GRDC investments relevant to "deep dive" issues and strategic reviews of investment –

High Rainfall Zone Southern RCSN – July 2019

GRDC-FAR Australia and SFS investment – Hyper-yielding cereals - a feed grain initiative (FAR00003)

Hyper-yielding cereals - a feed grain initiative (FAR00003)	Whilst not focussed on new grain crops for the HRZ, this project sought to improve grower profit through step change improvements in yield of cereals grown in the HRZ. The objective of the project is the delivery of higher yields of quality feed grains in HRZ through genetic improvement, management and recognition of quality. Specific outputs are: 1. Engagement between breeders, researchers, growers and advisers to evaluate and better manage new feed wheat and barley cultivars with the target of increasing average red feed wheat yields from 4.4 t/ha to 7t/ha by 2020. 2. Delivery of commercial wheat crops yielding 14t/ha by 2020. Through engaging and collaborating with the dairy industry the project also seeks to identify and endorse the value of metabolisable and digestible energy in feed grain cereals and: 1. Create an independent testing and reference system whereby high yielding cereals can be reliably described in terms of energy content and value to the end user (particularly dairy industry). 2. Create a positive environment based on trading feed cultivars with quality attributes for better milk solid production in order to create the stimulus for further investment in improved variety development.
Research and Extension programme at SA Crop Technology Centre (FAR1903-002WCX)	This investment is designed to give growers and agronomists access to local data and assist the selection of adapted, robust cereal varieties including long season cultivars to achieve optimal flowering dates, and to showcase adaptable agronomic strategies to achieve higher and stable yields across a range of sowing opportunities and seasons for the specific environmental conditions of the South-East SA districts and High Rainfall Zone.

Optimising the yield and economic potential of high input cropping systems in the HRZ" (DAV00141)

Optimising the yield and economic potential of high input cropping systems in the HRZ" (DAV00141)	This investment will provide knowledge and tools to increase the profitability of canola in the HRZs of the Southern and Western grains regions. An increased understanding of Genotype by Environment by Management (GxExM) interactions will help identify superior, better adapted wheat and canola plant types for the region. This will increase the speed at which new varieties are available to growers either through direct importation from overseas breeding programs or through the incorporation of traits into breeding material specifically suited to the HRZ. Modelling will help quantify the value of new traits to industry. The project will focus upon 3 key areas (Canola, Wheat and Nutrition) for the HRZ and develop key learnings and tools for grower / advisor use including: • The quantification of the value of new traits relating to phenology (vernalisation / photoperiod) (Construction phase development) and canopy architecture (i.e. Floppy v erect leaves) in wheat. • The identification of superior canola varieties (Spring / Winter / Spring-winter types) for direct importation and knowledge of yield related traits (Water and radiation use) for incorporation into breeding programs. • The development of tools that predict the production and economic response (Benefit: Cost ratios) as

	well as the risks associated with applying the level of inputs needed for wheat and canola crops to achieve their high yield potential.
Optimising high rainfall zone cropping for profit in the Western and Southern region (9177056) (DAW1903-008RMX)	• Define the key elements of the HRZ environment in the Western and Southern Region plus run workshops in Year 1 (2019) of the project with advisers, researchers, farmers and industry stakeholders to raise awareness of the project objectives and define the R&D needs in the HRZ Western region to support increased productivity. • Develop guidelines about the profitability and risks of incorporation of new agronomic practices and more diverse rotational sequences into HRZ farming systems. • This project will collate feedback from growers and consultants on key issues and opportunities for increasing yield and reducing the yield gap of wheat and canola crops grown in the HRZ Western region and Southern regions. This feedback will help to develop and prioritize researchable questions with growers. Workshops to be held at: ▪ Naracoorte – August 6th ▪ Maitland – August 8th ▪ Lake Bolac – August 15th

Issue No. 3 - "Emerging K deficiencies in crops and interactions with other elements - what is the best practice approach (4Rs)?"

GRDC investments addressing this issue

Using soil and plant testing data to better inform nutrient management and optimise fertiliser investments for grain growers in the southern region (**ASO1806-001RTX)**	At present soil testing is widely recognised across Australia as the best way to determine supplies of plant available phosphorus, potassium and sulphur, and fertiliser requirements applications needed to meet crop demand. Soil and plant testing are the cornerstone of Fertiliser Australia's stewardship program FERTCARE and commercial analytical laboratories and interpretation services operate across the country. Despite the availability of these services, levels of adoption of soil and plant testing in the southern region are low and appear to have declined from 40% of cropping paddocks in 2008 to about 15% in 2016. The GRDC seeks to provide grain growers in the GRDC Southern region with evidence of the usefulness and economic value of well-informed fertiliser decisions, to influence their attitudes and motivation to adopt improved nutrient management techniques. This will be achieved by working directly with growers, FERTCARE accredited advisors and industry across the southern region to demonstrate the process and benefits of soil and plant testing, and improved crop nutrition advice across two seasons. An economic framework will be developed to quantify the likely returns from improved nutrient management techniques and the opportunity to boost farm profit, and these findings will be extended to other growers not directly involved in the demonstration program. The large numbers of soil profile analyses collected by the demonstration program (about 7,000 p.a.) will also provide a useful snapshot of nutrient status and soil fertility in these states, and could be used to highlight emerging issues like soil acidity and declining organic matter.
Increasing profit from N, P and K fertiliser inputs into the evolving cropping sequences in the Western Region (**UWA1801-002RTX)**	The evolving cropping sequences in the Western Region require specific advice that improves precision in nitrogen (N), phosphorus (P) and potassium (K) fertiliser decisions. The current body of evidence used to support N, P, and K decisions is inadequate across a range of situations and this uncertainty has led to a lack of confidence in fertiliser recommendations. Decision gaps exist in N, P and K fertilizer management because of climate and systems changes since most crop nutrition knowledge was obtained. N and K decisions are problematic and negative balances are common for these nutrients The project includes, providing advice on K management. The investment expects to report on K leaching, K cycling and the K supply to crops in loam and clay soils. K experiments will be delivered to characterise soil K supply and cycling for crops on a range of soils. The efficacy of new K fertilisers and the benefit from ameliorating subsoil K deficiency will also be assessed. Using knowledge from the research program, the team will model economic responses to N, P and K management strategies, update nutrient decision guidelines. The project is a collaboration between the University of Western Australia, DPIRD, Murdoch University and partners in the fertilizer industry. The project is led by Dr Craig Scanlan, with guidance from Professors Daniel Murphy, Zed Rengel and Richard Bell. This project is also part of a program of research in collaboration with PROC-9175171 and PROC-9175172, facilitated by SoilsWest.

Fertiliser form and soil interactions when applied in high concentration bands – Post-Doctoral Fellow aligned UQ00063 (UQ00086)	Soil testing information is one of the key factors needed to identify nutrient limits to productivity and subsequently devise a fertilizer program. However, without calibrated soil test - yield relationships that are robust enough to quantify likely yield response to added fertilizer, farm managers and advisors are not able to make fertilizer decisions that will optimize productivity, nutrient use efficiency or profitability. The national database. Making Better Fertiliser Decisions for Crops has identified some significant gaps in these relationships. The purpose of this project is to start filling those gaps in our knowledge of plant responses to the supply of nutrients. The project is national in scope. This project describes the work for the Northern GRDC region, in partnership with the projects from the West (Brennan et al.) and the South (Conyers et al.).In the Northern region there are a number of gaps in knowledge that can be summarised as follows:N data for sorghum crops P data (starter fertilizer) for all crops except wheat, and subsoil P requirement for all crops K and S data for all crops. Even where data are plentiful, such as starter P and wheat, the influence of modern management practices (no-till, sowing width, stubble retention, sowing date) is often difficult to assess. The impact of no-till vs conventional cultivation in particular is a gap in knowledge, since most P response curves were produced prior to the adoption of no-till practices. In addition, there are significant gaps in soil testing methodology for all nutrients except N. The greater reliance on stored soil moisture for crop productivity in the clay soils of the northern region, rather than in-season rainfall, places a greater emphasis on subsoil nutrient reserves that can be accessed during periods when topsoils are dry. These levels are being depleted across the region. The 10-30cm layer looks to be the most important for assessing soil P and K status (in addition to the traditional testing of the top 10cm), while for the more mobile S the critical depth is probably extended to 60cm. There is currently no information on the critical soil concentrations of these nutrients in the subsoil for any crop.We therefore have large gaps in our knowledge for many of the crops grown in the northern region, and for most of the nutrients, as well as the appropriate soil testing methodology to assess subsoil P, K and S status. Our aim is to fill these gaps by conducting trials across the region from the Central Highlands in Qld to the southern Liverpool Plains in NSW, with sites also located in western areas of southern Qld and central and northern NSW. We will provide soil test - plant response calibrations covering the above gaps in knowledge, with this project focussing on P, K and S soil test-crop response information for the major crops in the region (sorghum, wheat and chickpea), with the objective of better matching fertilizer inputs to meet crop demand yet minimise nutrient losses.
UQ00061 - Fertilizer from Wastes Phase II°	The Fertiliser from Wastes project aims to enable generation of alternative, renewable nitrogen, phosphorous and potassium (NPK) mineral fertilisers specifically for the grains industry in Australia. This will buffer against external price movements and contribute towards a long-term sustainable grains industry. The current work has developed from a previous phase aimed at identifying opportunities and feasibility of nutrient recovery. Based on Phase I outcomes, renewable fertilisers are emerging as a realistic and substantial contributor to future agricultural activity, particularly for the grains market. The previous phase had four main goals: identification of opportunities, development of release technology, development of recovery technology and initial cost-benefit analysis. There was a strong focus on phosphorous recovery as the most price-sensitive nutrient and the one most technically feasible to recovery. Up to 25% of the domestic phosphorous market can be recovered from waste streams. This can be readily released by thermal or biochemical methods, though where calcium or magnesium is present the phosphorous will re-bind with these chemicals. Phosphorous can be readily recovered as a magnesium or calcium precipitate and a combined process is economically and technically feasible on a wide variety of waste streams, but with particular opportunities in the agro-industrial space. Current research is focused on progressing outcomes from Phase I to pilot and demonstration projects across a variety of agro-industrial and urban opportunities, as well as addressing additional opportunities for nutrient recovery and product testing. The project is split into research and application components across three major outputs. Output 1 is application focused and will develop waste-stream-specific demonstration and pilot processes. It will initially apply technology developed in the Phase 1 but it is expected that additional outcomes will be applied as they become available. Output 2 will focus on laboratory optimisation of digestion processes and full recovery of nitrogen and potassium. Output 3 will be agronomic trials of the range of fertiliser products developed as part of this project. Outputs 1 and 2 are co-funded by other organisations, particularly to optimise processes for specific waste streams. The outcomes will be a range of demonstrated feasible processes that will include recovery of all nutrients and an opportunity matrix for the developed products. It is expected that the technology developed through this project will allow for long-term independence of agriculture from mineral phosphorous, with enhanced medium-term buffering against price movements.

Southern Pulse Agronomy, Southern Pulse Validation and Southern Pulse Extension investments

GRDC investments -

Understanding the implications of new traits on adaptation, crop physiology and management of pulses in the southern region (DAV00150)

New traits for modern farming systems - Strategic genotype x management research will be conducted that provides information on understanding and maximising the benefits of new traits/genes recognised in the breeding program through improved crop management:
a. Herbicide tolerance and weed ecology
b. Disease management
c. Canopy management (biomass and architecture)
d. Harvest quality
Variety specific agronomy packages are a focus of this investment that predominately is focussed upon traditional pulse growing region of the GRDC Southern region.
HRZ trials of the existing project were focussed upon the following crops and agronomic factors:

2016	
CROP	**FOCUS**
Faba Bean	Plant Density
Faba Bean	Disease Management (Fungicides)
Faba Bean	Canopy Management (incl PGR's)
Chickpea	Variety traits for geographic suitability
Field Pea	Disease Management (Fungicides)
Field Pea	Variety traits for geographic suitability
Lentil	Variety traits for geographic suitability
Lupin	Variety testing for geographic suitability
Faba Bean	Sowing Time (variety x TOS)
Faba Bean	Canopy Management (incl PGRs and desiccant herbicides)
Lentil	Disease Management
Faba Bean	Sowing Time
Faba Bean	Sowing Time and sowing rates
Faba Bean	Canopy Management
Faba Bean	Crop Topping

2017	
CROP	**FOCUS**
Faba Beans	Sowing Time x rates x variety (HRZ relevant cultivars)
Faba Beans	Disease Management with different fungicide strategies)
Faba Beans	Herbicide Tolerance of Group B treatments
Faba Beans	Lime (+/- Calcipril)
Field Peas	Lime (+/- Calcipril)
Lentils	Lime (+/- Calcipril)
Chickpeas	Lime (+/- Calcipril)
Lupin	Testing of plant traits suited for HRZ
Faba Beans	TOS x variety
Faba Beans	Canopy Management (PGR's x application timings)
Faba Beans	Canopy Management
Faba Beans	Disease Management (variety x application timings)
Lentils	Disease Management (14 varieties x 2 application treatments)

2018	
CROP	**FOCUS**
Faba Beans	11 x Nutrient application treatments
Faba Beans	Disease Management of new cultivars with 3 fungicide strategies

Faba Beans	Herbicide Tolerance of group B varieties and timings
Faba Beans	10 x Inoculant treatment comparisons
Lentils	5 x Inoculant treatment comparisons
Lentils	11 x Nutrient application treatments
Chickpeas	12 x Nutrient application treatments
Faba Beans	TOS - (9 varieties x 3 Dates)
Faba Beans	Canopy Management with 2 PGR's x 2 strategies
Lentils	Disease Management - 14 cultivars x 2 treatment types
Faba Beans	Disease Management - 3 cultivars x 4 application timings
Faba Beans	Disease Management - 1 cultivars x 6 application timings
Faba Beans	Sowing Time - 3 TOS x 12 Varieties
Faba Beans	Disease Management - 4 varieties x 4 fungicide application timings
Faba Beans	Sowing Time - 3 TOS x 9 varieties

Improving the profitability of pulse production through local validation of research outcomes in the Southern Region (DAV00150)

A targeted validation trial program to deliver local data and knowledge for the development of pulse crops suitable to areas across the southern region where research and development is limited (*i.e. Non-traditional pulse growing regions*). This variation is an expansion of the existing Southern Pulse Agronomy project, and will deliver greater knowledge of the pulse phenotypes suited to each agro-ecological zone and management practices to optimise their production and profitability.
These data and results will further increase confidence in pulse production and will inform optimum agronomic practices for specific pulse phenotypes through evaluation of their applicability, profitability and risk in local HRZ environments.

2018	
CROP	**FOCUS**
Faba Beans	Testing of varieties (Traditional and IMI tolerant)
Faba Beans	2 varieties x 3 populations
Faba Beans	Compare old and new fungicide options at different timings
Faba Beans	Disease Management
Lentils	Sowing Time - 2 dates x 6 varieties
Chickpeas	Sowing Time – (May and August) x 6 varieties
Field Peas	Sowing Time - 2 dates x 6 varieties
Lentils	Sowing Time - 2 dates x 3 varieties
Field Peas	Disease Management - different options at different timings
Field Peas	Nutrients - 6 topdressing application options
Various pulses	PSPE and Early PE Herbicide options
Various pulses	Mid and late PE herbicide options
Lentil	Inoculants - 6 treatments x 1 variety
Lentil	Disease Management - 3 varieties x 3 treatments
Faba Bean	Herbicides - 3 varieties x 7 treatments
Lentil	Herbicides - 3 varieties x 7 treatments
Chickpea	Herbicides - 3 varieties x 7 treatments
Lentil	12 varieties x 3 harvest timing
Faba Beans	6 varieties x 3 harvest timing
Chickpea	Inoculants - 4 treatments x 3 varieties

Increasing symbiotic nitrogen fixation for the benefit of following crops (9176601)

This extension and communication investment adds value to previous and current GRDC projects improving N fixation of winter pulse crops and promoting their wider adaptation and adoption. The three year investment commenced in in 2018, working with local influencers to promote best management inoculation and pulse management practices, and raise awareness and knowledge around pulse nodulation and N fixation, and the impact of soil acidity, especially subsoil acidity.

Increasing the effectiveness of nitrogen fixation in pulse crops through improved rhizobia strains, inoculation and crop management practices (9176500)	Recent expansion of the pulse industry is seeing crops increasingly grown in new and marginal environments that are responsive to rhizobial inoculation. In these situations, the viability of the pulse crop is strongly dependant on the availability of competent inoculant strains of rhizobia and best practice application of those rhizobia. This project will improve the viability and profitability of high value pulses (bean, lentil and chickpea) through the provision of improved inoculant strains, the assessment of inoculant delivery technologies under hostile establishment conditions and improved understanding of pesticide impacts on the symbiosis. It will demonstrate where inoculation is of value and identify opportunities for future symbiotic improvement. Specifically, the program will: • Complete the evaluation and commercialisation of a new acid tolerant strain of rhizobia for bean and lentil. • Isolate, test and short list improved rhizobia for chickpea. • Provide an objective assessment of inoculant technologies across a range of marginal environments and sowing conditions. • Quantify the impact and develop strategies that minimise the impact of crop protection and herbicide applications on pulse N fixation. Promising strains of acid tolerant rhizobia for faba bean and lentil have been identified in previous GRDC supported research. The next phase of this work will focus on commercialising one of the strains and understanding the pH boundaries where it reliably delivers benefits. The ability of the new rhizobia to survive in soils outside of the host plant, will also be tested, which is an important to understanding future inoculation requirements. Similar rhizobia strain improvement work will be initiated for chickpea. New formulations and methods of inoculant application have been developed by industry to improve the options that growers have to inoculate their crops. However, there is a lack of current objective information on how the inoculants perform especially when sown into hostile soils. This project will assess the merit of different inoculant formulations and whether they provide advantages under challenging conditions, including where they are applied under dry sowing conditions. The effectiveness of inoculation can also be reduced through mixing with additives such as herbicides, fungicides, insecticides and fertilisers. The impacts, particularly on N fixation, are easily overlooked in the field. The extent to which crop protection chemicals are impacting on N fixation will be measured and growers and industry informed about which pesticides are most damaging and avoided where possible. The work will investigate the extent to which herbicide tolerant pulse varieties overcome the detrimental impacts of some herbicides on N-fixation. The project will be delivered by applied N-fixation researchers from the South Australian Research and Development Institute and University of Adelaide, collaborating with southern pulse agronomy and farming system groups in SA and Victoria. The program will have a strong field focus. To encourage practice change, the benefits will be demonstrated in validation trials across southern region in collaboration with key influencers of the pulse industry.
Managing legume and fertiliser nitrogen in the southern region (UA00165) - COMPLETED 2018	Grain growers in the southern region have a high level of uncertainty about the amount of nitrogen (N) supply required for cereal crops and the value of legume N in their cropping systems, including the amount of N contributed by legumes and when that N is available to the following crop. A significant amount of research has been done in quantifying amounts of N fixed by different legume crop and pasture species, but this information is only a small part of what is required by growers to make rational fertiliser decisions for following crops, and will depend on the frequency of legumes in rotation. What growers need to know is what proportion of the legume N is made available to the following crop or crops and the timing of the N availability and how this compares with fertiliser and mineral N, in order that they can supply appropriate N to cereal and canola crops in the southern region. The project will assist advisors and growers through improved knowledge and tools to assist the prediction of N supply from legume and fertiliser in the southern region. In summary, this two year project will: • seek advisor and grower input on issues with current N fertiliser decisions, through facilitated workshops, • produce a preliminary report on the current knowledge of N cycling and N management in commercial grain production systems of the southern grains region. • evaluate and develop a support tool or tools, fact sheets and, for the southern region to assist in N decision-making by growers and advisors;

	• develop a comprehensive user-friendly manual to be used by advisors and growers in the southern region to inform decisions on fertiliser N and soil N management in grain cropping • apture advisor and grower feedback on the tool/s and manual through facilitated workshops.