RIVERINE PLAINS

2024 TRIAL BOOK

RESEARCH FOR THE RIVERINE PLAINS

ORGANISATIONAL PARTNERS

PREMIER PARTNERS

IK Caldwell AGnVET
Commonwealth Bank

SIGNATURE PARTNERS

AGT
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Corteva agriscience
Elders Yarrawonga | Albury Shepparton
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Precision agriculture
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Advanced Ag
BASF We create chemistry
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Cobram Farm Equipment Pty Ltd
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Market Check Independent Commodity Specialist
nbn Local
Pacific Seeds
Pioneer brand • seeds
Rabobank
Rivalea
Rural Bank
RAGT
Thera Capital Management

YOUTH IN AG PROGRAM PARTNERS 2023

Corteva agriscience
Elders
Australian Government Department of Agriculture, Fisheries and Forestry
Future Drought Fund
FRRR Foundation for Rural Regional Renewal
Australian Rural Leadership Foundation

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SCHOLARSHIPS 2023

RIVERINE PLAINS SCHOLARSHIP

The inaugural Riverine Plains Scholarship was established to support tertiary students studying a degree or diploma in agriculture, agricultural science, agribusiness or engineering, or who demonstrate a passion for agriculture in another discipline.

2023 RECIPIENT
ZOE WILSON

From a young age, Zoe had a great love for animals and all things that grow. Zoe is currently studying a Bachelor of Agriculture at the University of Melbourne's Dookie Campus.

ALVAN BLANCH AUSTRALIA SCHOLARSHIPS

Established in 2023, these scholarships provide support to either agriculture or engineering students from non-farming backgrounds who are considering a career in agriculture.

2023 RECIPIENT AGRICULTURE
HAYLEE MURRELL

Haylee grew up near Gunnedah in northwest New South Wales and is now studying a Bachelor of Agriculture at the University of New England. She has a passion for the cropping industry.

2023 RECIPIENT ENGINEERING
LEONARD O'CALLAGHAN

Leonard is interested in agrotechnology, genetics, climate change research and protein-rich crop development. He is currently studying a Diploma of General Studies at The University of Melbourne's Dookie Campus.

CORTEVA AGRISCIENCE SCHOLARSHIP

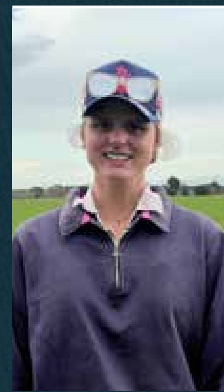
Corteva Agriscience is proud to be helping young people develop their passion for agriculture. The Corteva Agriscience Scholarship was established in 2022 and has a focus on plant breeding and agronomy.

2023 RECIPIENT
AVA ROBERTSON

Ava is currently studying at The University of Sydney. Ava's future goal is to find solutions to maximise yields and minimise constraints on finite natural resources, ensuring future food and water security.

HANRAHAN FAMILY SCHOLARSHIP

The Hanrahan Family Scholarship was established in honour of the late John Hanrahan, a valued member from Coreen. John's community spirit, passion for agriculture and thirst for knowledge was renowned.



2023 RECIPIENT
TIFFANY THOMAS

Tiffany grew up on a sheep and cropping property and believes life is best on the land. Tiffany is furthering her passion by studying a Bachelor of Agricultural Business Management at Marcus Oldham College.

UNCLE TOBYS SCHOLARSHIP

The Uncle Tobys Scholarship was established in 2021 to support future leaders in agriculture, especially those from the local region, who are crucial to the success of the food industry.

2023 RECIPIENT
KURT LUKIES

Kurt is currently studying a Bachelor of Agricultural Science at The University of Melbourne and is looking forward to starting a career in agronomy and plant and soil science.

THANK YOU TO OUR 2023 HOST FARMERS

Thank you to the members who very generously donated their time, paddocks and experience to enable Riverine Plains to undertake research, extension and validation locally. Your contribution to our region is appreciated and impactful.

The Bouffler family
The Brown family
John and Sarah Bruce
Adam Feuerherdt and the Bird Family
Chantelle and Christine Gorman
Roy and Michael Hamilton
Adam and Ingrid Inchbold
The Kellock family
Tom and Carly Marriott
The Marshall family
Lee Menhenett
The Moll family
Nathan and Kara Lawless
Beau and Rebecca Longmire
Don Piper
Neville and Kate Reilly
The Russell family
The Sandral family
The Spence family
Craig and Julia Thomas
Lawson, Doug and Bronwyn Thomas
Ian and Melanie Trevethan
Tim and Lara Trevethan
Uncle Tobys (Nestle`)
Ian and Kaye Wood

PROJECT PARTNERS

Riverine Plains was proud to collaborate with the following research and extension partners during 2023:

Australian Centre for International Agricultural Research (ACIAR), Ag Excellence Alliance, Agriculture Victoria, AgriFutures Australia, Allied Pinnacle, Australian Government's Future Drought Fund, Australian Government's National Landcare Program, Australian Government's Preparing Australian Communities Program, Australian National University, Birchip Cropping Group, Black Duck Foods, Bureau of Meteorology, Burdekin Productivity Services, Central West Farming Systems, Charles Sturt University, CSIRO, Deakin University, Farming Systems Groups Alliance, Federation University, FAR Australia, FarmLink, Food and Fibre Gippsland, First Nations Governance Circle, Foundation for Rural and Regional Renewal (FRRR), Gap Flat Track Native Foods, Gecko ClaN, Grains Research and Development Corporation (GRDC), Goulburn Broken Catchment Management Authority, Griffith University, Herbert Cane Productivity Services, Holbrook Landcare Network, Hughes Creek Catchment Collaborative Irrigation Farmers Network, Irrigation Research and Extension Committee, Kellogg's Group, La Trobe University, Local Land Services NSW, Mallee Regional Innovation Centre, Mallee Sustainable Farming, Many Mobs Indigenous Corporation, Mars Petcare, Monaro Farming Systems CMC, Manildra Group, Nicon Rural Services, NSW Department of Primary Industries, Rural Aid, Soil CRC, Southern Farming Systems, Southern Growers, Southern Cross University, Southern NSW Drought Resilience Adoption and Innovation Hub (SNSW Innovation Hub), Sustainable Food Lab, The University of Melbourne, The University of Sydney, University of Canberra, University of Wollongong, University of Southern Queensland, Victoria Drought Resilience Adoption and Innovation Hub (Vic Drought Hub), Western Australian No Tillage Farmers Association (WANTFA) and West Midland Group.

RESEARCH YEAR IN REVIEW

RESEARCH HIGHLIGHTS

The 2023 season for the Riverine Plains team marked several significant milestones. These include:

- The commencement of four new Grains Research and Development Corporation (GRDC) National Grower Network (NGN) projects addressing locally relevant issues for our farmer members.
- Completion of several Australian Government Future Drought Fund projects, delivering crucial information about community resilience and technology innovations in mixed farming systems.
- Expansion of the Riverine Plains team with the addition of two new staff members.
- Continued focus on high-profile extension events such as our Ladies Luncheon, Youth in Ag, and Innovation Expo.
- Securing a GRDC infrastructure grant to significantly enhance our field and laboratory capacity for managing risks in project delivery.

The 2023 season represented a consolidation of our field and extension activities, resulting in return-business from GRDC, the Australian Government, the Foundation for Rural and Regional Research, and the Soil Cooperative Research Centre, securing an additional 23 new projects for the organisation. This represents a further investment of nearly $4 million, which is delivering real impact for our farmer members and the wider community.

Our ability to attract ongoing investment in local trials, innovation, and capacity building, is increasing the return-on-investment from R&D levies and is helping build national and global innovation, contributing to prosperous farming communities in the Riverine Plains.

Despite facing challenges caused by another wet season, our ability to manage trials with appropriate inputs, herbicides, pesticides, and fungicides led to excellent yields across pure cropping and mixed farming enterprises in the Riverine Plains region. While challenges with accessing urea and staff shortages persisted, they did not hinder operations significantly this year.

Riverine Plains was thrilled to present the results of last year's trials at our member-based events, attracting high-calibre speakers and full attendance to our capacity-building events. We express our gratitude to our wonderful partners who make the field trials and extension events possible. As we shift our focus to 2024, we hope this information has empowered you to be more resilient, better informed, and ready to capitalise on the opportunities presented by this year's season.

NEW PROJECTS

Since the publication of the last trial book we have commenced the following new projects:

COMPANION CROPPING LEGUMES FOR LOWER COST NITROGEN SUPPLY IN FARMING SYSTEMS

TERM DATE 2024-2027

Grains growers have identified their increasing reliance on inorganic fertiliser nitrogen for crop production and are looking at innovative ways of reducing synthetic nitrogen inputs. Incorporating legumes can help farmers add nitrogen to the soil in organic form that is later mineralised to ammonium and nitrate and taken up by subsequent non-leguminous crops.

This project is testing nitrogen fixation in companion cropping scenarios for different desiccation timings, to establish the impact on the impact on the non-leguminous crop and the nitrogen-fixating contribution to the farming system, as well as the costs associated with sowing and desiccation.

This project is an investment of the Grains Research and Development Corporation (GRDC).

OPTIMISING SLUG MANAGEMENT

TERM DATE 2023-2026

Slugs are becoming an increasingly difficult to manage problem across the Riverine Plains. This project involves the monthly monitoring of slug populations in dryland and irrigated paddocks located in NSW and Victoria, as well as the design and establishment of annual spring baiting trials, including non-chemical treatments, in collaboration with SARDI. Extension events and activities will support farmers in better understanding and managing their slug populations

This project is an investment of the GRDC.

HYPER PROFITABLE CROPS

TERM DATE: 2024-2027

The Hyper profitable props (HPC) project initiative aims to boost on-farm profitability for wheat and barley growers in Australia's high rainfall zones by bridging the gap between current crop yields and their full profitability potential.

The project builds on the successes of previous GRDC Hyper yielding crops and Hyper yielding cereals work. Its focus is on closing the yield gap through informed decisions on variety selection, sowing dates, fertiliser use, and disease management.

This project is an investment of the GRDC.

ON FARM WATER MANAGEMENT

TERM DATE: 2021-2024

Drought is an inevitable part of farming in Australia. Managing water effectively can minimise the impacts of drought on livestock, pastures, soil health, and natural assets, ultimately improving production during and after drought.

This project aims to help farmers develop farm water management strategies to improve water quality, maintain livestock health, and preserve soil and natural assets. The project supports landholders in developing farm water management plans to ensure their dams, tanks and waterways meet stock and domestic needs, especially during drought.

This is a Southern NSW Drought and Innovation Hub project, funded by the Australian Government's Future Drought Fund.

DEMONSTRATING RYEGRASS CONTROL STRATEGIES

TERM DATE: 2023-2025

Cereals form a key part of the rotation for growers in the Riverine Plains region, with reports of increased ryegrass numbers in this phase due to limited control options. This has been exacerbated by poor trafficability in wet and waterlogged paddocks over recent years, with excessively wet conditions also impacting pre-emergent weed control for some product uses.

This GRDC National Grower Network project is evaluating diverse ryegrass management strategies, with the aim of enhancing crop yield and combating herbicide resistance.

This project is an investment of the GRDC.

LINK BETWEEN CEREAL STUBBLE, SUBSURFACE ACIDITY AND CROWN ROT

TERM DATE: 2023-2026

Sampling conducted as part of a previous project identified high levels of Fusarium crown rot at sites with high stubble loads and subsurface acidity across the Riverine Plains. The build-up of Fusarium crown rot has likely been favoured by recent consecutive good seasons, along with stubble retention and tight cereal rotations in the region.

This project is investigating the potential link between Fusarium crown rot, subsoil acidity and stubble management techniques through demonstrations, surveys and trials to help farmers mitigate yield loss.

This project is an investment of the GRDC.

DE-RISKING EARLY SOWN CROPS

TERM DATE: 2023-2025

Dry and early sowing of cereal crops is a practice commonly used by farmers in southern Australia to combat erratic and late opening season rainfall, and to effectively manage the sowing program on increasingly large farms.

This collaborative project aims to enhance the adoption of strategic dry sowing crop management techniques to help farmers reduce their production risk and better manage increasingly large sowing programs.

This project is supported by Ag Excellence Alliance Inc, through funding from the Australian Government's Future Drought Fund.

MACHINE LEARNING FOR MANAGING SOIL CONSTRAINTS

TERM DATE: 2023-2025

This project aims to find the best ways to manage multiple soil constraints such as sodicity, acidity, and salinity to help farmers make informed soil management decisions to maximise productivity and profitability.

The project uses data and a computer-based approach to predict which management and amelioration practices will work best for a particular soil, to enhance soil productivity and profitability for farmers.

This project is funded by the CRC for High Performance Soils Limited (Soil CRC).

IRRIGATION DISCUSSION GROUPS

TERM DATE: 2023-2025

This project aims to link new and innovative research investments by GRDC with local farmer-driven groups to improve the adoption of practices that improve the efficiency and sustainability of irrigated crop production.

The project follows on from the *Facilitated Action Learning Groups to support profitable irrigated farming project.*

This project is an investment of the GRDC.

SOIL EXTENSION ACTIVITIES

TERM DATE: 2023-2025

The project aims to give farmers a better understanding of their soils and how soils can be managed to improve production and water retention. This project supports land managers by promoting the benefits of increased frequency of extensive soil sampling and testing to inform soil management decisions and take action to improve soil health.

This project is funded by the Australian Government through the National Landcare Program Smart Farms Small Grants initiative. This project is co-funded by the Grains Research and Development Corporation.

CURRENT PROJECTS

Projects that continued during 2023 include:

SUPPORTING CLIMATE RESILIENCE THROUGH WEATHER STATIONS

TERM DATE: 2022-2024

The project is investigating the feasibility of bringing together five networks of weather stations and moisture probes across southern Australia into a single, standardised platform to inform key stakeholders on a series of localised climatic information to assist with disaster planning.

This project received grant funding from the Australian Government through the Preparing Australia Program – Local Stream.

ORGANIC FERTILISERS FOR CROP NUTRITION

TERM DATE: 2022-2024

In partnership with FAR Australia, this two-year pilot project is looking at the value of faba bean stubble with and without organic manures in restoring fertility and increasing yield in the following wheat crop. The impact of two different timings of nitrogen application on the faba crop in the subsequent wheat crop is also being assessed.

This project is an investment of the GRDC.

DROUGHT RESILIENT PASTURE SYSTEMS

TERM DATE: 2022-2024

This project, led by Holbrook Landcare Network, is using the latest research on species and management to increase the use of perennial pasture species within farming landscapes and increase resilience in dry seasons.

The project is helping farmers to improve their pasture base, either by using practices to enhance favourable species already present, or to establish new pastures. This will help address feed-base management and farmer concerns around its impact on drought resilience.

This project is supported by the Southern NSW Drought and Innovation Hub, through funding from the Australian Government's Future Drought Fund.

REWARDING SOIL STEWARDSHIP

TERM DATE: 2022-2025

This project, led by Charles Sturt University, is configuring, trialing and evaluating novel financial mechanisms to reward soil stewardship.

The project is working to improve connections among soil scientists, growers and the finance sectors and review the benefits, costs and uncertainties related to different soil stewardship practices, as well as the available returns from different markets/sources.

This project is funded by the Soil CRC.

BUILDING SOIL RESILIENCE AND CARBON THROUGH PLANT DIVERSITY

TERM DATE: 2023-2026

This project, led by Southern Cross University, follows on from the *Plant based solutions to improve soil performance* project. The project continues to investigate changes in soil function, resilience and carbon stocks under a range of agronomic practices that incorporate plant diversity in cropping systems. The project also investigates how much carbon from rhizo-deposits from cover crop and intercrop species is stabilised in soil and its contribution to soil aggregation.

This project is funded by the Soil CRC.

HELPING REGIONAL COMMUNITIES PREPARE FOR DROUGHT – GOULBURN COORDINATION

TERM DATE: 2023-2025

This project is strengthening drought preparedness and driving local action in the Goulburn region through the coordination of Community Impact Program activities and evaluation administration.

This project is supported by FRRR through funding from through the Australian Government's Future Drought Fund.

VISUALISING AUSTRALASIA'S SOILS

TERM DATE: 2023-2024

This project aims to increase the soils data and related information that can be discovered through the Visualising Australian Soils portal, to sustain a soil knowledge system that is inherently useful for research, development, extension and adoption.

This project is led by Federation University and is funded by the Soil CRC.

RIVERINE PLAINS INNOVATION EXPO EVENTS

TERM DATE: 2023-2025

This project aims to build depth of social connection and increase skills, knowledge and understanding of the risks posed by drought and climate change by delivering Innovation Expo events, awareness and education activities from 2023-2025.

This project was supported by FRRR through funding from the Australian Government's Future Drought Fund. The Riverine Plains 2023 Innovation Expo was also supported by; Alvan Blanch Australia, Uncle Tobys, Bayer Crop Science, New Edge Microbials, GRDC, Australian Grain Technologies, ANZ, Thera Capital Management, Wiesners, Goldacres, AgriFutures Australia, Agriculture Victoria and Moira Shire.

LADIES' LUNCHEON

TERM DATE: 2023-2025

This project aims to build depth of social connection, a shared sense of purpose and longer-term community belonging that can be drawn upon in future drought by hosting Ladies' Lunches in 2023 and 2024. The lunches align with International Rural Women's Day, reducing social isolation and building local networks and social supports for women in this remote region.

This project is supported by FRRR through funding from the Australian Government's Future Drought Fund. The 2023 Ladies Luncheon was also supported by Riverine Plains Project Partner, GrainGrowers.

YOUTH IN AG

TERM DATE: 2023-2025

This project aims to build depth of social connection, a shared sense of purpose and longer-term community belonging that can be drawn upon in future drought through the facilitation of two mentoring and networking events for youth in the region and two 'Youth in Ag' dinner events.

This project was supported by FRRR through funding from the Australian Government's Future Drought Fund. The 2023 and 2024 Youth in Ag Program was also supported by Riverine Plains Youth in Ag Program partners, Corteva Agriscience and Elders Rural Services, Elders Shepparton, Elders Yarrawonga, Elders Albury.

BEST PRACTICE LIMING

TERM DATE: 2021-2024

This project aims to increase awareness of the speed of acidification and stratification of soils in the region and the availability of tools to assist in the management decision process.

It involves a replicated lime treatment field trial at Lilliput, Victoria, which aims to demonstrate best practice liming methods and how the incorporation of top-dressed lime can improve its distribution down the soil profile, lessening the impacts of soil acidity on subsequent crops.

This project is an investment of the GRDC.

HYPER YIELDING CROPS

TERM DATE: 2020-2024

This project aims to close the yield gap of wheat, barley and canola in the high rainfall zone. Riverine Plains has established annual focus farm sites at various locations in support of the NSW Centre of Excellence at Wallendbeen. Riverine Plains has also established Discussion Groups to link local growers with the focus farm paddock trials at these sites.

This project is an investment of the GRDC.

CURRENT PROJECTS

VICTORIA DROUGHT RESILIENCE ADOPTION AND INNOVATION HUB

TERM DATE: 2021-2024

The Victoria Drought Resilience, Adoption, and Innovation Hub is led by the University of Melbourne's Dookie Campus and is conducted in association with Deakin, La Trobe, and Federation University and Agriculture Victoria.

Riverine Plains leads the "Northeast Victoria Node", consulting the agricultural industry through farmers, councils, businesses, health organisations, and community groups in their region about building drought resilience at the local level. This process has led to the development of pilot projects to address specific knowledge or technical skill gaps identified through the hubs, capacity building and the brokering of knowledge between nodes.

This project is funded through the Australian Government's Future Drought Fund.

SOUTHERN NSW DROUGHT RESILIENCE ADOPTION AND INNOVATION HUB

TERM DATE: 2022-2024

The Southern NSW Drought Resilience, Adoption, and Innovation Hub is a consortium of nine regional partners including primary producers, Indigenous, industry and community groups, researchers, entrepreneurs, education institutions, resource management practitioners and government agencies.

Riverine Plains has appointed a part-time knowledge broker who is assisting to gather and share knowledge to southern NSW members and their communities. The outcome of this partnership is user-driven innovation, research and adoption and the facilitation of transformational change through the co-design of research, development, extension, adoption, and commercialisation activities.

This project is funded through the Australian Government's Future Drought Fund.

CLOSING THE YIELD GAP IN FABA BEAN WITH IMPROVED DISEASE MANAGEMENT, NUTRITION AND CANOPY MANIPULATION

TERM DATE: 2021-2024

This project, led by FAR Australia, is designed to deliver local development and extension to maximise farming benefits from grain legume production. This will be achieved through grower-driven grain legume validation and demonstration trials across the region.

This project is an investment of the GRDC.

ASSESSING SOIL WATER STORAGE

TERM DATE: 2022- 2025

This project aims to improve the understanding of crop access to water and resources. Through installation of field sensors, the project is quantifying changes in soil water infiltration, storage, drainage, and crop interaction, due to the diagnosis and management of soil constraints at an existing Soil CRC project site at Burramine. This is allowing the development of tools supporting soil management for increased access to soil water and give a better understanding of the competition for water and resources between mixed species cover crops and impacts on soil water availability.

This project is funded by the Soil CRC.

DIAGNOSIS FRAMEWORKS FOR MULTIPLE AND COMPLEX SOIL CONSTRAINTS

TERM DATE: 2021-2024

The productivity of 77% of Australian agricultural soils is limited by one or more soil constraints, however, efficiently ameliorating constrained soils often requires an accurate diagnosis.

This project will develop and validate diagnostic methodologies that can diagnose soil constraints from the data that producers already have access to (e.g., crop yields, surface soil tests), in combination with information in the public domain. This will reduce the cost associated with detailed soil sampling.

This project is funded by the Soil CRC.

SILICON FERTILISER FOR DROUGHT RESILIENCE IN BROADACRE CROPPING

TERM DATE: 2022-2024

This project is led by The University of Melbourne and is hosted on large plot demonstration or evaluation sites at four locations across northern Victoria.

Around fifty small-scale replicated research trials are being used to evaluate a broader set of varieties and management options, including silicon fertiliser application for drought mitigation in broadacre cropping. In this project, granular silicon fertiliser is being applied below the seed at sowing for wheat and faba beans, while foliar silicon fertiliser is being applied throughout the season.

The potential role of legumes in the standard cropping rotation and dual-purpose wheat options are also being demonstrated, as well as an evaluation of indigenous plant species.

This project is funded by the Australian Government's Future Drought Fund.

SMALL FARM DAM SUITABILITY ASSESSMENT

TERM DATE: 2022-2024

This project is led by Southern Farming Systems and aims to create a spatial tool to rapidly calculate the likely runoff (frequency and volume under current future climate scenarios) into existing farm dams to help prepare, cope, and recover from drought. This type of calculator does not exist, with current approaches designed for flood rather than drought planning.

This project is funded by the Australian Government's Future Drought Fund.

OPTIMISING SOILS AND AVAILABLE WATER TO IMPROVE DROUGHT RESILIENCE

TERM DATE: 2022-2024

This project has established 12 demonstration sites across southern NSW and north east Victoria, covering a range of soil types, environments, and land uses. The project will demonstrate three proven strategies that improve drought resilience compared to conventional farming, including diverse legume rotations, early sowing of slower-maturing crops and measuring residual nitrogen in the soil.

This project is supported through funding from the Australian Government's Future Drought Fund Drought Resilient Soils and Landscapes Grants Program, and is co-funded by the Grains Research and Development Corporation.

TECHNOLOGY UPTAKE PROGRAM

TERM DATE:2023-2024

The agritech space is complex and continually evolving. This means it can be difficult for farmers to work out which technology provides the best solution when solving a problem on farm. The Technology uptake program is supporting farmers in the Riverine Plains region to understand the types of agritech that are available, and how it can benefit their farming operation through a series of workshops, field tours, and case studies.

This project follows on from Riverine Plains *Producer technology uptake* program, which involved online technology workshops and case studies of local farmers adopting new technology.

This project is funded by AgriFutures Australia.

CONCLUDING PROJECTS

Projects that concluded during 2023 include:

IMPROVING SOIL TO OPTIMISE WATER USE ON FARM

TERM DATE: 2021-2023

This project addressed soil quality parameters, storing more rainfall for crop production, and how these are related. The project aimed to provide farmers with a better understanding and knowledge of their soil and how they can identify local constraints, improve production, and water retention, and build resilience for future droughts.

This project received funding from the Australian Government's Future Drought Fund.

COMMUNITY LED DROUGHT RESILIENCE

TERM DATE: 2022-2023

This project investigated differences in the multi-dimensional (economic, social, environmental) experiences of rural women and men to drought. This identified gender specific opportunities, information and training needs to capitalise on the untapped potentials of women and men to build better drought resilience, while also increasing leadership depth within the community.

This project was funded by the Australian Government's Future Drought Fund through the Victoria Drought Resilience Adoption and Innovation Hub.

VICTORIAN AGRICULTURAL INNOVATION HUB – AGTECH INNOVATION

TERM DATE: 2023

This project supported activities focused on increasing the adoption of digital agriculture solutions and increased digital agriculture awareness, education and improved data literacy, data collection, collation and permissions, as well as data access and sharing practices related to electronic identification (EID). Farmers and advisors learnt new approaches for combining and analysing historical and current spatially referenced data to create new insights into the resilience and reliability of different parts of the farm, examined across multiple seasons.

This project was funded by the Australian Government's Future Drought Fund through the Agricultural Innovation Hubs Program with the Victoria Drought Resilience Adoption and Innovation Hub.

DROUGHT RESILIENCE PRACTICES IN MIXED FARMING SYSTEMS

TERM DATE: 2022-2023

This project fast-tracked direct support to cropping and livestock farmers across Victoria, South Australia, and Tasmania, in the management of pastures, the use of livestock containment and different feeding systems for drought resilience.

The use of demonstrations, activities and outputs in this project aimed to improve farm decision making, leading to improvements in soil cover, livestock welfare and nutrition in periods leading into, during and post drought.

This project was funded by the Australian Government's Future Drought Fund through the Victoria Drought Resilience Adoption and Innovation Hub.

STRATEGIES TO HELP WITH NITROGEN DECISIONS

TERM DATE: 2022-2023

This project, led by FarmLink, established a replicated trial site that compared 'nitrogen banking' and 'nitrogen demand' based strategies for closing the nitrogen limited yield gap with nil and national average control treatments. An economic analysis of scenarios for 'nitrogen banking' and 'nitrogen demand' based strategies compared to controls was also completed.

This project is an investment of the GRDC.

IRRIGATION DISCUSSION GROUP

TERM DATE: 2019-2023

This project was led by the Irrigated Cropping Council and assisted the formation of the Riverine Plains Irrigation Discussion Group. This group aimed to link new and innovative irrigated cropping research investments by the Grains Research and Development Corporation with local farmer-driven groups and to tie these research projects more closely with farmer needs.

This project is an investment of the GRDC.

SAVING SOIL DURING DROUGHT

TERM DATE: 2022-2023

Soils that are exposed due to loss of groundcover often become dry and powdery, making them vulnerable to wind and water erosion. Appropriate management of livestock during drought is critical to the resilience capacity of soils, vegetation and farming enterprises. This project demonstrated best practice application of Stock Management Areas (SMA), supported by a suite of tools, materials and information to provide producers with knowledge and confidence to adopt SMAs for maximum benefit.

This project was delivered through the Southern NSW Drought Resilience Adoption and Innovation Hub, supported by Local Land Services, through funding from the Australian Government's Future Drought Fund.

COOL SOIL INITIATIVE

TERM DATE: 2018-2023

The Cool Soil Initiative aims to increase the long-term sustainability and yield stability of southern New South Wales and northeast Victoria grain-producing regions, by adopting innovative agronomic strategies to improve soil health and related function.

Riverine Plains' involvement in this project sought to create a platform for the food industry to support grain farmers in reducing greenhouse gas emissions, leading to increased long-term sustainability.

The project was funded by Mars Petcare, Kellogg's, Manildra Group, Corson and Allied Pinnacle, in partnership with Charles Sturt University and the Food Agility Cooperative Research Centre, with support from the Sustainable Food Lab.

GRDC INFRASTRUCTURE GRANT

TERM DATE: 2023

This project allowed Riverine Plains to purchase several key items that provide significant improvements in overall operational capacity.

This included two large drying ovens that enhance our efficiency in processing soil and plant samples, and two additional utes to enable staff to complete their fieldwork. The project also provided for the purchase of a BBQ trailer for events, as well as a tandem trailer to transport equipment to our trial sites. The addition of a Minibatt grain thresher also helps streamline sample collection during harvest.

Riverine Plains also purchased a ute spray setup, with a 200L tank and a 6m boom, and made improvements to video conferencing facilities in our new office.

This project is an investment of the GRDC.

A BRIEF UPDATE ON THE VICTORIA DROUGHT RESILIENCE ADOPTION AND INNOVATION HUB

KEY MESSAGES

- During 2023, four new Drought Hub projects kicked off including the *SCOUT* pilot program, *Non-chemical slug control,* and *Non-chemical weed control* pilot projects
- The Hub also made contributions to the Riverine Plains Ladies Luncheon, Youth in Agriculture events, the Riverine Plains Innovation Expo, as well as an ongoing investment into the Riverine Plains Livestock Officer position during 2023
- Several Hub projects were completed in 2023, including the *Community resilience* project, the *Renewable energy in agriculture feasibility study,* and the *Agriculture innovations program.*

WHAT IS THE VICTORIA DROUGHT RESILIENCE ADOPTION INNOVATION HUB?

The Victoria Drought Resilience Adoption and Innovation Hub is an $8 million program funded from the Australian Government's Future Drought Fund.

Running over four years, the Hub is a collaboration between Deakin, La Trobe, and Federation Universities, Agriculture Victoria, Riverine Plains, Southern Farming Systems, Birchip Cropping Groups, Food and Fibre Gippsland and the Mallee Research and Innovation Centre, with the University of Melbourne taking the lead at Hub HQ.

Riverine Plains is the "North East Node" partner for Victoria, representing the agricultural industry through consultation with farmers, councils, businesses, health organisations, and community groups in the region and helping to build drought resilience at a local level. This process has led to the development of pilot projects which address specific knowledge or technology gaps identified through the Hubs, as well as capacity building and the brokering of knowledge between partnering organisations.

Riverine Plains will continue as the "North East Node" partner for Victoria, with funding extended by the Future Drought Fund.

COMPLETED HUB PROJECTS - OUTCOMES

The completion of several initiatives by Riverine Plains, coordinated through the Hub, has delivered significant benefits for the local region. In 2023, the *Farmer renewables opportunity* assessment project was completed, which explored key opportunities to support farmers and regional infrastructure transition to renewable energy, this project is being built on through the *Understanding the ROI of on-farm energy storage* project.

The *Containment feeding to boost business performance and resilience* project, which was also completed in 2024, aimed to build the capacity of advisors in farming systems groups across Victoria, Tasmania and South Australia. It did this by conducting group and online training on how to manage stock containment effectively, including when to implement it and how to begin the stock containment process. The project helped advisors increase their knowledge of the timing and mindset for using stock containment, allowed one-on-one follow-up with farmers, and built capacity by building a livestock network.

Additionally, Drought Hub funding contributed to capacity-building projects such as the Ladies Luncheon, the Youth In Ag program, and the Riverine Plains Innovation Expo, all of which saw sell-out crowds and provided valuable information to a diverse and highly engaged audience. While the far-reaching impact of these events may not be immediately measurable, the ongoing popularity of these initiatives, combined with feedback regarding improvements in knowledge and networks, clearly demonstrates their success.

The ongoing funding of the Riverine Plains Livestock Officer role has resulted in five additional events being delivered in the Riverine Plains and surrounding regions, with feedback supporting the continuation of this position and an ongoing focus on livestock. This included the *Maximising utilisation of electronic identification tags to better inform livestock management decisions* project, delivered through the Hub's Agtech Innovation program which delivered a field day, webinar, and several publications, including a decision support tool and product guides.

In 2024, new projects will be delivered to support farmers to build resilience and preparedness for future droughts and changing weather conditions.

ACKNOWLEDGMENTS

The Victoria Drought Resilience Adoption and Innovation Hub is funded by the Future Drought Fund, through the Australian Government's Department of Agriculture, Fisheries, and Forestry.

SOUTHERN NEW SOUTH WALES DROUGHT RESILIENCE ADOPTION AND INNOVATION HUB

KEY MESSAGES

- The Southern NSW Drought Resilience Adoption and Innovation Hub (Southern NSW Hub) enables regional communities to have a voice in drought resilience activities, gain access to resources, and provides tools and programs to assist adoption
- The work to date has revealed that while many learnings can be applied from past droughts, there are still knowledge gaps that could be filled by helping farmers not only in managing current situations but being prepared for climate variability.

BACKGROUND

The partners in the Southern NSW Hub are the Australian National University, Charles Sturt University, University of Canberra, NSW Department of Primary Industries, NSW Local Land Services, Rural Aid and the Farming Systems Groups Alliance, which includes Riverine Plains. The Hub encompasses most of the Macquarie River catchment and lower reaches of the Darling River, the Illawarra and South Coast, Riverina, Australian Alps, Western NSW and includes Canberra, Dubbo, Orange and Bathurst and their surrounding regions.

The Knowledge Broker Network, established by the Hub, has provided opportunities to build capacity in Riverine Plains staff members as well as share knowledge between professionals at various partner organisations. The Southern NSW Hub works with the Knowledge Broker network and Universities to provide relevant resources as well as support projects that help address identified priorities across southern NSW.

PROJECTS

As a result of collaboration with the Southern NSW Hub and various partner organisations, Riverine Plains has been involved in three projects within the Drought Resilient Soils and Landscapes grant program.

The *Improved drought resilience through optimal management of soils and available water* project showcases the work of John Kirkegaard's previous small-scale field trials looking at increased water use efficiency, soil organic carbon and nitrogen utilisation. The *Saving Our Soils During Drought* project demonstrated the best practice application of stock containment areas and was supported by a comprehensive suite of tools, materials and information to provide producers with knowledge and confidence to adopt. The *Changing landscapes with drought resilient pastures* project uses the latest research on species and management to increase the use of perennial pasture species within farming landscapes, to increase resilience during dry seasons.

Riverine Plains is also involved in the *On-Farm Water Management* project which will assist farmers to prepare and implement on-farm water management plans. These plans will be developed at workshops and one-on-one sessions to help farmers determine their stock and domestic water requirements and the capacity to meet these needs.

The Southern NSW Hub have awarded multiple partner organisations, including Riverine Plains, co-design grants which will assist with development of various projects and programs. To this end, Riverine Plains has completed co-design and consultation with our members and industry on the topic of succession planning and the challenges associated with starting the journey.

Finally, the Southern NSW Hub have been successful in the recent Future Drought Fund (FDF) Long Term Trial grant process, with Riverine Plains to be involved in the Long Term Field Trials in Southern NSW project. This project will see six years of small plot trials research extended to demonstration sites managed by farming systems groups such as Riverine Plains.

FUTURE OF THE SOUTHERN NSW HUB

A further commitment by the Australian Government has now also been announced committing to a further eight years of funding for the drought hub model subject to nation-wide review of the hubs. The Hub has produced a prospectus with a vision for the Hub's operations for the 2024-2028 period. The prospectus involves an enhanced and targeted focus on five impact areas for the SNSW region which include social and cultural resilience, enhancing and preserving the natural environment, ground cover, soil health and water, and water use. The prospectus has been submitted to the Department of Agriculture, Fisheries and Forestry (DAFF) to be considered in the FDF 2024-28 Funding Plan.

ACKNOWLEDGEMENTS

The Southern NSW Drought Resilience Adoption and Innovation Hub is funded by the Future Drought Fund, through the Australian Government's Department of Agriculture, Forestry and Fisheries.

THE YEAR IN REVIEW

KEY MESSAGES

- **Good autumn rains saw sowing get underway on time, however slug damage was widespread**
- **Wet conditions in early winter caused waterlogging, which some crops failed to fully recover from**
- **Early – mid season urea shortages complicated nitrogen topdressing decisions**
- **Widespread rain in October played a major role in helping crops maximise yield potential after a dry September**

A wet end to the 2022 season caused disruptions for many farmers, with a long and drawn-out harvest rolling over into early 2023. While 2022-2023 harvest yields were good to excellent for those higher in the landscape or on better drained soils, some farmers experienced a disappointing harvest due to the extremely wet conditions that persisted from spring onwards, driven by La Niña.

A SUMMER DEFINED BY LA NIÑA

The La Niña event carried over into the start of 2023, with storm activity and rain bands bringing significant rainfall to the region. There were some exceptionally high rainfall totals in the eastern Riverine Plains for January (over 200mm in Albury, 155 mm in Rutherglen, 120 mm in Corowa and 100 mm at Henty), with more modest totals elsewhere.

Abundant soil moisture over January and February was good for perennial pasture growth, however it also meant that weed management became a priority. This saw many farmers move straight from harvest to spraying, and then into sowing and spraying again, with little opportunity to rest and reset post-harvest.

EARLY – MID SEASON RAINFALL AND MARKETS

Good rainfall in March and April (between deciles 5-9) (Table 1) saw sowing get underway early or on-time, with most crops sown into moisture and emerging well. Slugs continued to be a major problem in the region, showing up in new and unexpected areas as a result of the wet and favourable breeding conditions over the past few seasons.

A very wet June (decile 7-10) saw many crops struggle with waterlogging during winter. Some crops failed to fully recover, with pulses and canola generally the most affected. The wet conditions also meant there were trafficability issues which affected the timeliness of broadleaf weed control. Ryegrass management was also challenging given second or late germinations, especially in heavier soils and low competition areas.

Urea shortages around this time also meant potential yield was not achieved in some instances. Given the tight supply, farmers had to be strategic with nitrogen applications and prioritise which paddocks were best to receive it.

While pasture growth and quality were generally good in the Riverine Plains, dry conditions in northern Australia, combined with talk of a possible El Niño, saw livestock prices fall dramatically from about mid-year onwards. The resultant market volatility, which reached a low point in spring, made the season an especially difficult one for livestock producers in the region.

SPRING CONDITIONS

July to August rainfall across the region was between decile 2 and 5. While this allowed plants to recover from waterlogging, a very dry September (decile 1-2), combined with the declaration of El Niño and a strong positive Indian Ocean Dipole in early spring, increased concerns about the potential for a dry spring. Fortunately, good soil moisture stores carried over from 2022, the 2023 summer and the wet winter helped crops get through this period. The dry conditions meant that crop disease pressure was low in spring, however the timing of hot and dry weather during the critical flowering window likely impacted pulse and canola yields.

While El Nino and a positive Indian Ocean Dipole both increase the chance of drier-than-average conditions in southern Australia, significant rainfall can still occur even when these climate drivers are active. This was the case when a strong cold front and a low-pressure system with an associated rainband delivered significant rains across the whole region in early October.

Comparatively more rainfall was received from this weather system in the southern region, with Euroa, Caniambo/Dookie, Yarrawonga and Cobram receiving decile 9-10 rainfall for the month, while the more northern areas received declie 4-7 rains. This widespread and timely rain was a major factor in helping crops achieve high yield potentials, especially wheat and later sown crops that were able to make better use of the moisture.

While there was some rainfall during the hay-making season, local lay and silage producers were generally able to produce good quality fodder, allowing reserves to be built up again after an extremely difficult wet season the year before.

Above average rain (decile 7-10) was received across most of the region in November and December. Despite this, harvesting conditions were generally favourable, with most farmers finished well before Christmas. Canola and cereals generally yielded better than expected, although pulse yields were variable due to a combination of early waterlogging and hot and dry conditions during flowering. Yield generally made up for lower protein grain and quality was generally better than expected given harvest rains.

The combination of good yields and pricing made it a profitable year for many grain farmers in the region.

Table 1 2023 monthly and growing season rainfall totals and deciles across the Riverine Plains

	EUROA*	DEC	RRI	DEC	CANI-AMBO	DEC	YARRA-WONGA	DEC	COBRAM	DEC
Station ID	82016 & 82149		82039		81007		81124		80109	
January	31	6	150	10	44	7	33	7	26	6
February	13	4	5	3	8	4	5	3	4	3
March	53	7	54	8	39	7	28	5	19	5
April	66	8	77	9	47	7	57	8	63	9
May	54	6	40	5	42	6	24	4	18	3
June	154	10	118	10	120	10	80	9	93	10
July	29	2	53	5	26	2	35	4	33	5
August	58	4	53	5	43	5	34	4	41	5
September	25	2	9	1	18	2	12	1	6	1
October	100	9	65	7	92	9	73	9	105	10
November	41	5	76	8	31	6	51	7	72	9
December	53	8	82	9	63	9	62	8	61	9
GSR Apr-Oct	486	8	415	7	388	6	315	6	359	8
Year	677	7	782	9	573	7	494	6	541	8
January-March		5	209	9	91	5	66	4	49	3

	ALBURY	DEC	HENTY #	DEC	COR-OWA ^	DEC	LOCK-HART	DEC	URANA	DEC
Station ID	72160		74053		74034		RP		74110	
January	201	10	104	10	122*	10	67	9	79	9
February	13	4	19	5	9	3	47	8	10	4
March	69	8	105	9	54	8	85	9	39	7
April	58	7	92	9	77	9	71	9	55	9
May	45	5	52	7	30	4	18	3	38	6
June	91	7	72	7	96	9	50	7	67	9
July	61	5	38	4	39	4	27	3	27	4
August	53	3	49	5	39	4	38	5	26	4
September	8	1	7	1	13	1	3	1	1	1
October	68	6	46	6	50	6	30	4	46	7
November	81	8	92	9	57	8	68	9	57	9
December	56	7	63	8	85	9	45	8	107	10
GSR Apr-Oct	384	4	356	5	344	6	237	3	260	5
Year	804	8	739	9	549	6	549	7	552	8
January-March	283	10	228	9	63	3	199	10	128	7

Notes:

Dec = decile. Decile analysis conducted using Climate ARM Online (previously Rainman Streamflow)

RP = Riverine Plains network weather station

* Euroa October, November, December rainfall data from Bureau of Meteorology weather station number 82149

\# Henty April rainfall, from Riverine Plains Pleasant Hills Weather station; March, May, August, September, October, December monthly totals from Riverine Plains Culcairn weather station

^ Corowa Jan/Feb, October, November, Decembers figures adjusted or taken from Howlong on-farm weather station data. March, April data from RRI.

Annual rainfall deciles for both NSW and Victoria are shown in Figure 1.

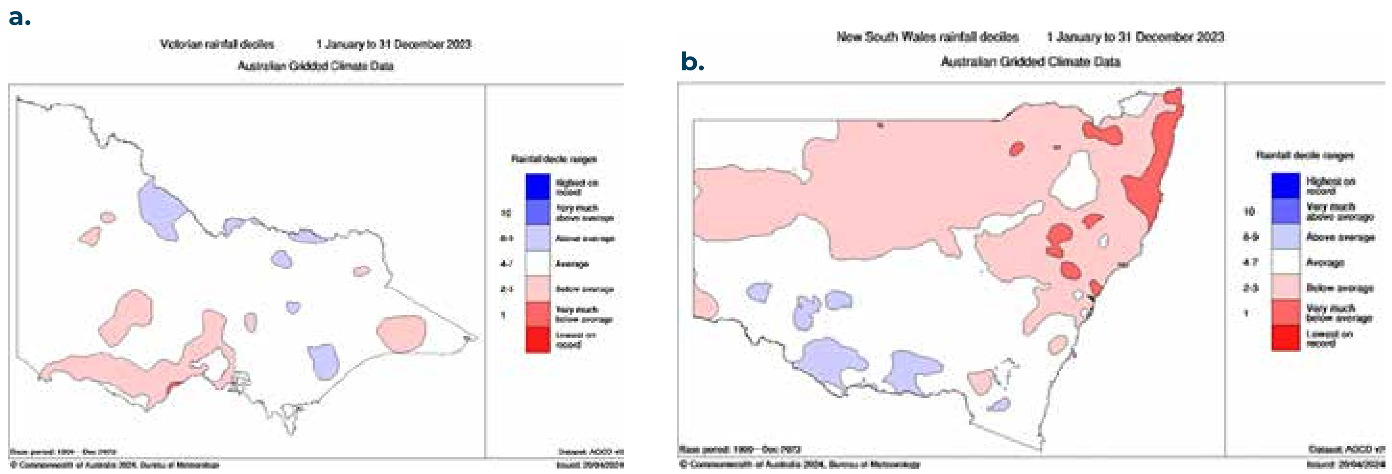


Figure 1a and 1b. Full-year rainfall deciles across Victoria and NSW during 2023 (Source: BoM, 2024)

TEMPERATURE

Average temperatures in NSW during 2023 were the sixth warmest since records began in 1910. In Victoria, this was the warmest year since 2019. For most of the Riverine Plains, mean temperature deciles for 2023 were above average (Figure 2).

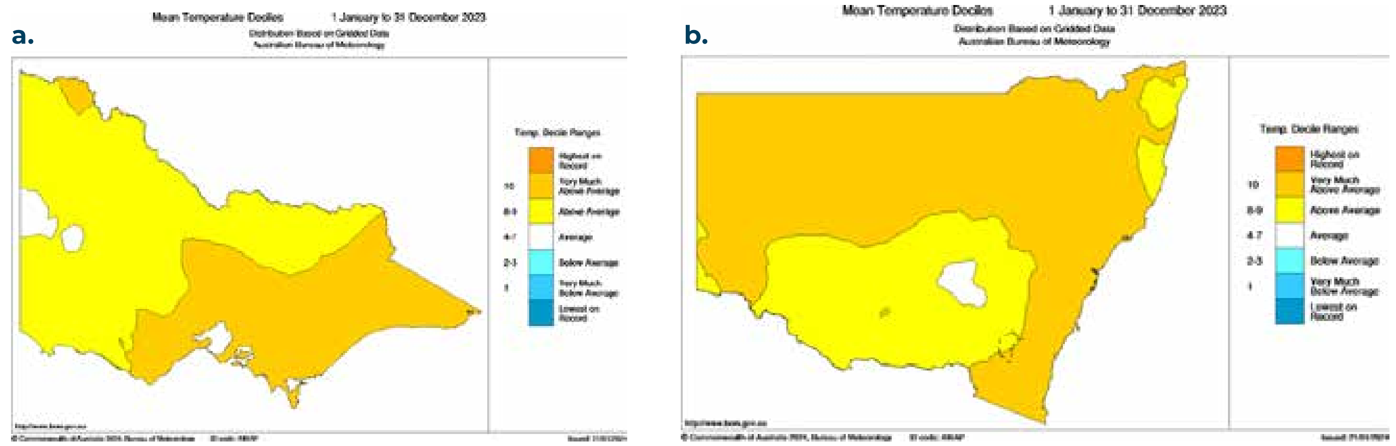


Figure 2a and 2b. Mean annual temperature deciles for Victoria and NSW, 2022. (Source BoM, 2022)

At Rand, frost days (days with a minimum temperate below 2.2°C), were about average for July, and higher-than average for August and September. While there may have been some localised frost damage, there was not a widespread damaging frost event in the Riverine Plains during 2023.

SUMMARY

A good start to the season allowed sowing to get underway on time, allowing crops to establish well. However a wet winter with widespread waterlogging proved challenging for grain growers, with pulse and canola crops worst affected. An extremely dry September was followed by timely rain in early October; this was a key factor in many crops achieving high yield potentials. While rain at harvest resulted in some quality downgrading, many grain growers were pleasantly surprised by canola and cereal yields given the seasonal conditions. While pasture growth was good, livestock producers had a very difficult year with pricing.

Overall, the season was generally positive for many farmers in the region, with good yields and strong pricing allowing many to shore up their financial and fodder reserves.

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TRIAL RESULTS

Kellock family harvest

UNDERSTANDING THE LINK BETWEEN CEREAL STUBBLE, SUBSURFACE ACIDITY AND CROWN ROT

KEY MESSAGES

- **Predicta B testing across the Riverine Plains during February 2024 showed that 79% of samples collected had medium to high levels of Fusarium crown rot present**
- **A demonstration site sown to wheat for two years (2021-2022), had high levels of Fusarium crown rot — burning the wheat stubble and planting faba beans in 2023 reduced levels to low within a 12 month period**
- **Segmented soil tests conducted across Riverine Plains revealed 64% of paddocks tested had pH less than 5 in the 5-10cm layer, with 50 % of the paddocks showing pH below 5 in the 10-15cm layer**
- **An acid layer, between 5 and 15cm, can affect production of acid-sensitive crops, as well as nodulation by legume species; if an acid layer is present, the recommended target pH(CaCl) for 0-10 cm is 5.8.**

BACKGROUND

Riverine Plains has identified that the extent and impact of Fusarium crown rot remains largely unrecognised by cereal growers in the region. This is despite an increase in Fusarium crown rot locally, as confirmed by surveillance and test results conducted by the NSW Department of Primary Industries.

The lack of recognition is likely due to the masking of disease symptoms by wet conditions in recent seasons. This has reduced the expression of the whiteheads and reduced yields typical of the disease, which occurs when cereal crops are filling under moisture stress. It is also likely that recent wet conditions have favoured disease build up and survival.

In 2021, the Riverine Plains project *Improving soils to optimise water use on farm* studied the impact of cereal stubble management and subsurface acidity on yield at a field site in Murchison. Four stubble treatments used in this project were sampled for Fusarium crown rot in January 2023 using Predicta B testing, with results indicating a potential correlation between stubble treatment and subsurface acidity, Fusarium crown rot infection and yield loss.

The Grains Research and Development Corporation (GRDC) and Riverine Plains are further investigating this potential link through a National Grower Network project, *Understanding the link between cereal stubble, subsurface acidity and crown rot*. Trials for this project commenced in October 2023 and will be completed in December 2026.

AIM

This project aims to determine how stubble management strategies and break crops can impact Fusarium crown rot pathogen levels over time. The project is also investigating the potential link between stubble management, subsurface acidity, and Fusarium crown rot in cereals over multiple seasons.

METHOD

LITERATURE REVIEW

A literature review was undertaken to understand if there is a correlation between Fusarium crown rot and soil pH.

INCREMENTED PH TESTING

A total of 14 farmer paddocks and 8 treatments at the Murchison stubble demonstration site were sampled for soil pH from 0-20 cm, in 5 cm increments.

PREDICTA B TESTING

Fourteen farmer paddocks were tested using Predicta B during February 2024. A demonstration site at Murchison also provided samples for Predicta B testing, to show how stubble management strategies can impact Fusarium crown rot levels

RESULTS AND DISCUSSION

LITERATURE REVIEW OUTCOMES

The literature review highlighted that acidic and saline conditions can reduce the ability of beneficial soil microorganisms to thrive and that such environments can cause crops, including cereals, to become more susceptible to diseases such as Fusarium crown rot.

The review clearly established that there was a lack of research into the link between subsoil acidity and Fusarium crown rot under Australian conditions. However overseas research indicates that low pH is correlated to higher levels of whiteheads caused by Fusarium crown rot.

INCREMENTED PH TESTING – FARMER PADDOCKS

Soil testing conducted across 14 paddocks in the region showed that at a depth of 0-5 cm, only a single paddock had a pH lower than 5 (Figure 1). Additionally, no paddocks showed aluminium toxicity at this depth, with aluminium levels remaining below the 5% toxicity threshold (data not shown). However, most pulse crops are sensitive to pH below 5.2, and several of the sampled paddocks showed a pH of 5.1 at this depth. This indicates they may not be suitable in supporting legumes as break crops to reduce diseases such as Fusarium crown rot.

An acidic layer, corresponding to the area with the highest aluminium toxicity, was often found at a depth of 5-10 cm (Figure 2). At the 5-10 cm depth, most paddocks samples had a pH below 5 and aluminium levels above 5 percent, with pH ranging from 4.5 to 5.6 across different paddocks. Seven paddocks had a pH below 5 at the 10-15 cm depth (Figure 3), while two paddocks had a pH below 5 at the 15-20 cm depth (Figure 4). The pH range at these depths varied from 4.6 to 5.5 and 4.6 to 5.7, respectively.

The Riverine Plains region is known for its acid soils, and the lack of significant acidity in the surface soil samples suggests that farmers are applying lime, but not at high enough rates to ameliorate acidity in the subsurface. The target pH(CaCl) to ameliorate subsurface acidity in the 0-10 cm depth is 5.8.

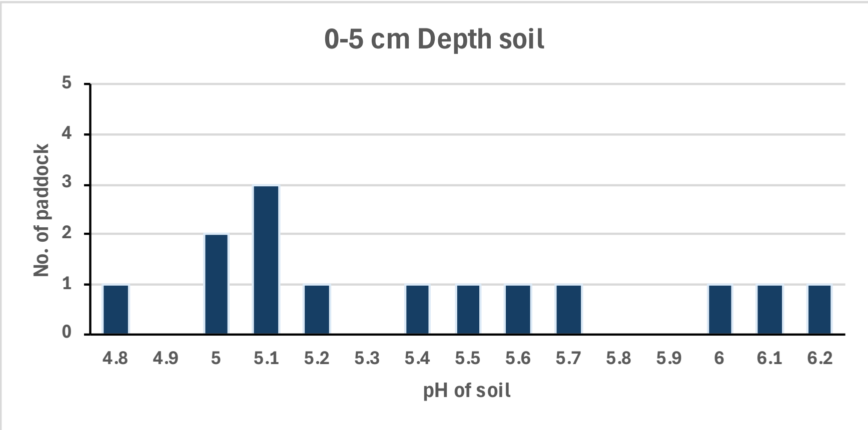

Figure 1 The pH range of paddocks sampled at 0-5 cm depth in the Riverine Plains, 2023

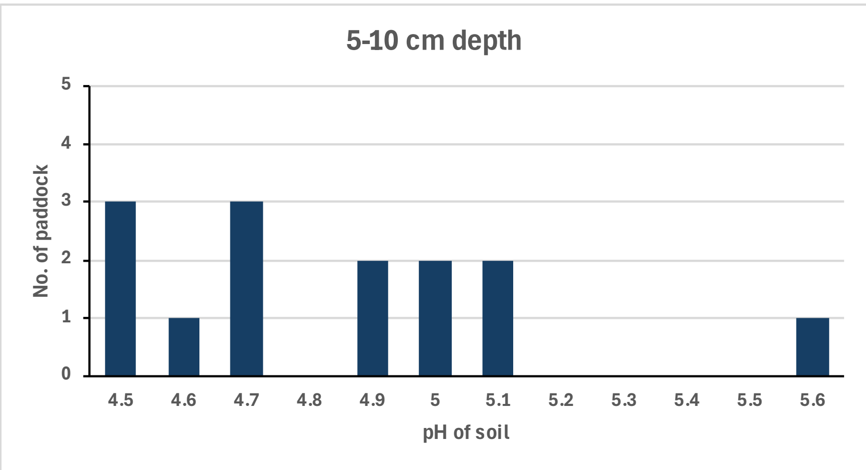

Figure 2 The pH range of paddocks sampled at 5-10 cm depth in the Riverine Plains, 2023

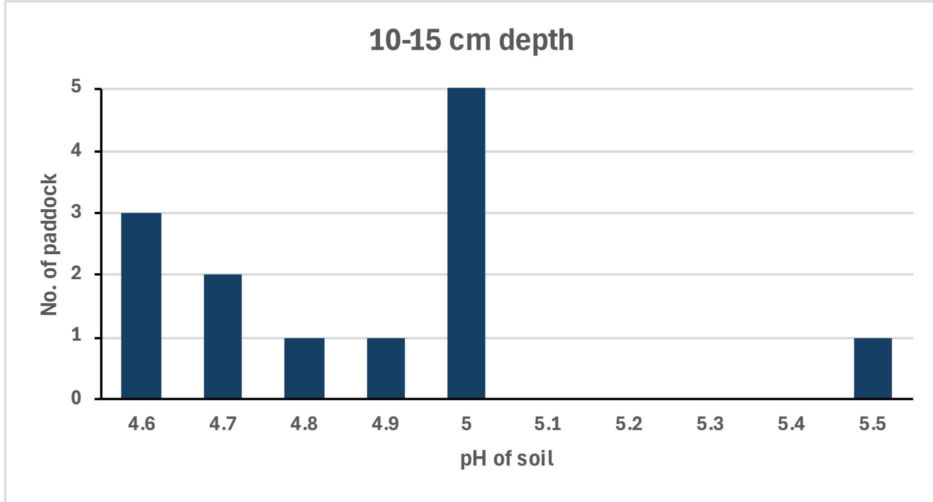

Figure 3 The pH range of paddocks sampled at 10-15 cm depth in the Riverine Plains, 2023

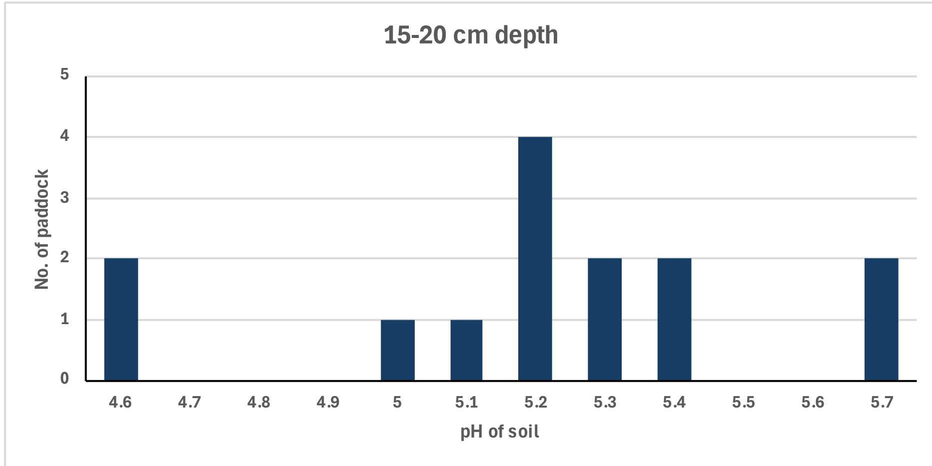

Figure 4 The pH range of paddocks sampled at 15-20 cm depth in the Riverine Plains, 2023

INCREMENTED PH TESTING MURCHISON STUBBLE DEMONSTRATION SITE

An acid layer at a depth of between 10 and 15cm was identified at the Murchison stubble demonstration site in 2021. To raise soil pH, 6.7 t/ha lime was applied across the paddock in March 2022.

Follow-up soil testing at the site in 2024 showed that the lime improved both soil pH and aluminium levels across various treatments at the soil surface (Table 1). However, only the deep incorporation treatments (Treatments 3 and 4) increased pH and reduced aluminium at the 10-15cm depth, compared to other treatments. This is because the deep incorporation facilitated the downward movement of lime into the soil profile, ameliorating acidity to a greater depth over the two year period.

Table 1 Soil pH and aluminium levels at the Murchison stubble demonstration site, 2024

	Soil pH				
TREATMENT APPLIED POST-HARVEST 2021	**0-5 CM DEPTH**	**5-10 CM DEPTH**	**10-15 CM DEPTH**	**15-20 CM DEPTH**	**ELEVATED ALUMINIUM (>5%)**
1 - Harvest cut high and bale	6.2	4.8	4.5	4.7	10-15cm
2 - Harvest cut low	6	4.8	4.5	4.7	10-15cm
3 - Harvest cut high, deep incorporation of stubble	6.2	5.7	4.8	4.9	
4 - Harvest cut low, deep incorporation of stubble	6.3	5.4	5.2	4.8	
5 - Harvest cut high, flail mulch stubble	6.3	5	4.6	4.8	10-15cm
6 - Harvest cut high, shallow incorporation of stubble	6.4	5.3	4.6	4.8	10-15cm
7 - Harvest cut low, shallow incorporation of stubble	6	4.7	4.5	5.1	10-15cm
8 -Burn	6.3	4.9	4.6	4.9	10-15cm

These stubble management treatments were oversown with faba beans inoculated with rhizobia in 2023. Follow-up rhizobial testing was undertaken at the site in 2024 to assess survival rates under the various stubble management treatments. Survival of rhizobia and other microbes, which can suppress pathogens like Fusarium crown rot, are linked to a better pH environment and the results showed nitrogen-fixing rhizobia were at medium to high levels across all treatments in February 2024 (Table 2). This result was likely improved by the application of lime the previous season, which increased pH and created a more favourable environment for the nitrogen-fixing rhizobia to survive. While the link between Fusarium crown rot and soil acidity has not been proven in Australia, overseas research indicates a correlation between low pH and an increasing incidence of whiteheads associated with Fusarium crown rot.

The highest faba bean yield was observed in Treatment 4, attributed to deep stubble incorporation which facilitated the downward movement of lime. The more favourable soil conditions in this treatment likely enhanced plant growth and soil structure, leading to higher yield.

Table 2 2023 and 2024 detection rates for fusarium and rhizobia, and yield of faba beans at the Murchison stubble demonstration site, 2023

TREATMENT APPLIED POST-HARVEST 2021	2023 FUSARIUM LEVEL *	2024 FUSARIUM LEVEL ^	2024 RHIZOBIA LEVEL	2023 FABA BEAN YIELD (T/HA)
1 - Harvest cut high and bale	High	Low	High	3.4
2 - Harvest cut low		Low	Medium	3.8
3 - Harvest cut high, deep incorporation of stubble	High	Low	High	3.8
4 - Harvest cut low, deep incorporation of stubble		Low	High	4.0
5 - Harvest cut high, flail mulch stubble		Low	High	3.8
6 - Harvest cut high, shallow incorporation of stubble		Low	High	3.4
7 - Harvest cut low, shallow incorporation of stubble	High	Low	High	3.4
8 - Burn	High	Low	High	3.4

* Stubble plating risk assessment. ^Predicta B risk assessment.

PREDICTA B RESULTS

FARMER PADDOCKS

To improve our understanding of Fusarium crown rot, 14 sites were selected and sampled across the Riverine Plains region during February 2024. Predicta B testing showed that 78% of these paddocks, which were to be sown to wheat in 2024, had medium to high levels of Fusarium crown rot. Of these, 14% were considered at low risk, while 7% were below the level of detection (Table 3).

Table 3 Fusarium crown rot level of farmer paddocks.

FUSARIUM LEVEL RISK CATEGORY	Below detection	Low risk	Medium risk	High risk
% OF PADDOCKS IN CATEGORY	7 %	14%	14%	64%

This high incidence of Fusarium crown rot can be attributed to consecutive wet seasons, which have built up disease levels in local paddocks. Given Fusarium crown rot requires a dry spring for the classic "whitehead" symptoms to appear (and it has been at least four years since this last occurred), it is likely that many Riverine Plains region growers are unaware of the presence of the disease in their paddocks, or of its potential to build up and cause damage under drier conditions during grain fill.

PREDICTA B RESULTS MURCHISON STUBBLE DEMONSTRATION SITE

During February 2023, four of the treatments at the Murchison demonstration site, including 1 - harvest cut high and bale, 3 - harvest cut high, deep incorporation of stubble, 7 - harvest cut low, shallow incorporation of stubble and 8 – burn, were tested using stubble plating techniques provided by NSW DPI for Fusarium crown rot after two years of being sown to wheat.

The results indicated a high risk of Fusarium crown rot across these treatments, and in an effort to reduce disease levels, the wheat stubble was burnt and the paddock was sown to faba beans in 2023. These practices successfully reduced the crown rot levels to low for all the stubble management treatments.

This season, the project will continue to monitor the 14 sites for Fusarium crown rot.

SUMMARY

Results from this project to date highlight the benefits of understanding Fusarium crown rot risk in the Riverine Plains. Using tests such as Predicta B can help farmers understand the risk of disease and yield loss, allowing for management strategies to be put in place to reduce yield loss in high-risk situations.

Further work is being conducted this year to determine the interaction between soil acidity and stubble management.

ACKNOWLEDGEMENTS

This article was produced as part of a GRDC National Grower Network investment in the *Understanding the link between cereal stubble, subsurface acidity and crown rot* project. Riverine Plains acknowledges the assistance provided by Dr Steven Simpfendorfer, NSW DPI, the Brown family as farmer co-operators, as well as technical assistance provided by Lee Menhennett, Incitec Pivot, and the farmers who volunteered their paddocks for testing.

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BEST PRACTICE LIMING DEMONSTRATION TO ADDRESS SUB-SOIL ACIDITY IN NORTH EAST VICTORIA

KEY MESSAGES

- **Lime incorporation is essential in broadacre cropping soils to optimise benefits**
- **Farmers in the Riverine Plains should assume that their farm has some degree of subsurface acidification, unless soil test results prove otherwise**
- **To-date, results from the Best-practice liming trial show that when lime is applied without incorporation, it only impacts pH levels at the surface and does not flow down through the soil profile**
- **Incorporating lime by sowing changed pH in the top 5cm, with the rate of change depending on the quantity of lime applied**
- **Shallow discs moved the lime to 15cm, while the Horsch Tiger moved lime to 20cm as targeted**
- **Farmers should only incorporate lime to the depth that is suitable for that soil, as other soil constraints (eg sodicity, slaking), seedbed preparation, emergence and trafficability can come into play.**

OVERVIEW

This project involves the establishment of a replicated field trial to demonstrate best practice liming strategies, as well as a field demonstration of the impacts of lime quality, each year for three years. The trials are designed to demonstrate different incorporation methods, evaluate the impact of different lime types and sources and extend findings, including comparisons of the economic and agronomic returns using the *Acid Soils SA* calculator tools.

Trials were established in the Rutherglen district of Victoria and monitored for three years during 2022, 2023 and 2024. Treatments were initially undertaken in 2022, however these trials had to be abandoned prior to harvest due to waterlogging and slug damage as confounding variables.

Extension efforts continue to focus on raising farmer awareness about the speed of acidification and stratification of soils in this region, including providing resources and tools available to assist management decisions.

Soil analysis over time has been used to illustrate the impact of lime incorporation methods and the impact of lime source and quality on efficacy of addressing stratified subsoil acidity. This is in addition to assessing the economic benefits of each treatment and potential losses of production and decline in pH. A null control — where no lime is applied — was used to highlight the cost of complacency when addressing pH issues in both the short and long term.

The data generated through this project is helping farmers evaluate the most practical and economical methods to manage soil pH and paddock variability.

AIM

The objective of the project is for growers and advisers in north east Victoria to have an improved understanding of the state of topsoil and subsoil acidity, the limitations to crop profitability it causes, and an improved knowledge of the agronomic and economic benefits of different lime sources, lime quality and incorporation methods.

WORK TO DATE

Treatments for the project were developed in consultation with a steering committee made up of growers and researchers. These treatments are shown in Table 1.

Table 1 Best practice liming trial treatments

TREATMENT #	DETAILS
1	Control – nil lime, nil incorporation
2	Nil lime, with incorporation
3	Lime to target pH 5.2, incorporated by sowing
4	High rate of lime (to pH 5.8 in 0-10cm value), incorporated by sowing
5	High rate of lime (to pH 5.8 in 0-10cm value), incorporation by shallow discs
6	High rate of lime (to pH 5.8), deep incorporation to 10-15cm, follow up with speed-tiller
7	High rate of lime (to pH 5.8), to deep incorporation to 10-15cm, follow up with speed-tiller (rate calculated for pH 5.8 at depth) Deluxe option

An intense soil sampling regime was completed in February 2022 across each replicate. This provided baseline information to characterise the whole site, as well as an understanding of current pH levels to ensure that the proposed incorporation methods were appropriate. Using this information, it was calculated that the rates of lime used in that year would be:

- Lime required to achieve a target pH of 5.2: 1.2 tonnes/ha
- Lime required to achieve a target pH of 5.8 (high rate): 5.0 tonnes/ha
- Lime required to achieve a target pH of 5.8 to depth (high rate to depth): 8.5 tonnes/ha

The application of lime to these levels was done using a range of surface and incorporation techniques, including a shallow incorporation by sowing, incorporation by discs to a depth of 15cm and a deeper incorporation by a Horsche Tiger to a depth of 20cm.

Fine lime was sourced from a manufacturer in Galong and coarser lime was sourced from a manufacturer in Mt Gambier.

Figure 1 shows the layout of the field-scale replicated trial, which includes a buffer sown to wheat, in 2023. At one end of the replicated trial, strip trials were established to assess the impacts of two types of lime quality, granular (Mt Gambier lime) and fine (Galong lime), applied at 3t/ha and incorporated with sowing. The lime from Galong was very fine, with bulk density of 1.4, while the Mt Gambier lime was much coarser, with a bulk density of 1.1.

TRIAL PLAN	
Demonstration 1: Mount Gambier lime 3t/ha, incorporate by sowing	
Demonstration 2: Nil lime, incorporate by sowing	
Demonstration 3: Galong lime 3t/ha, incorporate by sowing	
1 Lime 5 t/ha, incorporate with TIGER	28 Lime 5 t/ha, incorporate by sowing
2 Lime 5 t/ha, incorporate by shallow discs	27 No lime, with incorporation
3 Control, nil lime, nil incorporation	26 Lime 1.2 t/ha, incorporate by sowing
4 Lime 1.2 t/ha, incorporate by sowing	25 Lime 5 t/ha, incorporate by shallow discs
5 No lime, with incorporation	24 Lime 8.5 t/ha, incorporate with TIGER
6 Lime 8.5 t/ha, incorporate with TIGER	23 Lime 5 t/ha, incorporate with TIGER
7 Lime 5 t/ha, incorporate by sowing	22 Control, nil lime, nil incorporation
8 Control, nil lime, nil incorporation	21 Lime 8.5 t/ha, incorporate with TIGER
9 Lime 5 t/ha, incorporate by sowing	20 Lime 5 t/ha, incorporate by shallow discs
10 Lime 5 t/ha, incorporate by shallow discs	19 Lime 5 t/ha, incorporate by sowing
11 No lime, with incorporation	18 Lime 1.2 t/ha, incorporate by sowing
12 Lime 5 t/ha, incorporate with TIGER	17 No lime, with incorporation
13 Lime 8.5 t/ha, incorporate with TIGER	16 Control, nil lime, nil incorporation
14 Lime 1.2 t/ha, incorporate by sowing	15 Lime 5 t/ha, incorporate with TIGER

Figure 1 Liming demonstration trial layout

Plot size 40m x 13m, buffer 30m

Lime was applied on 16 February 2022, with the incorporation completed on 17 February 2022. A Horsch Tiger was used for the deep incorporation, with calibration to ensure that the depth of the lime was kept above 20cm. The speed tiller was run over both incorporated treatments to ensure a smooth surface for ease of sowing. Once the treatments were completed, the host sowed and managed the trial site in line with the management practices used for the remainder of the paddock.

Soil sampling was conducted in January 2022, before the treatments were established, and resampled in January 2023 and 2024 to enable a direct comparison of liming treatments and their effect on soil properties over time. Soil samples were collected in increments of 0-5, 5-10, 10-15, 15-20 cm using a hand corer, while the 20-30, 30-40, 40-50 cm depth increments were collected using a hydraulic trailer-mounted corer.

The site was sown to Scepter wheat on 13 May 2023, with 80 kg/ha of MAP and 50 kg of urea. An additional 175kg/ha of urea was applied during the season.

GreenSeeker® NDVI measurements were taken on 20 July, 15 August and 4 September to assess any differences in growth of the plots (data not presented). Photos were also taken during the season as a record of plot growth.

The trial was harvested using a plot header on 19 December 2023, with yield ranging from 9.8 – 11.1 t/ha. The host farmer harvested the remaining crop on the trial site, along with the rest of the paddock.

OBSERVATIONS AND COMMENTS:

The results presented in this article are a subset of the data collected. A full article will be produced when the project is completed in 2025.

Results from the trial to date show that when lime is applied without incorporation, it only impacts pH levels at the surface and does not move down through the soil profile. Figures 2a and 2b show that acidification is occurring in the soil when no lime is added.

Figures 2c and 2d show that incorporating lime by sowing can result in lime influencing pH in the top 5cm, with the rate of change depending on the quantity of lime applied. Incorporation of lime using shallow discs (Figure 2e), or deeper incorporation with the Horsch Tiger (Figure 2f, g), enables the lime to move further down the profile, to the depth of incorporation. Shallow discs moved the impact of liming to 15cm, while the Horsch Tiger moved lime to 20cm.

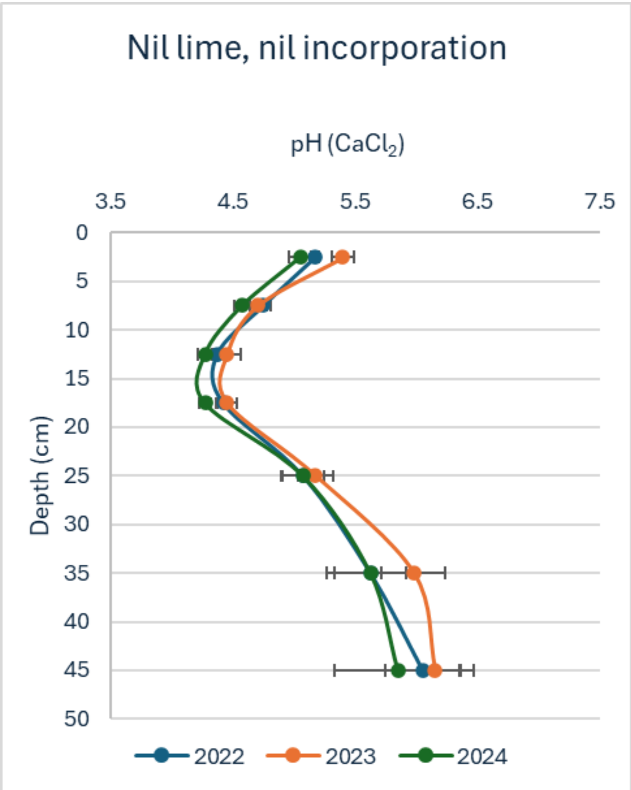

Figure 2a Soil pH results for Treatment 1: nil lime, nil incorporation, 2022 (pre-liming), 2023 and 2024

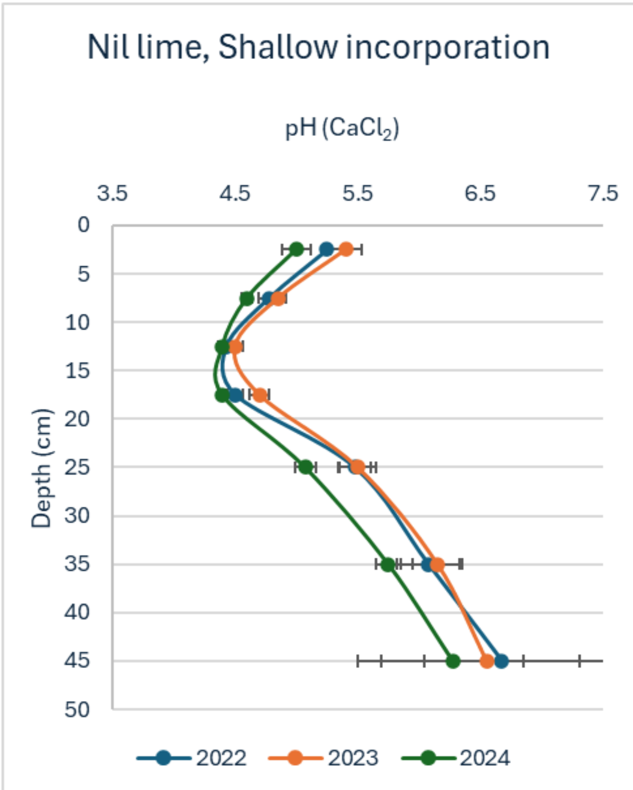

Figure 2b Soil pH results for Treatment 2: Nil lime with shallow incorporation, 2022 (pre-liming), 2023 and 2024

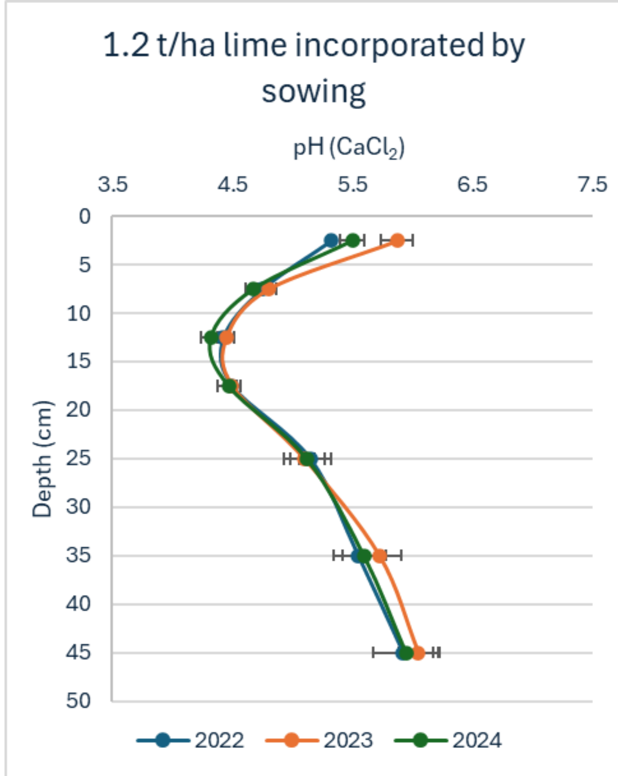

Figure 2c Soil pH results for Treatment 3: lime to target pH 5.2, incorporated by sowing, 2022 (pre-liming), 2023 and 2024

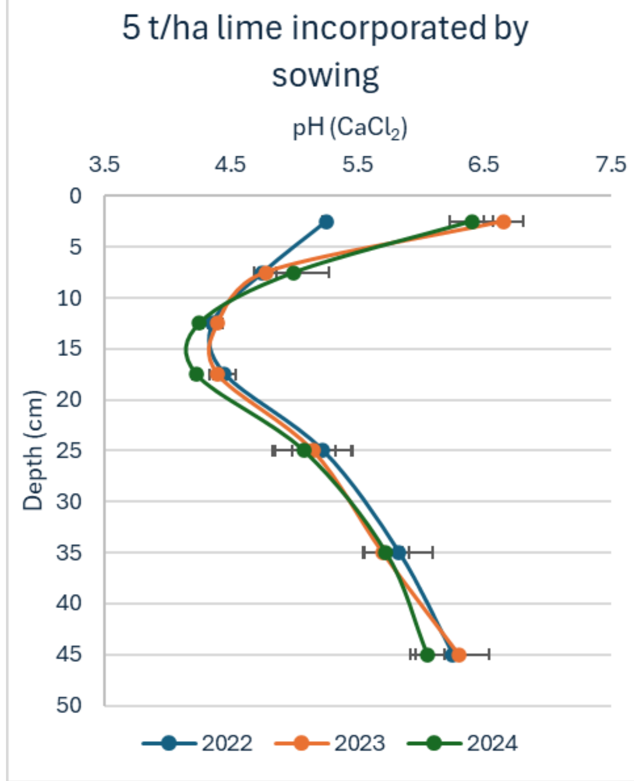

Figure 2d Soil pH results for Treatment 4: high rate of lime to target pH 5.8, incorporated by sowing, 2022 (pre-liming), 2023 and 2024

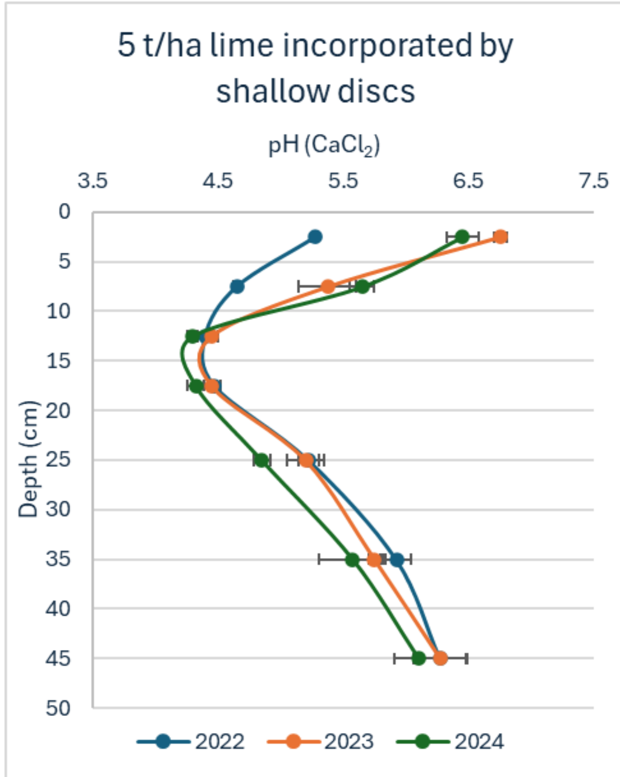

Figure 2e Soil pH results for Treatment 5: high rate of lime to target pH 5.8, incorporated by shallow discs, 2022 (pre-liming), 2023 and 2024

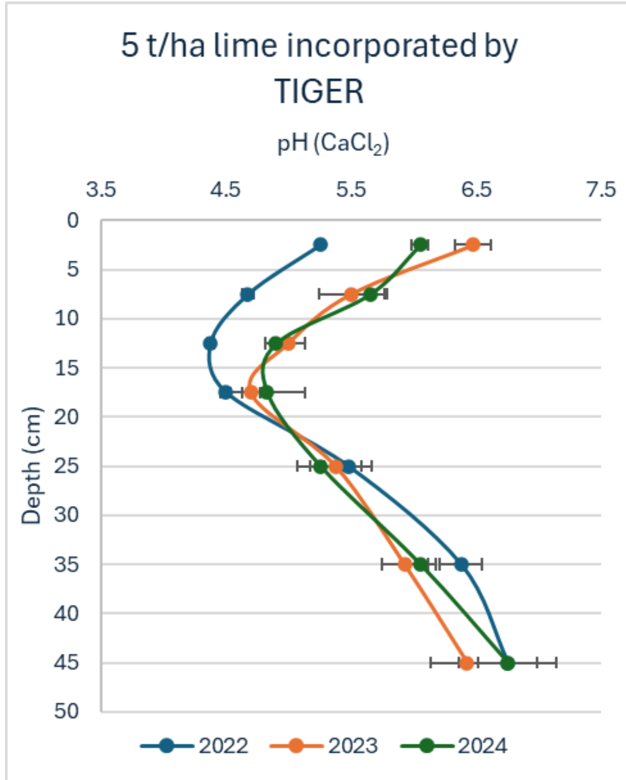

Figure 2f Soil pH results for Treatment 6: high rate of lime to target pH 5.8 with deep incorporation 2022 (pre-liming), 2023 and 2024.

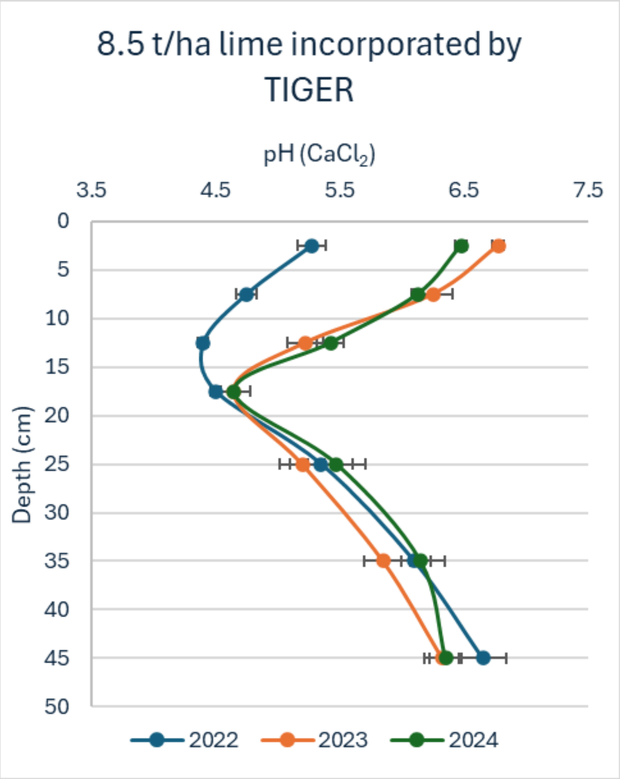

Figure 2g Soil pH results for Treatment 7: high rate of lime to target pH 5.8 with deep incorporation, 2022 (pre-liming), 2023 and 2024

While deep incorporation has shown positive results, it's important that farmers only incorporate lime to the depth that is suitable for that soil, as other soil constraints (eg sodicity, slaking), seedbed preparation, emergence and trafficability can come into play.

For example, if you can only cultivate to a depth of 10cm, load up that zone with adequate lime for full amelioration, so that it can move to depth over time.

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SOIL EXTENSION ACTIVITIES – EVALUATING DIFFERENT RATES OF LIME AND INCORPORATION TECHNIQUES WHEN AMELIORATING ACID SOILS

KEY MESSAGES

- **Segmented pH soil testing in problem paddocks can help farmers get a clearer picture of what is happening within each soil layer**
- **Many factors influence soil behaviour, so it's important to understand your soil before making amelioration decisions**
- **Soil can have high levels of variability and this will play a role in choosing which amelioration options will suit best**
- **Once a soil constraint is identified, it is important to understand other soil characteristics before committing to deep incorporation of an ameliorant such as lime; some machines may go too deep and cause further issues, for example, by bringing up toxic sub-layers**
- **Where surface lime was applied, pH increased in the 0-5cm range only. The use of machinery incorporation resulted in a pH increase at depth, with a higher pH achieved as liming rate increased.**

OVERVIEW

Soil issues in the Riverine Plains region are often complex and can be variable across both vertical and horizontal profiles. For example, acidity may not be present at the surface (< 10 cm) and can be quite profound at depth (e.g 15-20 cm). Soil constraints such as acidity, when left unmanaged, can cause serious yield losses and reduce profitability in susceptible crop types. Typically, the most pH sensitive crop types are lentils, faba beans, chickpeas, and vetch. A highly acidic soil is usually considered to have a pH less than 4.8 ($CaCl_2$), below which aluminium availability often increases dramatically, while soil with pH less than 5.2 will cause yield loss in sensitive species. It's recommended farmers should target pH above 5.5 in the root zone to avoid crop losses and maximise nitrogen fixation from pulse crops. The vertical stratification of pH means soil testing needs to be comprehensive in order to understand where problems lie, so that they can then be effectively addressed. You can only fix the problem if you truly understand the problem.

Traditional bulked soil testing at 0-10cm depth does not identify acidity issues below 10 cm, which means many farmers may be unaware of the sub-soil constraints in their paddocks. The issue for many growers is that comprehensive soil mapping, ground truthing of soils and amelioration is expensive, and this has traditionally been a disincentive for farmers to take the important first step to improving their soils.

AIM

This project is supporting land managers by promoting the benefits of increased frequency and comprehensiveness of soil testing to inform soil management decisions and take action to improve soil health.

PROJECT PROGRESS

In early 2022, Riverine Plains worked with farmer hosts that had identified paddocks with problem soils through EM surveys. These sites were soil tested, in 5cm increments to a depth of 20cm, to understand the key constraints contributing to the issues being seen above ground (for example poor emergence, poor nodulation of pulse crops, weeds that thrive at low pH, poor crop growth and yield).

As part of the project, which also involved discussion group meetings and workshops, a trial was established which focused on different machinery options to incorporate various lime rates at two sites. The trial aimed to better understand and compare the options for product incorporation and depth, seed bed preparation and overall plant establishment in soils with highly acidic soils. Each paddock was grid sampled by Precision Agriculture before deciding upon an area within the paddock to host the trial.

The first demonstration site, at Hopefield New South Wales, was sown to barley on 4 May 2023 and the pre-treatment soil test results (Table 1) show pH to be below 4.8 at all depth increments. Soil pH below 4.8 ($CaCl_2$) results in aluminium becoming more soluble, which is a problem because solubilised aluminium is highly toxic to growing roots. This results in severe root stunting, limiting plant access to water and nutrients and causing reduced yield outcomes.

To examine the effect of pH and pH stratification, a demonstration trial was established that included five incorporation methods (lime mixing methods), including a control (no incorporation), speed tiller, deep offset discs, deep offset discs and speedtill, and a Horsch Tiger, combined with four liming rates of 0, 1, 2.5 and 5 tonnes/ha, applied in a matrix layout. Lime was applied and incorporated in March 2023, with post-treatment soil testing completed in August 2023. At this site, aluminium was particularly problematic between 5 and 30 cm.

Table 1 Pre-treatment soil test results Hopefield, June 2022

DEPTH (CM)	PH (CACL2)	SODIUM % OF CATIONS (ESP)	ALUMINIUM SATURATION (%)
0-10	4.3	<1.00	12
0-5	4.7	<1.00	3
5-10	4.0	<1.00	25
10-15	4.0	<1.00	37
15-20	4.1	<1.00	46
20-30	4.2	<1.00	45
30-40	4.6	<1.00	8

A second demonstration site, at Rand NSW, was sown to faba beans in May 2024, and pre-treatment soil test results are shown in Table 2. This site is a heavier clay compared to the sandier soils seen in the Hopefield site and has soil pH of <4.8 in the 0-15 cm depth, beyond which pH increases to above 5. Aluminium toxicity is present in the 5-10 cm layer but was not as severe as at the Hopefield site.

At this site, incorporation methods include a control (no incorporation), kelly chain plus offset discs, and compact disc harrows (Rubin 12" and 10"). Similar to the Hopefield site, lime application rates of 0, 1, 2.5 and 5 tonnes/ha, were applied in a matrix layout. The site also received of 0.8t/ha gypsum post incorporation.

Table 2 Pre-treatment soil test results Rand (average of plots), January 2024.

DEPTH (CM)	PH	SODIUM % OF CATIONS (ESP)	ALUMINIUM SATURATION (%)
0-5	4.8	4.3	2.0
5-10	4.5	4.8	7.1
10-15	4.8	6.5	1.9
15-20	5.4	8.2	0.5
20-30	5.8	10.1	0.4

Test results from the Rand site (Table 2) show that soil sodicity (ESP) starts to increase above 15 cm, while soil pH is not in the problematic range below this depth. Consequently at the Rand site, applying lime and gypsum to 15 cm is likely the best option to correct the low pH stress. This will avoid bringing sodic dispersive soils to the surface and ensure gypsum is fast-tracked to greater depths where sodicity is more prevalent.

RESULTS – HOPEFIELD, NSW

Post-incorporation soil test results taken during August 2023 showed noticeable differences between rates of lime applied and various incorporation methods.

Where lime was surface applied, pH increased in the 0-5 cm range only, with higher pH achieved as the liming rate was increased. In this surface-only application, the soil pH increased 0.39 pH units for every 1 tonne of lime applied.

Figure 2 shows the response to lime spread at 5 t/ha, which is the top end of the application rate scale in this trial. The control, speed tiller, and the deep offsets plus speed tiller treatments show an increase in soil pH in the 0-5 cm range, however this drops back to starting levels in the 5-10 cm range, indicating the lime had not yet moved to this depth. Both the Horsch Tiger and deep offset disc treatments were able to incorporate lime to a greater depth, which is reflected in the increased pH at the 5-10 and 10-15 cm depths, respectively.

As well as showing the benefits of deeper incorporation, these results demonstrate the importance of segmented testing to depth. In this instance, a traditional 0-10 cm soil test would have been misleading, because it would have only captured the effects of the lime sitting on the surface, and not provided a true picture of the acidity remaining at depth.

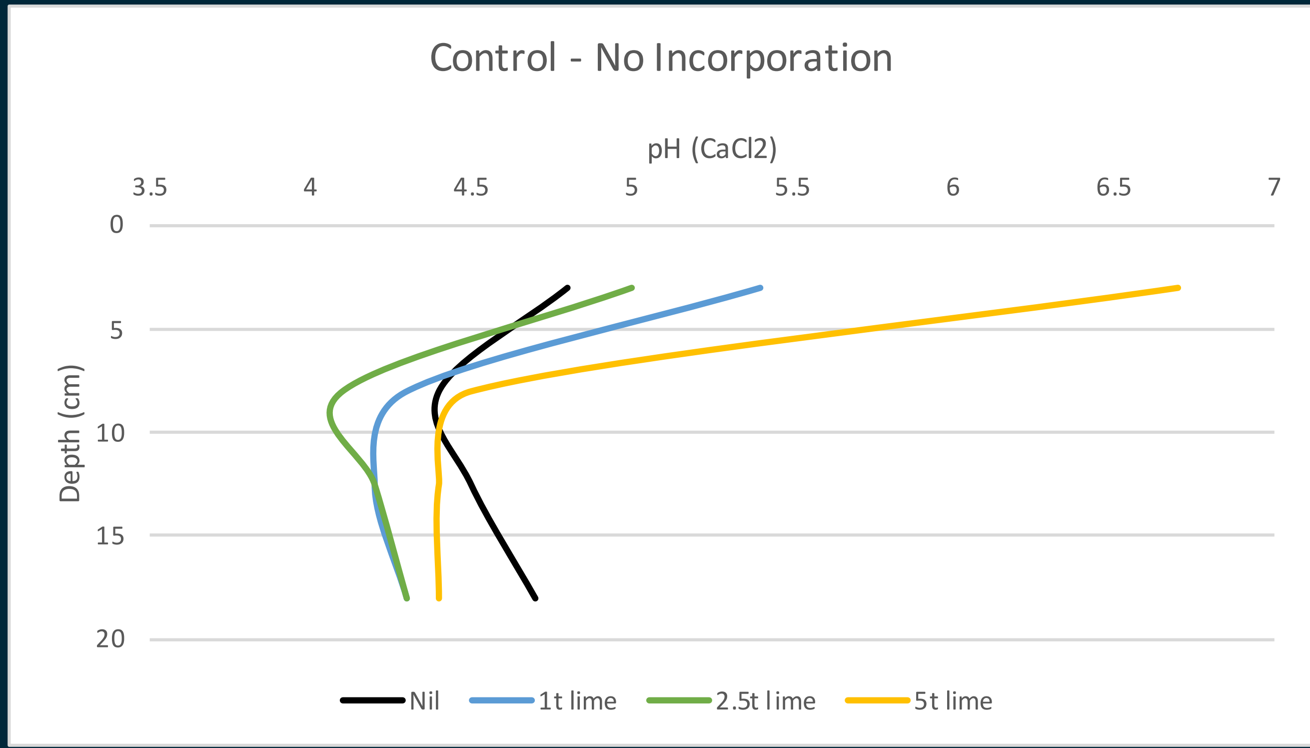

Figure 1 The effect of surface applied lime (no incorporation) at nil, 1, 2.5 and 5t/ha application rates, sampled during August 2023

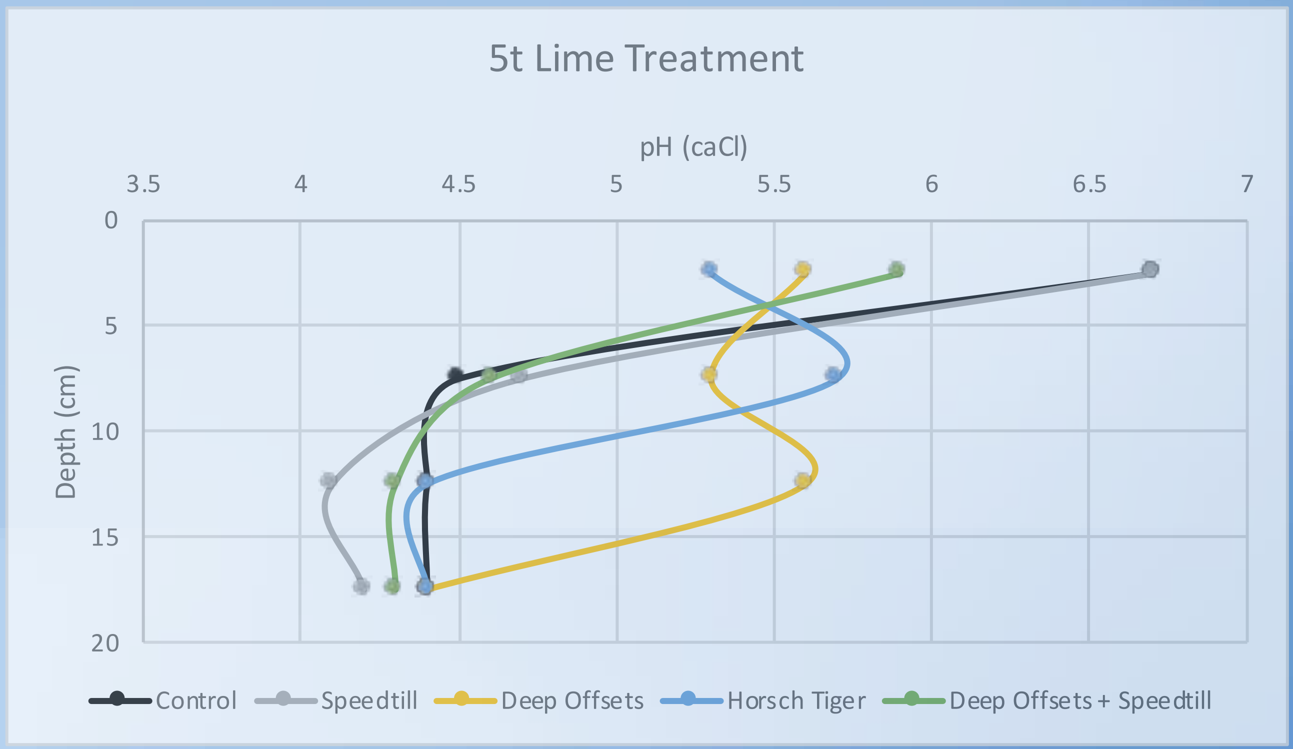

Figure 2 The effect of 5t/ha lime incorporated using different techniques when sampled in August 2023

OBSERVATION AND COMMENTS

Soils are variable by nature and amelioration is costly. Consequently, it is worthwhile spending the extra time to gather more information to improve decision making when amending soil pH. The NSW DPI soil acidity and liming publication provides an excellent guide as to how best to estimate your lime inputs based on soil pH and soil ECEC (effective cation exchange capacity).

It is recommended that farmers complete segmented pH soil testing in 'problem' paddocks first, to get a clear picture of what is happening at each layer. In addition to soil pH, the ECEC test is necessary to help estimate the lime amount required for the target depth. Once the pH is identified, including severity and depth, it is important to understand other soil characteristics before incorporating lime, as some soils may have other non-pH related problems. For example, in sodic dispersive soils (estimated by ESP), which are found in many soils across the NSW Riverina, the sodicity problem increases with depth (Table 2). At the Rand site, the pH and ESP changeover occurs at 15 cm (below 15 cm it is acid and above 15 cm it is sodic), so mixing lime to 20 cm would in this case would bring sodic soil to the surface and be counterproductive. A simple dispersion test for each soil layer can be applied. This test, along with a pH test in 5 cm increments will help identify the recommended depth of cultivation that is best for lime incorporation.

Throughout this project we have engaged with experts from AgriSci, Precision Agriculture and NSW DPI to guide our decision making on machinery choice and product rate. Completing side-by-side strips in this trial has demonstrated which machinery works best with this soil type and can help landholders with similar conditions make more informed decisions.

NEXT STEPS

The pre-treatment and post-treatment tests at the Rand site will be taken from individual plots, and once these results are available it will be easier to compare. Detailed learnings from this site and across the entire project will be available next year, once final soil testing and analysis has been completed at the Rand site.

ACKNOWLEDGEMENTS

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IMPROVED DROUGHT RESILIENCE THROUGH OPTIMAL MANAGEMENT OF SOILS AND AVAILABLE WATER

KEY MESSAGES

- **Deep nitrogen analysis and farmer observations show that the use of a legume in a rotation provided more nitrogen than a pure cereal history for the subsequent canola crop**
- **The application of nitrogen based on deep soil nitrogen (DSN) testing, and the use of nitrogen budgeting by the farmer, resulted in more uniform nitrogen levels across the whole paddock and availability for crops**
- **Comprehensive soil testing for variety and crop types is increasingly important for future farm resilience**
- **Soil water measurements taken prior to sowing canola showed higher plant available water under wheat stubble compared to faba bean stubble, likely the result of greater ground cover provided by the wheat stubble over summer**
- **Early sowing crops can provide opportunities for grazing and diversification of the farming system**
- **Early sowing a portion of the cropping program can bring more crops into the ideal sowing window and reduce the risk of seasonal effects, such as frost.**

BACKGROUND

The *Improved drought resilience through optimal management of soils and available water* project consists of 12 demonstration sites across a region that includes north east Victoria and central and southern New South Wales.

The project aims to improve the management of natural capital through increased water use efficiency, soil organic carbon, and nitrogen (N) utilisation, which, in-turn, is crucial to environmental and economic resilience in drought.

In delivering this project, Riverine Plains has collaborated with three other farming systems groups including Central West Farming Systems, Farmlink, and Southern Growers, as well as Charles Sturt University (CSU).

The 12 sites focus on demonstrating three management strategies (diversity, early sowing and N-banking) that have been previously shown in small-plot GRDC field trials in NSW to increase profitability and productivity. The GRDC field trials are being led by John Kirkegaard, CSIRO.

PROJECT PROGRESS

Riverine Plains hosted three of the 12 demonstration sites established as part of this project during 2022 and 2023.

Data collected from the demonstration sites, as well as audio and video content featuring the host farmers, is being developed into project case studies which will be used to extend the findings of both the GRDC small plots trials, and the demonstration sites. The extension and promotion of the case studies through the Victoria and southern NSW Drought Resilience Adoption and Innovation Hubs, as well as through Riverine Plains' network of farmers, aims to encourage wider adoption of the management practices being trialed in the project.

Table 1 Riverine Plains focus paddock 1 site details, Howlong, 2023

Sowing Date	16 May 2023
Crop	Eagle Truflex Canola
Fertiliser	Starter and in-season
Row spacing	16.5 cm
Average GSR rainfall	347 mm
2023 GSR rainfall	292 mm

RIVERINE PLAINS FOCUS PADDOCK 1: DIVERSE ROTATIONS

AIM

To demonstrate how diverse legume rotations can potentially provide a range of system benefits.

METHOD

A demonstration site located at Howlong, NSW, consisted of a paddock half sown to faba beans and half sown to wheat in 2022. Extensive waterlogging in 2022 reduced the yields of faba beans (0.98t/ha) and wheat (2.5t/ha). Canola was sown across the whole paddock on the 16 May 2023. Deep nitrogen and soil water tests were taken prior to cropping to determine the quantity of nitrogen available for the canola, based on the previous year's crop. Sulphur, soil pH and sodicity were also measured. The paddock was irrigated with approximately 50mm in September 2023.

RESULTS AND DISCUSSION

Soil tests were taken prior to sowing the canola, with results showing that the 2022 faba bean residue contributed 78 kg N/ha more nitrogen than the wheat residue (Table 1).

Based on soil tests and in-crop observations, 58 kg/ha nitrogen and 14 kg/ha sulphur were applied to the paddock on 25 May 2023. Subsequently, the farmer applied an additional 58 kg/ha nitrogen and 14 kg/ha sulphur to the wheat stubble portion of the paddock on 10 July, to balance the nitrogen level across the paddock. A 72m wide nitrogen-rich test strip of 58 kg N/ha was applied to the faba bean portion of the paddock to understand if there were any key differences in yield.

Soil moisture tests showed that the wheat residue stored 51.3 mm more plant available water (PAW) than the faba bean residue (Table 2), which was consistent with soil moisture tests taken previously (reported in *Research for the Riverine Plains, 2023*.

Table 2 Nitrogen and plant available water (PAW) status under faba bean and wheat stubble at Howlong, 2023.

PROPERTIES	DEPTH (CM)	FABA BEAN STUBBLE	WHEAT STUBBLE	FABA BEAN STUBBLE	WHEAT STUBBLE
Sample date		4 April 2023		20 July 2023	
Nitrogen (kg N/ha)	0-90	249	171	174	187
PAW (mm)	0-90	107	158	N/A	N/A

OBSERVATIONS AND COMMENTS

Plant establishment counts showed that canola plant populations (not presented) were less than desirable due to a heavy stubble load and wet conditions during early growth.

The paddock was harvested on 19 November, and unfortunately yield maps were not collected due to a technical issue. The paddock yielded an average of 2.4 t/ha, with the dryland area outside of the pivot yielding approximately 3.5 t/ha, while the irrigated area was estimated to have yielded less than 2.5 t/ha.

Anecdotally, the farmer saved $95.70 /ha, due to a saving of 58 kg/ha in nitrogen application (based on urea at $700/t and application cost of $7.50/ha). This was a direct result of the inclusion of legumes in the previous paddock rotation.

Through this project, the importance of sulphur for canola nutrition has been highlighted. Sulphur availability is often lower after wet, high yielding seasons and soil tests identified that an application of gypsum would also benefit the system by addressing the sodicity seen in elevated levels in the 10-20cm layer. Soil water measurements taken prior to sowing canola showed that the wheat stubble stored 50mm more water than the faba bean stubble, which is a likely result of the increased ground cover provided by the wheat stubble over the summer.

RIVERINE PLAINS FOCUS PADDOCKS 2 AND 3: EARLY SOWING

AIM

To understand the benefits of early sowing wheat in a farming system, in addition to the known benefits of dual-purpose cropping.

Table 3 Riverine Plains focus paddock 2 and 3 site details, Mulwala, 2023

	North Mulwala		West Mulwala		
	IRRIGATED + GRAZED	**DRYLAND**	**IRRIGATED**	**DRYLAND**	
Sowing Date	15 April	3 May	7 April	7 April	1 May
Crop	Illabo wheat @ 100kg/ha	Planet Barley @ 80kg/ha	Illabo wheat @ 90kg/ha	Illabo wheat @ 90kg/ha	Scepter wheat @ 70kg/ha
Fertiliser	MAP 80kg/ha + urea 250kg/ha	MAP 80kg/ha + urea 150kg/ha	MAP 90kg/ha + urea 250kg/ha		
Row Spacing	19 cm		30cm		
Average growing season (Apr-Oct) rainfall 311 mm					
2023 growing season (Apr-Oct) rainfall 304 mm					

METHOD

Two farmers, located at north and west Mulwala, hosted early sowing demonstrations as part of this project. Both farmers sowed Illabo wheat for the 2023 season and both regularly employ early sowing as a management practice in their overall operation.

Data from focus paddock 2 (North Mulwala) is excluded from this report, as the West Mulwala site produced data which was more comparable across its three paddocks.

WEST MULWALA

The West Mulwala site compared a flood-irrigated paddock with a dryland paddock. The irrigated paddock was sown to Illabo wheat in early April, whereas the dryland paddock was divided in two, with 50 percent sown to Illabo wheat in early April and 50 percent sown to Scepter wheat within the standard sowing window (early May). Pre-season soil samples were taken to understand starting nitrogen and soil moisture levels (Table 3).

To gain an understanding of crop establishment in each treatment, plant emergence counts were taken early in the season. Biomass cuts were also taken prior to harvest for each early sown paddock and sent to NSW Department of Primary Industries (NSW DPI), Wagga Wagga, for harvest index, yield and seed protein estimate calculations. Post-harvest soil tests for total nitrogen and soil water content were taken in January 2023, to allow comparison with pre-sowing results.

RESULTS

Plant counts taken at emergence show a significant difference between the dryland and irrigated paddocks, with emergence in the irrigated early sown paddock significantly higher than the dryland early paddock (data not shown). There was not a notable difference between emergence in the early sowing and standard sowing treatments.

A comparison of pre-sowing and post-harvest soil test nitrogen and plant available water results are shown in Table 4. Biomass cuts taken at harvest and yield estimates based on these cuts are also shown in Table 5.

Table 4 Soil properties at the West Mulwala early sowing focus paddocks, 2023

PROPERTIES	DEPTH (CM)	IRRIGATED ILLABO (EARLY SOWING)		DRYLAND ILLABO (EARLY SOWING)		DRYLAND SCEPTER (STANDARD SOWING)	
		Pre-sowing	Post-harvest	Pre-sowing	Post-harvest	Pre-sowing	Post-harvest
Nitrogen kg N/ha	0-90	174.1	45.1	129.9	28	129.9	37.8
Soil moisture (PAW mm)	0-90	18.6	0	34.5	3.5	34.5	0

Table 5. Harvest data at the West Mulwala early sowing focus paddocks, 2023

	IRRIGATED ILLABO (EARLY SOWING)	DRYLAND ILLABO (EARLY SOWING)	SDRYLAND SCEPTER (STANDARD SOWING)
Total dry matter (DM t/ha)	18.7	19.3	N/A
Harvest index	0.4	0.4	N/A
Actual grain yield (t/ha)	8.0	7.6	6.4

OBSERVATIONS AND COMMENTS

The early sown crops were shown to use more nitrogen compared to the standard sown crop. This can be attributed to the higher yield of the early sown Illabo, compared to the Scepter sown in the standard sowing window. Additionally, Illabo is a long season wheat which likely produced more biomass over the course of the growing season than the mid-season sown Scepter, and therefore required more nutrition for growth.

The comparison of dryland Illabo and Scepter showed that Illabo had a greater water use efficiency than Scepter, probably due to its higher yield (grown using the same available moisture), based on measures of plant available water taken after harvest.

Both the irrigated and dryland early sown Illabo crops showed a higher yield than the dryland standard-season sown Scepter. The irrigated early sown Illabo had a yield of around 0.4 t/ha more than the dryland early sown Illabo, which in turn yielded around 1.1t/ha more than the dryland Scepter. This demonstrates the benefits of early sowing for improved crop yields, even when dual-purpose long season wheat crops aren't grazed.

Yield maps were obtained post-harvest for each of the three paddocks detailed in this article. These maps highlight the yield variability within each paddock, with Figure 1 showing the dryland paddock, with Scepter on the left side (west) and Illabo on the right (east). The greener areas of the Illabo represent the overall yield increase between each half of the paddock. Figure 2 shows the irrigated paddock of Illabo, with even higher yields.

Figure 1 Yield map of dryland wheat (Scepter and Illabo)

Figure 2 Yield map of irrigated wheat (Illabo)

These two focus paddocks have been able to highlight key benefits of including early sown crops in a farming system. Early sowing is a practice that introduces diversity into the system, with opportunities for grazing as well as harvesting for grain yield. Longer season crops can also provide added benefits to the soil, including increased protection from erosion, as well as greater opportunities for microbial activity and the building of soil carbon because of the increased amount of time living roots are present in the soil. Starting the sowing program earlier also ensures more crops are sown at the optimal time, and avoids crops falling out of this window, which can make them more prone to seasonal risks at key growth stages, such as frost.

CONCLUSION

This project will end in September 2024, when the 12 case studies will be published in a range of formats including audio, video and printed case studies.

It is hoped that at the end of the project, farmers will have an improved understanding of the strategies available to help manage future climate extremes and drought, by seeing the benefits of using pulses, nitrogen banking and early sowing strategies. This will ultimately increase gross margins for the farm enterprise and help farmers be more resilient.

ACKNOWLEDGEMENTS

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DEMONSTRATING RYEGRASS CONTROL STRATEGIES – AN UPDATE

KEY MESSAGES

- **Integrating a range of locally validated weed management strategies is important when tackling annual ryegrass**
- **Rotating crop types and chemistry are vital components of all weed and disease control strategies**
- **It is important to also consider non-chemical weed control strategies, due to the increasing rates of herbicide resistance being seen in local ryegrass populations**
- **Seed testing indicated ryegrass resistance to Group 1 herbicides at the trial site.**

OVERVIEW

A GRDC National Grower Network industry meeting, held in 2022, identified the issue of 'ryegrass blowout' — when ryegrass numbers start to increase at uncontrollable rates — and its subsequent management as a priority issue for north east Victoria.

In recent years, excessively wet conditions have led to poor trafficability, making application of pre-emergent weed control difficult for some products. As a result, growers have observed an increase in ryegrass numbers, due to limited control options available over subsequent wet seasons.

This project is demonstrating locally validated weed management strategies to assist growers improve control of ryegrass populations emerging in different environments, and where herbicide application alone fails.

PROJECT PROGRESS

The jointly managed Riverine Plains and Uncle Tobys trial paddock in Wahgunyah, Victoria is hosting a two-year demonstration trial, which began in 2023.

In consultation with local agronomists, a range of treatments were established in 2023. The GRDC Weedsmart 'Big 6' framework, developed to assist farmers and agronomists with sustainable management practices, was a key reference when designing the trial. Where practicable, 'The Big 6' principles were incorporated into trial design. These are:

1) rotate crops and pastures

2) increase crop competition

3) optimise spray efficacy

4) mix and rotate herbicides

5) stop weed seed set

6) implement harvest weed seed control.

Table 1 describes the timing of various operations for each treatment applied to a grazing wheat crop sown in 2023. All treatments received pre-emergent chemistry of 1.5L/ha Trifluralin and 118g/ha Sakura, incorporated by sowing (IBS), with the exception of Treatment 2 which only received Trifluralin IBS. In addition to the described treatments, the entire site also received an in-crop broadleaf herbicide application, as well as a fungicide application.

During the season, crop establishment and ryegrass emergence counts were taken across each treatment. In addition, ryegrass plant samples (collected in-season) and seed samples (collected at maturity) were sent to Charles

Table 1 2023 (Year 1) treatment details for the ryegrass management trial sown at Wahgunyah

TREATMENT #	TREATMENT DESCRIPTION	DETAILS
1	Control	-
2	High level chemistry	1L/ha Mateno herbicide applied early post-emergent (EPE) Glyphosate applied as a dessicant in early December as per label directions
3	Sowing rate increased by 50%	Sowing rate: 120kg/ha
4	Cut for Hay	Hay Cut: 17 October
5	HWSC (Harvest weed seed control)	*Due to seasonal constraints, we were unable to source a HWSC adapted header, so this area was grazed

Sturt University (CSU) for herbicide resistance testing. Ryegrass plant counts were also taken at intervals throughout the season, to understand the effect of each treatment.

The 2024 (Year 2) demonstration is being overlaid at right angles to the 2023 trial, allowing the analysis of follow-on effects from Year 1 treatments, using a matrix trial set up.

Treatments for Year 2 of the project were selected after discussion with local agronomists and input from local farmers (Table 2). The trial paddock was sown to OptimumGLY® canola (cv PY525G) and the treatments will compare windrowing and direct-heading of canola, along with other chemical and cultural techniques consistent with the 'Big 6 principles'.

Table 2 2024 (Year 2) treatment details for the ryegrass management trial sown at Wahgunyah

TREATMENT #	TREATMENT DESCRIPTION	DETAILS
1	Control	No till (windrow)
2	Control	Speedtill (windrow)
3	Control	Speedtill (direct head)
4	High level chemistry	Double knock with Paraquat Overwatch IBS Spray top post windrow cut (speedtill, windrow)
5	High level chemistry	Double knock with Paraquat Overwatch IBS Spray top pre-harvest (speedtill, direct head)
6	Sowing rate increased by 50%	Sowing rate: 3.3 kg/ha (speedtill, windrow)
7	HWSC/Seasonal Risk Management	Use HWSC, hay cut or manure to manage risk (speedtill)

OBSERVATIONS AND COMMENTS

While results from the ryegrass resistance 'quick test' conducted in 2023 suggested no evidence of herbicide-resistant ryegrass at the trial site, seed tests are known to provide a more accurate measure of herbicide resistance status. In line with this, the ryegrass seed sampled at maturity in early 2024 demonstrated resistance to Group 1 herbicides, which includes 'fops' and 'dims'.

In this trial, the various treatments for controlling ryegrass showed potential in terms of reducing ryegrass numbers at the start of this season compared to the control only (data not presented).

At the end of the 2024 season, the two full years of results will be collated and analysed, to help understand which treatments have the greatest impact on ryegrass control. This will lead to the development of locally relevant control strategies and recommendations for ryegrass management in farm enterprises across the Riverine Plains.

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SILICON FERTILISER FOR DROUGHT RESILIENCE IN BROADACRE CROPPING

KEY MESSAGES

- **Previous trial work under controlled experimental conditions has shown that silicon (Si) fertiliser application can improve tolerance to abiotic stress, including drought, via various plant physiological processes, leading to increased water uptake, reduced water loss from the leaves and improved plant growth**
- **While silicon application in this project has yet to show significant differences in grain yield or quality of the evaluated crops, positive trends for plant growth traits for various crop types were observed**
- **Further work is required to determine the potential yield effects of applying silicon on a commercial scale and the potential for economic returns to farmers.**

BACKGROUND

In Australia, climatic events have challenged the resilience and profitability of farming businesses. The occurrence and severity of climatic events such as drought, heat and frost, require more resilient approaches to sustain farm productivity, especially in the face of a changing climate. On-farm diversification can be a strategy to help farming communities prepare for, cope with, and recover from stressors, like drought.

The project *Whole-system redesign of broadacre farming of southeast Australia*, explores how the agricultural industry can build resilience by promoting diversity in farming systems while taking into consideration changing future climate scenarios. Drought is a major climate challenge, and this project is trialing the use of silicon fertiliser in broadacre systems as a primary drought mitigation strategy. The project also considers overall farm diversity enhancement, with the inclusion of legumes in a predominately wheat-canola production system, as well as dual purpose crops for grazing and grain production and native vegetation cover on non-farming areas of the farm.

AIM

To provide evidence-based innovative research for diversified farms in south-eastern Australia and allow farmers in the Riverine Plains region to consider options outside of the typical inputs, to build resilience to more frequent droughts.

METHOD

SILICON TRIAL

To test the effects of silicon on crop performance, a replicated trial was sown at the Riverine Plains and Uncle Tobys trial site in Wahgunyah, Victoria, during the 2022 and 2023 winter cropping seasons. The second year of the trial was established on 24 May 2023, with 24 small plots (three treatments with eight replicates) of each crop type. Crop types included faba beans, spring wheat and dual-purpose winter wheat, with further details on site set-up shown in Table 1. Treatments included a control (no silicon), granular silicon and foliar silicon application. Granular silicon was applied alongside MAP as an additional fertiliser at sowing, at a rate of 200 kg/ha for wheat and 300 kg/ha for faba beans. Foliar silicon was applied five times throughout the season, at a rate of 300 ml/ha. The first spray was applied at tillering, with follow-up sprays taking place every 2-3 weeks thereafter, and the final spray was applied at anthesis.

A large-scale demonstration site was also included as a part of this project and was sown to wheat on 27 April 2023 at Bundalong South, Victoria. This site was managed by the host farmer, in-line with their management strategy for the overall paddock. A foliar silicon fertiliser spray was applied to half of the selected area, to allow a comparison between treated and untreated areas. The commercially available silicon fertiliser was applied at the rate of 300 ml/ ha, using a water rate of 150L/ha, four times throughout the season. The first spray was applied using the Riverine Plains six-metre boom trial sprayer, in mid-July. Each spray was applied 2-3 weeks thereafter, finishing in mid-September. The product used was acidic in nature and it was important to check the pH of the water to ensure the spray solution did not crystallise and cause a blockage in the lines.

Prior to sowing, 0-10cm soil cores were taken for soil testing across both the replicated and demonstration sites, to allow comparison with post-harvest results. Soil test results are presented in Table 2.

Table 1 Site and treatment details for the replicated trial site at Wahgunyah and the demonstration site at Bundalong South, Victoria.

	REPLICATED TRIAL	DEMONSTRATION TRIAL
Location	Wahgunyah	Bundalong South
Sowing date	24 May 2023	27 April 2023
Varieties	**Spring wheat:** Scepter **Dual-purpose wheat:** Kittyhawk **Faba bean**: Samira	Scepter sown @ 90kg/ha
Starter fertiliser	80 kg/ha MAP	60 kg/ha MAP, 5 t/ha cow manure
In season fertiliser	120 kg/ha urea (wheat only)	300kg/ha urea
Average GSR (April-Oct)	347 mm	353 mm
Actual GSR rainfall	247 mm	273 mm

The impacts of grazing were assessed for the dual-purpose wheat plots by mowing half the plots area (to represent grazing) when the crop was at mid tillering (GS25). Biomass cuts were taken for all plots when the wheat was at mid-flowering (GS65), while harvest index was calculated at crop maturity. Plots were harvested for grain yield and sub-samples were taken to test for protein and nutrient content. The dual-purpose wheat plots were harvested separately in the grazed and non-grazed areas. Grain protein and moisture were analysed using near infrared spectroscopy (NIRS), and seed silicon content was analysed using the CaCl2 method.

NATIVE CORRIDOR

As part of the overall project, the impact of a native corridor in adjacent paddocks was assessed. Experienced ecologist, Meredith Mitchell assisted in marking and identifying native grasses for continuous monitoring. For assessment of soil chemical properties and microbial communities, The University of Melbourne team collected and analysed 0-10cm cores from no-cover and native grass cover areas of the native corridor.

RESULTS

SILICON TRIALS

Soil sampling results showed pH and other soil parameters to be in acceptable ranges for the type of crops being grown. The Wahgunyah site had lower nitrogen and phosphorus reserves than the demonstration trial site at Bundalong. This is the second year of the demonstration trial at Bundalong, and the faba beans sown at the site in 2022 likely contributed to the higher nutrient content observed in this soil.

Table 2 Soil chemical properties (0-10 cm) from samples collected pre-sowing at the replicated trial site at Wahgunyah and the demonstration site at Bundalong South, Victoria.

	REPLICATED TRIAL			DEMONSTRATION TRIAL	
Location	**Wahgunyah**			**Bundalong South**	
Soil chemical properties	**Faba beans**	**Dual purpose wheat**	**Wheat**	**Control**	**Silicon treated**
pH (CaCl2)	5.9	5.5	5.3	6.4	5.9
EC (dS/m)	0.1	0.1	0.1	0.2	0.17
Nitrate N (mg/kg)	2.8	2.8	3.4	67.8	57.5
Ammonium N (mg/kg)	2.8	2.0	2.3	5.8	3.7
Colwell P (mg/kg)	42.6	39.4	33.8	63.4	51.1
PBI	85.5	89.9	88.9	48.0	49.9
CEC (cmol(+)/kg)	8.4	7.2	7.3	8.7	7.1
Organic carbon %	1.6	1.6	1.6	1.2	1.2
Silicon(mg/kg)	46.1	40.3	47.8	47.4	45.6

RESULTS

Tables 3, 4 and 5 show biomass, harvest index, grain yield and grain traits, averaged across all replicates and crop types. The demonstration site was not replicated and thus acts to show the effects of silicon application in a scaled-up format.

Across all crop types at the replicated trial site, some positive trends were detected when silicon treatments were applied, such as increased in-season biomass production in spring wheat. However, there were no significant effects of silicon treatment (either granular or foliar applied) on final biomass, harvest index or grain yield (Tables 3 and 4). Silicon application also did not markedly increase yield over the control at the demonstration site, though statistical comparisons are not possible due to the nature of this trial. Silicon is understood to improve plant response to stress, and while the season was exceptionally dry during September, the remainder of the growing season was conducive to crop growth. Different results may have been seen in a more challenging, or drier, season.

The faba bean crop did not perform well due to heavy rain during crop establishment, resulting in significantly reduced biomass and lower-than-average yield. Significant damage from birds was also seen across multiple plots, resulting in decreased yield in spring wheat, however the dual-purpose wheat did not suffer the same level of pest damage. It is important to consider that these compounding effects may have affected the observations of silicon treatment effects.

Applying silicon did not affect the grain protein of dual-purpose and spring wheat or faba bean, and silicon was not detected above threshold levels in the grain (Table 5).

Table 3 In-season biomass production during mid October for the replicated trial site at Wahgunyah and the demonstration site at Bundalong South

	BIOMASS PRODUCTION (MID OCTOBER)		
Crop type	**Control**	**Foliar silicon**	**Granular silicon**
	DM t/ha	**DM t/ha**	**DM t/ha**
Wheat	7.1	7.3	7.3
Ungrazed dual purpose wheat	6.9	6.6	6.9
Faba beans	6.1	5.2	5.1
Wheat – demonstration Site	16.5	17.6	N/A

Table 4 Harvest traits for the replicated trial site at Wahgunyah and the demonstration site at Bundalong South.

CROP TYPE	HARVEST INDEX			GRAIN YIELD (T/HA)		
	Control	**Foliar silicon**	**Granular silicon**	**Control**	**Foliar silicon**	**Granular silicon**
Wheat	0.4	0.4	0.5	3.3	2.9	3.4
Grazed dual purpose wheat	0.4	0.4	0.4	2.4	2.4	2.4
Ungrazed dual purpose wheat	0.4	0.4	0.4	3.0	3.1	3.1
Faba beans	0.5	0.5	0.5	2.9	2.8	2.4
Wheat – demonstration site	0.5	0.5	N/A	10.6	10.8	N/A

Table 5 Grain quality characteristics for the replicated trial site at Wahgunyah

CROP TYPE	GRAIN PROTEIN %			MOISTURE %		
	Control	Foliar silicon	Granular silicon	Control	Foliar Silicon	Granular silicon
Wheat	8.0	7.2	7.4	10.6	10.5	10.5
Grazed dual-purpose wheat	9.3	9.1	9.0	11.3	11.3	11.3
Ungrazed dual purpose wheat	8.9	9.5	9.2	11.1	11.1	11.1
Faba Beans	20.8	20.7	20.6	7.8	7.7	7.7

NATIVE CORRIDOR

The native corridor area has been monitored throughout the project to understand the effect of native vegetation on the soil biodiversity and nearby cropping systems. Nine species were identified as native grass species as part of this work; tall speargrass (Austrostipa aristiglumis), spear grass (Austrostipa scabra), red grass (Bothriochloa macra), windmill grass (Chloris truncate), curly windmill grass (Enteropogon acicularis), common wallaby grass (Rytidosperma caespitosum), Brown-back Wallaby-grass (Rytidosperma duttonianum), wallaby grass (Rytidosperma erianthum), bristle wallaby grass (Rytidosperma setaceum). Over the two years of monitoring, Brown-back Wallaby-grass has been the dominant species with the highest plant density seen at each visit.

CONCLUSION

Long-term sustainability of broadacre farming under changing climatic conditions requires testing and trialling of old practices, as well as new and innovative ones. This project trials the innovative use of silicon fertiliser and the inclusion of legumes in a typical wheat-canola crop rotation to show how it can enhance soil health and productivity. The inclusion of native corridors on non-farm land could also be a long-term strategy for improved above and below ground biodiversity.

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THE BUSINESS CASE FOR HAVING A ROBUST NETWORK OF ON-FARM WEATHER STATIONS IN THE RIVERINE PLAINS

KEY MESSAGES

- **Privately owned, on-farm weather stations provide real-time data that informs and supports decision-making by farmers**
- **A connected, robust regional network of on-farm weather stations has the potential to support decision-making for a wider range of farmers and emergency services**
- **Having access to real-time climate and soil moisture data through on-farm weather stations can provide a range of private benefits to farmers**
- **On-farm weather stations can help inform crop choice at sowing, helping to prevent crop failure in high-risk crops and improve returns from grain marketing; these benefits can increase profit by between $36/ha to $655/ha, with the largest benefit occurring when crop failure in canola is prevented**
- **Public benefits from a weather station network include the prevention of dust storms, achieved by maintaining ground cover, which has an estimated public benefit of $300 million per year**
- **Further work is required to determine the return on investment for how connecting on-farm weather stations through Robust Weather Station Network will increase the sustainability and profitability of grain growers.**

OVERVIEW

The *Supporting climate resilience through weather stations* project is investigating how an integrated network of 80 on-farm weather stations across central and southern NSW and northern Victoria could better support the community, emergency services and farmers in bushfire and flood management.

Currently, emergency services are reliant on Bureau of Meteorology Weather Stations, which can be located up to 200km apart and do not provide local climate information when fires start. On-farm weather stations have the potential to fill information gaps where no alternative weather information is available.

As part of the project, a business case was developed to evaluate the potential economic and environmental benefits of providing more localised, accurate weather and soil moisture information to farmers and emergency services in the region though the Robust Weather Station Network. The business case compared benefits to baseline information provided by the Bureau of Meteorology. Both qualitative and quantitative data were collected and analysed to provide an estimate of the return on investment for developing a network of weather stations and soil moisture probes.

Consultation conducted as part of the business case development indicated that the Robust Weather Station Network can provide many benefits and opportunities to grain growers, natural resource management organisations and industry bodies. For example, it has the potential to benefit grain growers by assisting with the decision to cut a crop for hay or predict yield to optimise insurance cover. It can also identify likely crop failure based on soil moisture at sowing time and reduce the inaccuracy of yield predictions associated with estimating soil moisture levels.

A more detailed social research study would be

required to further quantify and confirm the benefits of the proposed network outlined in this report.

RESULTS FROM THE BUSINESS CASE

The results presented in this report rely on the use of soil moisture and weather data by growers to improve the on-farm decision making process. This report does not attempt to quantify adoption of the information for use in decision making.

The key economic measures used to indicate the value of the robust weather station network are summarised below, including both private and public benefits.

The **private** benefits to grain growers and close neighbours for using soil moisture data at sowing time include:

- A $267 per hectare return by assisting with the decision to cut a crop for hay
- A $13 per tonne increase in price received for canola by optimising yield predictions for grain marketing
- A $3 – $100 per hectare return from increasing the accuracy of yield predictions for crop insurance
- Up to $504 per hectare return from predicting a crop failure at sowing for wheat
- Up to $516 per hectare return from predicting a crop failure at sowing for barley
- Up to $655 per hectare return from predicting a crop failure at sowing for canola
- A $36 – $143 per hectare return from improving the decision to sow a drought tolerant variety based on soil moisture status at sowing
- A return of $433 per tonne of wheat produced by using soil moisture to predict yield to optimise nitrogen application and reduce greenhouse gas emissions

An example of a **public** benefit from the Robust Weather Station Network is where data is used by farmers to determine likely yield outcomes and help predict when ground cover levels are likely to become low. This information can inform decisions around whether to graze stubbles, cultivate soils and sow crops to increase ground cover in dry conditions and reduce the incidence of major dust storms that can cost up to $300million.

OBSERVATIONS AND COMMENTS

The business case explored the perceived benefits using a range of assumptions. A summary is provided below.

1. **Understanding frost timing and duration, to make more informed decisions.**

   The Robust Weather Station Network would not contribute to reducing losses associated with frost damage in grain production systems, however it could assist with informing the decision-making process should a frost event occur. Determining if a crop has suffered significant frost damage, and therefore whether it should be salvaged by being cut for hay or silage, requires an understanding of the severity of the frost, its duration and the crop growth stage. Having access to accurate local weather information is valuable given the cost of delaying the decision to cut a crop for hay can be as high as $267/ha in reduced income for grain growers.

   Those who are near weather stations would be more likely to be able to accurately make this decision using the data provided.

2. **Making more accurate fertiliser decisions, based on better knowledge of soil moisture conditions.**

   Research shows that the rate of fertiliser application has a greater impact on yield than the timing of fertiliser application. As such, the report concluded that a Robust Weather Station Network would not be expected to contribute to improved fertiliser decision making, because rate is the driver of yield. However, anecdotal evidence from Riverine Plains farmers indicates that soil moisture probe information and climate projections are used to inform fertiliser rates during the season (not presented in the report).

3. **Better yield predictions for grain marketing planning, based on more accurate knowledge of local rainfall and soil moisture conditions.**

   The Robust Weather Station Network would increase the accuracy of yield predictions by growers and advisors. However, a long-term analysis of wheat prices indicates that this will have little impact on overall profitability for growers. For canola production, there is a potential $13 per tonne benefit from being able to accurately predict grain yield, which could help farmers market their grain earlier.

4. **Better yield predictions for crop insurance planning, based on more accurate knowledge of local rainfall and soil moisture conditions.**

   A study conducted by the Independent Pricing and Regulatory Tribunal (IPART) in 2016 found that although weather stations are unlikely to increase the uptake of crop insurance by farmers, they can assist farmers better prepare for drought. It was found that while improved weather information might improve the accuracy of insurance models, it would not materially reduce the costs of insurance premiums. As such, the benefit of additional weather stations in increasing the uptake of crop insurance was found to be negligible. This study also reported a benefit cost ratio for additional weather stations of 2.3:1, due to the increase in growers' ability to be drought prepared.

5. **More accurate local temperature and wind information to inform farmers of fire risk days, prevent loss from fires at harvest.**

   Data around temperature and fire risk is currently unavailable, however it's hypothesised that improved weather data can be used to increase the accuracy of announcements of high fire risk days, allowing emergency services to plan resources and issue more accurate stop harvest warnings.

6. **Better understanding of soil moisture levels at sowing to inform crop choice.**

   In regions such as central west NSW, knowing the soil moisture status at sowing can help farmers determine whether they should switch to a drought tolerant variety or whether a crop failure is likely. This can help reduce the risk of yield penalties and failed crops, with the value to the grain grower varying from $36/ha in a dry season to $143/ha in a wet season. The decision to sow canola on low soil moisture can cost farmers up to $655/ha, which can be avoided if soil moisture information is used in conjunction with yield prediction models.

7. **Environmental impacts of having better knowledge of soil moisture conditions.**

   The Robust Weather Station Network could be used to assist growers to set a target soil moisture level, which they can then use to inform decisions around whether to graze stubbles, cultivate soils and sow crops. This has the potential to provide an estimated public benefit of up to $300 million, associated with the costs of the clean-up from major dust storms. The Robust Weather Station Network could also reduce the costs associated with crop failure for growers, which can be up to $655/ha for canola.

   Assessing water limited yield and matching nitrogen inputs to this can reduce greenhouse gas emissions that result from excess nitrogen application. This can reduce the carbon footprint of a grain growing business.

CONCLUSION

The outputs of the consultation process and business case development indicate that a Robust Weather Station Network has the potential to provide many benefits and opportunities to grain growers, natural resource management organisations and industry bodies. Collaborative opportunities to expand upon networks, for example those already invested in GRDC, would increase the ability of growers to access and use weather station data to refine their decision making.

The economic benefit of the Robust Weather Station Network to grain growers is centred around increasing the accuracy of weather and soil information, to inform the decision-making process. Further economic and social research is required to determine if the data presented in this business case will achieve the economic benefits stated, as it relies on adoption of the technology by growers to improve the decision-making process.

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BREAK CROP FERTILITY AND ORGANIC MANURES AT BUNDALONG SOUTH

KEY MESSAGES

- **This trial is part of a project looking at the legacy effects of organic amendments and manure compared to inorganic fertilisers on cereal and oilseed production following a pulse crop. This is the first year at this trial site, with effects to be assessed over the next two growing seasons.**
- **Wheat yield following faba beans was high at this site, averaging over 9t/ha, demonstrating how legacy nitrogen from a previous pulse crop can contribute to yield and help buffer against high synthetic fertiliser inputs**
- **The lowest average yield at this site was recorded in the fallow treatment with farm-standard nitrogen (7.93 t/ha), while the highest yield was observed in the 10t/ha manure treatment with extra nitrogen (9.68 t/ha). This shows the potential for increased yield when nitrogen (and other nutrient) supply is matched to demand under high yielding seasonal conditions**
- **When wheat yields were averaged across manure treatments, the application of an extra 75kg/ha of nitrogen in-season significantly improved yield when compared to the farm standard, indicating the farm standard rate was not either enough to realise potential yield or supply did not match plant demand from stem elongation onwards this season**
- **When yields were averaged across nitrogen treatments, the 10t/ha manure treatment was the only manure treatment to significantly improve yield when compared to the untreated control**
- **When averaged across all treatments, grain protein increased from 10% to 11.2% when an extra 75kg of nitrogen was applied at stem-elongation, lifting quality from ASW to APW**
- **Slashing at flowering and removal of faba bean biomass reduced the yield benefit to the following crop.**

BACKGROUND

There is an abundance of organic amendment options in north east Victoria due to the proximity of feedlots and other intensive livestock operations. Consequently, there is local interest in using these by-products to supply nutrients for grain production systems and to improve soil constraints.

Nitrogen fixation provides most of the nitrogen demand of grain legume crops at high yields, assuming adequate rhizobial function. A large part of this fixed nitrogen is exported in grain, which can affect the pulse crop's potential to restore fertility to the soil. Consequently, the nitrogen fixed by the legume crop may not be enough to sustain higher-yielding wheat crops the following season.

AIM

This project is evaluating whether the benefits of nitrogen fixation by legume crops can be amplified in a subsequent wheat crop by using added organic amendments (eg. compost) or manure. It also looks at whether the application of manures can buffer the farm business from costs associated with high synthetic fertiliser inputs.

METHOD

A commercial faba bean crop was sown in Autumn 2022 at Bundalong South in Victoria. During September 2022, when the crop was at early to mid-flower, parts of the faba bean crop were slashed and removed to create a 'fallow' effect, while in other areas the beans were slashed and spread evenly on the surface to create a 'green manure' effect. The remaining crop was harvested.

To leverage the fertility of this crop's legacy, a manure trial was established at the same site during 2023, with 16 treatments on paired plots. Treatments received either farm standard nitrogen (N) (92 kg/ha) or farm standard N plus an extra 75 kg N /ha (167 kg N/ha).

Prior to sowing in April 2023, three rates of manure — 2.5, 5.0 and 10 t/ha at 23 percent moisture — were spread on the soil surface. Additional treatments, including a treatment equivalent to the nitrogen (N) value of 5t manure and a blend of ammonium sulphate, monopotassium sulphate, muriate of potash and urea (N-P-K-S) equivalent to 5t manure, were also spread prior to sowing (Tables 1 and 2). A small amount of manure was withheld to allow final testing of its constituents and then applied on 1 June, 2023.

Table 1 Nutrients applied to treatments prior to sowing using ammonium sulphate, monopotassium sulphate, muriate of potash and urea.

NUTRIENTS APPLIED (KG/HA)				
Treatment	Nitrogen	Phosphorus	Potassium	Sulphur
Nil	-	-	-	-
2.5 t/ha manure	23.2	13.7	27.0	7.5
5 t/ha manure	46.3	27.4	54.0	15.0
10 t/ha manure	92.6	54.8	108.0	30.0
N value 5t/ha manure	46.3	-	-	-
NPKS value 5t/ha manure	46.3	27.4	54.0	15.0
Fallow	-	-	-	-
Green manure	-	-	-	-

Note: Nutritional values do not include nitrogen applied in-season as urea.

Table 2 Application dates and rates of artificial nutrients applied to the N value 5t/ha manure equivalent and NPKS value 5 t/ha manure equivalent treatments at Bundalong South, 2023.

NUTRIENTS APPLIED (KG/HA)				
	Nitrogen	Phosphorus	Potassium	Sulphur
App 1 – 26 April	32.7	16.9	50.2	10.6
App 2 – 1 June	13.6	10.5	3.8	4.4
Total	**46.3**	**27.4**	**54.0**	**15.0**

The whole trial site was fertilised with the same rate of urea that the farmer used on the surrounding paddock, which was 46 kg N/ha (100 kg urea) spread on 26 June and 46 kg N/ha (100 kg urea) spread on 24 July, 2023. Following this application, each pair of plots was split, with half of each treatment receiving an extra 75 kg N/ha as top-dressed urea on 4 August at early stem elongation (GS32).

RESULTS AND DISCUSSION

After a wet finish to 2022, stored moisture was high heading into the 2023 season. This, and adequate winter rainfall, helped carry the crop through the warm, dry September. Timely rainfall and mild temperatures during October provided good finishing conditions, and allowed high yields to be achieved.

Table 3 Influence of treatment on grain yield (t/ha) at Bundalong South, 2023

	GRAIN YIELD (T/HA)		
Treatment	**Standard N**	**Standard N + 75 kg N/ha**	**Average**
Nil	8.70 -	9.40 -	9.05 bc
2.5t/ha manure	8.87 -	9.36 -	9.11 abc
5t/ha manure	8.73 -	9.46 -	9.09 abc
10t/ha manure	9.01 -	9.68 -	9.34 a
N value 5t/ha manure	8.56 -	8.98 -	8.77 d
NPKS value 5t/ha manure	9.16 -	9.47 -	9.31 ab
Fallow	7.93 -	8.94 -	8.44 e
Green manure	8.53 -	9.24 -	8.89 cd
Mean	**8.69 b**	**9.32 a**	**9.00 -**
Manure	**LSD** 0.27	**P Val** <0.001	
Nitrogen	**LSD** 0.14	**P Val** <0.001	
Manure x Nitrogen	**LSD** ns	**P Val** 0.300	

Grain yields averaged 9.0 t/ha across the trial (Table 3). While the lowest yielding treatment was the fallow treatment with no additional nitrogen (7.93 t/ha), it's yield was still impressive. The application of an additional 75 kg N/ha to the fallow treatment boosted yield by over 1 t/ha, demonstrating the benefits of high soil nitrogen fertility under high yielding conditions. Applying 10 t/ha of manure with an extra 75 kg/ha of nitrogen produced the highest yield (9.68 t/ha).

There was no interaction between manure treatment, nitrogen treatment and grain yield. However, supplying an additional 75 kg/ha of nitrogen during the growing season increased average yield by 0.63 t/ha, from 8.69 t/ha to 9.32 t/ha. This suggests that nitrogen carried over from the previous faba bean crop and a farm-standard fertiliser application rate could not meet the needs of the wheat crop under high-yielding conditions.

When yields were averaged across nitrogen treatments, the fallow treatment resulted in a lower grain yield the following year (8.44 t/ha), compared to the nil treatment (9.05 t/ha) — a difference of 0.61 t/ha. This was likely due to the removal of nitrogen-rich plant residues, which would have contributed to soil nitrogen stores if left to break-down naturally. The application of 10 t/ha of manure increased grain yield by 0.29 t/ha over the nil treatment, to 9.34 t/ha, however yield for this treatment was not significantly different to the 2.5 and 5 t/ha manure treatments or the NPKS 5t/ha manure equivalent, suggesting that nutrients were not limiting in these treatments. Where only nitrogen was applied in the N value 5 t/ha manure treatment, the yield was lower than the control, suggesting nutrients other than nitrogen limited yield.

Harvest index is the ratio of grain to total shoot dry matter and is used as a measure of reproductive efficiency. Although there were no statistically significant differences in harvest index due to any of the manure treatments, the plots that had an extra 75kg of nitrogen had a significantly higher harvest index (42%) than the plots with the farm-standard nitrogen (40%).

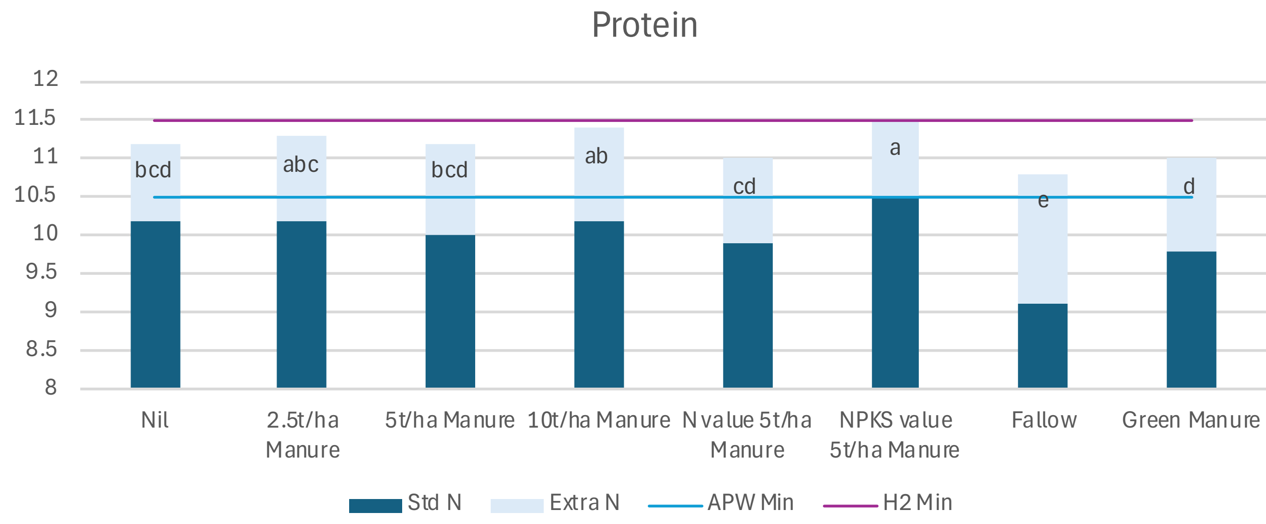

Figure 1 Influence of manure treatment on protein content at Bundalong South.

There was no interaction between manure treatment, nitrogen treatment and grain protein. Adding 75kg of nitrogen per hectare over and above the farm standard increased grain protein from 10 percent to 11.2 percent when averaged across all treatments (Figure 1). When only the farm standard nitrogen rate was applied, grain protein for all treatments was below the 10.5 percent required to meet APW specifications, except for the NPKS 5 t/ha manure equivalent, which was exactly 10.5 percent. The application of an additional 75kg/ha of nitrogen increased grain protein for all treatments, however this was still below the 11.5percent required to meet AH2 specifications, except for the NPKS 5t/ha manure equivalent, which was exactly 11.5 percent.

Both test weight and grain screenings were well within receival standards for all treatments.

SOIL NITROGEN STATUS

Soil samples were collected from selected treatments at GS32. Soil mineral nitrogen in these treatments ranged from 83 to 136 kg/ha over the profile to a depth of 90 cm. Although there were no statistical differences, the lowest levels were recorded in the fallow plots. The highest soil mineral nitrogen was observed in the green manure plots, which was expected given a green manure crop can fix a high amount of nitrogen and can begin returning that nitrogen to the soil shortly after termination, compared to a grain crop that will remove approximately 40kg N per tonne of grain production (Table 5).

Table 5 Influence of manure treatment on soil mineral nitrogen (kg N/ha), sampled 4 August, 2023

	SOIL MINERAL NITROGEN (KG N/HA)			
Treatment	**0-30cm**	**30-60cm**	**60-90cm**	**0-90cm**
Nil	66 -	16 -	15 -	92 -
10 t/ha manure	70 -	17 -	14 -	103 -
NPKS Value 5 t/ha manure	71 -	25 -	13 -	111 -
Fallow	57 -	13 -	11 -	83 -
Green manure	95 -	17 -	11 -	136-
Mean	**72**	**18**	**13**	**107**
LSD	ns	ns	ns	ns
P Val	0.333	0.009	0.430	0.250

Post-harvest soil sampling showed a significant increase in soil mineral nitrogen levels due to the addition of an extra 75kg N/ha. This was replicated at each depth sampled, with an increase of around 24 kg N/ha over the entire profile.

Table 6 Influence of applied nitrogen on soil mineral nitrogen (kg N/ha), sampled 30 January 2024.

SOIL MINERAL NITROGEN (KG N/HA)				
Treatment	**0-30cm**	**30-60cm**	**60-90cm**	**0-90cm**
Farm standard N	43 b	10 b	7 b	60 b
Extra 75kg N/ha	58 a	17 a	10 a	84 a
Mean	**50**	**14**	**9**	**72**
LSD	8.03	2.64	2.24	9.76
P Val	0.001	<0.001	0.002	<0.001

When averaged across nitrogen treatments, the use of manure (or equivalent nutrients) did not significantly increase the soil mineral nitrogen recorded at any depth (Table 7). The NPKS value treatment had the highest soil mineral nitrogen over the entire profile at around 86 kg/ha, which was 32kg/ha greater than the N value treatment, which recorded the lowest nitrogen levels. Soil mineral nitrogen in the manure treatments ranged from 74 to 82 kg/ha, with levels increasing in line with increases in the amount of manure applied.

Table 7 Influence of manure treatment on total soil mineral nitrogen (kg N/ha), sampled 30 January 2024, Bundalong South

TOTAL SOIL MINERAL NITROGEN (KG N/HA) 0-90CM					
Treatment	**Standard N**		**Standard N + Extra 75 kg N/ha**		**Mean**
Nil	48 -		81 -		65 -
2.5t/ha manure	60 -		87 -		74 -
5t/ha manure	77 -		79 -		78 -
10t/ha manure	59 -		105 -		82 -
N Value 5t/ha manure	47 -		60 -		53 -
NPKS Value 5t/ha manure	61 -		110 -		86 -
Fallow	59 -		70 -		65 -
Green Manure	72 -		83 -		77 -
Mean	**60**	**b**	**84**	**a**	
Manure	LSD	ns	P Val		0.078
Nitrogen	LSD	9.762	P Val		<0.001
Manure x nitrogen	LSD	ns	P Val		0.153

ECONOMICS

For the economic evaluation three prices were used for the manure. This allowed for variance in the cost of freight and spreading depending on the distance from the manure supply. The evaluations are called 'cheap', 'dear' and 'expensive' with manure prices of $30, $40 and $50 per tonne respectively. The gross income was calculated on a per plot basis and averaged over the 4 replicates. This was to avoid unfair advantages where one treatment will 'just' meet a higher-grade than another treatment, leading to a substantial difference in gross income.

Nutrients were valued as follows: nitrogen - $1.52/kg, phosphorus - $4.76/kg, potassium - $2.00/kg, sulphur - $0.50/kg, based on fertiliser prices of urea - $700/t, MAP - $1200/t, muriate of potash (MOP) - $1000, gypsum - $80/t.

The NPKS value 5 t/ha manure treatment, which yielded 9.31 t/ha, was 260 kg/ha higher yielding than the Standard treatment (9.05 t/ha), however when taking the extra cost of the fertiliser into account, it was $203/ha less profitable. To have a legacy effect, the extra fertiliser would need to maintain this higher level of production for two to three seasons before it starts to become profitable.

When manure was either cheap ($30/t) or dear ($40/tonne), then any rate of manure (2.5 – 10t/ha) was statistically as profitable as the NPKS equivalent. When manure was expensive ($50/t), then the higher rate of manure (10 t/ha) becomes less profitable, while the other rates (2.5 – 5 t/ha) were equally profitable to the NPKS equivalent.

In any situation, the legacy effect of the nutrients or manure, as well as the nutrients that are lacking in the soil, needs to be considered.

SUMMARY

Organic manures have the potential to be a profitable addition to the farmers toolkit if the manure can be sourced and applied economically. An extension to this project will enable the legacy effects of the manure and synthetic fertilisers to be monitored at this site over the next two growing seasons.

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GROWING PULSES IN THE RIVERINE PLAINS REGION

KEY MESSAGES

- Due to lower-than-average rainfall during September, 2023 was generally a low disease pressure year for faba beans in the Riverine Plains
- Low levels of Cercospora leaf spot and chocolate spot were detected at both the Daysdale and Bundalong trial sites, with, the chocolate spot susceptible variety PBA Bendoc showing a significant yield improvement of up to 1.1t/ha due to fungicide application
- Six pulse species were assessed for adaptation at the Daysdale site, with lupins averaging 2.15t/ha, field peas 2.44t/ha, faba beans 2.00t/ha, lentils 1.21t/ha, vetch 1.16t/ha, and chickpeas averaging 2.22t/ha
- Faba bean yield was lower than expected at the Daysdale site due to the dry finish
- Estimated residual nitrogen legacy from the different pulse species ranged from 97kg N/ha to 146kg N/ha; the rule of thumb for net biological nitrogen contribution from pulse species is 19 kg N/t of dry matter
- Maintaining seeding rate at 25 plants/m^2 or above was essential to optimising grain yield
- Ultimately, the dry September period experienced in 2023 reduced the yield potential of pulse crops across the region, as it coincided with flowering and pod-setting in most pulse species.

AIM

To develop management approaches that increase the adoption and productivity of grain legumes, in particular faba beans, in areas dominated by canola – wheat rotations, leading to more resilient farming systems.

BACKGROUND

Replicated field trials were established during 2023 at Daysdale and Bundalong to evaluate the response of different legume species and cultivars to disease control, nutrient and canopy management.

DAYSDALE (NSW)

METHOD

Sowing date: 4 May

Starter fertiliser: 80kg MAP/ha

Row spacing: 22.5cm

Stubble: Wheat stubble, kelly chained pre-sowing

The Daysdale site consisted of six legume species variety screening trials on a red loam soil, as well as a faba bean disease management trial (Tables 1 and 2).

Table 1 Pulse species, seeding rates and varieties sown in the 2023 Daysdale trials. Bolded varieties were also tested under high nitrogen status (100 kg N/ha applied as urea).

SPECIES	SEEDING RATE (SEEDS/M²)	VARIETIES			
Faba Beans	25	**PBA Samira**	PBA Amberley	PBA Nasma	PBA Ayla
Lupins	60	**PBA Bateman**	Murringo	Lawler	Luxor
Field Peas	60	**PBA Butler**	PBA Taylor	PBA Pearl	APB Bondi
Vetch	80	**Timok**	Benetas	RM4	Morava
Chickpeas	50	**CBA Captain**	Genesis 090	PBA HatTrick	PBA Seamer
Lentils	120	**PBA Hallmark**	PBA Kelpie XT	GIA Leader	ALB Terrier

Table 2 Faba bean varieties and fungicide strategies used in the Daysdale faba bean disease management trial, 2023.

Cultivars
PBA Amberley (MR-MS)
PBA Bendoc (S)
PBA Samira (MS)

	Fungicide applied	Date (Growth stage)
Nil	Nil	---
Old Chemistry	2.3L/ha Chlorothalonil 720 + 0.5L/ha Carbendazim 500 2.3L/ha Chlorothalonil 720 + 0.5L/ha Carbendazim 500	29 Aug (Mid flower) 2 Oct (Podding)
New Chemistry	0.75L/ha Miravis Star 0.75L/ha Veritas	29 Aug (Mid flower) 2 Oct (Podding)
Complete	0.145L/ha Tebuconazole 430 2.3L/ha Chlorothalonil 720 + 0.5L/ha Carbendazim 500 0.75L/ha Miravis Star 0.75L/ha Veritas	24 Jul (8 node) 3 Aug (Start flowering) 29 Aug (Mid flower) 2 Oct (Podding)

The old chemistry treatment includes older, multi-site chemistry with purely protective activity, while the new chemistry treatment utilises new modes of action with longer lasting protection and some curative activity. The complete control treatment is aimed at keeping the canopy completely free of disease.

RESULTS

DISEASE MANAGEMENT

There was low disease pressure during the 2023 growing season and the moderately resistant to chocolate spot variety PBA Amberley showed no significant yield response to fungicide strategy, while the moderately susceptible and susceptible varieties PBA Samira and PBA Bendoc showed significant responses to fungicide application (Table 3).

The improved disease resistance of PBA Amberley over PBA Bendoc was highlighted by a lack of disease present, less than two percent of leaf area, in the untreated control plots (Figure 1). This indicates its reduced need for fungicide treatments, at least under low disease pressure situations. When growing PBA Amberley, growers should be aware of its long growing season and requirement for early sowing.

When disease was controlled in the complete control treatment, there was no yield difference between the three varieties tested, with yield ranging from 2.04t/ha to 2.20t/ha. This treatment included four fungicide applications from late July to early October and the dry conditions experienced during late winter and early spring were a likely contributing factor to this result.

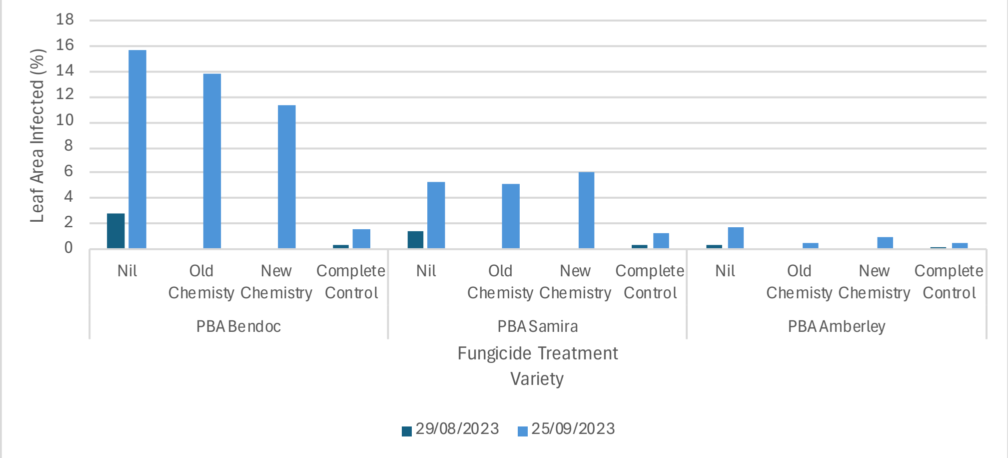


Figure 1 Chocolate spot infection of faba bean plots at Daysdale, NSW, 2023.

Table 3 Effect of fungicide management and faba bean variety on grain yield (t/ha) at Daysdale, NSW.

	PBA BENDOC	PBA SAMIRA	PBA AMBERLEY	MEAN
Nil	1.90 c	1.88 c	2.10 ab	1.96 c
Old chemistry	2.15 ab	1.88 c	1.99 bc	2.01 bc
New chemistry	2.15 ab	2.15 ab	2.09 ab	2.13 a
Complete control	2.20 a	2.04 abc	2.04 abc	2.09 ab
Mean	2.10 -	1.99 -	2.05 -	
Cultivar	P Value	0.170	LSD	ns
Fungicide	P Value	0.013	LSD	0.11
Cultivar x Fungicide	P Value	0.049	LSD	0.19

For the varieties that responded to fungicide, there was no benefit to early fungicide applications before early-mid-flowering. This has been a consistent result across other sites included in this project work, even under high disease-pressure situations, such as during 2021 – 2022. By delaying the first fungicide application until early-mid flowering, legume growers have a much better idea of the seasonal outlook and the yield potential of the crop. This enables more informed tactical decisions to be made around fungicide use, i.e. if a dry spring is forecast, applications can be reduced, conversely if a wet spring and high yield potential is forecast, the use of high rates of fungicide using good chemistry is recommended.

VARIETY COMPARISON TRIALS

While the trial design does not allow statistical comparisons between species, we can see that most species performed reasonably well given the dry start to early spring, with no crop failures occurring.

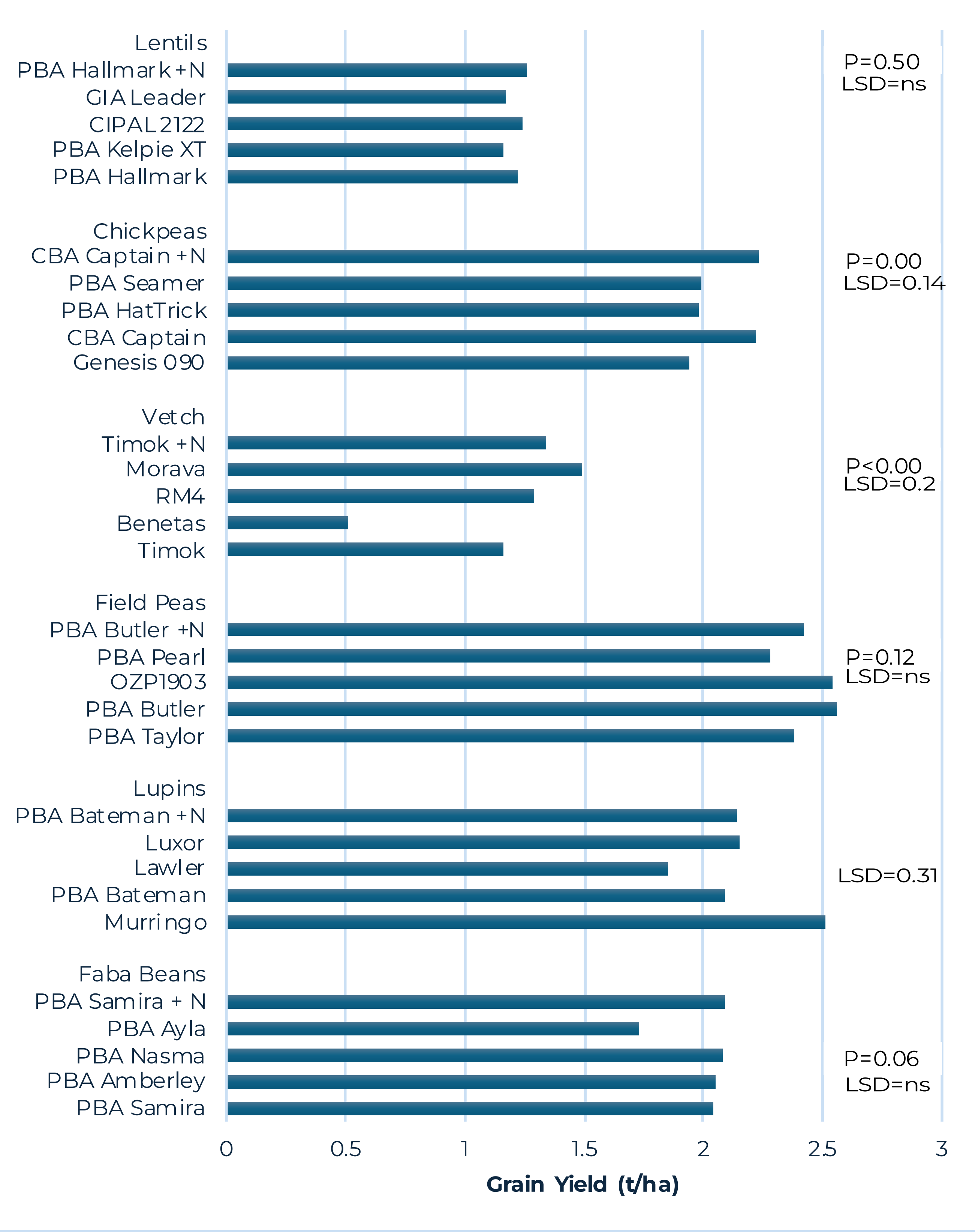
For faba beans, field peas, and lentils there was no statistical difference between the varieties tested. Species with significant varietal differences included chickpeas, vetch and lupins, with CBA Captain chickpea outyielding all other chickpea varieties. The vetch variety Benetas was significantly lower yielding than other varieties, likely because it has a longer phenology compared to other varieties and suffered from the dry spring. The albus lupin variety Murringo outyielded the other lupin varieties. Across all varieties, there was no yield increase seen when in-crop nitrogen was applied.

A big part of the NSW Pulse project is getting a better understanding of the nitrogen fixing abilities of the different pulse species, to get a better idea of the legacy effects of the pulse crop. This involves collecting peak biomass samples and analysing them to determine the amount of nitrogen in the crop that is derived from the atmosphere (fixed nitrogen). The results from 2023 trials are not yet available, but estimates are provided in Table 4, based on previous years' results.

Table 4 Estimated nitrogen fixing ability of different pulse species during 2023

SPECIES	VARIETY	YIELD (T/HA)	BIOMASS (T/HA)	ESTIMATED N FIXED* (KG N/HA)	N BALANCE # (KG N/HA)
Faba Bean	PBA Samira	2.04	5.52	182	103
Lupin	PBA Bateman	2.09	7.08	234	138
Field Pea	PBA Butler	2.56	5.75	190	97
Vetch	Timok	1.16	5.81	192	136
Chickpea	CBA Captain	2.22	6.20	205	143
Lentil	PBA Hallmark	1.22	5.56	183	138
* Nitrogen fixed estimate based on 33kg N fixed per tonne of above ground biomass from 2021 results.					
# Nitrogen balance calculated by N fix estimate minus N removed by grain.					

Figure 2 Grain yield of each variety of the six pulse species tested at Daysdale, NSW in 2023.



BUNDALONG

METHOD

Sowing date: 24 April
Starter fertiliser: 80kg MAP/ha
Row spacing: 22.5 cm
Stubble: Standing wheat stubble

The Bundalong site hosted three faba bean trials investigating disease management (Table 5), crop nutrition (trial data not presented as no treatment effects were seen), and canopy management (Table 6).

Table 5 Fungicide strategies applied to both PBA Bendoc and PBA Amberley at Bundalong during 2023

	APPLICATION DATE AND GROWTH STAGE				
TREATMENT	**12-JUL 8 NODE**	**1-AUG 12 NODE/ EARLY FLOWER**	**16-AUG GS60-61**	**6-SEP GS65**	**2-OCT MID-PODDING**
Untreated Control	-	-	-	-	-
1 Unit	-	-	-	-	Chlorothalonil 2.3L/ha + Carbendazim 500mL/ha
2 Units	-	-	-	Chlorothalonil 2.3L/ha + Carbendazim 500mL/ha	Chlorothalonil 2.3L/ha + Carbendazim 500mL/ha
3 Units	-	-	Mancozeb 2kg/ha + Nosclex 300g/ha	Chlorothalonil 2.3L/ha + Carbendazim 500mL/ha	Chlorothalonil 2.3L/ha + Carbendazim 500mL/ha
4 Units	Tebuconazole 145mL/ha	-	Mancozeb 2kg/ha + Nosclex 300g/ha	Chlorothalonil 2.3L/ha + Carbendazim 500mL/ha	Chlorothalonil 2.3L/ha + Carbendazim 500mL/ha
2 Units Expensive	-	-	-	Miravis Star 750mL/ha	Veritas 750mL/ha
1 Unit Reactive	-	-	-	Miravis Star 750mL/ha	-
Complete Control	Tebuconazole 145mL/ha	Mancozeb 2kg/ha + Procymidone 240g/ha	Mancozeb 2kg/ha + Nosclex 300g/ha	Miravis Star 750mL/ha	Veritas 750mL/ha
Experimental	Tebuconazole 145mL/ha	-	Mancozeb 2kg/ha + Nosclex 300g/ha	Experimental fung FAR23-01	Veritas 750mL/ha

The reactive treatment is designed to be 'reactive' to disease infection, so applications were delayed until disease had developed in the canopy, while the complete control treatment is designed to go above and beyond what is commercially reasonable to completely remove the influence of disease. The experimental treatment replicates the four-unit treatment but involves new and experimental (not commercial in 2023) products.

Table 6 Canopy management strategies applied to both PBA Samira and PBA Amberley at Bundalong during 2023.

TREATMENT	AIM OF TREATMENT
Standard plant density (target 25 plants/m^2)	Control
Low plant density (target 12 plants/m^2)	
High plant density (target 50 plants/m^2)	

RESULTS

DISEASE MANAGEMENT

Similarly to Daysdale, overall disease infection was low at the Bundalong site due to a lack of conducive conditions, with chocolate spot again being the main disease infecting faba bean canopies. The low disease pressure allowed more flexibility in the timing of fungicide applications, as well as the products being used.

Despite the low disease pressure, statistically significant yield gains were achieved using several of the fungicide strategies described in Table 5. Despite differences in disease resistance ratings, both varieties responded the same way to the fungicide strategies applied (no statistical interaction). When variety yield was averaged and compared across treatments (Table 7), all fungicide strategies gave a significant yield increase above the untreated control. The 'experimental strategy' achieved the highest yield (6.20t/ha) with an increase of 0.94 t/ha above the untreated control. Across all fungicide treatments, PBA Amberley was significantly higher yielding than PBA Bendoc.

Table 7 Effect of fungicide management and faba bean variety on grain yield (t/ha) at Bundalong, Vic.

	Yield (t/ha)			
TREATMENT	**PBA AMBERLEY**		**PBA BENDOC**	**MEAN**
Untreated Control	5.54 -		4.98 -	**5.26 c**
1 Unit	6.07 -		5.47 -	**5.77 b**
2 Units	6.33 -		5.71 -	**6.02 ab**
3 Units	6.16 -		6.12 -	**6.14 a**
4 Units	5.89 -		5.73 -	**5.81 b**
2 Units Expensive	5.96 -		5.63 -	**5.80 b**
1 Unit Reactive	6.03 -		5.94 -	**5.98 ab**
Complete Control	6.08 -		5.75 -	**5.92 ab**
Experimental	6.36 -		6.04 -	**6.20 a**
Mean	**6.05 a**		**5.71 b**	
Variety	**LSD**	0.23	**P val**	0.018
Fungicide Strategy	**LSD**	0.28	**P val**	<0.001
Variety x Fungicide Strategy	**LSD**	ns	**P val**	0.302

CANOPY MANAGEMENT

The canopy management trial allowed us to test methods which have the potential to influence canopy structure or improve crop standability, with the aim of increasing crop yields. This focussed on using high and low plant densities with two faba bean varieties as described in Table 5. The results showed that none of the treatments improved grain yield (Table 8), despite their effect on lodging (Figure 3). There was a significant yield reduction when plant populations were reduced from 25 plants/m² to 13 plants/m².

Table 8 Effect of canopy management and faba bean variety on grain yield (t/ha) at Bundalong, Vic

	Yield (t/ha)				
TREATMENT	**PBA AMBERLEY**		**PBA SAMIRA**	**MEAN**
Low plant density (target 12 plants/m²)	5.46 -		5.87 -	**5.66 b**
Standard plant density (target 25 plants/m²)	5.95 -		6.00 -	**5.97 a**
High plant density (target 50 plants/m²)	5.99 -		6.09 -	**6.04 a**
Mean	5.82 -		5.97 -	
Variety	LSD	ns	P val	0.107
Canopy Management	LSD	0.19	P val	0.010
Variety x Canopy Management	LSD	ns	P val	0.102

Crop lodging was significantly affected by plant density (Figure 3), with the low plant density resulting in less lodging, but also reduced yield. Increasing the seeding rate did not result in more lodging or yield compared to the standard density. The biggest factor influencing crop lodging was variety choice, with PBA Amberley having significantly lower lodging scores than PBA Samira. Yield data from two years of trials hasn't been able to demonstrate an improvement grain yield with canopy management strategies. While they may help with the harvestability of the crop due to the prevention of grain yield losses, the nature of harvesting trials (low and slow to collect all grain) means this is not evident in the results.

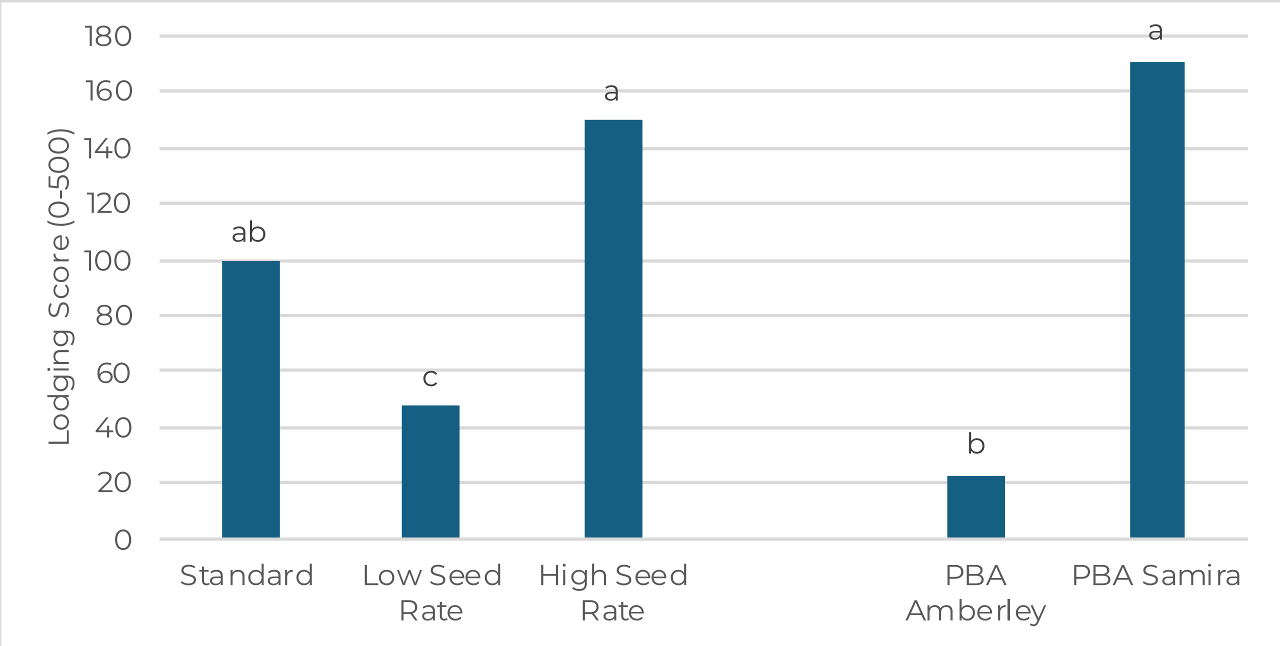


Figure 3 Influence of canopy management strategies and faba bean variety (analysed separately) on crop lodging, lodging score calculated by severity (0-5) x percentage of plot affected (0-100).

Detailed assessments of canopy structure were undertaken within the different seeding rate (low, standard and high) treatments in PBA Amberley (Table 9).

Table 9 Canopy structure of PBA Amberley at varying seed rates.

TREATMENT	PLANTS/M²	STEMS/ PLANT	STEMS/M²	PODS/STEM	PODS/M²	SEEDS/POD
Low Seed Rate	12 d	4.8 a	51 b	7 a	385 -	2.4 -
Standard Control	25 c	2.9 b	70 a	6 bc	397 -	2.4 -
High Seed Rate	46 a	1.8 c	84 a	5 c	355 -	2.3 -
Mean	28	3.1	70	6	381	2.4
LSD	7	0.7	17	1	ns	ns
P val	<0.001	<0.001	0.023	0.018	0.561	0.639

Results showed that plant density had a significant effect in PBA Amberley on the number of stems produced per plant and the number of pods produced per stem, with plants grown under low plant densities producing a greater number of stems and pods when compared to plants grown under standard and high plant densities.

The greater stem/plant and pod/stem numbers produced by PBA Amberley when grown under low plant densities failed to compensate for the lower plant numbers, with the yield achieved under this treatment 0.49t/ha lower than the standard seeding rate and 0.53t/ha lower than the highest seeding rate.

SUMMARY

2023 was another successful year for growing pulses in the Riverine Plains region with faba bean yields exceeding 6t/ha. Disease pressure was low, which provided growers with more flexibility in their fungicide program and timing and product choice were less significant compared to previous high-pressure years. Yield penalties were still observed where no fungicide was used.

Management options that were trialed to reduce lodging in faba beans were unsuccessful at increasing yields. Reducing plant numbers to reduce lodging came at a yield penalty, showing the importance of maintaining plant populations at or above 25 plants/m². If lodging is present in the crop, care can be taken at harvest to prevent losses.

At Daysdale grain legume yields ranged from 0.51t/ha (Benetas vetch) to 2.56t/ha (PBA Butler field peas). Lentils, field peas and faba beans showed no differences between varieties, but variety choice in vetch, lupins and chickpeas did cause significant yield differences.

ACKNOWLEDGEMENTS

This work was supported by GRDC investment in the *Development and extension to close the economic yield gap and maximise farming systems benefits from grain legume production in Victoria (DJP2105-006RTX)* and *Development and extension to close the economic yield gap and maximise farming systems benefits from grain legume production in New South Wales (BRA2105-001RTX)* projects.

We acknowledge the project leads Rohan Brill (Brill Ag) and Jason Brand (Agriculture Victoria) for their contributions. Thanks also to farmer co-operators the Inchbold family (Bundalong) and Hanrahan family (Daysdale).

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COMPARING PASTURE QUALITY AND PERSISTENCE AND LIVEWEIGHT GAINS IN CLOVER AND LUCERNE BASED PASTURES

KEY MESSAGES

- Lucerne is a valuable perennial legume pasture capable of producing high-quality feed for stock from spring to autumn
- Rotationally grazing lucerne-based pastures, to allow a rest period, is important for lucerne persistence and productivity, as well as the productivity of stock grazing it
- To support persistence, lucerne sowing rates and cultivars should be selected to achieve target plant densities and productivity, while also being suited to the region's rainfall, temperature, and type of farming system
- At Savernake, lucerne quality declined from September to January before stabilising between January and March
- Well-managed lucerne pastures are valuable options for improving livestock farmers' drought resilience

BACKGROUND

This project aims to use the latest research on pasture species and management, to promote the use of perennial pastures within farming landscapes and increase resilience in dry seasons.

A species demonstration and grazing demonstration were established at Savernake and Barooga, respectively, in May 2023. These two demonstration sites aimed to showcase best-practice pasture management to build greater resilience for farmers in central and southern New South Wales.

METHOD

Pasture quality, plant frequency, plant species composition and biomass measurements were collected between spring 2023 to autumn 2024 at both sites, to monitor changes in pasture performance and persistence over the first summer of growth.

SAVERNAKE SPECIES DEMONSTRATION SITE

AIM

To demonstrate the impact of lucerne seeding rate and variety on pasture persistence and quality.

METHOD

The paddock was sown in late May 2023, with the treatments listed in Table 1.

Table 1 Savernake species demonstration site treatments.

TREATMENT	PERENNIAL PASTURE SPECIES	CULTIVAR	GROWTH TYPE	SOWING RATE (KG/HA)
Control (Lucerne/ sub clover mix)	Lucerne	SARDI 7s2	Winter active	5
	Brachycalycinum sub clover	Mintaro	Mid-maturing	3
	Yanninicum sub clover	Monti	Early-mid-maturing	3
Treatment 1 (Heavy lucerne rate/sub clover mix)	Lucerne	SARDI 7s2	Winter active	9
	Brachycalycinum sub clover	Mintaro	Mid-maturing	3
	Yanninicum sub clover	Monti	Early-mid-maturing	3
Treatment 2 (Two lucerne cultivars/sub clover mix)	Lucerne	SARDI 7s2	Winter active	2.5
	Lucerne	SARDI Grazer	Winter active, grazing tolerant.	2.5
	Brachycalycinum sub clover	Mintaro	Mid-maturing	3
	Yanninicum sub clover	Monti	Early-mid-maturing	3

Pasture quality samples were collected in mid-late September 2023 as well as mid-January and mid-March 2024. Lucerne and sub clover plant frequency, plant composition and biomass were measured in mid–late September 2023 and mid-March 2024 to measure differences before and after the first summer.

RESULTS AND DISCUSSION

The lucerne and sub clover stands established well across all treatments, with the first grazing event occurring in mid-late January 2024. The eight-month period between sowing and grazing was intended to enable the lucerne to establish an extensive root base to support plant persistence. At the time of the first grazing, the lucerne in the control (lucerne / sub clover mix) appeared shorter and lighter in colour compared to Treatment 1 (heavy lucerne rate / sub clover mix) and Treatment 2 (two lucerne cultivars/ subclover mix).

Average lucerne and sub clover pasture quality was similar in September 2023, as shown by the key feed quality measurements in Table 2. Lucerne quality declined from September to January, as indicated by the increase in neutral detergent fibre (NDF) and decline in crude protein (CP) and metabolisable energy (ME), and then remained relatively stable between January and March. Lucerne quality was consistently similar across all treatments (data not shown).

Table 2 Savernake species demonstration site showing average lucerne and sub clover quality across all treatments.

	NEUTRAL DETERGENT FIBRE (NDF) - NIR	ACID DETERGENT FIBRE (ADF) - NIR	CRUDE PROTEIN (CP) - NIR	DRY MATTER DIGESTIBILITY (DMD) - NIR	CALCULATION OF METABOLISABLE ENERGY (ME) - NIR
	%	%	%	%	MJ/kg DM
Mid September 2023					
Lucerne (Average all treatments)	26.0	17.0	22.3	82.0	12.7
Sub clover (Average all treatments)	28.0	19.0	25.5	82.0	12.3
Mid January 2024					
Lucerne (Average all treatments)	43.0	28.6	12.8	64.1	9.3
Mid March 2024					
Lucerne (Average all treatments)	40.1	28.9	19.1	66.7	9.7

Note: Pasture quality samples analysed on a dry matter basis by near-infrared spectroscopy (NIR).

Lucerne plant density remained stable over the first summer, as shown in Table 3, illustrating good initial pasture persistence. Sub clover is an annual plant which experiences seed dormancy over summer, and as such, density and composition (data not shown) were zero in March 2024.

Table 3 Savernake species demonstration site plant density.

	SEPTEMBER 2023		MARCH 2024	
	Lucerne	**Sub clover**	**Lucerne**	**Sub clover**
Treatment	**(plants/m²)**			
Control	41	32	43	0
1	50	29	50	0
2	47	37	45	0

In September 2023, lucerne composition was greatest in Treatment 1 (heavy lucerne rate/sub clover mix), and similar between the control (lucerne/sub clover mix and Treatment 2 (two lucerne cultivars/sub clover mix). This was as expected given the heavier lucerne sowing rate in Treatment 1 (data not shown).

Total biomass was similar across all treatments at both measurement times, with the greater biomass recorded in Treatment 2 being attributed to a historic soil disturbance from the digging of a pipe beneath part of the treatment (Figure 1). Across all treatments, total biomass was greater in March than September, despite two short grazing periods in late January and early February.

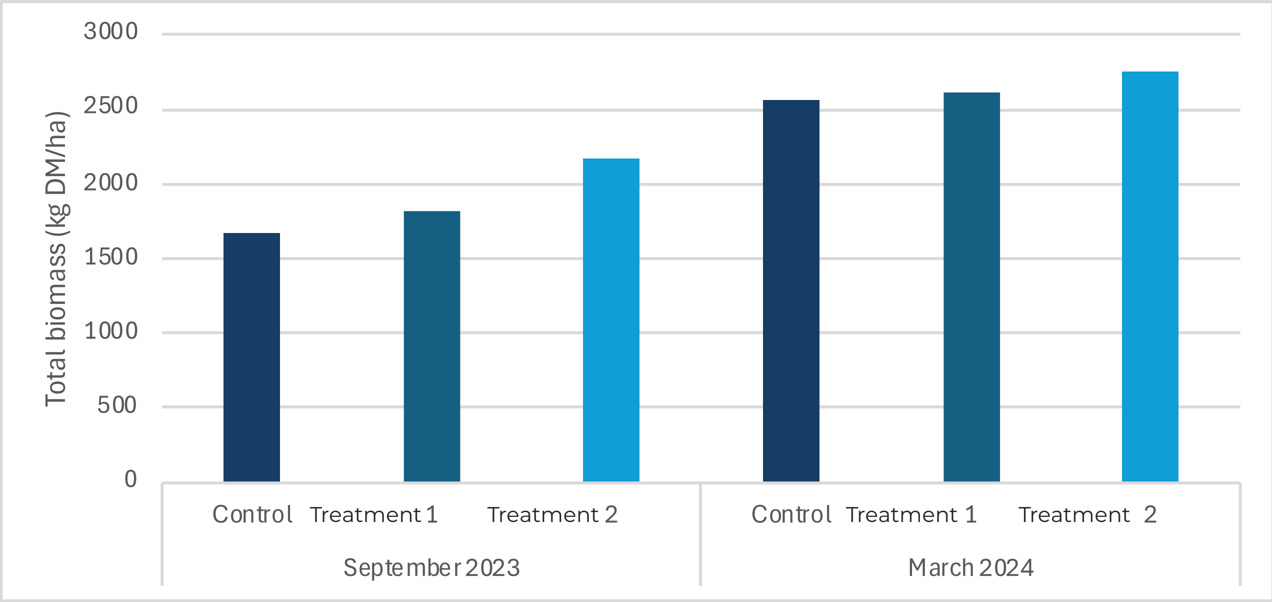

Figure 1 Savernake species demonstration site Total biomass (kg DM/ha).

While little difference was found between the treatments at four and 10 months after establishment, it's recommended that farmers sow the most appropriate species and cultivar at the best sowing rate for the region's rainfall and temperature, and the type of farming system. This is important for maximising pasture production and persistence.

BAROOGA GRAZING DEMONSTRATION SITE

AIM

To demonstrate the benefits of rotationally grazing lucerne for improving pasture persistence, pasture quality and animal production.

METHOD

The site consisted of two 10 hectare dryland paddocks, “A3 West” and “A3 East”, which were sown to 9 kg/ha lucerne (cv L70) and 6 kg/ha arrowleaf clover (cv Zulumax) in late May 2023. Two irrigated 20 ha paddocks, “A7 West” and “A7 East”, which were sown to lucerne in 2019, were also included as part of the demonstration.

Pasture quality samples were collected on 9 October 2023, 19 January and 14 March 2024. As the A3 West and A3 East paddocks were sown to the same species and treated similarly, quality samples were combined across both paddocks. Lucerne quality samples from both A7 West and A7 East were also combined for measurement. Lucerne and arrowleaf plant density, composition and biomass were collected on 9 and 30 October 2023 (data not shown) and 14 March 2024.

RESULTS

Pasture quality was relatively similar between the A3 lucerne and A3 arrowleaf clover (Table 4). The lucerne quality was also similar between the A3 and A7 paddocks. The volunteer grasses in the A3 paddocks were predominantly annual ryegrass, and had higher NDF and lower CP and ME than the legumes, reflecting their poorer quality.

Table 4 Barooga grazing demonstration site pasture quality.

	NEUTRAL DETERGENT FIBRE (NDF) - NIR	ACID DETERGENT FIBRE (ADF) - NIR	CRUDE PROTEIN (CP) - NIR	DRY MATTER DIGESTIBILITY (DMD) - NIR	CALCULATION OF METABOLISABLE ENERGY (ME) - NIR
	%	%	%	%	MJ/kg DM
Mid-October 2023					
Lucerne - A3	23.2	13.1	22.1	83.9	13.1
Lucerne - A7	23.3	14.7	25.4	85.1	13.1
Arrowleaf clover - A3	27.7	15.4	20.3	79.0	11.8
Grass weeds - A3	41.6	23.3	12.0	80.5	12.0
Mid January 2024					
Lucerne - A3	25.8	18.5	26.8	81.4	12.5
Lucerne - A7	26.5	19.2	25.0	80.4	12.3
Mid March 2024					
Lucerne - A3	45.2	30.9	18.5	67.3	9.7
Lucerne - A7	37.9	27.1	24.1	71.4	10.6

Note: Pasture quality samples analysed on a dry matter basis by near-infrared spectroscopy (NIR).

Lucerne and arrowleaf clover plant density remained stable over the grazing period, indicating appropriate sowing rates and grazing management (Table 5). The only notable decline in lucerne density over the summer occurred in A3 West, where the grass weeds population had increased by March 2024. Arrowleaf clover plants were not present in the A7 paddocks (not sown), or in March in the A3 paddocks due seed dormancy. As such, arrowleaf clover density (Table 5) and composition were zero at this time (data not shown).

Table 5 Grazing demonstration site: Plant density.

	END OCTOBER 2023		MID MARCH 2024	
	Lucerne	Arrowleaf clover	Lucerne	Arrowleaf clover
	(plants/m2)			
A3 West	56	27	34	0
A3 East	46	30	41	0
A7 West	104	0	90	0
A7 East	98	0	87	0

The lucerne in A7 West and A7 East maintained almost 100% composition across all dates (data not shown). This, combined with the fact that the lucerne in these paddocks was more established and irrigated, likely contributed to its greater biomass at each sampling date (Figure 2). The late-summer dormancy of arrowleaf clover may have contributed to the lower total biomass in A3 West and A3 East during March.

Rotational grazing of all paddocks between October to March attributed to the decline in biomass between measurements (Figure 2). Similar weight gains were achieved for both mobs of wether lambs over the grazing period (data not shown).

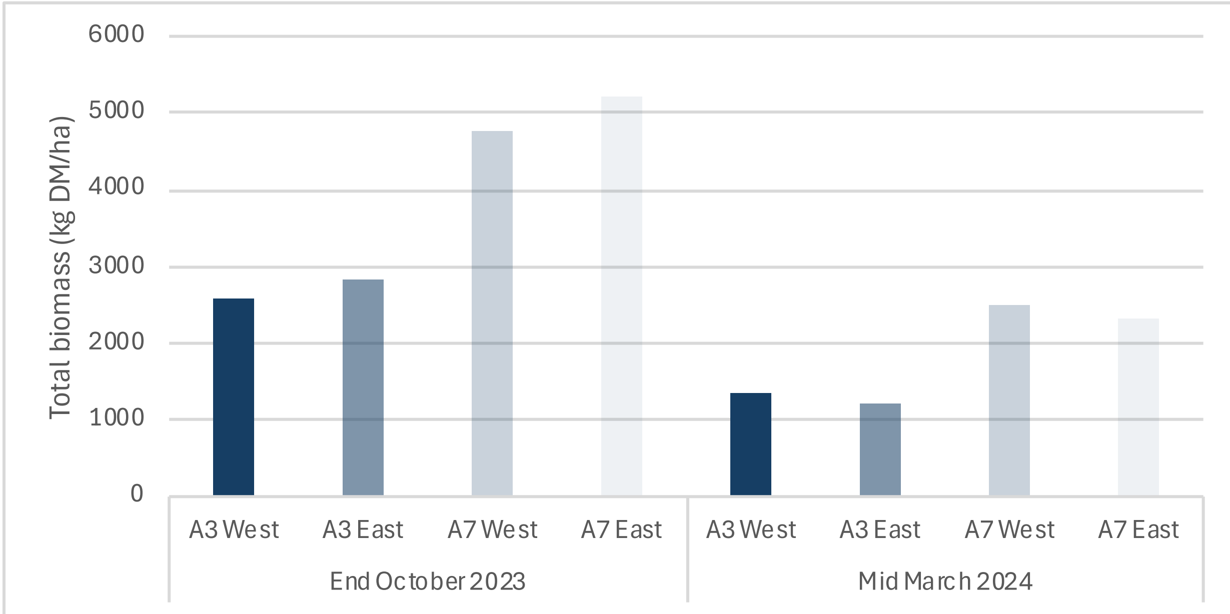

Figure 2 Barooga grazing demonstration site total biomass (kg DM/ha) for each paddock.

SUMMARY

Selecting the best sowing rate, species, and cultivar of pastures for your region and farming system, and rotationally grazing perennial pastures, is important for maximising pasture persistence and production. Lucerne provides a relatively high-quality feed option over summer, with quality being greatest in spring and declining through to autumn. Well managed perennial plants are valuable for extending the growing season and carrying livestock over summer, given their extensive root system and summer activity.

ACKNOWLEDGEMENTS

This article was produced as part of the *Creating landscape-scale change through drought resilient pasture systems* project. This project is supported by the Southern NSW Drought Resilience Adoption and Innovation Hub Through funding from the Australian Government’s Future Drought Fund. Thank you to the Gorman and Bruce families for hosting the two demonstration sites.

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CASE STUDIES

Sophie Hanna, Chantelle and Christine Gorman at the Savernake demonstration site.

CHANGING LANDSCAPES THROUGH DROUGHT RESILIENT PASTURES

RIVERINE PLAINS DEMONSTRATION SITE CASE STUDIES

INTRODUCTION

Creating Landscape-scale Change through Drought Resilient Pasture Systems, otherwise known as *FDF Resilient Pastures* is a project funded by the Future Drought Fund's Drought Resilient Soils and Landscapes Grants Program and has a project period of June 2022 - June 2024. The project is led by Holbrook Landcare Network and partners include Central West farming Systems, Monaro Farming Systems, Riverine Plains, FarmLink, Local Land Services, NSW DPI, CSU and The Southern NSW Resilience, Adoption and Innovation Hub.

The project supports pasture demonstration sites across central and southern NSW to showcase modern pasture species combination and management practices known to build greater resilience to their landscape. Farmer workshops, publications, case studies and conducting on-farm consultations with farmers have supported delivering extension messages from the project.

BACKGROUND

As part of this project, Riverine Plains established two perennial pasture demonstration sites during May 2023 at Savernake and Barooga (NSW). The Savernake site was hosted by Chantelle and Christine Gorman, while the Barooga site was hosted by John and Sarah Bruce. Details about the demonstration sites, as well as results, are published in *Research for the Riverine Plains, 2024,* and are also available at www.riverineplains.org.au.

CHANTELLE AND CHRISTINE GORMAN

Savernake, NSW.

Farming enterprise

- Approximately 2830 hectares (ha)
- Mixed farming, with a 50/50 split between livestock and cropping
- Running beef cattle, merino sheep and first cross ewes for prime lamb production
- Cropping 1010 – 1200 hectares annually of canola, lupins, oats, wheat and barley, as well as grazing wheat and barley for ewes and lambs
- Irrigation – running two centre-pivots, sourcing water from a private irrigation scheme, with one centre pivot established during the 2018 drought.

What proportion of your land do you grow annual and perennial pastures, and has this changed over time?

In the last five years we have increased our pasture to around 30 percent between both properties and could potentially increase this further.

However, you also have to work in with your crop rotations. So, if you are pulling a paddock out of grain production to put pasture in, you have to balance how much grain you're producing with the quantity of mouths (livestock) you have to feed.

Which pasture species do you grow and why?

We grow lucerne SARDI 7s2 and SARDI Grazer, with Mintaro and Monti sub clovers. The SARDI 7s2 and SARDI Grazer are both winter active lucerne cultivars that seem to complement each other well, as the SARDI Grazer has a higher grazing tolerance due to its lower crown. Mintaro is a mid-maturing Brachycalycinum sub clover cultivar and Monti is an early-mid-maturing Yanninicum sub clover.

For the demonstration paddock that was established during May 2023, we sowed the SARDI 7s2 at 5 kg/ha with 3 kg/ha of Mintaro and 3 kg/ha Monti. To compare a different sowing rate and the SARDI Grazer, we sowed a strip with a higher SARDI 7s2 seeding rate at 9 kg/ha with the same quantity of clover, and a second strip containing a combination of SARDI 7s2 and SARDI Grazer at a total of 5 kg/ha with the same quantity of clover, in the middle of the paddock.

Lucerne works well during spring and summer, while it is less active in winter, which is when the clovers bridge the gap by providing good feed during the winter months. Providing a year-round feed supply is important, but of course the quantity depends on the weather conditions during the season.

Why do you consider perennial pastures an important part of your system?

Perennials allow us to have more feed over the summer months, when there isn't much other feed around.

Getting our management strategies in place and establishing an increased number of high-quality grazing paddocks, like at our demonstration site, will hopefully boost our production by allowing us to increase our stocking rate.

As a legume, lucerne is capable of fixing nitrogen. It can therefore increase nitrogen in the soil profile, which can be drawn on for a few years after the paddock is rotated back into cereal crop production. Down the track, we should see the nitrogen benefits of having the lucerne stand, which has the potential to boost cereal crop yields, without relying too much on synthetic nitrogen fertilisers.

Describe the way you manage pastures throughout the year and over various seasonal conditions.

We rotationally graze our perennial pasture paddocks throughout the year, ensuring they are not overgrazed.

When establishing a new pasture, it's very important to allow perennials time to take off in the first year and establish an extensive root system before being grazed too heavily. It's also really important not to graze it down too close to the crown; this can kill the plants and reduce the density of the lucerne. We want a lucerne sward to last at least five years, and if we manage it well, we can help it survive longer.

Our demonstration paddock, which was sown in May 2023, was first grazed in mid-January 2024, when we put 1200 sheep on the 58 hectare paddock for a week. The lucerne handled it well, as we grazed the more fibrous stems to just above the crowns, ensuring there was a good amount of stem and leaf remaining for strong future growth.

Adding in a straw (feed) component when lambs are grazing lucerne helps their stomachs and helps prevent bloat, so having that roughage is important when grazing lucerne and clovers. We've also found lucerne has a higher nutritional value than grazing wheat and grazing canola.

Do the pastures in your system increase your farm's overall drought resilience, and if so, how?

Yes. Having an established perennial crop helps maintain ground cover throughout the year, which helps reduce soil erosion. When we do strike those drought years, it also gives us more of an opportunity to be prepared for it, not only for erosion control, but for feed supply as well.

The plan for later in the year is to reduce the grazing to get a good cut of hay off the paddock and store it for drier times.

What were your key learnings from hosting the demonstration site on your farm?

The demonstration site provided us the opportunity to see the difference in sowing rates and cultivar selection on our own soil types and see how it fits in our operation.

The plan for the next five years is to put more pasture in, to support the higher stocking rates we aim to achieve.

The two different strips within the paddock allowed us to visualise what we can do differently, and what works and what doesn't. We've seen that if we increase our sowing rate and add the more grazing tolerant lucerne, we're able to grow more feed. It will be good to see what happens when we graze it further and how it comes back during the next couple of months.

JOHN AND SARAH BRUCE

Barooga, NSW.

Describe your farming enterprise.

- Approximately 1200 ha
- Mixed farming enterprise
- Winter cropping rotation includes wheat, canola, and barley
- Summer cropping rotation includes rice and corn
- Producing first cross lambs from Merino ewes and Border Leicester rams, lambing in April-May.

What proportion of your land do you grow annual and perennial pastures, and has this changed over time?

We've always had around half of our land sown to pasture, and about 50 percent of our winter canola and wheat crops are grazing crops.

Which pasture species do you grow and why?

We've been growing lucerne forever. I've been farming for 20 years and I've tried chicory and everything, but as far as sheep tucker goes, you can't really beat it.

For the last four to five years, we've been growing the L70 lucerne cultivar as it's one of the hardier varieties and it is relatively cheap. For the two 10 ha demonstration paddocks which we established in May 2023, we sowed 9 kg/ha of L70 lucerne with 6 kg/ha of Zulumax arrowleaf clover. This was later than usual given the wet start to the year. Adding arrowleaf clover helps bulk the feed, as it produces good quality and quantity feed through spring and into summer, typically allowing us to first graze it in August.

Why do you consider perennial pastures an important part of your system?

Having grown lucerne for the past 20 years, I've found the deep-rooted nature of lucerne allows it to have good longevity, even through a drought.

A key part of why I like perennials is that they're relatively easy to manage. Having sown lucerne into the dryland paddocks, we won't need to resow anything in there for five to six years if we look after it well. I don't like to come in with a tyne machine to over-sow into a pasture, as I've found it causes too much damage. You're better off looking after it well from the beginning.

Describe the way you manage stock on your pastures throughout the year.

We have lucerne both under a centre pivot and in dryland paddocks. We have split the 40 hectare irrigated paddock into four smaller paddocks using a two-strand electric fence running east-west and a permanent fence running north-south, to allow for well-managed rotational grazing and to use them as lambing paddocks. We typically will have 500 ewes split evenly across the four paddocks under the irrigator.

In the dryland paddocks, we keep the numbers relatively low, with around seven to eight head per hectare, rotating them across the paddocks based on feed availability and to ensure the pasture isn't grazed too hard. By keeping the sheep off the paddocks when it's been dry, like during the 2024 autumn, we've been able to see it pick up well after rain. When we have quite mild autumns and good rain, like we have in the previous four years, the lucerne has grown well, providing good feed for pregnant and lactating ewes. Once we mark the lambs, they are then shifted onto the grazing crops.

Describe the way you manage your pastures agronomically.

We sow most of our lucerne with an air seeder with 25.4cm spacings at 8-10 kg/ha in the dryland paddocks. For the irrigated paddocks, we'll speed-till the soil then sow it with a spreader due to the targeted heavier sowing rate (20-25 kg/ha), which we use because much higher plant densities can persist with greater soil moisture under irrigation.

We've found that some of our best lucerne establishment results come when we sow it after a barley or wheat crop, and by sowing it on its own and during early April, not August. It's generally the first thing we sow, and we typically add 200 kg/ha single super and 80-100 kg/ha potash. We cut lucerne hay off the irrigated paddocks, and if we have a good spring, we'll cut a bit of hay off the dryland paddocks as well.

We do manage the dryland and irrigated lucerne quite differently, because the irrigated is a lot more intensive and we are pulling a lot more off it. In the dryland paddocks, we don't generally do too much spray topping. We instead try to counteract that with fertiliser, keeping it clean, so if we want to make hay, it's good-quality hay.

The Bruce family, Barooga.

Do the pastures in your system increase your farm's overall drought resilience, and if so, how?

Given the lucerne grows well over summer, we use the lucerne paddocks to set ourselves up well for lambing in April-May. Having a good quantity of high-quality fresh feed is valuable over the summer as it saves us from trail feeding in a good season.

In 2018-19 when it was quite dry, we established a containment feeding area to enable us to get stock off the paddocks to prevent the pastures from being over grazed. Back in the millennial drought we were grazing the country pretty hard, but since having a containment area, we've found we can better support the lucerne after 10-15mm of rain, by keeping the stock off it initially, which helps it get going. If we were to graze it straight away, we'd be forcing it to continue drawing energy reserves from its roots, which can reduce plant density over time. Once receiving a bit of moisture, lucerne can provide a good feed source relatively quickly, compared to an annual which would need sowing, then time to establish.

Having the grazing crops also allows us to give our pastures a rest. We can mark the lambs, then put them onto the grazing crops. Depending on what the weather does, for example if it's still looking dry and the grazing area has been eaten, we can wean early and feed the ewes into the containment area to get them off the pastures. This way we can keep the ground cover in the paddocks.

ACKNOWLEDGEMENTS

This project was funded by the Australian Government's Future Drought Fund Drought Resilient Soils and Landscapes Grants Program, secured by Southern NSW Drought Resilience Adoption and Innovation Hub (SNSW Innovation Hub).

The project, which ran from 2022 – 2024, was led by Holbrook Landcare Network. Project partners included Central West Farming Systems, Monaro Farming Systems, Riverine Plains, FarmLink, Local Land Services, New South Wales Department of Primary Industries, Charles Sturt University and the Southern NSW Innovation Hub.

This case study, which was first published in June 2024 by Riverine Plains, is one in a series developed through the *Creating landscape-scale change through drought resilient pastures* project.

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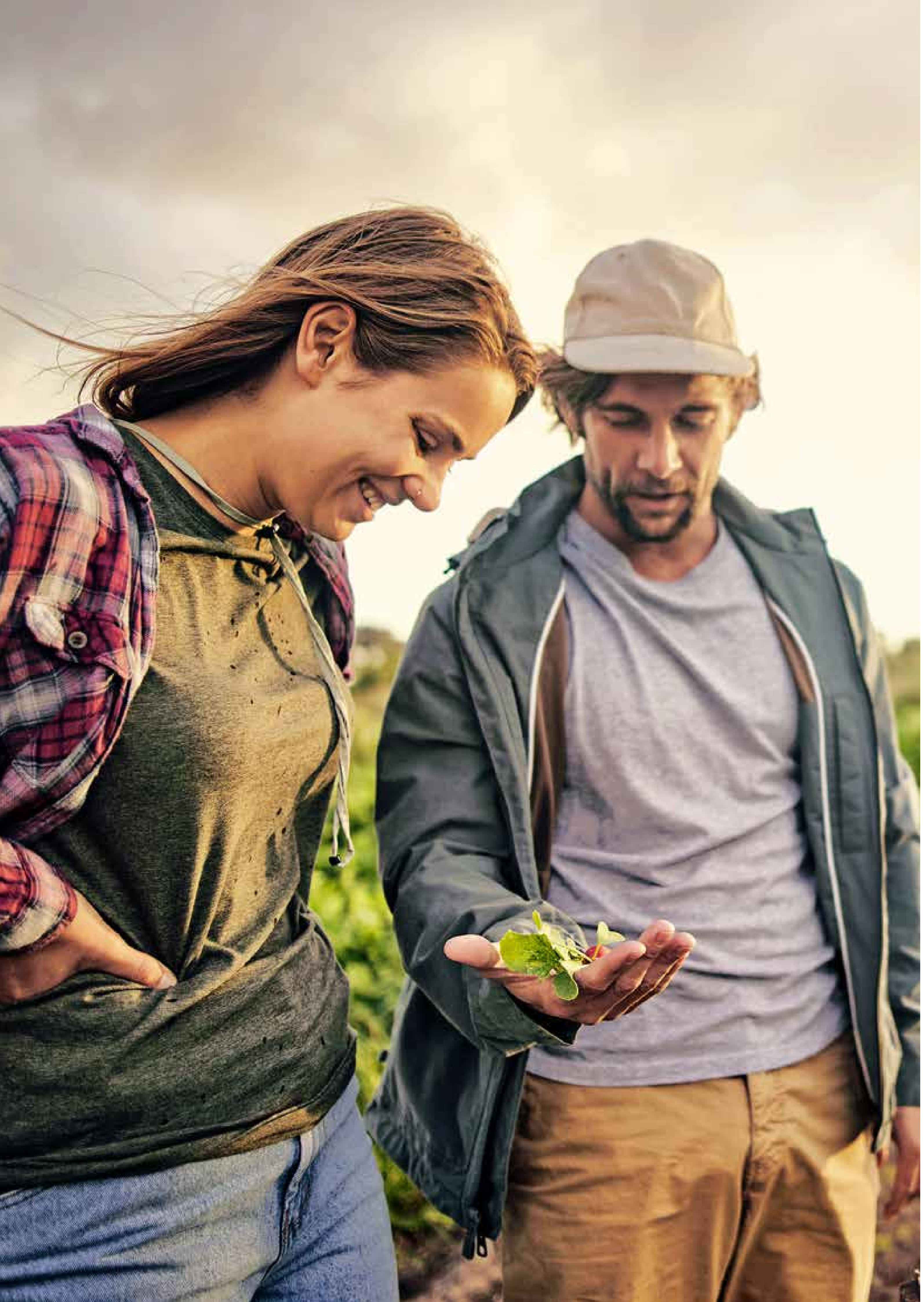


Commonwealth Bank

AGTECH AT THE FOREFRONT OF CEREAL BREEDING PROGRAMS

According to Tress Walmsley, CEO of InterGrain, a long time CommBank customer, when people think of agtech, plant breeding isn't generally top of mind. But as one of the leaders in cereal breeding in Australia, this WA company is at the cutting edge of integrating agtech throughout their entire breeding process.

"Cereal breeding programs generally take around 10 years to finalise. It's a lengthy process with many steps, from development in our glasshouses, to field and quality testing and grower trials. We're always looking to hit three targets with a successful breed: improved yield, good agronomics including drought tolerance and disease, and third, ultimately the cereal grain, has to deliver a good end product," Tress says.

"To ensure the quality and viability of the end product, we use technology to our advantage. Wheat is five times more genetically complex than a human, as it is made up of significantly more genes, but only recently have we been able to gain a better understanding of its genotypic and phenotypic data. The adoption of agtech tools such as genotyping, drones, or thermal imagery to detect plant stress, have all dramatically increased our ability to assess different gene impacts. It means our processes are rich with data and insights, and this has been a gamechanger for our breeding programs."

She adds that collaboration with other leading agribusinesses, such as seed design companies, tertiary partners or government-led organisations means they can target what their research should be addressing.

"We want to continue to be at the forefront of cereal breeding, whether that be gene editing, biometrics or other new breeding technologies, collaborating throughout the entire process ensures we're connecting with the growers and delivering varieties that are tailor made for them and their regions.

"Financial partners, like CommBank, are critical for us to keep our programs running, too. We've been working with them for nearly 15 years and have had an outstanding relationship from the get-go thanks to their expert, tailored advice and support. The structure of our business means our revenue comes in ebbs and flows, but the bank has been able to accommodate this and support us no matter what position where in. The opportunities the bank has been able to provide us with networking, connecting and collaborating with our industry peers has also been extremely valuable," Tress says.

PRECINCT DELIVERS COLLABORATION OPPORTUNITIES ACROSS SUPPLY CHAIN

Western Australia's premier location for agri-food innovation, Food Innovation Precinct Western Australia (FIPWA), opened in 2023, and General Manager, Dr. Chris Vas, says the precinct has big goals to help build a robust and vibrant food and beverage manufacturing sector out of the west.

"FIPWA was developed with a clear goal in mind, to help drive business growth, develop new products and exports, and transform Western Australia's food and beverage manufacturing industry. Our three key pillars of innovation, collaboration and production, each play an equally important role in fostering a successful agribusiness sector" Chris says.

"We want the precinct to be seen as the one stop place for producers, or those in the agri supply chain, to workshop and stress test their ideas to see where they could go. From R&D, to manufacture, as well as business services, it's all here for them to access."

With FIPWA in its first year of official operation, during which time it received the National Economic Development award for Partnerships and Collaboration, Chris says that a key part in its success is connecting and collaborating with the supply chain of agrifood production.

"Getting producers and industry groups involved has been quite critical. We've been working with grower groups and individual farmers to help identify where their pressure points are, or what opportunities they would like to see us explore. They then use this insight to identify new technologies and drive productivity at the farm level.

"Some standouts we've seen come through the precinct include an indoor vertical farm pioneering the growth of speciality crops and an indigenous brewing company that has produced its first export shipment to South America from the doors of the precinct. We're hoping with evokeAG putting a focus on industry in the west, we'll see even more interest in the precinct from both domestic and international businesses," Chris says.

Agtech adoption and development of new technologies are critical to Australia's agricultural sustainability, profitability and resilience. CommBank is committed to collaborating with leading agribusinesses to better understand the products and services the sector needs to keep moving forward.

This includes the announcement of our pilot with emissions platform Ruminati to support farmers measure emissions and model abatement options. The Ruminati pilot follows our investment in agtech integrator Pairtree Intelligence, which aims to reduce complexity for farmers by providing seamless integrations with 100+ leading agtech companies.

OPTIMISING OP CANOLA AGRONOMY

AUSTRALIAN GRAIN TECHNOLOGIES (AGT)

KEY FINDINGS

- **Open-pollinated (OP) canola varieties can provide a lower risk and more profitable option over hybrid varieties for growers in the medium and lower rainfall zones**
- **Sowing OP varieties at a higher seeding rate and with larger seed improves grain yields**
- **Grain yields are also higher when using treated seed compared to untreated seed.**

INTRODUCTION

The costs and risks associated with hybrid canola are substantially different from OP canola. Whilst sub-optimal seeding rates are often used with hybrid canola to reduce upfront cost and risk, the same compromises do not need to be made when growing an OP canola.

Given the average canola yield in Australia is about 1.5t/ha, there is a large portion of the country where OPs play an important role for growers.

In 2021, a dedicated experiment was conducted across 11 locations in Western Australia, South Australia, Victoria and southern New South Wales. Grain oil was recorded in six of those environments. The variety gross margin ([grain yield x price x oil premium] – [seed cost x sowing rate] – [EPR rate x grain yield]) was calculated for each variety at each location to compare the profitability of AGT's varieties Bandit TT[P] and Renegade TT[P] to the most widely adopted hybrid triazine tolerant (TT) varieties.

The effect of seed size (>2mm vs between 1.5mm and 2mm), seed treatment (+/- Fluqinconazole 167g/L, Imidacloprid 600g/L) and seeding rate (2.5, 3.5, 4.5 and 5.5kg/ha) were also examined in relation to the grain yields of the varieties sown.

TREATMENTS

VARIETIES

OP Varieties - ATR Bonito[P], ATR Stingray[P], ATR Wahoo[P]

Hybrid varieties - HyTTec® Trophy, HyTTec® Trifecta, HyTTec® Trident

AGT OP Lines - Bandit TT[P], Renegade TT[P]

SEED SIZE

OP varieties = >2mm

Hybrid = commercial size

AGT OP lines = >1.5 mm and <2mm, >2.0 mm

SEED RATE

Hybrid

- 25, 35, 45, 65 plants/m^2
- 1.5, 2.5, 3.5, 4.5kg/ha

OP

- 35, 45, 65, 80 plants/m^2
- 2.5, 3.5, 4.5, 5.5kg/ha

SEED TREATMENT

Checks (Hybrid + OP) = Treated only (Fluquinconazole 167g/L & Imidacloprid 600g/L)

AGT lines = Untreated + treated (+/- Fluquinconazole 167g/L & Imidacloprid 600g/L)

LOCATIONS

11 sites throughout Western Australia, South Australia, Victoria and southern New South Wales.

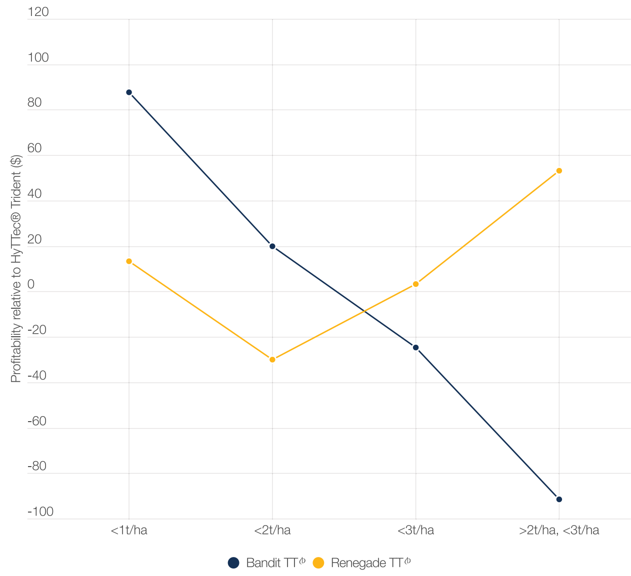
ASSUMPTIONS

For the economic comparison, the following assumptions have been made:

1. OP retained, sized (>2mm) and treated seed costs of $5/kg
2. Hybrid seed costs of $27/kg
3. OP varieties are sown at 4.5kg/ha (targeting 45 plants established/m^2) or 5.5kg/ha (targeting 55 plants established/m^2). Hybrids were sown at the generally recommended rate of 2.5kg/ha
4. A long-term average canola price of $550/t
5. Oil is priced according to the standard GTA specifications
6. End point royalty rate of $10/t for AGT varieties and $5/t for the HyTTec® hybrids

RESULTS

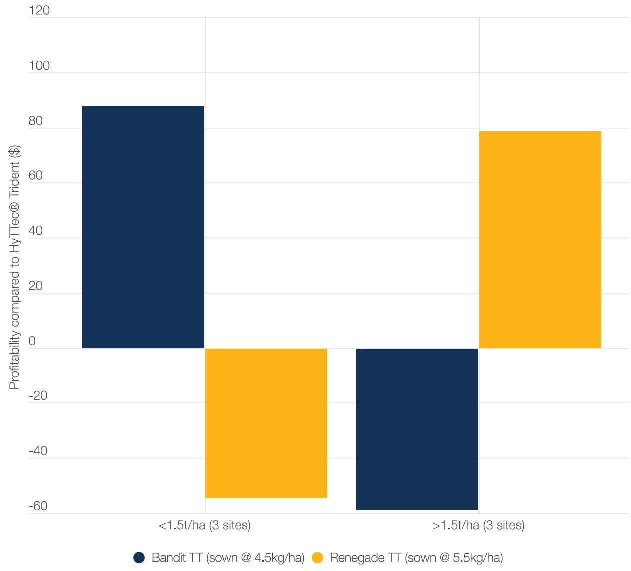
When profitability (excluding oil data) was compared across all 11 locations to the most widely grown TT hybrid, HyTTec® Trident, it is clear that at lower-yielding locations Bandit TT[P] was the more profitable choice, while at medium and higher-yielding locations Renegade TT[P] was the more profitable choice (Figure 1). Again, the wide adaptation of Renegade TT[P] can be seen here, where even in lower-yielding environments it is financially competitive with HyTTec® Trident.



Source: AGT canola trials 2021 (11 sites)

Figure 1 Profitability of Bandit TT and Renegade TT relative to HyTTec® Trident (grain yield only), AGT Canola trials 2021 (11 sites)

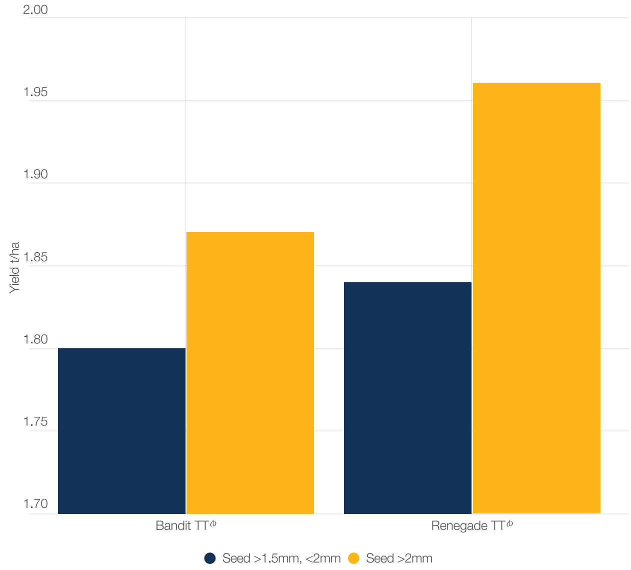
Oil data was recorded at a subset (six) of these locations, however very similar conclusions are drawn when this dataset is examined (Figure 2). Here we can see that in environments yielding less than 1.5t/ha, Bandit TT[P]'s profitability (sown at 4.5kg/ha) was a staggering $88/ha higher than HyTTec®Trident. In environments yielding more than 1.5t/ha, Renegade TT[P] (sown at 5.5kg/ha) showed a profitability $79/ha higher than HyTTec® Trident. Even compared to the longer season hybrid HyTTec® Trophy, Renegade TT[P] was only $34/ha less profitable at locations yielding 1.5t/ha or higher.



Source: AGT canola trials 2021 (6 sites)

Figure 2 Profitability of Bandit TT and Renegade TT relative to HyTTec® Trident (grain yield and oil), AGT Canola trials 2021 (11 sites)

The grain yield benefit achieved by sieving seed and only planting seed greater than 2mm, as opposed to sowing seed between 1.5mm – 2mm was dramatic (Figure 3). Very small (0.05%), but consistent positive impacts on oil were also observed.



Source: AGT canola trials 2021 (11 sites)

Figure 3 Effect of seed size on grain yield of Bandit TT and Renegade TT, AGT canola trials during 2021 (11 sites)

Increasing the seeding rate for treated and sized (>2mm) seed of Bandit TT[P] was beneficial to grain yield, while for Renegade TT[P] the effect was less consistent, however higher seeding rates achieved higher yield than the lowest seeding rate (Figure 4).

The impact of seeding rate on oil content was minor and inconsistent (data not shown). A general rule of thumb seems to be that more seed is better.

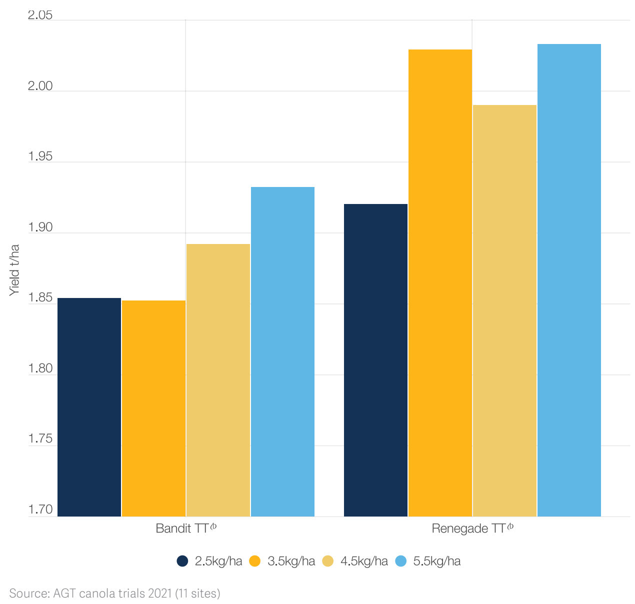


Figure 4 Effect of seeding rate on grain yield of Bandit TT and Renegade TT, AGT canola trials 2021 (11 sites)

Finally, applying a seed treatment showed a positive effect on grain yield for both varieties. Seed treatment did not show a consistent effect on grain oil (Figure 5).

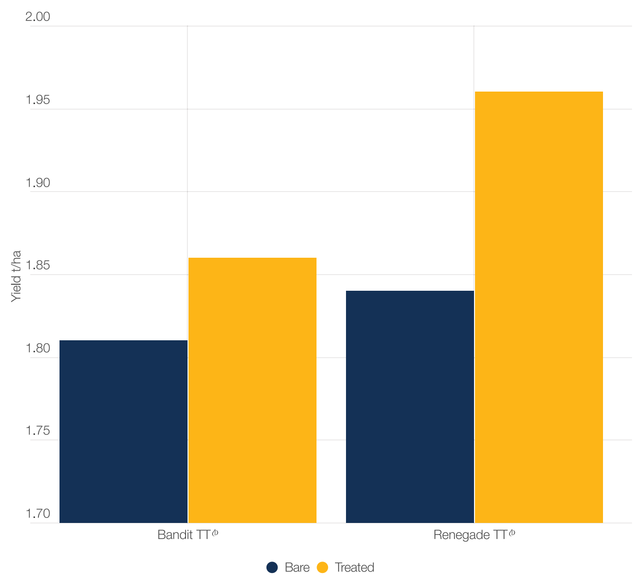


Figure 5 Effect of seed treatment on grain yield of Bandit TT and Renegade TT, AGT canola trials 2021 (11 sites)

SUMMARY

In general, better performance and financial gains were achieved from Bandit TT[P] and Renegade TT[P] when treated seed greater than 2mm was sown at a high seeding rate of 4.5 or 5.5kg/ha.

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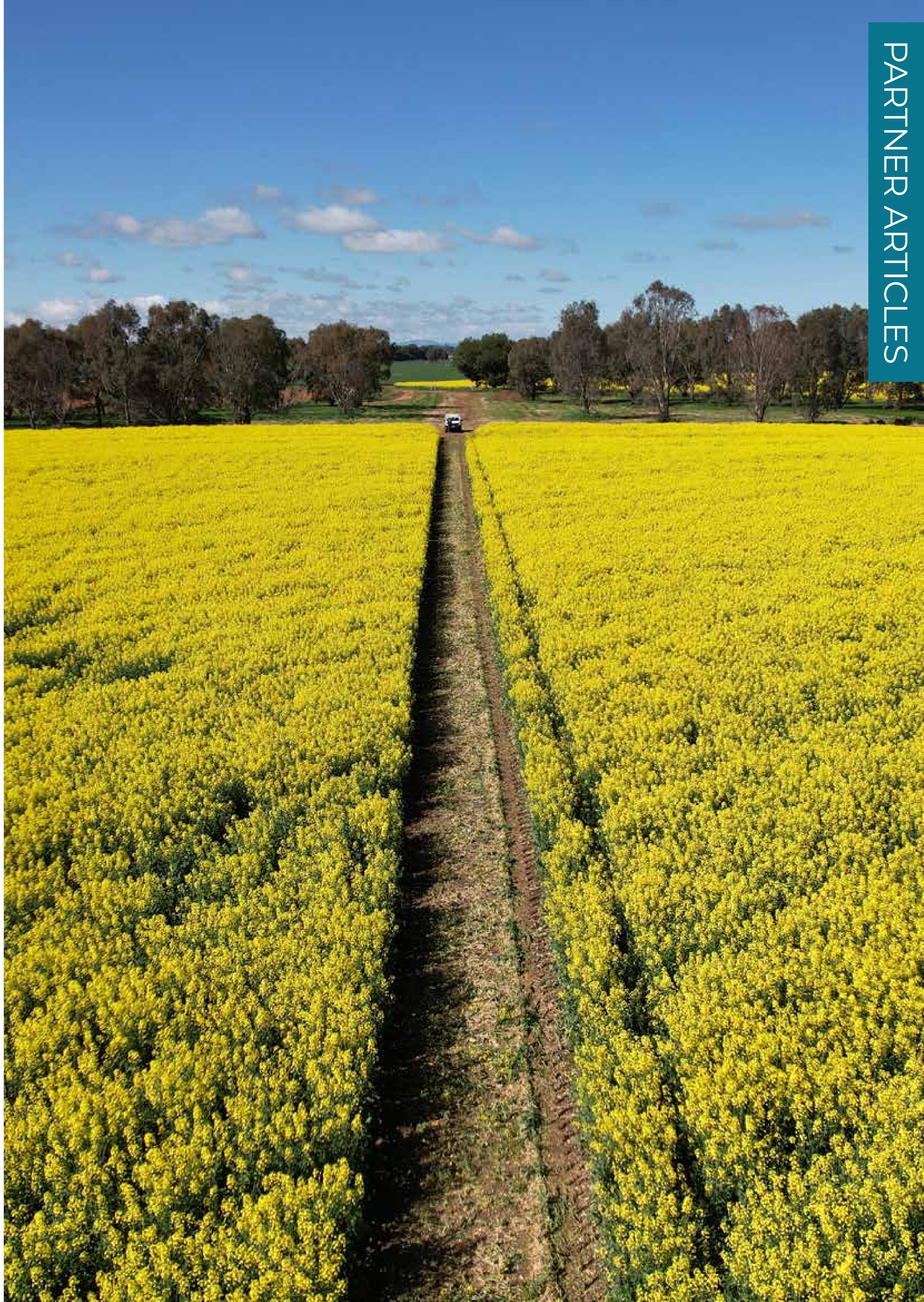


BAKER SEED CO 2023 TRIAL RESULTS

The 2023 season presented many challenges with a wet summer, followed by good autumn sowing conditions, then a very wet winter, and a dry September and early October.

However, this also made it a good season to test some of the new genetics coming through the breeding programs, with most living up to high expectations.

The Baker Seed Co trial program at Rutherglen again consisted of three times of sowing (TOS), TOS 1: 6 April, TOS 2: 28 April and TOS 3: 22 May and evaluated new wheat, barley and oat genetics.

The first time of sowing on 6 April was followed by a considerable rainfall event the following day and it's suspected that this damaged some of the seed, leading to poorer plant establishment and vigour.

Dry matter (DM) cuts for the grazed treatments in TOS1 were taken on 28 June. Wheat dry matter removal averaged 1.3 t DM/ha, while oats averaged 2.6 t DM/ha and barley averaged 2.7 t DM/ha. Due to the lack of vigour and the high variability in the dry matter results from TOS1, the decision was made to only conduct the one dry matter cut.

Results from the wheat, barley and oat variety trials are presented below.

WHEAT

New wheat genetics for the Anzac Day sowing window include Major, Leverage, Sundancer & Genie. These varieties offer choices for disease resistance, standability, acid and sodic soil tolerance, and have performed well in our trials and in seed production.

Wheat yield and protein results for an early April time of sowing (TOS) are shown in Figure 1, while results for a more traditional Anzac Day sowing are shown in Figure 2, and Figure 3 shows variety performance for a mid-to-late May sowing.

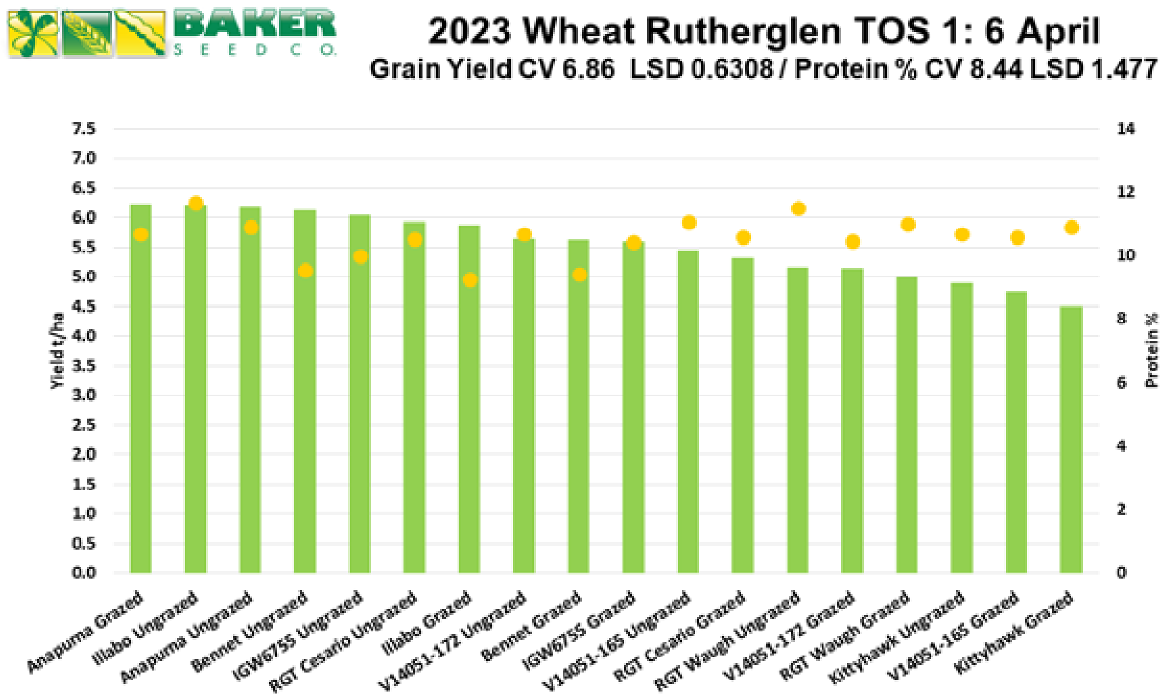


Figure 1 Baker Seed Co wheat yield and protein results for TOS 1, sown 6 April, 2023.

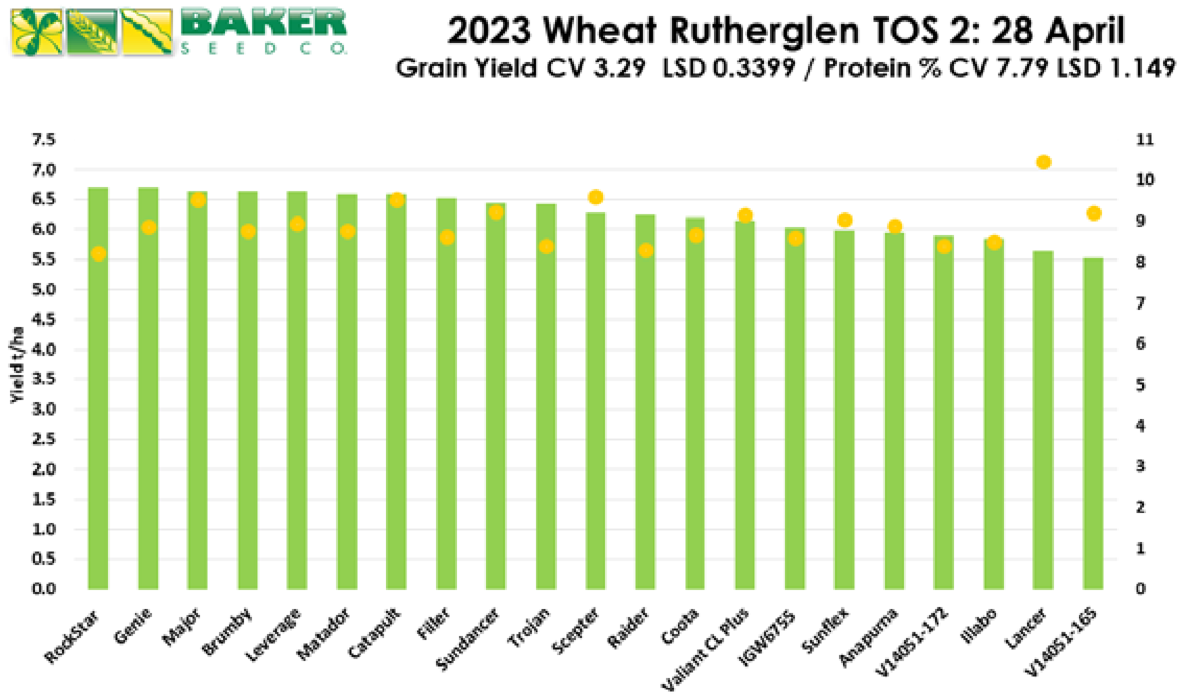


Figure 2 Baker Seed Co wheat yield and protein results for TOS 2, sown 28 April, 2023.

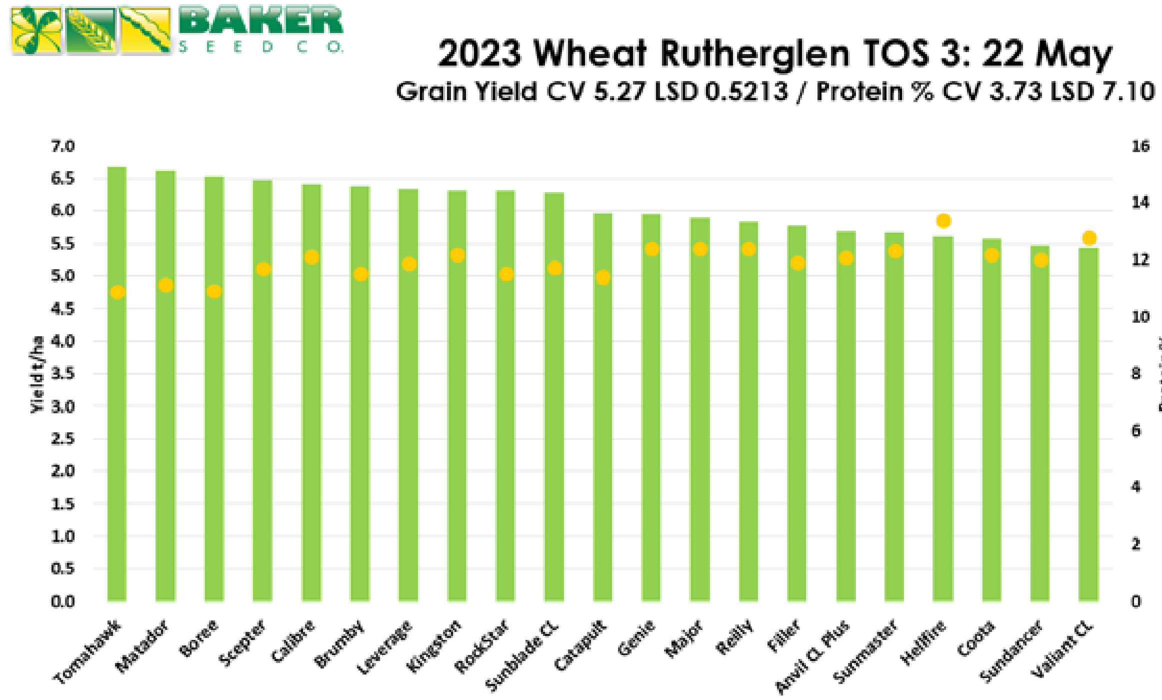


Figure 3 Baker Seed Co wheat yield and protein results for TOS 3, sown 22 May 2023.

For the first time in a long time, wheat yield results from time of sowing 1, were lower than from time of sowing 2 and 3, albeit not by much. This was likely the result of poor establishment following the unexpectedly large rainfall event post-sowing. In these trials, the earlier sowing has historically provided a 1-1.5t/ha advantage over the later sown wheats, highlighting the benefits of early sowing that occurs in many farm programs by extending resources and ensuring main season varieties are planted early to maximise potential.

BARLEY

Barley performed well, though it was harvested at the same time as the wheat, probably three weeks later than desired. Neo CL lived up to expectations and Planet showed why it has been so widely adopted in the mid-to-high rainfall environments. Results are presented in Figures 4, 5 and 6.

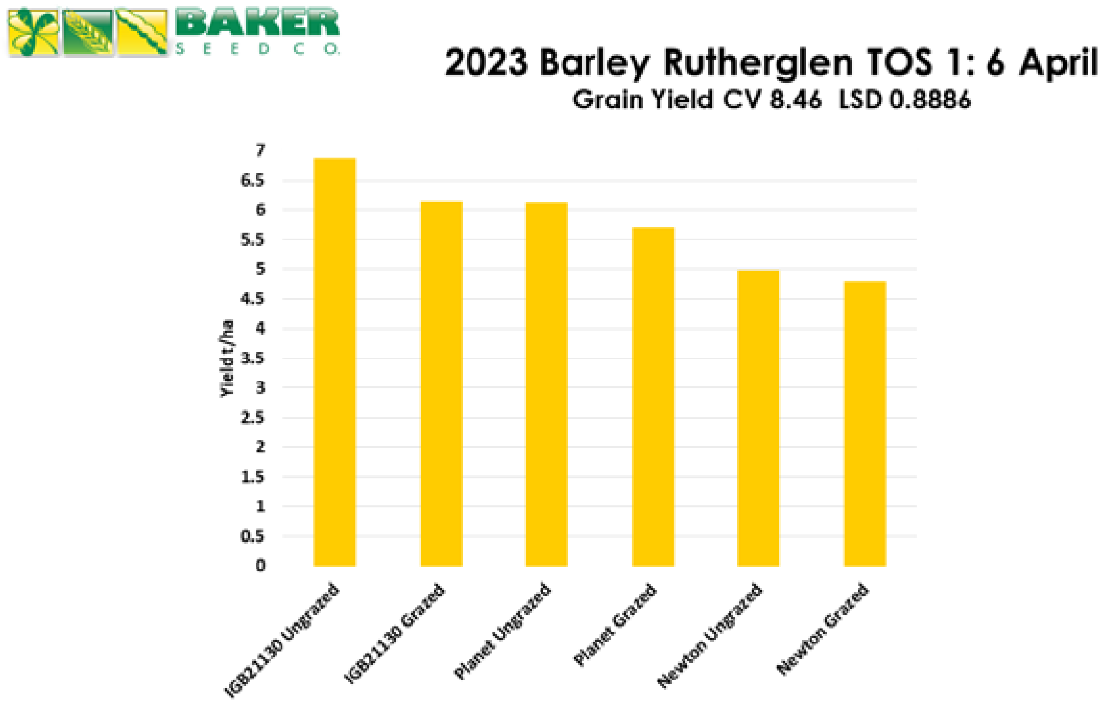


Figure 4 Baker Seed Co barley yield results for TOS 1, sown 6 April, 2023.

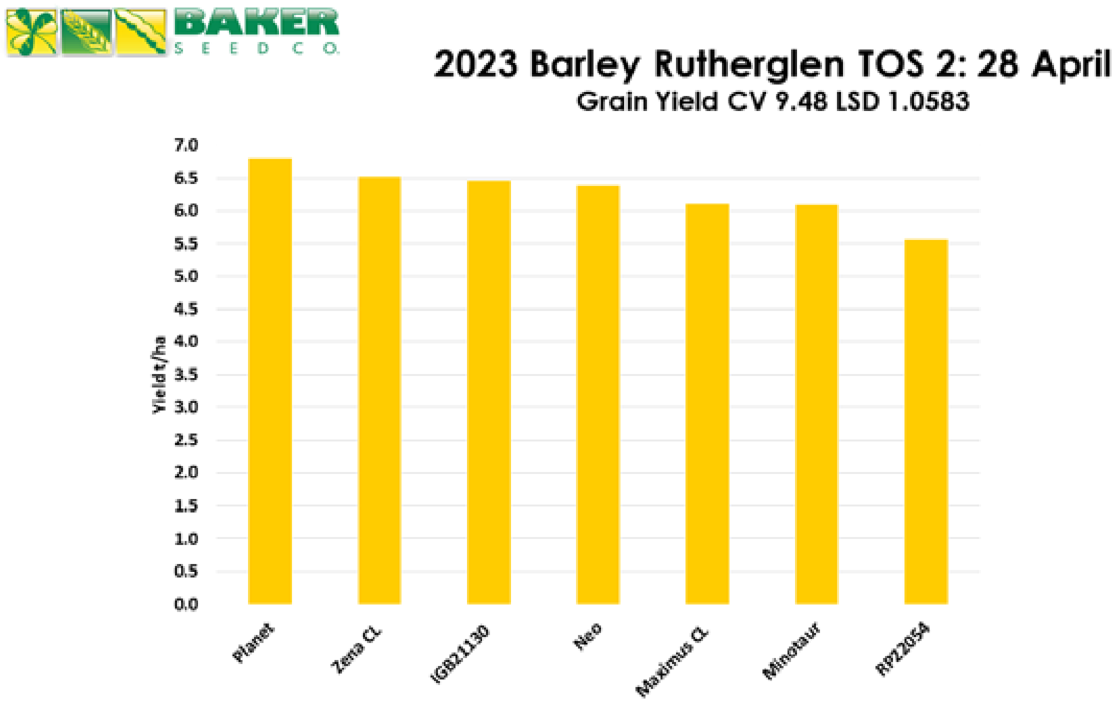


Figure 5 Baker Seed Co barley yield results for TOS 2, sown 28 April, 2023.

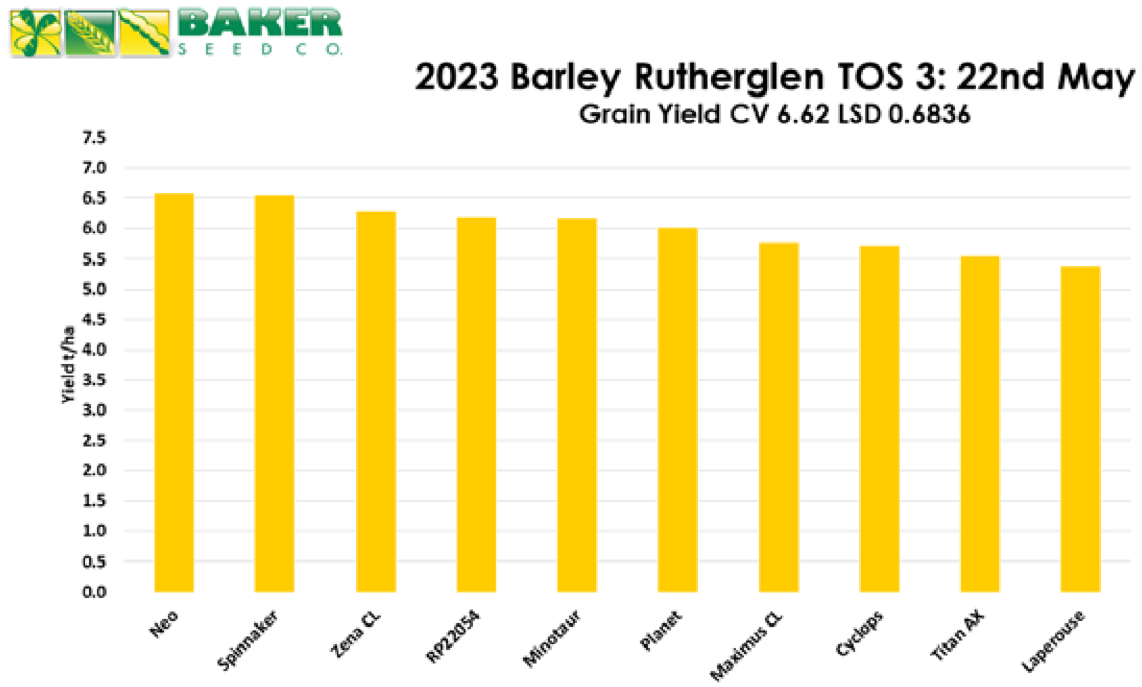


Figure 6 Baker Seed Co barley yield for TOS 3, sown 22 May, 2023.

OATS

The new milling oat Goldie yielded over 7mt/ha in our trials (Figure 7), making oats the highest yielding species. The three varieties at the top of the oat yield chart – Goldie, Koala and Archer – are all new releases from the last 12 months, which is great news for oat growers.

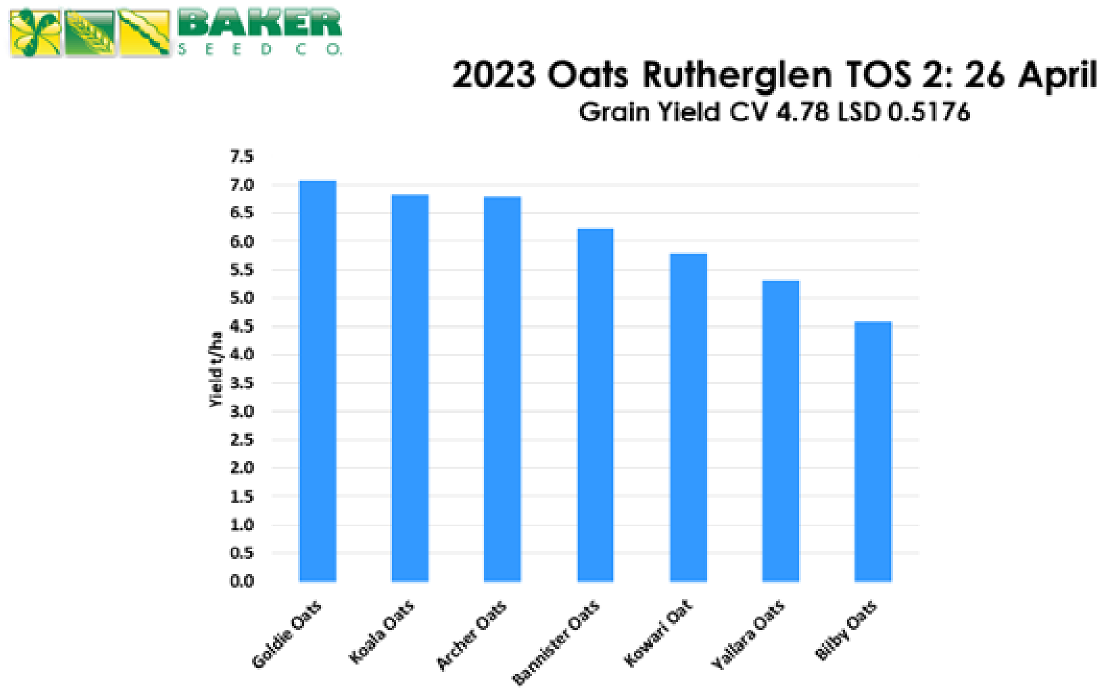


Figure 7 Baker Seed Co Oat yield results for TOS 2 sown 26 April, 2023.

These and additional results can also be accessed by scanning the QR code below. For more information, visit **bakerseedco.com.au** or contact Aaron Giason on 0400 232 703.

UTRISHA N BIOSTIMULANT FROM CORTEVA AGRISCIENCE

WHAT IS IT?

Utrisha® N is a new biostimulant from Corteva Agriscience. It contains Methylobacterium symbioticum, a unique bacterium that can fix atmospheric nitrogen (N) in the green top growth of plants, to supplement nitrogen nutrition for crops or pastures.

HOW AND WHEN SHOULD IT BE APPLIED?

Utrisha N comes as a wettable powder formulation, which is mixed with water and applied at the low rate of 333g/ha. Once sprayed onto the leaves, the bacteria enter the plant through the stomates. Application when stomates are mostly open is the ideal time to spray. Morning is likely to be best, when temperatures are cooler and humidity is higher.

WHERE AND WHEN CAN IT BE USED?

Utrisha N is approved for use in a wide range of crops and pastures such as wheat, canola, legumes and grass pastures. It needs to be applied prior to the period of peak nitrogen demand in crops or pastures i.e. mid tillering in wheat, so that it supplements the soil applied nitrogen as the crop moves to the noding stage.

RESULTS

Utrisha N has been available in other countries around the world for up to five years. In Australia, work began two years ago to test whether it would work in our conditions.

LENTILS

A replicated small-plot lentil trial (using cv. Highland XT) was sown at Elmore, Victoria, on 31 May, 2023. Plots received MAP at 50, 75 and 100kg/ha at sowing, plus or minus Utrisha N at 333g/ha. Lentils were then checked periodically for crop effect, greening, biomass and yield at the season end.

Figures 1 and 2 show the Normalised difference vegetation index (NDVI) scores mid-season and the yield at normal harvest time. Plots showed improved greening and higher yield of 250-300kg/ha (NS, p=0.1), where Utrisha N was added to MAP.

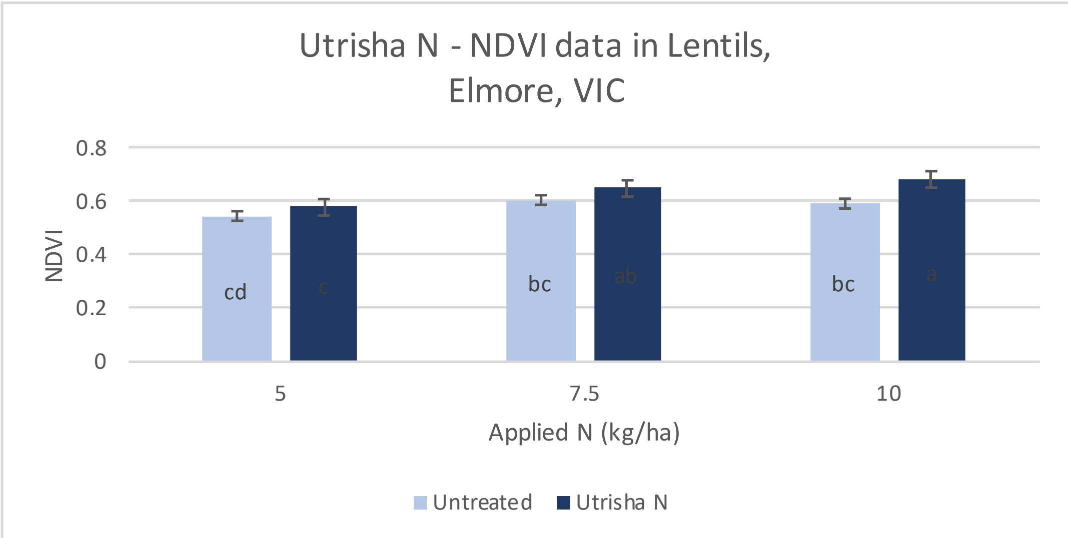


Figure 1. MAP +/- Utrisha N, NDVI scores, lentil, Elmore, Victoria

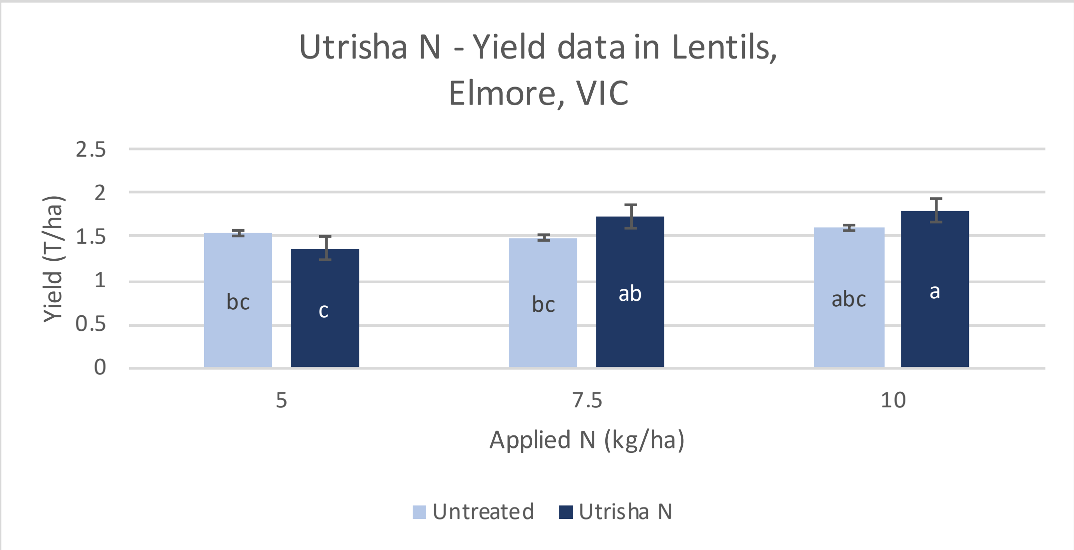


Figure 2. MAP +/- Utrisha N, lentil yield (t/ha), Elmore, Victoria.

RYEGRASS TRIAL

In 2022, a replicated small-plot trial was conducted at Breeza, NSW. Ryegrass (cv. Ascend) was planted on 24 June, 2022. A planting nitrogen treatment of 75kg Starter Z, which supplied 8kg N/ha, was applied at sowing.

Urea at either 100 or 150kg/ha +/- Utrisha N was applied post-emergence on 29 August 2022. Plots were checked for greening, biomass and dry matter (DM) yield in the spring. Figure 3 shows the dry matter yield two months after treatment with Utrisha N. It showed (numerically) improved DM yield where Utrisha N was added to the low nitrogen rate, of about 1t/ha.

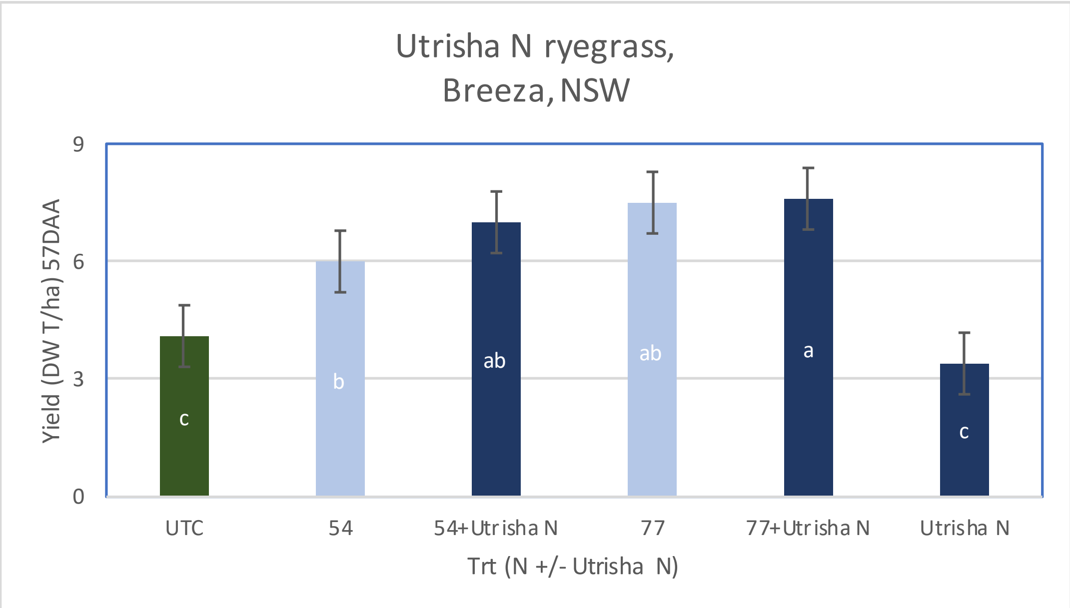


Figure 3. Urea +/- Utrisha N, Ryegrass dry matter per hectare, Breeza, NSW.

Contact: To find out more about Utrisha® N visit www.utrisha-n.com.au or use the QR code.

OUTSTANDING SOIL CARBON GAINS SHEPPARTON, VIC

Luke Felmingham is an innovative cropper and hay contractor North of Shepparton, VIC. Between Luke and his father Ken they crop 640 hectares with 185 hectares under irrigation (mixture of flood and center pivot). With a crop rotation of Canola, Lucerne, Wheat, Tef Grass, Rye Grass, and Clover, the annual rainfall is 468 mm, and the majority of the soil is shallow loam topsoil overlying clay dominant subsoil.

In May 2022 Luke & Ken both registered soil carbon projects with the Australian Government's Emissions Reduction Fund (ERF) (Now known as The Australian Carbon Credit Unit (ACCU) Scheme. Luke and Ken chose to use the support of the LawrieCo/ AgriProve partnership in having their Carbon projects established, as they were able to provide end to end support; soil carbon building products and advice and a low-risk / low-cost model.

Soil Carbon "Baseline" tests were taken in July 2022, measuring the starting soil carbon stocks down to 1 metre. 12 months later, satellite data indicated that soil carbon levels had grown, so again a soil testing rig was deployed (24/7/23) to perform a second round of tests.

Soil carbon gains were outstanding on Luke's property equating to around 0.25% in the top 30cm. On average 12.7 tonne/ha of carbon was built at Luke's property and 0.8 tonne/ha at his father Ken's.

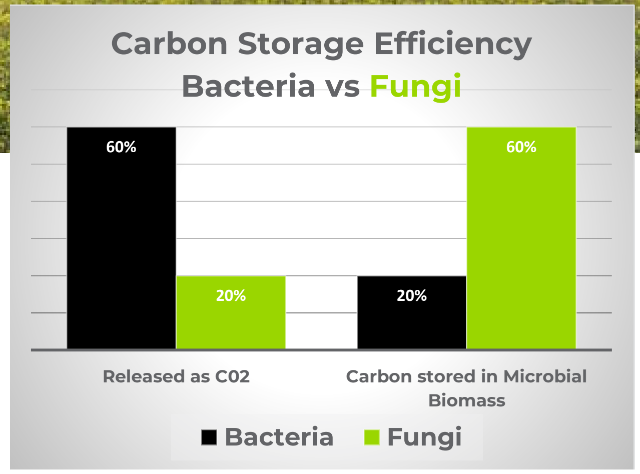
To ratify the significant increase a further round of soil testing was undertaken (in August 2023), the carbon test data confirmed the initial findings. In order to secure Australian Carbon Credits a property and testing audit is now in process.

Luke and Ken will have the choice to hold the Carbon Credits awarded to them, or trade them at the current spot market price, holding and selling them later or in future "retiring" them to offset other farm emissions for carbon neutral status of their farm produce. Either way, the benefits of soil carbon gains will be of benefit to their overall farm productivity with the boost to soil health and moisture holding capacity growing their natural asset value of the farm.

The different management practices deployed on Luke and Ken's property provide a most interesting case study of what can be done to build soil carbon. As mentioned earlier, LawrieCo supported Luke and Ken in adopting the soil carbon projects. However, unlike most other soil carbon project providers, LawrieCo also actively supports growers with carbon building fertiliser products, training and advice. LawrieCo have a long history of building soil carbon and have developed / tested and brought to market fertiliser products designed for maximising farm productivity whilst building soil carbon.

On Luke's property he adopted 5 main changes to his farm practice:

1. The biggest and newest step on Luke's property was the decision to DIGEST his stubble. There was a significant amount of stubble following his wheat crop of 5 – 6 T/ ha. Normal practice was to burn stubble, as practically next crops could not be sown into this amount of stubble, due to machinery blockages. Luke lightly tilled his stubble with a speed disc and applied with boom spray on stubble two products DIGEST READY, a live biological ferment of cellulous digesting fungi, and KICKER, a powerful fungi stimulant and food source to break down the remaining stubble in the paddock. Fungi are much more efficient converters of carbon than bacteria.



2. The traditional Ag-chem summer program was buffered with the LawrieCo F75 FULVIC to reduce the impact on soil biology and tie up off target spray within the system.
3. Canola seed was treated with LawrieCo SureCrop PRIME – a powerful biostimulant and microbial seed dressing, in order to establish a strong network of plant roots and biology to maximise carbon draw down. This was sown with a new disc seeder, which was then able to travel easily through the digested stubble.
4. At sowing Humate Granules at 10kg/ha were included with 100 kg/ha of MAP. Humates stimulate beneficial soil fungi, buffer the use of synthetic fertilisers, act as a natural chelating agent due to a high CEC of approx. 450, and promote significant root growth which is key for both nutrient scavenging, increasing water uptake, and importantly building carbon.
5. Broadcast Nitrogen was supplemented with foliar applied application; a balanced Nitrogen, Calcium and Phosphorous product called LawrieCo GROWTH and a LawrieCo Biostimulants containing fish, kelp, amino acids and trace minerals, called BOOST. Used in conjunction with urea coated with LawrieCo ENHANCE; a fulvic / biostimulant based fertiliser coating designed to increase nutrient uptake and decrease leaching throughout the soil profile.

On Ken's property the approach was different, he maintained his existing fertiliser practices. Ken decided to simply trial a few products with the view to wait for the results on Luke's property. Ken used LawrieCo Boost as a soil bio stimulant, and LawrieCo F75 Fulvic with all chemical applications.

In adopting the carbon building strategies / products, Luke found that his perception of productivity was challenged, as he now found himself considering things such as the living soil microorganisms, naturally occurring plant hormones and stimulants. It really does demonstrate successful farmers are farming carbon with the development of microbial populations being the new "livestock."

Both farms' yields were either unaffected or enhanced by the carbon building systems and at or above district average. In regard to cost of the inputs Luke suggests he did invest a little more around $80/ ha but considering the long-term benefits of his soil carbon and health he is focused on being sustainable. Should Luke choose to trade his credits today, Luke's "carbon" would return him $1220 /ha. (Spot ACCU price of $35).

LawrieCo have supported the adoption of growers in over 250 soil carbon projects throughout Australia in the last 2 years. The AgriProve satellite monitoring has flagged other LawrieCo client projects as possible leads for carbon gains, so soil testing rigs are being deployed on these projects.

What is a carbon credit?

One carbon credit is equal to one tonne of carbon dioxide equivalent (CO_2e) sequestered or avoided by the project.

Carbon credits generated from ERF projects are called Australian Carbon Credit Units (ACCUs)

1 tonne Soil Carbon = 3.67 tonnes of CO2e

1 tonne Soil Carbon = 3.67 ACCUs

MANAGING N IN VARIABLE PADDOCKS: N BANK STRATEGIES

TAKE HOME MESSAGES

- **Variable rate applications of nitrogen (N) to a 125 kg N/ha N bank in 2023 resulted in equivalent or greater yields in comparison to a theoretically applied blanket application approach**
- **Applying the N Bank theory with the grid soil sampling technique resulted in relatively uniform yields across both demonstration paddocks in 2023, however longer term analysis is required to validate if this is an economical approach for applying this nitrogen management strategy**
- **Zone or grid-based sampling allowed for a better understanding of within-paddock variability and more targeted nitrogen inputs.**

BACKGROUND

Australian wheat yields are only half what they could be for the rainfall received. For other non-legume crops such as barley, canola, and oats, this is also likely to be true. Nitrogen deficiency is the single biggest factor contributing to this yield gap and alleviating nitrogen deficiency has the potential to increase national wheat yields by 40 per cent.

Nitrogen fertiliser is a costly input, and this combined with a lack of accurate seasonal rainfall forecasts at the decision-making time, means it can be difficult to match nitrogen supply to crop demand. As a result, growers tend to be conservative with their inputs. To simplify the approach, novel management strategies have been explored, including nitrogen banks (N banks). The N banking approach aims to maintain a base level of soil mineral nitrogen that is topped up each season to a target N bank level that is most appropriate for a given location, to achieve the water-limited yield potential in most seasons. This strategy has potential to manage nitrogen in crop production areas with low environmental losses, for example from leaching or denitrification.

This article reports on a project led by Birchip Cropping Group (BCG) investing variable rate nitrogen combined with nitrogen banking strategies. In 2022, two paddock-scale demonstration sites were established and maintained during 2023. The full report, Managing N in Variable Paddocks - Application of N Bank Strategies Part 2, can be found at bcg.org.au. This paper presents insights from a paddock at Warne, on a typical soil type and rotation for the southern Mallee region.

AIM

1. To look at strategies that quantify and optimise the use of sub-paddock level soil sampling and the application of variable rate (VR) technology for nutrient management to maximise productivity, while minimising the mining of key soil nutrients.
2. To further validate the N Bank nitrogen management strategy.

YEAR	2022	2023
Rainfall (Nov-Oct)	497 mm	290 mm
GSR (Apr-Oct)	384 mm	194 mm
Crop type	Canola (cv. 44Y94 CL)	Wheat (cv. Scepter)
Target N strategy	~170kg N/ha	125kg N/ha
N application timing	Sowing: 6kg N/ha June 9: 40 kg N/ha blanket June 24: VR N application	Sowing: 6kg N/ha June 1: 60kg N/ha blanket July 12: VR N application
Sowing date	19 April 2022	29 April 2023
Harvest date	24 November 2022	4 December 2023
Average yield	3.0 t/ha	4.4 t/ha

PADDOCK DETAILS

Table 1 Paddock details, Warne 2022-2023.

METHOD

The demonstration site was established near Warne in the southern Mallee, north west Victoria.

At the beginning of the 2022 season, grid soil sampling and EM38 mapping was undertaken to develop a baseline soil-map by Precision Agriculture. The paddock was divided into a 2ha grid with soil sampling undertaken in February 2022 and 2023 across the grid with 0-30 cm and 30-60 cm deep samples collected. Lab analyses were used to calculate the soil mineral nitrogen (nitrate and ammonium) in the soil profile, along with other soil characteristics.

The results from each year were then used to calculate the urea required to achieve a uniform N Bank across the paddock, with a target N bank of 125kg N. In 2022 the Warne site received starter fertiliser at sowing and a blanket application of 40kg of N/ha, so the N bank of the site had ~170kg N/ha. This was reset in 2023 to 125kg/ha.

RESULTS AND INTERPRETATION

Available Nitrogen

Grid soil sampling was used in this project to investigate the variability in soil mineral nitrogen, with 0-60cm soil mineral nitrogen varying significantly across the paddock and from year to year (Figure 1). In 2022, mineral nitrogen ranged from 76-207 kg/ha, while in 2023 it ranged from 39-69 kg/ha.

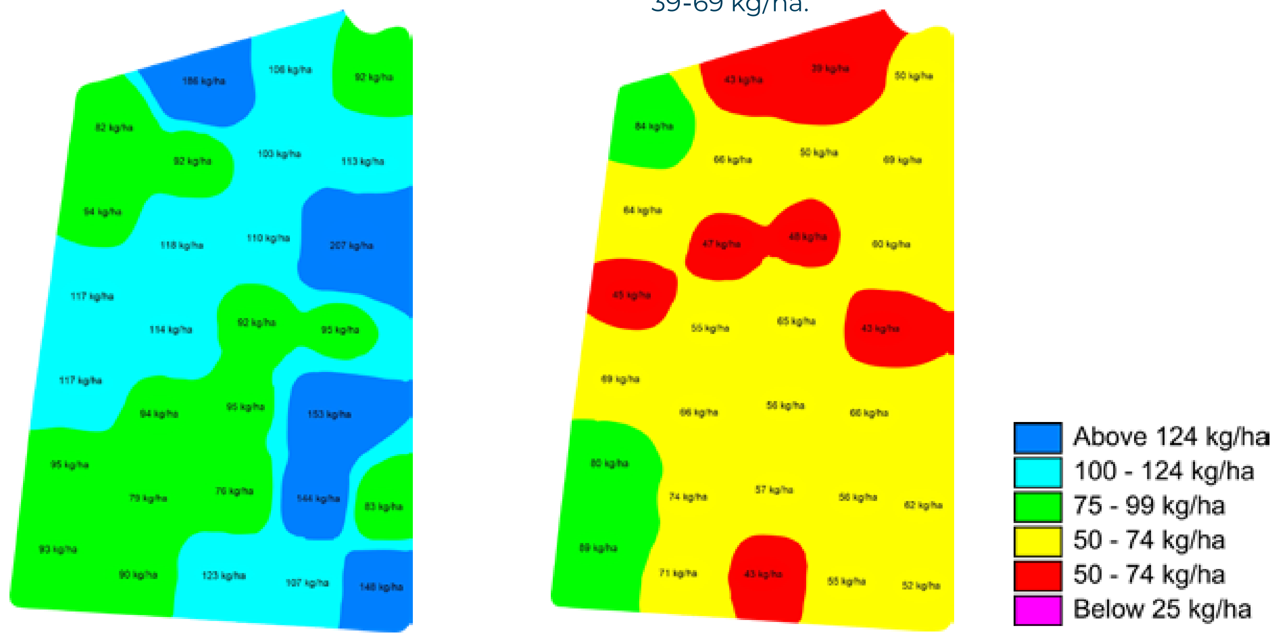


Figure 1 Grid sample map for soil mineral N (kg/ha) for 0-60cm at the Warne in 2022 and 2023.

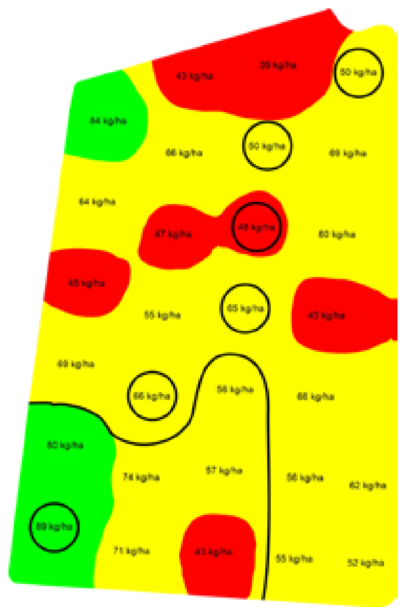


Figure 2 Grid sample map for soil mineral N 0-60cm at Warne, 2023 overlayed with the theoretical paddock transect (grids circles) and zones (delineated by the line in the SW corner).

Sampling technique comparison

The project investigated how sampling methodology may affect the pre-season measurement of soil mineral nitrogen. Grid-based results were used to estimate nitrogen measured using a traditional paddock transect or in two management zones developed from an EM38 survey. Mineral nitrogen varied slightly with each approach (Figure 2), with grid nitrogen being the lowest average at 59 kg/ha, while zone and paddock were 62 and 61 kg/ha. Nitrogen applied ranged from a blanket 62 kg/ha based on a hypothetical paddock average, to 66 kg/ha average using a zone (62-69 kg/ha) and grid (15-120 kg/ha) based approach.

OBSERVATIONS

This project highlighted the variability in soil nitrogen within a paddock and from year to year. Understanding this variability can increase the precision of nitrogen inputs, particularly when targeting an N bank strategy. While the differences between approaches (paddock/zone/grid) in this analysis seem small, particularly in terms of average paddock yields, it is important to note that the yield response was theoretical and assumes that nitrogen is the only driver of variability. The analysis was also conducted in the second year of the project when the within paddock measured variability in mineral nitrogen had decreased from 131 kg N/ha to 30 kg N/ha.

GRID VS. ZONE VS. PADDOCK – WHICH SOIL SAMPLING METHOD IS BEST?

In short, it depends. Knowledge is needed about a paddock's variability and the factors creating the soil and production variability before selecting a soil sampling method. If significant yield variation is observed, it is important to understand the factors driving this to develop an appropriate sampling strategy.

PADDOCK

Paddock scale is the traditional method of soil sampling and typically involves taking multiple cores either randomly or along a transect across a paddock. A composite sample is then sent off to a soil laboratory for analysis. If the same transect is used, this approach can provide some understanding of nitrogen over time. While this approach can be cost effective, it ignores the fact that soils are inherently variable, and inefficiencies are likely to occur when making fertiliser applications.

ZONE SAMPLING

Zones based on soil types (colour, texture and slope) can be defined using elevation and EM38 surveys, providing consistent zones year-on-year. Zones can also be developed based on production variability (e.g. high/low yielding or biomass); however these may vary year-on-year. Zones provide a more targeted strategy for measuring soil nitrogen and developing variable rate management strategies. While in paddock sampling and laboratory analysis costs are more expensive than the paddock scale approach, the results can be used with more confidence.

GRID SAMPLING

Grid soil sampling is considered the most accurate and robust method for determining spatial variability in soils and mapping the spatial variability present at the sub-paddock level. While grid sampling is a robust strategy for longer term inputs such as lime, gypsum, or capital phosphorus, it is not widely used for nitrogen management, which needs to occur more frequently, ideally annually. Grid sampling for nitrogen might have a place in highly variable paddocks, however the cost effectiveness of this practice needs to be evaluated. In paddocks with variable nitrogen, grid sampling could be a way to better target resources or ground truth management zones.

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