GRDC INVESTMENTS ADDRESSING A SELECTION OF ISSUES – LOW RAINFALL ZONE RCSN – April 2018

Issue No. 9 – Hard to control weeds.

Growers have observed an increase and/or ingression of "hard to kill" weed species in low rainfall districts. It is suggested that this may be attributed to a number of factors including seasonal conditions, changes in rainfall and temperatures, modern farming systems and practices, selection and shifts in weed ecology. Important hard to kill weeds include Fleabane, Feathertop Rhodes Grass, Windmill Grass, Button Grass, Gazanea and Statice. These weeds are not well controlled with blanket sprays. Understanding the ecology and cost effective management practices for low rainfall farming systems is required to reduce the impact of hard to kill weeds.

<u>GRDC investments addressing this issue</u>

Locally important weeds (DAW00257)	This project will undertake research to quantify the biology and ecology of eight (8) locally important weed species, 4 in the western region and 4 in the southern region. The weed species have been selected following a consultation process with the Regional Cropping Solutions Network (RCSN) and major Grower groups, with the final input and decision coming from GRDC. Weed species include matricaria (Oncosiphon spp.), marshmallow (Malva parviflora), stinking lovegrass (Eragrostis cilianensis) and Feathertop Rhodes grass (Chloris virgata) in the western region and Lincoln weed (Diplotaxis tenuifolia), wild vetch (Vicia sativa), caltrop (Tribulis terrestris), and Lake Boga poppy (Hypercoum pendulum) in the southern region. These weeds are of local importance but have not been the subject of major prior research projects.
Emerging weeds (seedbank biology) (UA00156)	Changes in farming systems, farm management practices and climate are changing the weed spectrum across the wheat-belt of Australia. Many weed species that tended to be weeds of pasture (i.e. barley grass) have now escalated to become serious weeds of crops. These changes in weed spectrum are contributing to the $3.3 billion cost of weeds to the Australian grains industry through lost production and increased costs of control (Llewellyn et al. 2016). In order to achieve more effective control of these emerging weeds, growers are now seeking information on their behaviour especially on seedbank persistence. However, information on seed biology and persistence of weed seedbanks of many of the emerging weeds in Australia is largely unknown. Furthermore, much of the Australian research on weed seed biology was undertaken prior to the intensification of cropping and before the introduction of no-till systems. It is quite likely that the behaviour of many weeds may have changed considerably in response to the changes in crop management practices. Increasing our knowledge of seed dormancy, seedling emergence patterns and seedbank persistence of emerging weed species will assist growers in making more informed decisions on weed management. OBJECTIVES – 1. To quantify the effect of maternal environment (e.g. site rainfall) and management history on the expression of seed dormancy in selected weed species in the southern, western and

	northern regions. 2. To determine seedbank persistence of selected weed species in southern, western and northern regions. 3. To investigate the effect of site rainfall and seed burial depth on the persistence of seeds of selected weed species in each region. 4. To quantify the competitive ability of selected weed species in wheat as well as determine the rate of seedbank build-up and the pattern of seed-shedding of different weed species in the southern, western and northern regions.
Mechanisms, evolution and inheritance of resistance (UA00158)	Herbicide resistance in weeds is a major threat to cost-effective grain production systems in Australia. Understanding the factors that contribute to herbicide resistance is important in developing strategies to delay the onset of resistance. This project will develop new information on the evolution, inheritance and mechanism of herbicide resistance to aid understanding of resistance and improve management and will concentrate on key existing and emerging resistance issues of importance to Australian grain growers. The key issues to be examined in this project will include: glyphosate resistance in brome grass, barnyard grass, sowthistle and prickly lettuce; clethodim resistance in ryegrass; diflufenican and phenoxy resistance in Indian hedge mustard; 2,4-D resistance in sowthistle; triallate and prosulfocarb resistance in annual ryegrass; and propyzamide and trifluralin resistance in annual ryegrass. Outcomes from the research will be delivered to farm advisers and growers to encourage better stewardship of key herbicides in Australian cropping regimes.
New biocontrol solutions for sustainable management of weed impacts (RnD4Profit-115-02-005)	The project will improve the long-term profitability of primary producers by developing novel biocontrol solutions that will reduce the recurrent costs of weed control for farmers affected by the target weeds. This sub-project focuses on four weeds of importance to many different agricultural sectors, including small industries, in Australia. These are: African boxthorn and cabomba (which are Weeds of National Significance) and, fleabane and sowthistle which are widespread agricultural weeds that have developed herbicide resistance in recent years and are now extremely difficult to manage with currently available methods. Successful identification, development and release of biocontrol agents, either on their own, or in integration with other management practices, that will assist with the control of the target weeds African boxthorn, cabomba, fleabane and sowthistle.

Issue No. 18 - The opportunity to use big data to improve grower profitability in the low rainfall zone.

Growers are unsure of what constitutes big data and if this provides opportunities to improve productivity and profitability in the low rainfall zone.

<u>GRDC investments addressing this issue</u>

Big-data can mean different things, and is somewhat analogous to the concept of data-driven agriculture. Within GRDC's new 5-year research, development and extension plan there are four key frameworks that underpin all RD&E investments, one of which is data management and analytics. Data-driven agriculture more broadly includes:

- within paddock, whole-paddock and whole-farm performance data
- regional, national and global production data, including yields and inputs
- data from R&D experimentation
- environment characterisation data (e.g. soil maps, high resolution imagery and climate and weather data)
- economic data (e.g. market supply and demand data).

New investment strategies are soon to be developed under the 5-year RD&E plan that will capture opportunities for growers in the LRZ to benefit from data-driven agriculture via numerous conduits, either indirectly (i.e. through advancements in genetic technologies and plant breeding), and more directly, such as through new, data-driven models to support decision making, optimise input allocations and improve the accuracy of yield projections.

Issue No. 20 - Glyphosate resistant weed populations are developing on fence lines.

Repeated spraying of fence lines with glyphosate based mixes is placing high selection pressure on weeds for resistance to glyphosate. While the threat and occurrence of glyphosate resistance in annual ryegrass is recognised, there is a threat of glyphosate resistance developing in other species which are potentially more difficult and costly to control. This could the increase cost and complexity of weed management in the low rainfall zone.

GRDC investments addressing this issue

GRDC Australian Glyphosate Sustainability Working Group (ARN0001)	Produce the latest information on the status of non-selective herbicide resistance and effective management strategies relevant to their farming systems through a nationally coordinated extension program that includes a specific web site, media releases and extension materials. Integrated weed management training programs will be modified to incorporate the latest developments. A consistent message on the management of glyphosate, paraquat and Group I resistance is extended across Australia. Web site - http://www.glyphosateresistance.org.au Facebook - https://www.facebook.com/Australian-Glyphosate-Sustainability-Working
GRDC – Bayer Crop Science Herbicide Innovation Partnership (HIP00001)	Investment in herbicide discovery. Increasing capacity of Bayer the leading cereal herbicide multinational. Australia lifted to priority 1 status in preliminary screening (equal with EU, USA and Sth America) with 10 Australian weeds in primary screening and primary field screening of molecules occurring in Australia.
Australian Herbicide Resistance Initiative (AHRI) – Phase V (UWA00171)	Australian grain growers, like their counterparts in other industrialised nations continue to rely on herbicides as the most important component of their weed management strategy. In the foreseeable future there are no alternative technologies in world cropping that will achieve the results that herbicides obtain. It is now understood that novel mechanisms of resistance to different herbicide modes of action exist and will continue to evolve under global herbicide selection - a better understanding of the factors and dynamics of herbicide resistance selection will delay the evolution of herbicide resistance in weeds. Evolutionary biology and Darwinian evolutionary theory provide a very powerful framework to interpret and understand how weeds can respond to herbicide use and other pressures in modern cropping systems. Improved crop/weed management strategies evolving from increased knowledge and understanding of the herbicide resistance phenomenon will ultimately benefit the Australian grains industry and represents a significant contribution towards achieving sustainable cropping systems. In AHRI, the 2015-2020 project encompasses three research programs; Resistance Evolution, Resistance Mechanisms and Resistance Management, plus a Communications program. All programs have a high level of engagement in delivering activities in all three GRDC regions. **1 - Resistance evolution:** Essential for monitoring on-going herbicide sustainability, field survey work will quantify herbicide efficacy and herbicide resistance evolution in key cropping weeds. Resistance surveys have been conducted for Ryegrass, Wild oats, Barley grass, Brome grass, Wild radish and Fleabane and testing for resistance has commenced. Ongoing research to highlight the importance of maintaining optimum herbicide efficacy (rates) has commenced together with evolution studies to predict the onset of resistance to new herbicides, ways to delay resistance onset and resistance management techniques. This information will be captured in the PERTH and RIM models for use in Australian cropping and disseminated widely. **2 - Resistance mechanisms:** Understanding how Australian crop weeds achieve resistance to powerful herbicides is of benefit to the nation and globally. AHRI is the international leader in this research area and attracts considerable ARC grant funding and industry support AHRI is working to establish the biochemical and molecular genetic basis of novel herbicide resistance in Australian major crop weeds and to ensure this information is widely disseminated and, when relevant, incorporated into management strategies. This fundamental AHRI biochemical/molecular research underpins an understanding of how to

	sustainably manage herbicides and minimise resistance. **3 - Resistance management**: The focus of this program is aimed at maximising crop production/sustainability while minimising crop-weed and herbicide resistance problems in Australian grain crops. This program has a national focus with the development of weed control solutions to fit cropping systems in each of the Western, Southern and Northern production regions. Harvest weed seed control (HWSC) systems have been developed as a major AHRI activity in response to the escalation in herbicide resistance and because of an identified opportunity to target weed seed production during grain crop harvest. The major annual weeds infesting Australian cropping; annual ryegrass, wild radish, brome grass and wild oats, all retain high proportions of their seed production at maturity. This attribute (biological weakness) is taken advantage of by targeting this seed for collection (harvested) during commercial grain crop harvest (Walsh and Powles 2007). **4 - Communication:** AHRI is committed to delivering AHRI's and other relevant research to the Australian broadacre cropping industry in an engaging manner, promoting greater awareness of herbicide resistance and educating industry stakeholders on strategies to increase crop yields and sustain herbicides. Tools to communicate AHRI messages include delivery of website, online courses, live webinars, face-to-face presentations, social media and targeted events.
WeedSmart (UWA001724)	WeedSmart is established by industry to ensure herbicide options are available for future generations. WeedSmart provides a consistent, single voice for the herbicide industry, linking stakeholders to world renowned herbicide resistance and agronomic research. WeedSmart Phase 3 builds on the strong and effective brand established in Phases 1 and 2 by continuing to work with growers and industry to increase awareness and to provide solutions to keep herbicides working. The WeedSmart campaign ensures that the latest information and practical solutions reach grain growers as quickly as possible. WeedSmart continues to promote practice change on farm by providing growers and advisers with well researched management strategies to curb the impact of resistance and, therefore, increase the sustainability of available chemicals.
Benchmarking and managing soil herbicide residues for improved crop production (DAN00180)	To benchmark the risk of soilborne herbicide residues to crop production, including indirect effects on soil function and direct plant-back risks. To develop models and monitoring tools to assist farmers and agronomists in managing herbicide residues in soils. Anecdotal evidence also suggests that plant-back damage in rotational crops due to herbicide residues is a growing concern amongst growers, but the scale and cost to the Australian Grains industry remains unknown. This project will benchmark level of herbicide residues in cropping soils and generate new knowledge about the fate, behaviour and risk of herbicides to productivity. This will enable the Australian grains industry to better understand the risks and implement changes in management for more productive and resilient farming systems. A review of over 340 peer-reviewed articles found that there is little evidence for consistent, long-term impacts to soil (microbially mediated) functions caused by herbicides when used at registered label rates. Some site-specific exceptions include the interaction of sulfonylurea herbicides with certain pathogens (e.g. Rhizoctonia) on alkaline soils to increase disease risks and inhibit N-cycling processes. Controlled laboratory experiments screened the impacts of 6 different herbicides on soil enzyme activities and N-cycling in 5 different soil types and confirmed that effects are minimal at up to 5 times label rate application. Metsulfuron-methyl had significant but minor impacts (<25% of control level) on nitrification in 3 of the 5 soils tested (impact on 2 alkaline soils and 1 low OM soil). Two nationwide field surveys across in 2015 and 2016 determined baseline levels of herbicide residues in Australian grain growing soils prior to sowing. The dominant residues in both surveys (in terms of detection frequency and residue load) were the herbicide glyphosate and its breakdown product AMPA, plus the herbicides trifluralin and diflufenican. Relatively high levels of triasulfuron and diuron were also found in some regions. Plant bioassays have been conducted to determine the risk of these herbicide residues on crop growth and symbiotic associations (rhizobia in legumes for biological N2-fixation). A new model to predict herbicide persistence in soil has been developed and validated in conjunction with a rapid, inexpensive Quicktest™ to quantify atrazine residues.

Mechanisms, evolution and inheritance of resistance (UA00158)	The objective of this project is to develop new understanding of the mechanisms, inheritance and evolutionary dynamics of resistance to key herbicides in Australian agriculture. The project will concentrate on understanding glyphosate resistance in brome grass, barnyard grass, Sowthistle, windmill grass, fleabane and feathertop Rhodes grass; 2,4-D and diflufenican resistance in Indian hedge mustard; 2,4-D resistance in common sowthistle; clethodim resistance in annual ryegrass; and resistance to the pre-emergent herbicides trifluralin, propyzamide, triallate and prosulfocarb in annual ryegrass.
Locally important weeds (DAW00257)	This project will undertake research to quantify the biology and ecology of eight (8) locally important weed species, 4 in the western region and 4 in the southern region. The weed species have been selected following a consultation process with the Regional Cropping Solutions Network (RCSN) and major Grower groups, with the final input and decision coming from GRDC. Weed species include matricaria (Oncosiphon spp.), marshmallow (Malva parviflora), stinking lovegrass (Eragrostis cilianensis) and Feathertop Rhodes grass (Chloris virgata) in the western region and Lincoln weed (Diplotaxis tenuifolia), wild vetch (Vicia sativa), caltrop (Tribulis terrestris), and Lake Boga poppy (Hypercoum pendulum) in the southern region. These weeds are of local importance but have not been the subject of major prior research projects.

Issue No. 20 - Nitrogen management decisions – value of legume contribution and cost vs return on investment in N fertiliser.

In the low and variable rainfall environment of the low rainfall zone, growing pulses and applying nitrogen fertiliser increases costs which could result in reduced returns in poor seasons. Quantifying the nitrogen contribution of pulses and the benefit to subsequent crops will enable growers to include the value of the nitrogen contribution when assessing the overall economic benefit of growing pulses. This knowledge can be combined with improved decision making tools to better match nitrogen applications to requirements, reducing the risk of losses when nitrogen is applied when it is not required, and increasing profitability when a return from nitrogen application is likely.

<u>GRDC investments addressing this issue</u>

Real time evaluation of soil nitrate using ion exchange technology (EPF00002-A)	This project sought to better assess N supply to cereal crops and canola in the southern region, based on an improved estimation of mineralisation of soil N and the supply of N from legume crops and pastures. This project assessed the accuracy and reliability of a portable ion selective, in field nitrate testing unit (SoilScan 360) under Southern Australian field conditions. The nitrate specific electrode tested was not as well correlated with yield responses to N applications compared to laboratory soil analysis techniques but these electrodes may have a role in estimating N availability in the root zone as the technology improves in the future. In season N testing using existing laboratory techniques (soil mineral N) was well correlated with wheat grain responses to N applications both at sowing and in-season (GS30) in a relatively favourable season.
Managing legume and fertiliser nitrogen in the Southern Region (UA00165)	The project is examining how growers and advisers make fertiliser N decisions, and is evaluating a number of rules of thumb, tools and models that estimate N cycling in farming systems and fertiliser N requirements of crops, against field trial data. These tools may help farmers evaluate the profitability or otherwise of growing grain or pasture legumes as commodity prices vary, as fertiliser prices vary and as attitudes to risk change. Depending upon the accuracy of these tools, recommendations will be made for the improvement of these models or the development of a new biophysical economic framework that values commodity prices, residual soil N and fertiliser prices to help farmers make optimum fertiliser N decisions and evaluate the role legumes can play in their farming system.
More Profit from Crop Nutrition Initiative – Phase II (MPCN II) Re-assessing the value and use of fixed nitrogen (CSA00037)	The project used the APSIM model across six regions to identify appropriate “trigger points” for when to grow the dominant legume in the region. Simulations were conducted in the Western Region for Dalwallinu and Kojonup, for lupin and Lucerne. In the Southern Region simulations were conducted for Karoonda and Birchip for field peas. In the Northern Region, simulations have been conducted for Moree using chickpeas and for Temora using faba bean and lupin. The legume commodity price and the amount of fertiliser applied to cereal crops were key drivers of relative profitability. The relative importance of legume price and fertiliser applied depended on the

	site and the legume. In general, the economic value of legumes increased if either the legume commodity price exceeded $300/t or famers were unable to apply fertiliser nitrogen to the cereal crop. The price of fertiliser N was only a small driver of relative profitability, indicating that fixed N was only a minor component of the total profitability of a legume crop. The N price had to nearly triple to $3.00/kg N before it became important. Growers now have the rules of thumb and a tool to help make the decision to grow a profitable legume.
Optimising nitrogen fixation of grain legumes - southern region (DAS00128)	This project will improve the amount of fixed nitrogen (N) from pulse legumes contributing to cropping systems in southern Australia through acid-tolerant rhizobial strains and improved understanding of N fixation and inoculation practices. The project has identified improved acid tolerant rhizobial strains for faba bean and lentil which require further field validation. This project has also quantified the symbiotic potential of different field pea cultivars, and developed N fixation indices that can be used by pulse development programs and growers.
Updated nutrient response curves in the northern and southern regions (UQ00082)	The aim of this project is to review macro-nutrient response data to prioritise gaps that constrain growers' ability to identify likely nutrient limitations and conduct trials to further create a critical soil test to determine accurately the nutrient requirement x crop type. After acceptance of that scoping study report, staff identified sites to establish P, K and N trials to fill research gaps. These trials sites host N (6 sites), P (8 sites) and K (2 sites), with response surfaces being developed for 44 crop species (16 reference crops of wheat/sorghum and 28 predominantly pulse or oilseed target species) across the northern and southern region.
Benchmarking wheat yield against nitrogen use (DAS000147)	Nitrogen management is an economically important decision for farmers. This project – 1. developed a new benchmark for wheat N-status; 2. showed that commercial crops in a rainfall transect in SA were largely well fertilised (no deficit or excess); 3. showed that 2 out of 5 National Variety Trials were under fertilised, where N-status might bias the ranking of varieties; 4. using the N benchmark, identified causes of yield gaps - mostly rainfall in SA, and low sowing rate in lower rainfall areas of WA; 5. found that selection for yield over five decades has dramatically reduced the root biomass and root length density of wheat; 6. found that increased N uptake per unit root length.
Improving profit and reducing risk by managing nitrogen in wheat and extreme temperature in pulses (DAS00166-BA)	Sowing date, variety and fertiliser trials are common. However, it is not unusual for this kind of agronomic experiments to return season and site dependent results, thus constraining interpretation and application. Here we focus on crop physiology to complement, explain, and add value to the most common agronomic studies. The project comprises two modules. Module 1 Wheat - Breeding for yield has resulted in varieties with higher N uptake, despite a reduction in root biomass. This means that N management has to be updated for new varieties. In addition, there is increasing interest in earlier sowing. This module is thus investigating the interaction between sowing date, variety and N. Late-sown crops grown under high temperature, but also higher radiation and vapour pressure deficit. To untangle the effect of temperature and confounded effects with photoperiod and other weather variables, the project is devising new methods to manipulate temperature in the field. Module 2 Pulses - Frost and heat can compromise yield and profit, hence constraining the share of pulses in cropping systems. This is a barrier to achieve Pulse Australia's national target of 5 million hectares of broad leaf crops and to raise average pulse yield to 1.75 t/ha. This module focuses on lentil and faba bean, and aims at filling basic gaps on the phenological windows where crops are more vulnerable to stress, measuring and modelling the influence of temperature and photoperiod on crop development, and assessing the risks associated with specific combinations of location (soil and climate), variety and sowing date.

Scoping study - Reviewing mechanisms and magnitude of nutrient mineralisation in Australian grain producing soils (CSP00207)	Matching the supply of nitrogen (N) with crop demand is critical to optimising nutrient use and profitability of grain production. Defining the ability of a soil to deliver available N both prior to and within the grain growing season is required to help optimise N fertiliser application rates. The amount of N delivered to crops from soil will be location specific due to variations in the environmental conditions, soil types and their properties and the manner in which agricultural management practices are implemented. N stocks in Australian soils are declining. On average, the production of cereal and oilseed crops is associated with a negative N balance. Performing N balance calculations is important to define the potential impacts of current management practices on long term soil productivity and N supply capacity. A short period of negative N balance is acceptable provided it is followed by a rebuilding phase through implementing practices capable of increasing soil organic N stock. As soil N supply capacity is reduced, a greater reliance on fertiliser N will result. Due to potential losses that N derived from fertilisers is exposed to, the greater reliance on fertiliser N may result in lower yields being associated with the optimisation of profits.

Issue No. 20 - Managing insects - forecasts and alerts, new pests, thresholds, new insecticide groups and control of resistant populations.

Due to logistical considerations, prophylactic applications of insecticide on a broad scale are common when managing insects but there are concerns about resistance, the effect on beneficial insects and the environment. Management of insects could be improved with better forecasts and alerts, thresholds and knowledge and tools to manage resistant populations.

GRDC investments addressing this issue

Predicting insect pest issues in Australian grain crops (UM00054)	In order for farmers to effectively, sustainably and efficiently manage invertebrate pests in grains, predictive models that describe the interaction between local weather conditions (e.g. rainfall and temperature) throughout the season and pest population dynamics should be developed. This project will gather (and in some cases establish) biological parameters for multiple pests of grain crops and use them to predict outbreaks and severity. Mechanistic and phenological models will be employed to generate predictive models that will be subsequently validated using field surveys and experimentation. In addition, correlative (Ecological Distribution Models such as MaxEnt) and semi-mechanistic (Climex and DEB) models will be used to identify the environmental variables that contribute to pest species distribution. These models will be validated directly in the field across different geographic regions and across several seasons. Ultimately such models can be used to forecast pest threats and provide information on uncertainty around events such as pest outbreaks and pest severity to growers and advisors. Landscape factors and on-farm practices will be fed into models to predict pest severity in a given space and time point, thus pointing to new ways to manipulate landscapes for promoting natural enemies (beneficial insects) and aiding the implementation of IPM strategies
Improving Plant Pest Management Through Cross Industry Deployment of Smart Sensors, Diagnostics and Forecasting (Rural R&D for Profit)	This project will develop a mobile cross-industry plant pest surveillance network, which will provide actionable information to primary producers and government on established, trade sensitive or exotic pests. It will underpin existing surveillance initiatives, and provide a foundation for a nation-wide surveillance network. Producers involved in production of grains, cotton, sugar, horticultural products, wine and forestry products will be primary beneficiaries through improved information on pest status and levels, and with the provision of improved forecasting tools. Producers will receive timely and accurate knowledge of the types of plant pests, and prevalence of these pests in their region, to give improved information to support management decisions. The network will move to respond to industries' seasonal needs, allowing greater efficiencies through a cross-industry approach that provides high quality, consistent data on plant pests that are economically relevant to multiple industries. In addition, the project will include a focus on exotic pests; their incursions have the potential to result in severe trade disruptions and production losses. The surveillance network will support claims of pest freedom and perform an important function in exotic pest detection. The project will facilitate gains in productivity, reductions in farm inputs, reduced pest resistance, and maintenance of market access. Project involves all seven plant based RDCs, SARID, AgVic, DAFWA, QDAF, NAQS,CSIRO The project is structured for controlled scale-up of hub construction and roll out. The project has five

	sub-projects (see below), which will be led by appropriate project partners. Data will be collated into *AUSPestCheck* and information will flow between each sub-project, allowing informed decision making within the project. *Governance:* Horticulture Innovation will ensure that the project is managed to a high quality, deadlines are met, and outputs meet project objectives. This component will undertake Monitoring and Evaluation ensure regular reporting of project progress to the Commonwealth and implement project governance arrangements. *Extension*: AUSVEG will collate regional priority pest information from producers in each industry, communicate progress to producers and other stakeholders and deliver training on the use of *AUSPestCheck* and industry surveillance data. This sub-project will support and build on existing preparedness and on-farm biosecurity initiatives and identify complimentary mechanisms to educate producers on biosecurity best-practices. *Surveillance:* SARDI will set up the flexi hub infrastructure, based on trapping technology developed by SARDI in partnership with Rothamsted Research and Burkard Manufacturing, GRDC and the Plant Biosecurity CRC. Flexi hub construction and development will be carried out as follows: Year 1 – Two flexi hubs produced and placed in Virginia-Barossa Valley and Renmark-Riverland. Years 2 and 3 – Three flexi hub produced and deployed per annum. SARDI, with support from a number of regional organisations, including DAFWA, the Department of Agriculture and Food, Queensland (DAFQ) and NAQS, will maintain and relocate these hubs to reflect seasonal industry and biosecurity needs. Samples will be collected and couriered for diagnosis. *Diagnostics:* SARDI and AgVic will diagnose hub samples using morphological identification to provide the samples for developing high throughput molecular diagnostic tests. Additional morphological identification will be undertaken through significant in-kind contributions from the forestry sector for forest pests and NAQS for northern Australia samples. Service providers will further develop molecular diagnostics for high throughput, high quality analysis of pest samples, with a key focus on reducing labour costs. Agriculture Victoria will develop next generation sequencing (NGS) technologies to screen for potential exotic incursions. SARDI will develop qPCR protocols to provide quantitative data on established priority pests. Diagnostic data will be uploaded to *AUSPestCheck* for industry and use in developing forecasts. *Forecasting:* Modelling platforms will be developed by CSIRO to simulate the timing, abundance and spread of pests. Integration of surveillance, modelling and weather forecast information will provide information to producers on four priority cross-industry pests (potentially Diamondback moth, Green peach aphid, Silverleaf whitefly and Downy mildew). Additional work on Cotton bollworm will be conducted with Rothamsted Research. This information will be used by producers to plan and execute pest scouting and management activities. Three industry specific sub-projects will also be conducted. A cotton specific project will measure BT resistance in trap samples, a sugar specific project will look at NGS diagnostics for exotic pests and a DAFWA 'Royalties for Regions' project trialling smart traps at 11 sites in the Western Australian grain belt will be used to provide data for this project.
The iSPY manual, which was an output of the National Invertebrate Pest Initiative (NIPI) (CSE00058)	The sustainable management of invertebrate pests in Australian grains production systems is an uphill battle. Grains are grown across a wide geographic area, under different rainfall conditions, and in different farm business contexts. Growers need to be able to manage for pest species that regularly attack crops each year, as well as coping with species that often go un-detected but display sporadic outbreaks. The extension capability required to support pest management decision-making on a day-to-day basis is not comprehensive, and knowledge gaps limit change of practice in some regions. In this environment maintaining an active network of research and extension specialists that deliver targeted research outcomes directly to the grains industry, and have the capacity to respond to new pest threats is critical. Over the past nine years the National Invertebrate Pest initiative (NIPI, www.nipi.com.au) has helped support such a network. NIPI has brought together scientists from state government departments, universities, farmer groups and CSIRO to address pest management issues in the Australian grains industry. In the past NIPI supported a range of extension and adoption

	activities, helped develop future research capacity to support grain producers, and ensured that research effort was focussed on current pest issues and emerging pest threats. Throughout this project we will continue this work by delivering workshops that focus on pest management issues from research through to extension and adoption. The future NIPI forums will contribute by maintaining the NIPI network as an active collaborative community of practice that improves: research outcomes and their delivery to industry, capacity to respond to emerging pest issues, and the identification and removal of barriers to the adoption of 1PM. We will develop a clear agenda for each of three workshops that each address a different target audience. The first workshop, taking place in a regional location, will focus on pest management issues in retained stubble systems. The workshop will allow local growers and consultants to discuss these issues and address questions directly to researchers in this field. The second workshop will focus on identifying the capabilities required of future researchers and extension people to address emerging pest, issues. There will be an opportunity to highlight student research that is critical for new knowledge generation for improved pest management. The final workshop will take a broad look at pest management in Australian grain crops. Identify areas that we have made good progress over the last decade and highlight areas that limit 1PM adoption and are a barrier to future sustainable pest management. The outcomes of these workshops include; a greater awareness of pest management issues in retained stubble systems, and identification of knowledge gaps, a greater understanding of the gaps in the RD&E capability relating to sustainable pest management in grains and new capabilities that may be required in the future, and identification of the most pressing pest management problems that need to be addressed in the near future.
Economic thresholds for the major pests reducing profitability in the Australian grains industry (DAQ1711-001RMX)	Economic thresholds for the major pests reducing profitability in the thresholds Australian for the grains major pests Industry reducing Australian grain growers-have few empirically derived thresholds are available to them on which to base their decisions making. Thresholds are the cornerstone of Integrated Pest Management strategies, and without these to guide decisions the industry is at increased risk of crop loss, overuse of insecticide and potentially more rapid development of insecticide resistance. This project will explore where the greatest need is for thresholds, both in from the perspective of the decision makers (advisors and growers), but also from the broader perspective of the research community in terms of medium and long-term risks and benefits of having thresholds to guide decisions. The findings of consultative workshops for industry, across the three grain production regions (Northern, Western, Southern), will be reviewed in the context of need, feasibility, cost, and benefit to the industry in the short-long term. A broad architecture of methodology to address the issues arising from the consultation will be formulated. The outcome of the consultation and technical review will be a strategic framework for future investment in the area of economic threshold research.
Opportunities for SMART surveillance for biotic threats in the Australian grains industry (9176028)	GRDC relies on periodic economic surveys on the costs of disease, weeds and invertebrate pests when making investment decisions. GRDC needs better information to support a seasonal or twice seasonal situation analysis on biotic threats to improve investment decisions and to alert growers to changes in abundance of current threats or movement of new threats into different regions, or changes in biology of weeds pests or diseases or increased resistance of these threats. The development of new tools for trapping biotic threats will assist in providing some of this data for pests and disease but not weeds. The grains industry has a high adoption of agronomic consultants, and the use of electronic recording platforms (both commercial agronomists and growers). The utilisation of this rich source of biotic threat information has not been attempted. This investment is to scope the feasibility of integrating the skills of agronomists and/or the records they or grower keep to provide a more detailed picture of the current distribution and abundance of biotic threats. Integration of these data could lead to: the provision of improved pest alerts to growers; determination of changes in species abundance and temporal activity; warnings of the appearance of new biotic threats; development of resistance and management options being implemented by growers.
The development of economic thresholds for the management of Russian wheat	Since first being detected in 2016, Russian wheat aphid (RWA) has established widely across parts of South Australia, Tasmania and Victoria. It continues to expand its distribution northwards into NSW. Western Australia remains RWA free. Initial observations were that RWA population densities varied greatly, within and between paddocks and even districts spraying low populations of RWA was not

aphid across rainfall zones of the Australian grain industry (9176535)	recommended as this would also kill predators and parasitoids, potentially causing a spike in RWA (and other aphids) in Spring when temperatures increase. Parasitoids were observed at several sites which may be providing biological control of this new pest. Local data are required to support/provide threshold recommendations around the timing and need for chemical controls to be applied. The threshold work conducted in 2016 was compromised due to the Spring rainfall which affected RWA numbers through washing aphids off plants and increasing the presence of ento-pathogenic fungi. Observed crop risk factors included early sowing, green bridge of grass plants (not just cereals) and stressed areas (e.g. sandy rises). Threshold work conducted in 2017 was restricted to South Australia (Loxton (low rainfall zone - LRZ), Roseworthy (medium rainfall zone - MRZ) and Bool Lagoon (high rainfall zone - HRZ)). The research indicated that the LRZ is the most vulnerable to yield loss from RWA. Feedback from growers directly and through RCSNs reinforced the risk to the LRZ. Feedback also identified the heightened risk where an alternate grass species hosts remain green throughout the year as occurs in the HRZs of Victoria and Tasmania. Further validation of 2017 data is required over a larger area, with additional sites in the LRZs in SA, Vic and NSW (west of the Newell highway up to Dubbo) and also the HRZs in Victoria and Tasmania. In these areas, the impact of other host grass species on RWA populations needs to be determined. This project will build on the experience from these previous investments ACO00008; CES00004; DAS00170.

Issue No. 24 - Phenoxys – alternatives.

Broad acre farming systems in the low rainfall zone are reliant on phenoxy herbicides for cost affective weed control but there is a risk of off target damage to horticultural crops. This is a constraint to broad acre farming operations in close proximity to horticultural crops, and could impact on the wider industry through tighter regulatory controls if damage to horticultural crops continues. There is a need to evaluate alternative herbicides that provide cost effective control of winter and summer weeds while reducing the risk of off target damage, and to prepare for tighter regulatory controls.

GRDC investments addressing this issue