removed livestock from their operations to reduce some of the risks associated with total cropping in a drier climate. Brown manuring assists with weed control and improves nitrogen levels in the soil.</p> <p>A crop production system involving brown-manured legumes can be as profitable as continuous cropping and, even if it is slightly less profitable, the system has much lower operating costs and financial risk due to lower input requirements¹⁰.</p> <p>Brown manure cropping involves growing a pasture legume or pulse crop with minimal fertiliser and herbicide inputs to achieve maximum dry matter production before the major weed species set viable seed.</p> <p>The crop is sprayed with a knockdown herbicide before seed set to kill the crop and weeds, ideally no later than the start of pod development. This timing will also conserve soil moisture. A second knockdown herbicide is generally applied to achieve a 'double knock'. This is different to green manuring where the crop and weeds are cultivated and incorporated into the soil.</p> <p>As a relatively new practice, there are a number of aspects that require refinement. These include:</p> <ul style="list-style-type: none"> • choice of legume species and crop agronomy for optimising weed control and nitrogen fixation; • timing of brown manuring to optimise weed control and nitrogen fixation; • deciding to leave brown manure residue on the soil surface or incorporate – there is very limited knowledge on how much of the nitrogen in the above-ground legume residue is retained and available to following crops or how much is lost through processes such as leaching and volatilisation; the sowing of a following crop can be hindered by the legume surface residue (especially field peas residue), so incorporation of the residue can address this issue; and • the economics of different production environments and legume types.
RCSN/panel prioritising this issue	Southern Panel
What is needed to address the issue	<p>Knowledge generated from a farming systems approach to R&D would enable best management practices for brown manuring to be developed.</p> <p>Extension information and activities based on best management practices need to be developed.</p>
RD&E actions in regards to this issue	<p>The issue is addressed by a range of current and new GRDC projects, therefore it was determined that a specific new investment was not required.</p> <p>There is flexibility in the 'crop sequencing' project (CSP00146) to respond to growers needs with respect to this issue. The project is being undertaken in collaboration with farming systems groups across the GRDC southern region and therefore it is well positioned to address needs.</p>
GRDC projects addressing this issue	<p>Current projects</p> <p><i>Facilitating increased on-farm adoption of broadleaf species in crop sequences to improve grain production and profitability (CSP00146) – i.e. 'crop sequencing' project</i></p> <p><i>Expanding the use of pulses in the southern region variety specific agronomy packages (DAV00113)</i></p> <p>Proposed projects for 2015-16</p> <p>The following GRDC proposed investments did not proceed due to competing higher priorities for funds; proposals will be held over for future potential investment.</p> <p>Crop Rotations Initiative</p> <ul style="list-style-type: none"> • Identification and development of new crop or forage legume options for use in medium and low rainfall cropping systems (GRDC Proposed Investment 2015.04.04A) • Region specific management packages (GRDC Proposed Investment 2015.04.04B) • Economic analysis (GRDC Proposed Investment 2015.04.04C) • Fodder and forage legume rotational strategies (GRDC Proposed Investment 2015.04.05A) • Economic analysis of the benefits of including legume fodder and forage crops in rotational strategies in the medium and high rainfall zone (GRDC Proposed Investment 2015.04.05B) • Crop rotation/sequencing triggers (GRDC Proposed Investment 2015.04.09) • Managing legume and fertiliser nitrogen in the southern grains region (GRDC Proposed Investment 2015.04.01S)

¹⁰ www.grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-116-May-June-2015/Brown-manure-legumes-lower-total-crop-risk

TABLE 46 Issue 40 – Refining the use of soil nitrogen testing for improved nitrogen management.

The issue	Soil nitrogen testing is an important source of information to guide nitrogen management in crop systems. Deep soil sampling (greater than 60cm) for nitrogen can be conducted either pre-sowing or in-crop; thereby assisting with nitrogen management decisions throughout the season. However currently, soil testing is not widely practised and it is poorly conducted, so the potential benefits are not fully captured by growers.
RCSN/panel prioritising this issue	Southern Panel
What is needed to address the issue	An assessment of the current adoption of soil nitrogen testing is required to identify barriers to adoption and limitations of current application. Development and extension is required to encourage best management practice that includes the adoption of soil nitrogen testing.
RD&E actions in regards to this issue	The issue is addressed by a range of current and new GRDC projects, therefore specific new investment is not required.
GRDC projects addressing this issue	Current projects <i>More Profit from Crop Nutrition (MPCN) II – Regional soil testing guidelines for the southern region</i> (DAN00168) Projects commencing 2015-16 Nutrient Initiative – N, P & K <ul style="list-style-type: none"> • MPCN II – <i>Deep placement of nutrients</i> (UQ00078) • MPCN II – <i>Evaluating testing methods for phosphorus and potassium soil reserves</i> (UNE00022) • MPCN II – <i>Nutrient performance indicators</i> (IPN00003) • MPCN – <i>Nutrient stratification and sub-surface soil testing</i> (UA00155) • MPCN II – <i>Organic matter and nutrient availability</i> (UQ00079) • MPCN II – <i>Phosphorus requirements to accompany high nitrogen fertiliser levels</i> (UA00154) • MPCN II – <i>Nitrogen and water interactions</i> (DAS00157)

TABLE 47 Issue 41 – Nitrogen management in seasons with high yield potential.

The issue	<p>In seasons with above-average plant available water (stored soil water and/or in-crop rainfall), crop yield potential and nitrogen requirement are higher than normal. Growers and advisers are often unable or unprepared to capitalise on the opportunity for higher crop yield and profitability when presented with such seasons.</p> <p>This situation is typified by the common occurrence of very low grain protein in wheat crops (as low as 7% reported in commercial crops) in such seasons. Further, in this situation 'hidden' yield losses have occurred.</p> <p>For example, in parts of the southern Riverina of NSW, 80% of grain delivered (ASW) had protein levels down to 7%. Growers did not have any windows of opportunity to spread nitrogen throughout that season.</p> <p>Nitrogen management together with moisture management are important drivers of grain protein, grain yield and canola oil content.</p>
RCSN/panel prioritising this issue	Southern Panel
What is needed to address the issue	<p>There is a need for a better system of crop management based on better understanding of soil moisture monitoring, better nitrogen management skills and use of yield potential tools.</p> <p>Development and extension is required to assist growers to:</p> <ul style="list-style-type: none"> • identify yield potential and monitor moisture throughout the season; and • assess crop nitrogen requirements and apply nitrogen to meet crop demands
RD&E actions in regards to this issue	The issue is addressed by a range of current and new GRDC projects, therefore specific new investment is not required.
GRDC projects addressing this issue	<p>Current projects</p> <p><i>More Profit from Crop Nutrition (MPCN) II – Regional soil testing guidelines for the southern region (DAN00168)</i></p> <p><i>Measuring and managing soil water in Australian agriculture (CSP00170)</i></p> <p><i>New tools to measure and monitor soil moisture (USQ00014)</i></p> <p>Projects commencing 2015-16</p> <p><i>Nutrient Initiative – N, P & K</i></p> <ul style="list-style-type: none"> • <i>MPCN II – Nutrient performance indicators (IPN00003)</i> • <i>MPCN II – Organic matter and nutrient availability (UQ00079)</i> • <i>Regional tillage practices and the availability and uptake of phosphorus, nitrogen, potassium and sulfur – deep placement of nutrients (UQ00078)</i> • <i>MPCN II – Nutrient stratification and subsurface soil testing (UA00155)</i> • <i>MPCN II – Nitrogen and water interactions (DAS00157)</i> • <i>MPCN II – Phosphorus requirements to accompany high nitrogen fertiliser levels (UA00154)</i> • <i>MPCN II – Evaluating testing methods for phosphorus and potassium soil reserves (UNE00022)</i> • <i>MPCN II – Nutrient Performance Indicators (IPN00003)</i> • <i>Tools for rapid, real time measurement of nutrients (CSO00045)</i>

TABLE 48 Issue 42 – Reliable break crop options for low rainfall crop environments.

The issue	More reliable and profitable break crop options are required for low rainfall production environments of the GRDC southern region.
RCSN/panel prioritising this issue	Southern Panel
What is needed to address the issue	The issue needs to be acknowledged as long term and ongoing, and requires a farming systems approach in terms of RD&E, incorporating holistic management systems that integrate both crop and livestock production systems.
RD&E actions in regards to this issue	The issue is addressed by a range of current and new GRDC projects, therefore specific new investment is not required.
GRDC projects addressing this issue	<p>Current projects <i>Facilitating increased on-farm adoption of broadleaf species in crop sequences to improve grain production and profitability</i> (aka 'crop sequencing' project) (CSP00146)</p> <p>Projects commencing 2015-16 <i>A better understanding of the sociological factors influencing the adoption of break crop research</i> (DER00020)</p> <p>Proposed projects 2015-16 The following list of GRDC proposed investments did not proceed due to competing higher priorities for funds; proposals will be held over for future potential investment.</p> <p>Crop Rotations Initiative</p> <ul style="list-style-type: none"> • Identification and development of new crop or forage legume options for use in medium and low rainfall cropping systems (GRDC Proposed Investment 2015.04.04A) • Region specific management packages (GRDC Proposed Investment 2015.04.04B) • Economic analysis (GRDC Proposed Investment 2015.04.04C) • Fodder and forage legume rotational strategies (GRDC Proposed Investment 2015.04.05A) • Economic analysis of the benefits of including legume fodder and forage crops in rotational strategies in the medium and high rainfall zone (GRDC Proposed Investment 2015.04.05B) • Crop rotation/sequencing triggers (GRDC Proposed Investment 2015.04.09) • Managing legume and fertiliser nitrogen in the southern grains region (GRDC Proposed Investment 2015.04.01S) • Coordination and communication (GRDC Proposed Investment 2015.04.07) • Crop rotation/sequencing triggers (GRDC Proposed Investment 2015.04.09)

TABLE 49 Issue 43 – Variety specific agronomy packages (VSAP) for pulses.

The issue	<p>Access to variety specific agronomy information is understood to be a key factor underpinning the adoption of pulse crops.</p> <p>In order to support the inclusion of pulse crops in rotations, there is an ongoing need for the development of variety specific agronomy packages (VSAP) to keep pace with the development and commercial release of new pulse varieties.</p>
RCSN/panel prioritising this issue	Southern Panel
What is needed to address the issue	Ongoing integrated RD&E is required to develop and extend VSAPs for new pulse varieties.
RD&E actions in regards to this issue	This issue is addressed by a range of current and new GRDC projects, and current needs associated with the issue are met by projects that run through to end of 2015-16. Ongoing needs will be addressed by a specific new investment in 2016-17, which is yet to be developed.
GRDC projects addressing this issue	<p>Current projects <i>Expanding the use of pulses in southern region</i> (DAV00113) <i>Improving weed management in pulse crops through herbicide tolerance</i> (DAS00132) <i>Optimising nitrogen fixation of grain legumes – southern region</i> (DAS00128) GRDC–SARDI bilateral agreement</p>

Theme 5 – Improving your farm resource base

TABLE 50 Issue 44 – Uncertainty how climate change will impact on low rainfall agriculture.

The issue	Farming systems in the low rainfall zone have developed under a highly variable climate. However, predicted climate change will increase that variability even further, subjecting current production systems to a different and more difficult range of extremes. Predictions are that the environment will be warmer and rainfall less – neither of which are likely to improve productivity in the low rainfall zone.
RCSN prioritising this issue	Low rainfall zone
What is needed to address the issue	<p>Farming systems in the low rainfall zone require tools and technology to better adapt to and be more resilient to adverse and extreme seasons.</p> <p>Improved seasonal forecasting is required to enable better and more time-responsive planning within the season. For example, there needs to be an increase in growing crops for multiple end uses that can be decided during the growing season such as crops that can be harvested for hay or grain as the season unfolds.</p> <p>Training and education of growers and advisers is required to improve farm business and risk-management skills in light of climate change.</p> <p>Variety development is also required to introduce improved heat and drought tolerance to crops and pastures.</p>
RD&E actions in regards to this issue	There is a range of RD&E investments (past and current) that partially address this issue. To address the gaps, a specific new investment has been developed by the GRDC in response to this issue.
GRDC projects addressing this issue	<p>Current projects <i>Managing climate variability</i> – various projects</p> <p>Projects commencing 2015-16 <i>Impacts of climate on low rainfall and marginal areas</i> (CSA00053)</p> <p>Proposed projects 2015-16 The following list of GRDC proposed investments did not proceed due to competing higher priorities for funds; proposals will be held over for future potential investment.</p> <ul style="list-style-type: none"> • Climate change scenarios and impacts (GRDC Proposed Investment 2015.05.08A) • Climate forecasts (GRDC Proposed Investment 2015.05.08B) • Business management (GRDC Proposed Investment 2015.05.08C) • Crop management strategies (GRDC Proposed Investment 2015.05.08D) • Extension, communication, demonstration and validation (GRDC Proposed Investment 2015.05.08E)

TABLE 51 Issue 45 – Poor productivity of sandy soils.

The issue	Soil profiles in the low rainfall zone that consist of sand throughout the root zone or sand from the surface and throughout the majority of the root zone, are realising very low crop and pasture productivity. In these profiles, it is not uncommon for the subsurface layers to contain substantial amounts of free water immediately after harvest. This free water is lost productivity and profitability, and increases the farm's vulnerability to erosion and weed invasion. Although these soil profiles are universally low in inherent fertility and productivity, and may respond to increased fertilisation, this is not always the case. These soils continue to be an intractable zone on many farms.
RCSN prioritising this issue	Low rainfall zone
What is needed to address the issue	<p>A greater understanding of soil characteristics and crop management on these sandy soils is required to realise better water use efficiency and improve productivity and profitability. In turn, farm stability will also be improved. There are several likely constraints to improved productivity on these soils, including nutrient deficiencies (nitrogen, phosphorus, potassium, sulfur, trace elements or multiple combinations), compaction, acidity, root diseases and herbicide residues. However, strategies to address these constraints have not always been successful, or only partially so.</p> <p>Field work is required to identify the constraint or combination of constraints that cause poor productivity on sandy soils. The Low Rainfall Zone RCSN believes a fast track project would address the issue in the first instance.</p>
RD&E actions in regards to this issue	A scoping study was conducted in 2014 (MSF00004), of which the outcomes have guided the development of further specific investments by the GRDC to address this issue. This new investment will commence in 2016-17.
GRDC projects addressing this issue	<p>Current projects <i>Scoping of the nature, extent and impact of 'underperforming' sandy soils in the low rainfall crop production zone of GRDC southern region</i> (Fast track project MSF00004)</p> <p>Current projects As part of the Southern Region Agribusiness Trial Extension Networks, there are three projects in 2015-16 to address locally-specific issues related to under-performance of sandy soils:</p> <ul style="list-style-type: none"> • Field trials located west of Griffith, south-west NSW, conducted by Agrow Agronomy & Research (AGG00001) • Moisture profile on sandy soils conducted by Elders Ltd (AGG00002) • Field trials Northern Yorke Peninsula, SA conducted by Trengrove Consulting (TRE00002)

TABLE 52 Issue 46 – Understanding of subsoil constraints and the evaluation of machines and alternate substrates.

The issue	<p>Subsoil constraints such as acidity, sodicity, poor fertility and poor structure significantly limit the yield potential of crops across almost all regions of the high rainfall zone. These constraints limit root development and therefore the ability of the crop to access the water and nutrients stored in the subsoil.</p> <p>The amelioration of subsoil constraints potentially provides a range of medium to long-term benefits that may contribute to increased yields. These benefits include physical breaking and/or shattering of dense and sodic clay subsoils, improved soil structure, increased subsoil porosity and increased water infiltration. In turn, there will be shorter and fewer periods of waterlogging and associated deleterious effects, increased soil water holding capacity, and increased rooting depth for crops to access more moisture and nutrients. The benefits will ultimately lead to yield increases.</p> <p>A number of subsoil amelioration techniques and options have been developed to suit the variations within a range of specific soil characteristics. Experimental equipment has been developed and trialled by the DEDJTR[®] and La Trobe University since 2005 to enable the deep ripping incorporation of organic matter at depth. Southern Farming Systems has also established a trial to evaluate and demonstrate the effectiveness of a range of alternative organic (compost, stubble and green or brown manured crops) and inorganic (synthetic fertiliser) substrates and other less intrusive and expensive tillage (ripping and/or incorporation) systems.</p> <p>However, a lack of evidence and key knowledge gaps are limiting the ability to achieve consistent and reliable yield increases in response to subsoil amelioration, and it remains unclear what factors are driving yield increases following subsoil amelioration. There is a lack of understanding of which soil types and characteristics will be most responsive; and there is a lack of understanding of what is the most cost-effective amelioration technique given the large variation in subsoil characteristics.</p> <p>Engineering solutions exist for the amelioration of sodic and/or acid subsoils. However, adoption is limited by the lack of cost-effectiveness on a broad scale.</p> <p>Current trial work is a start to addressing the problems but there is still much to understand in order for growers to effectively and economically manage subsoil constraints.</p>
RCSN prioritising this issue	High rainfall zone
What is needed to address the issue	<p>It is essential that there is ongoing monitoring and evaluation of established trial and demonstration sites to measure the relative yields and longevity of treatments. It is also important that additional trial and demonstration sites are included to evaluate impacts of subsoil amelioration in a wider range of environments and on a wider range of soil types.</p> <p>Tools that can diagnose and map subsoil constraints on a paddock scale produce foundational information that is required to provide a basis for determining the most effective approach to amelioration and management of subsoil constraints. The development of diagnostic and mapping tools for subsoil characteristics and constraints at the paddock scale requires further research and development.</p> <p>Further research and development is also required to develop and evaluate engineering options and substrates that would provide a cost-effective system to ameliorate the identified subsoil constraints. The type of substrate will have ramifications for design and specifications of the engineering solutions.</p> <p>It is also important to evaluate a range of locally available and less expensive alternate organic substrates including in-paddock plant residues, including green and brown manure crops and nutrient enriched stubble.</p> <p>Variable application depth and rate technology, which is cost-effective on a broad scale, would provide greater flexibility and a more strategic approach to subsoil amelioration at a paddock scale. The potential for this should therefore be trialled and evaluated.</p> <p>Research and development is required to better quantify and understand the key factors that are driving the increases in yields following subsoil amelioration. It is also important that research and development provides a better understanding of the soil types and characteristics that would be most responsive to amelioration, and therefore identify the most effective approach to amelioration and management given the specific subsoil characteristics.</p>
RD&E actions in regards to this issue	<p>There is a range of RD&E investments (past and current) with partial coverage of this issue. To address the gaps a specific new investment has been developed by the GRDC in response to this issue.</p> <p>Further RD&E investment is expected as part of the subsoil amelioration component of the GRDC's National Soil Constraints Initiative included in the GRDC 2015-16 Investment Plan</p>
GRDC projects addressing this issue	<p>Current projects</p> <p><i>Mapping the extent of subsoil constraints and identifying the cost of subsoil constraints across the southern and western grains regions</i> (RSS00011)</p> <p>GRDC–DEDJTR Bilateral Research Agreement – <i>Scoping study related to soils outcomes for the high rainfall zone.</i></p> <p>Projects commencing 2015-16</p> <p><i>Soil Constraints Initiative – management of sodic and magnesic soils</i> (DAQ00200)</p> <p><i>Soil Constraints Initiative – innovative approaches to managing subsoil acidity</i> (DAN00206)</p> <p>Proposed project 2015-16</p> <p>Deep placement of nutrients – improved understanding of yield and quality responses to nutrient placement at depth (GRDC Proposed Investment 2015.04.01P) – did not proceed due to competing higher priorities for funds; held over for potential future investment.</p>

*Victorian Department of Economic Development, Jobs, Transport and Resources

TABLE 53 Issue 47 – Making informed decisions about irrigation layouts to maximise returns from water applied.

The issue	<p>Currently there are several innovations in the design of irrigation layouts that allow irrigators to grow different types of crops on the same layout and avoid the expensive task of reworking of layouts. However, what is lacking is a side-by-side comparison of these layouts under the same crop type or rotation, where volume of water applied and crop yield are measured.</p> <p>The information gained from such work would enable irrigators to make informed decisions on the design of their irrigation layout and the best crops to grow, in terms of return per megalitre, given a particular layout.</p> <p>This issue has been identified as increasing in priority as the water price for 2014-15 increased.</p>
RCSN prioritising this issue	Irrigation zone
What is needed to address the issue	<p>A research trial is required to measure a wide range of variables that are important to irrigation cropping enterprises. The information required from the trial would include crop yield, crop quality and profit for a range of crops, where several different watering strategies were applied, across different irrigation layouts. An essential component of the trial work would be to measure the volume of water applied.</p> <p>Irrigators require a decision-support tool that can process a wide range of variables, to give useful feedback about the best crop to grow in a given season on a given layout, taking into consideration the price of water. The information gathered from the research trial would be essential data on which to build the model that drives the tool.</p> <p>The extension aspect required to address this issue would involve the preparation of case studies that include details of measured crop water use, benefit–cost information about alternative modern layouts, the crop sequences being used and the performance of the crop sequences, as well as individual crops.</p> <p>Best management practices are required for cropping systems under different irrigation layouts, with a focus on target yields for wheat and canola.</p> <p>Given the large amount of information that would be generated and delivered, a series of grower meetings throughout the zone would be required to provide training in water use evaluation tools, such as gross margin templates and a water portfolio tool, to evaluate crop management best practice tools and to identify key information gaps.</p>
RD&E actions in regards to this issue	Existing projects provide limited coverage of this issue but additional RD&E needs are yet to be identified and prioritised for additional investment by the GRDC. Further advice is required from the Irrigation Zone RCSN as to the requirement and nature of an investment.
GRDC projects addressing this issue	No projects at the time of reporting

TABLE 54 Issue 48 – Examining the effectiveness of new layouts for irrigation set-ups.

The issue	<p>Irrigation growers need more information and support to assist them in making informed decisions on irrigated crop selection, water use and investment in irrigation layouts to optimise profitability.</p> <p>Currently there are a number of innovations in irrigation layouts which are allowing irrigation farmers to grow different crop types. What is lacking is a side by side comparison of these layouts under the one crop type or rotation where yield and ML of water applied are measured.</p> <p>Cotton is becoming an increasingly popular and viable crop choice in irrigated cropping rotations in the irrigation areas of the southern grain-growing region. However, there is no objective information about the interaction of cotton with other crops in the rotation, and how cotton performs on the different types of irrigation layouts used in southern irrigation regions.</p>
RCSN prioritising this issue	Irrigation zone
What is needed to address the issue	<p>Trials measuring crop yield, quality and profit under variable irrigation strategies in a range of crops and under different irrigation layouts. Actual water use would be one of the key measurements; with the aim of calculating relative financial returns from irrigation water use.</p> <p>A decision-support tool, process or model based on data from the above-mentioned trials, designed to assist growers with decision-making on irrigated crop selection, water use and investment in irrigation layouts.</p> <p>In addition to the above, development of grower case studies covering:</p> <ul style="list-style-type: none"> • measured crop water use; • benefits and costs of alternate modern layouts; and • crop sequences being used and the resulting crop performance. <p>Targeted extension activities would be conducted in each irrigation region associated with above activities.</p>
RD&E actions in regards to this issue	<p>To be considered by the GRDC along with the previous irrigation issue (see Table 53, Issue 47) as the two issues are linked. The two issues will be considered as one with the revised title: 'Increasing the capacity of irrigated grain growers to respond to significantly increased water value'.</p> <p>Additional RD&E needs are yet to be prioritised for additional investment by the GRDC. Further advice is required from the Irrigation Zone RCSN as to the requirement and nature of an investment.</p>
GRDC projects addressing this issue	No projects at the time of reporting

TABLE 55 Issue 49 – Digitising soil maps of the Murrumbidgee Irrigation Area.

The issue	<p>The soils of the southern irrigation areas were surveyed and mapped many years ago. Information from the paper maps for the Murray Irrigation Area and Districts and the Coleambally Irrigation Area have been digitised as part of a GRDC project (ICF00008). Digitisation is the process of converting information into a digital format, which for this issue means copying paper maps into a digital geographic information system (GIS).</p> <p>This process has not been undertaken for the soil maps of the Murrumbidgee Irrigation Area and Districts (MIA&D). Digital information can be used to efficiently assess soils for irrigation land use planning and analysis of irrigation production trends.</p> <p>Digitised information is also required for completion of the <i>Soils under an irrigated environment</i> (ICF00008) project.</p>
RCSN prioritising this issue	Irrigation zone
What is needed to address the issue	The digitisation of MIA&D soils maps is estimated to take four weeks of labour and require the purchase of GIS software.
RD&E actions in regards to this issue	This issue has been addressed by way of a contract variation to an existing project (ICF00008).
GRDC projects addressing this issue	<p>Project commencing 2015-16</p> <p><i>Soils under an irrigated environment</i> (ICF00008)</p>

TABLE 56 Issue 50 – Modifying soils to increase productivity and profitability.

The issue	<p>Estimates by SARDI suggest 40% (4.1 million hectares) of the area under broadacre agriculture in South Australia has soil issues limiting agricultural production that can be addressed with innovations in soil amelioration and crop husbandry.</p> <p>The area quoted above includes:</p> <ul style="list-style-type: none"> • 2.8 million ha of low fertility of sandy soils; and • 1.7 million ha of poorly structured, sodic clay subsoils that are hostile to plant growth. <p>There is clear evidence that these soils could be significantly more productive through the application of advances in soil science and management. There is potential for crop and pasture yield increases of 70% with amelioration.</p>
RCSN/panel prioritising this issue	Southern Panel
What is needed to address the issue	Application of a farming systems approach to RD&E.
RD&E actions in regards to this issue	<p>Past and existing projects provide partial coverage of this issue but a new investment is required to address ongoing needs associated with this issue.</p> <p>There is significant opportunity for collaboration with other organisations to address this issue. PIRSA has initiated a major program called 'New horizon', which has ambitious aims of increasing farm productivity by application of soil modification technologies that have been thoroughly proven through robust R&D. \$800,000 has been allocated in the first year by the state government to start the trial program and create leverage with other investors.</p>
GRDC projects addressing this issue	<p>Current project</p> <p><i>Application of controlled traffic in the low rainfall zone</i> (ACT00004)</p> <p>Projects commencing 2015-16</p> <p>Soil Constraints Initiative</p> <ul style="list-style-type: none"> • <i>Soil constraints initiative – coordination and communication</i> (DAQ00199) • <i>Soil constraints initiative – management of non-wetting soils</i> (CSP00195) • <i>Soil constraints initiative – innovative approaches to managing subsoil acidity in the southern grain region</i> (DAN00206) • <i>Soil constraints initiative – management of sodic and magnesic soils</i> (GRDC proposed investment 2015.05.06) – did not proceed due to competing higher priorities for funds; held over for future potential investment.

TABLE 57 Issue 51 – Management of non-wetting soils in no-till farming systems.

The issue	<p>Growers and advisers report that sandy soils are becoming more non-wetting with more time without tillage (no-till systems). In response, growers are considering returning to tillage to overcome the issue. Areas affected are commonly in lower rainfall environments, with widespread reports in the NSW, Victoria and SA mallee areas and the Upper Eyre Peninsula.</p> <p>The main issue with non-wetting soils is poor crop emergence. Yield losses are estimated to vary from 5% to over 30%, averaging 10% across the mallee. The total area of non-wetting sands in the SA Mallee is around 200,000 hectares. Modern farming systems (continuous/more intensive cropping, grass control, improved nutrition) have reduced the impact of non-wetting soils on productivity and profitability, compared with cereal rotations with grassy pasture breaks. Soil organic matter and health have also improved over time with modern practices.</p> <p>Good farm management practices are critical in minimising the effects of non-wetting on crop production. Furrow sowing has improved crop emergence and reduced non-wetting at the bottom of furrows, but the environment between the furrows has become more hostile.</p>
RCSN/panel prioritising this issue	Southern Panel
What is needed to address the issue	Application of a farming systems approach to RD&E is required. There is also potential for adaption and application of RD&E from the GRDC western region.
RD&E actions in regards to this issue	A new investment is required to specifically address this issue.
GRDC projects addressing this issue	<p>Projects commencing 2015-16 Soil Constraints Initiative</p> <ul style="list-style-type: none"> • <i>Soil constraints initiative – coordination and communication</i> (DAQ00199) • <i>Soil constraints initiative – management of non-wetting soils</i> (CSP00195)

TABLE 58 Issue 52 – Management of drainage and waterlogging.

The issue	<p>The need to manage drainage and waterlogging is placing restrictions on crop options (on sodic clay subsoils), especially in the high rainfall zones of Tasmania. However, the issue also occurs in other high rainfall areas of the GRDC southern region.</p> <p>Seasonal waterlogging and the development of perched watertables occurs over extensive areas of south-eastern Australia including Tasmania, in areas with high rainfall (>700mm) and duplex or texture contrast soils.</p> <p>In Tasmania, texture contrast soils occupy approximately 16.5% of the Tasmanian landmass, including much of the agricultural midlands. While extensively used for dryland cropping and grazing, these soils are under increasing demand for conversion to irrigated cropping, perennial horticulture and irrigated pasture (dairy).</p> <p>Duplex or texture contrast soils are associated with a range of management problems including waterlogging, poor crop establishment, crusting, poor root penetration, desiccation, wind erosion, water erosion, salinity, poor nutritional status, water repellence, poor water-holding capacity, low infiltration rates, and natural hard setting.</p> <p>During the early 2000s raised beds were commonly used throughout the Tasmanian midlands, especially for poppies. Raised beds are not common now and it is not understood why. Raised beds have been shown to work effectively in other high rainfall crop areas on texture contrast soils.</p>
RCSN/panel prioritising this issue	Southern Panel
What is needed to address the issue	Application of a farming systems approach to RD&E is required.
RD&E actions in regards to this issue	Past and existing projects provide partial coverage of this issue, however a new investment is required to address ongoing needs associated with this issue.
GRDC projects addressing this issue	<p>Projects commencing 2015-16 Soil Constraints Initiative</p> <ul style="list-style-type: none"> • <i>Soil constraints initiative – coordination and communication</i> (DAQ00199) • <i>Soil constraints initiative – management of non-wetting soils</i> (CSP00195) • <i>Soil constraints initiative – innovative approaches to managing subsoil acidity in the southern grain region</i> (DAN00206) • <i>Soil constraints initiative – management of sodic and magnesic soils</i> (GRDC Proposed Investment 2015.05.06) – did not proceed due to competing higher priorities for funds; held over for future potential investment.

Theme 6 – Building skills and capacity

TABLE 59 Issue 53 – Mentoring for the development and retention of skilled advisers.

The issue	<p>The transition from formal study to skilled agronomic adviser takes up to 10 years. Training and support in the first two years after graduation are crucial for the development and retention of quality advisers within the grains industry. However, the limited availability or lack of established and available support and mentoring programs is constraining the number of graduates successfully making the transition.</p> <p>Mentoring is considered to be the most effective strategy to support the development and retention of grains industry advisers during the early stages of their careers. Currently, mentoring occurs on an ad hoc basis and its importance and value is not widely recognised. The reduction in public advisory services in the grains industry and its replacement with private extension providers has considerably diminished the opportunities and processes for mentoring. Currently there are very few individuals with the required knowledge and skills to provide the necessary support.</p> <p>Anecdotal evidence suggests that many agricultural graduates and fledgling advisers have become disillusioned with their roles due to a lack of mentoring rather than a lack of technical training or traineeships. As a consequence, they are leaving the industry during the critical formative years of their career. Further anecdotal evidence suggests that unrealistic expectations, confusion and frustration about directions and pathways for careers in the grains industry are also contributing to the loss of advisers early in their careers. The potential of those who stay in the industry is inhibited by a lack of support for their ongoing development given a reluctance of employers to make this investment given the potential threat of staff leaving the organisation or business.</p> <p>A range of segments within the grains industry has confirmed the relevance of this issue. Tight budgets and a lack of programs and services are limiting the opportunities for farm staff to access required mentoring to support their development in farm businesses. Commercial agribusinesses tend to invest in training that is linked to the success of their businesses. Therefore, training is generally focused on the development of specific technical skills in weed, disease, pest and nutrition management and generally does not focus on the whole farm system, trial design and protocols, managing people, communication and extension skills, succession, finance and marketing.</p> <p>A system is required to develop and retain skilled agronomic advisers in the grains industry. These advisers need a refined skill set and understanding of the whole farming system, not just a focus on production systems, as well as practical skills, including applied research and development.</p>
RCSN prioritising this issue	Medium rainfall zone
What is needed to address the issue	<p>A study to explore and review a range of different models and programs for mentoring (not training) is required. This study needs to identify the most appropriate models of mentoring for the grains industry that could then guide a coordinated, industry-funded program.</p> <p>A pilot project is needed to test and evaluate a number of models of mentoring to support and develop the skills of advisers during the early stages of their careers.</p> <p>Opportunities to incorporate or link mentoring activities and outputs within GRDC projects and develop linkages with existing mentoring programs in related industries, should also be explored. It would also be prudent to explore funding opportunities to leverage GRDC or industry investment.</p>
RD&E actions in regards to this issue	GRDC acknowledges this issue and seeks to address it with a range of ongoing investments under investments made in Theme 6 – Building Skills & Capacity.
GRDC projects addressing this issue	<p>Current projects</p> <p><i>Extension, adoption, training and support program</i> (ACC00006)</p> <p>GRDC Grower and Adviser Development Program: see www.grdc.com.au/Apply/Grower-and-Adviser-Development</p>

TABLE 60 Issue 54 – Transfer of agronomic (research and systems) knowledge from overseas to local high rainfall zone conditions and farming systems.

The issue	<p>Recent introductions of canola and barley varieties from Europe have shown that European genetic material can be successfully grown in the high rainfall zone of southern Australia, which has a similar environment to parts of Europe. The yields of the European varieties have been higher than those of varieties bred in medium rainfall areas of Australia. For example, in trials and by modelling, late spring canola varieties have shown to be capable of producing higher grain yields compared with shorter season spring types.</p> <p>Growers and advisers in the high rainfall zone have recognised the benefits of not only the genetic material from overseas but also the agronomic knowledge and experience available in the UK, which could be transferred and adapted to local conditions to further increase crop production in the high rainfall zone.</p> <p>To maximise benefits to the grains industry it is important that researchers and more particularly advisers and growers are able to capture new and innovative agronomic developments from Europe.</p> <p>It is critical that new and innovative developments identified as having potential in Australia are evaluated and adapted for local conditions. Communicating and extending the potential innovations early in the development phase, to a wide audience, will be essential to recognise the opportunity to adapt and apply these ideas.</p>
RCSN/panel prioritising this issue	High rainfall zone
What is needed to address the issue	<p>A process is required to transfer agronomic knowledge (research and systems) so that the high rainfall zone community can identify and develop opportunities and strategies to increase crop yields in the high rainfall zone.</p> <p>The most effective approach to maximise the uptake of the most recent agronomic information and development from Europe would be to sponsor or host agronomy, farming systems and plant physiology specialists from Europe. It is suggested that the identified specialists would be based in the high rainfall zone of the GRDC southern region for a period of perhaps one month each. These hosted visits would provide opportunities for RD&E staff, advisers and growers to meet with these experts, providing a platform for grains industry stakeholders to explore potential opportunities and ideas for adaption or application in the high rainfall zone of the southern region.</p> <p>The above suggested approach would not only identify and develop opportunities to increase grain production in the high rainfall zone but would also build important relationships to enable local and international collaboration. This approach would also further develop the capability of the grains industry community within the high rainfall zone.</p>
RD&E actions in regards to this issue	Existing projects provide partial coverage of this issue, and additional RD&E needs are yet to be prioritised for additional investment by the GRDC.
GRDC projects addressing this issue	<p>Current project</p> <p><i>GRDC Grains Research Updates</i> (ORM00014)</p> <p><i>Technical Workshops</i> (ACO00001)</p> <p>GRDC Grower and Adviser Development Program: see www.grdc.com.au/Apply/Grower-and-Adviser-Development</p>

TABLE 61 Issue 55 – Improving skills and expertise to support the development of improved farming practices in the high rainfall zone.

The issue	<p>There is a lack of skills, knowledge and expertise across all sectors of the grains industry, and especially in the high rainfall zone farming systems and environments, limiting the opportunity to increase yields and profitability.</p> <p>In the 1990s there was a rapid increase in cropping across the high rainfall zone of south-eastern Australia. Crop production has continued to increase, more significantly, as a result of improvements in crop genetics and agronomic management systems. However, based on results of modelling there remains a substantial opportunity to increase yields.</p> <p>Improved skills, knowledge and expertise among all sectors of industry participants (growers, farm staff, farm contractors, agronomists, advisers, and research and extension providers) will provide the capability and capacity required to develop and adopt improved agronomic practices that would lead to increased crop yields and profits.</p>
RCSN prioritising this issue	High rainfall zone
What is needed to address the issue	<p>A range of strategies is required to ensure that each sector is specifically engaged to foster active participation in identifying, planning and delivering research, development and extension outcomes. However, it is also important that each sector comes together to develop collaborative relationships to ensure that research, development and extension delivery can be integrated and coordinated.</p> <p>It is important that the skills, knowledge and expertise are developed specifically for the high rainfall zone farming systems. It is also important that there are mechanisms to assess and validate or adapt information and knowledge to unique local and environmental conditions to the high rainfall zone.</p> <p>The current level of the required skills and knowledge is highly variable across and within the regions of the high rainfall zone. Hence, the starting point for any investment would be to have a clear understanding of the current situation in terms of skills and knowledge required, and what and where the gaps are. It would also be important to understand the current range and geographical influences on the processes for developing skills and knowledge. These understandings are necessary to identify and develop appropriate strategies. It would also be important to understand the reach and influence of the communication and extension networks and then identify the gaps and opportunities to increase the coverage, influence and effectiveness of networks.</p>
RD&E actions in regards to this issue	<p>Existing projects provide partial coverage of this issue. Additional RD&E needs are yet to be prioritised for additional investment by the GRDC.</p> <p>Key current investments addressing this issue are with development and extension activities being undertaken by farming systems groups as part of the GRDC Stubble Initiative: Southern Farming Systems (SFS), Mackillop Farm Management Group (MFMG), Agriculture Kangaroo Island (AgKI) and Mid North High Rainfall Group (MNHrg).</p>
GRDC projects addressing this issue	<p>Current project</p> <p><i>Maintaining profitable farming systems with retained stubble in Victoria and Tasmania (BWD00024)</i></p> <p><i>Maintaining profitable farming systems with retained stubble in the South-East and KI regions (MFM00006)</i></p> <p><i>Maintaining profitable farming systems with retained stubble on Yorke Peninsula and the mid North of South Australia (YCR00003)</i></p>

TABLE 62 Issue 56 – Governance skills for farming systems groups.

The issue	<p>Farming systems groups are driven by grower volunteers and play an important role in general development and extension (D&E) and a prominent role in farming systems D&E.</p> <p>While many volunteers are competent at running farm businesses, many do not have a range of management skills and ability to run small not-for-profit organisations. Group financial turnover ranges from tens of thousands to several million dollars each year.</p> <p>Balancing and managing resources to undertake and manage project investments takes a lot of skill and boards made up of farmer volunteers are largely responsible and accountable for group project management. Most of the volunteers have no training in project management, staff management, group governance, or science and extension principles.</p> <p>The turnover of leadership roles in farming system groups can result in leaders having little or no governance expertise within a role that requires good governance knowledge. It is imperative that the groups are aware of the governance requirement for leaders and provide appropriate training.</p>
RCSN/panel prioritising this issue	Southern Panel
What is needed to address the issue	Farming systems groups require leaders with necessary skills and governance procedures in place to manage D&E projects.
RD&E actions in regards to this issue	Existing projects provide partial coverage of this issue, however additional needs are yet to be prioritised for further investment by the GRDC.
GRDC projects addressing this issue	Current project <i>Stubble Initiative – Component 1 – Regional communication and coordination support (DAS00145)</i>

TABLE 63 Issue 57 – Trial design and evaluation skills for farming systems groups.

The issue	<p>Farming systems groups are driven by grower volunteers and play an important role in general development and extension (D&E) and a prominent role in farming systems D&E.</p> <p>Due to turnover of personnel and lack of opportunities for linkages with research partners, some farming systems groups have inadequate knowledge and skills in trial design and statistical analysis.</p> <p>The ability for the GRDC to meet local D&E needs can be limited by the lack of a suitably skilled farming systems group.</p>
RCSN/panel prioritising this issue	Southern Panel
What is needed to address the issue	<p>Farming systems groups require knowledge and skills to design, manage and analyse results of D&E projects. The knowledge and skills could be acquired via:</p> <ul style="list-style-type: none"> • suitably qualified personnel; and • partnerships with research providers. <p>Access to suitably qualified personnel could be achieved through a combination of support of tertiary education and on-the-job training. Partnerships can be facilitated through the design of GRDC investments and encouragement and support of research partners.</p>
RD&E actions in regards to this issue	Existing projects provide partial coverage of this issue, however additional needs are yet to be prioritised for further investment by the the GRDC.
GRDC projects addressing this issue	Current project <i>Stubble Initiative – Component 1 – Regional research support (CSP00186)</i>

5. Issues to action

The value of the Regional Cropping Solutions Network (RCSN) is being demonstrated by the clear links between the issues identified by the RCSNs and many of the new programs, projects and products that are being instigated through the Grains Research and Development Corporation (GRDC) investment process. The GRDC is using the information that the RCSNs submit about priority issues, in terms of gaps in current knowledge and tools, and actions required to address the issues, to invest in RD&E at a local and national scale. The input of the RCSNs into the GRDC investment planning process helps make the investment of the grains R&D levy relevant and valuable to grain growers.

Local action

Fast track projects were an investment pathway introduced by the GRDC in 2012-13. Fast track projects were designed to give the grains industry an opportunity to be responsive to localised, seasonal and tactical issues, which are best addressed with timely, small-scale, small-budget projects. The projects are generally in-season, delivered within short

timeframes (usually no longer than 12 months) and instigated where the speed of response is critical to meeting industry needs.

To date, fast track projects in the GRDC southern region have looked at issues such as slug control and snail baiting, and have enabled herbicide-resistance surveys to be carried out. Some of the data from fast track projects have formed the foundation of information used in larger GRDC investments. For example, herbicide-resistance data from a one-year, in-crop study in the low rainfall zone – where a large amount of herbicide resistance was not expected – highlighted to the GRDC Southern Panel and the GRDC that herbicide resistance is in fact an issue for the whole of the southern region, including the low rainfall zone, and for Australia in general.

Since their establishment in 2012, the RCSNs have instigated and seen the completion of 10 fast track projects in the southern region (Table 64). More detailed project information about fast track projects is presented in Appendix B.

TABLE 64 RCSN fast track projects for 2012-13, 2013-14 and 2014-15 in the GRDC southern region*.

Fast track project	RCSN zone	GRDC Project Code [#]
2012-13		
Testing retained sowing seed of hybrid canola in a range of rainfall zones	High rainfall	YCR00001
Quantifying herbicide resistance in farming systems in the Griffith region	Low rainfall	AGG00001
Preliminary evaluation of fungicide efficacy for control of eyespot in wheat and extension of cost-effective management strategies	Medium rainfall	AAG00002
Improving snail bait distribution	Medium rainfall	YPA00002
2013-14		
Evaluation of management strategies to effectively control slugs in the HRZ region	High rainfall	SFS00023
Broadleaf herbicide resistance targeted survey of the Victorian Wimmera-Mallee	Medium rainfall	BWD00023
Evaluation of late nitrogen applications to achieve yield potential and increased protein content in wheat	High rainfall	SFS00025
Irrigated faba beans – a profitable break crop for irrigators in the southern region	Irrigation	DAN00183
Scoping of the nature, extent and impact of ‘underperforming’ sandy soils	Low rainfall	MSF00004
Evaluating the use of precision agriculture technology to increase the efficacy of slug baiting systems in no-till cropping systems	High rainfall	SAM00001

* See 2013-14 RCSN annual report for details of 2012-13 and 2013-14 fast track projects.

[#] Final reports for projects can be accessed from GRDC website at http://finalreports.grdc.com.au/final_reports.php and entering the project code listed in this table

Regional and national action

The 2015-16 investment plan demonstrated that the issues and information presented to the GRDC by the southern region RCSNs and the GRDC Southern Panel are contributing to the planning of RD&E investments.

A summary of the considerations by the GRDC of the issues identified as priorities by the RCSNs and the panel for the 2014-15 investment cycle is presented in Table 65.

Of the 57 priority issues put forward by the RCSNs and the panel in 2014-15, eight issues were addressed directly through new specific or broader GRDC investments in the 2015-16 GRDC investment plan and 22 issues were addressed by new and ongoing GRDC investments. There were 21 issues presented that were already addressed by ongoing projects and five issues that required further consideration in future investment cycles. One issue will be addressed by the GRDC's collaboration with other industry organisations.

TABLE 65 Priority issues identified by RCSN groups in 2014-15 that will be addressed by new, broader or ongoing RD&E investments by the the GRDC in 2015-16.

#	ISSUE	GRDC INVESTMENT
THEME 1 – MEETING MARKET REQUIREMENTS		
1	Grain classification systems	Collaboration with other industry organisations
2	Independent market information on grain quality	Ongoing broader project
3	Agronomy for durum grain quality	Ongoing broader projects
4	Grain marketing training	New broader project
THEME 2 – IMPROVING CROP YIELD		
5	Access to well-adapted canola varieties	Ongoing broader projects
6	Crop varieties and management for late autumn breaks	Ongoing broader projects
7	More accurate assessment of longer-season wheat varieties	Ongoing broader projects
8	Increasing the area sown to pulse crops	New broader projects
THEME 3 – PROTECTING YOUR CROP		
9	Weed science is under-resourced and reactive	New & ongoing broader projects
10	Advancing and extending knowledge of the behaviour of major weed species for better implementation of integrated weed management in the GRDC southern region	New & ongoing broader projects
11	An understanding of the economic impact of yellow leaf spot	Ongoing broader projects
12	A farming systems challenge to increase the longevity of crop protection chemicals and reduce the resistance risk	New & ongoing broader projects
13	Management of a range of weeds with resistance to multiple herbicide groups	New & ongoing broader projects
14	Improved understanding to manage emerging pests – millipedes, slaters and earwigs – in retained heavy stubble loads	New & ongoing broader projects
15	Effective strategies to manage the small conical snail to avoid grain contamination at harvest	New & ongoing broader projects
16	Glyphosate resistance on irrigation farms	Ongoing broader projects
17	White grain disorder	New specific project
18	'New' fallow weeds	New & ongoing specific projects
19	Efficacy of propyzamide on trifluralin-resistant ryegrass	Ongoing broader projects
20	Improved management of barley grass	New & ongoing broader projects
21	Improved management of net blotch in barley	New & ongoing specific projects
22	Improved management of rhizoctonia	New & ongoing specific projects
23	Extending the knowledge from the GRDC western region on herbicide resistance management	New specific projects

TABLE 65 CONTINUED PAGE 76

TABLE 65 (CONTINUED) Priority issues identified by RCSN groups in 2014-15 that will be addressed by new, broader or ongoing RD&E investments by the GRDC in 2015-16

#	ISSUE	ORIGINATING ZONE
THEME 4 – ADVANCING PROFITABLE FARMING SYSTEMS		
24	More profitable and less risky ways to manage nutrition, pests, weeds and diseases following cereals	Ongoing broader project
25	Poorly integrated livestock and cropping enterprises	Ongoing broader project
26	Identifying, understanding and adapting robotic technology (including drones) for agriculture	New & ongoing broader projects
27	Brown manuring – an option to increase inclusion of legumes for more sustainable and diverse farming systems	Ongoing broader project
28	Applying soil moisture knowledge over the whole production system	Ongoing broader project
29	Agronomic packages to increase yields of canola	Ongoing broader project
30	Understanding the impact and management strategies for foliar diseases in high yield potential canola crops	New broader project
31	A viable legume phase or crop for the high rainfall zone on acidic and alkaline soils	New specific project
32	Plant growth regulators – compiling specific data on key interactions and filling the gaps in registrations	Future investments in RD&E are yet to be determined
33	Optimum time of sowing and agronomy packages to increase crop yields in the high rainfall zone	New & ongoing broader projects
34	Nitrogen budgeting and management	Ongoing broader projects
35	Best management practice for irrigated barley	Ongoing broader project
36	Irrigated durum wheat production	Future investments in RD&E are yet to be determined
37	Increasing faba bean yields in the irrigation zone and growing them consistently	Future investments in RD&E are yet to be determined
38	Holistic approach to the management of pests, weeds, diseases and nutrition	Southern region
39	Refining the practice of brown manuring	Southern region
40	Refining the use of soil nitrogen testing for improved nitrogen management	Southern region
41	Nitrogen management in seasons with high yield potential	Southern region
42	Reliable break crop options for low rainfall crop environments	Southern region
43	Variety specific agronomy packages (VSAP) for pulses	Southern region
THEME 5 – IMPROVING YOUR FARM RESOURCE BASE		
44	Uncertainty how climate change will impact on low rainfall agriculture	Low rainfall
45	Poor productivity of sandy soils	Low rainfall
46	Understanding of subsoil constraints and the evaluation of machines and alternate substrates	High rainfall
47	Making informed decisions about irrigation layouts to maximise returns from water applied	Irrigation
48	Examining the effectiveness of new layouts for irrigation set-ups	Irrigation
49	Digitising soil maps of the Murrumbidgee Irrigation Area	Irrigation
50	Modifying soils to increase productivity and profitability	Southern region
51	Management of non-wetting soils in no-till farming systems	Southern region
52	Management of drainage and waterlogging	Southern region
THEME 6 – BUILDING SKILLS AND CAPACITY		
53	Mentoring for the development and retention of skilled advisers	Medium rainfall
54	Transfer of agronomic (research and systems) knowledge from overseas to local high rainfall zone conditions and farming systems	High rainfall
55	Improving skills and expertise to support the development of improved farming practices in the high rainfall zone	High rainfall
56	Governance skills for farming systems groups	Southern region
57	Trial design and evaluation skills for farming systems groups	Southern region

Appendices

A. Identifying critical industry issues to determine RD&E

A key role of each RCSN is to identify the critical issues affecting growers in their rainfall zone and to ensure these are identified, captured and appropriately addressed on a priority basis by the GRDC. Ultimately, the RCSNs are working to ensure the future long-term prosperity of the grains industry in each rainfall zone. Issues are typically identified by members' networks, broader industry feedback, observation and/or experience, and are reported back to the RCSN at the scheduled meetings or via out-of-session correspondence.

GUIDED CONSIDERATION

With hundreds of issues presented and discussed annually, the RCSN members work to clearly understand and define the issue, and identify the gaps in knowledge, technology and extension in regards to the issue. 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 problem or opportunity and how does it fit within the context of the farming system? How is it limiting production, or, more importantly, profit? Is it common to most growers in the district or limited in extent? What contribution will finding a solution make to individual farm profit, risk management and overall economic impact. How likely is it that the solution will be adopted?

2 What is already known? Have we explored the literature 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? Do we need to do further work or would it be better to share the current know-how with other scientists and growers? Understand the funding requirements.

3 Review what type of work is needed. Do we need to generate a solution through research and do we have the resources and scientific capability? Or should we engage someone else with greater experience and skills? Will the research just provide technical information or can we add a profitability dimension? Or, if there is already a body of knowledge (see step 2), should we concentrate on validating that information in our district, either by a simple small plot trial or larger demonstration strips in grower paddocks? Or should we just move straight to extending the known information?

4 What value is the solution? Having generated a possible technical solution what difference will it make to production and profitability. 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 industry deliver the information so that growers are confident to build it into their decision-making? Do we use demonstrations, field days, farmer discussion groups or something else? What is the role of the commercial sector in extension (for example private consultants)? How are we going to measure the level of adoption and understand the reasons why some growers do or do not adopt? 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 and determining what can be learnt 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 further more structured analysis to identify and define what RD&E is required to address the issue – the process is called program logic.

USING PROGRAM LOGIC

The program logic approach identifies 'practice changes' that would address the issue. A practice change is described as 'how things can be done differently once an issue is addressed'.

Using this approach, members can visualise what practices they believe can realistically be adopted by various stakeholders (growers, consultants, industry, government) in an ideal, yet commercial, environment.

Once the practice change has been identified then 'what is stopping growers from adopting the practice change' is determined. Is it motivation, attitude, knowledge, ability or tools?

This process is called the MAKAT process and it provides a structured way to identify the biggest hurdles to overcoming an issue. That is, is it:

- Motivation?
- Attitude?
- Knowledge?
- Ability?
- Tools?

The MAKAT approach is primarily used to expand participants' thinking on an issue, rather than going straight to a solution (for example, more trial sites!), to help drill down to define the activities/actions required to achieve the desired practice change. The MAKAT process also considers where the audience is now and where it needs to be in the future.

- Issue 'justification' – what is the evidence that this issue is a problem, is it just the squeaky wheel?
- Defining the outcome(s) – how do growers want the issue to look after the activity?
- Define the practice changes that are needed to get to the outcome.

The GRDC has adapted the program logic concept, which demonstrates the logic pathway to achieving the desired outcome, from Cameron Nicholson (Figure A1). While this process challenges many RCSN members' natural thinking styles, it has proven very successful as it prevents members from diving straight into 'solution mode' without having first considered the desired outcome. It has also been successful in providing GRDC program managers with a comprehensive insight into each issue and helps develop a sound project proposal.

To date, the program logic process has enabled each RCSN to generate:

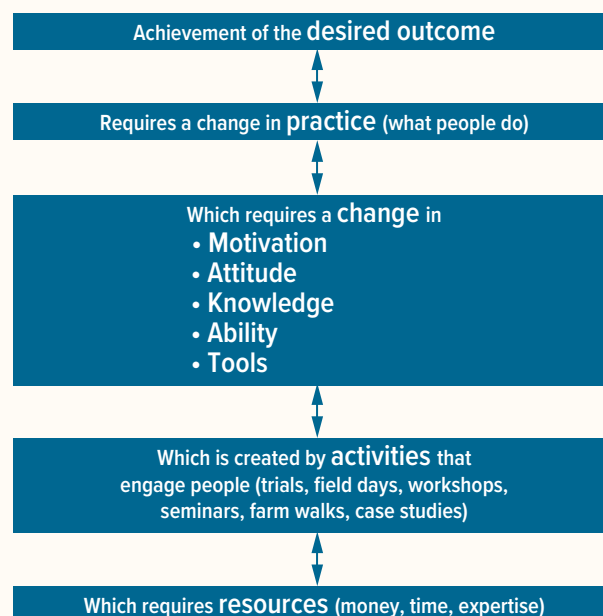
- a list of key issues;
- prioritised practice changes required to address each key issue; and
- a MAKAT completed for the top priority practice changes, as well as key activities (RD&E) identified to create change (which is a work in progress).

Once a MAKAT has been completed for a specific issue, it is fed back to the GRDC, via the GRDC Southern Panel and manager regional grower services – south. The feedback on issues contributes to the formulation of the GRDC's investment program on an ongoing basis.

The information from the MAKATs that have been completed for specific issues is collated by the RCSN facilitators and supplied to the GRDC, via the Southern Panel and regional staff, to contribute to the formulation of the GRDC's annual investment program.

The information from the process also provides solid points of reference about the issue, which can be used to monitor the performance of any investment made in regards to the issue.

FIGURE A1 The program logic process used by the RCSNs identifies the practice changes, resources and actions that are required to address priority issues.



Southern Regional Cropping Solutions Network

CONTACT DETAILS (2014-15)*

Low Rainfall Zone RCSN facilitators

Nigel Wilhelm
0407 185 501
nigel.wilhelm@sa.gov.au

Naomi Scholz
0428 540 670
naomi.scholz@sa.gov.au

Medium Rainfall Zone RCSN facilitators

Jen Lillecrapp
0427 647 461
hrznetwork@bigpond.com

Tony Craddock
0417 809 317
tcraddock@ruraldirections.com

High Rainfall Zone RCSN facilitators

Jen Lillecrapp
0427 647 461
hrznetwork@bigpond.com

Trent Potter
0427 608 306
trent@yeruga.com.au

Former Irrigation Zone RCSN facilitators

Rob Fisher
0428 545 263
vicc@dragnet.com.au

Bree Laughlin
0409 529 883
bree.laughlin@irrigatedcroppingcouncil.com.au

Keith Pengilley
Chair, GRDC Southern Panel
0448 015 539
kgpengilley@bigpond.com

*The contact details listed above were correct at the time of writing this report.
Should they be incorrect please contact the GRDC to obtain the latest RCSN contacts.



GRDC, PO Box 5367, Kingston ACT 2604 T 02 6166 4500 F 02 6166 4599