Grains Convo

Date: March 2024

Contents

Project targets traits for enhanced wheat yields, strengthening against frost

Project name

Determining the effect of wheat morphological and anatomical traits on frost susceptibility of wheat

GRDC Code

CSP2307-003RTX

Boosting wheat profits

In Australia, frost is a major threat to wheat crops, especially during spring.

Frost can harm the formation and development of grains, leading to lower yields and lower profits for farmers. Reducing sensitivity to frost is crucial to ensuring the viability of growing grain crops in regions that experience frost damage.

Even a small improvement, such as making wheat less sensitive to frost during flowering by one-degree Celsius, could bring an extra 360 million to wheat farmers every year.

This project, with support from the Grains Research and Development Corporation (GRDC) seeks to validate whether certain physical traits of wheat can help it withstand frost better.

For example, how the heads are protected, the presence or absence of awns, and some internal features which may play a role.

The results will establish whether the manipulation of these traits represents a feasible route that wheat breeders could take to improve crop yields in frost-prone cropping environments.

Australian wheat breeders set to benefit

Beginning in July of 2023 and concluding in December of 2026, researchers are set to get an understanding of how wheat traits impact frost sensitivity in both controlled environments and real fields.

This information will be shared with Australian wheat breeding companies.
While the main outcome, by 2028, is for wheat breeders in Australia to have tools to create wheat varieties that can better withstand frost.

Field experiments

The project involves several modules and activities over multiple years.

Module 1: Germplasm Selection

Over the first year of the project, the team will assess a panel of around 130 paired Near Isogenic Lines (NILs) developed by Greg Rebetzke and colleagues at CSIRO.

Then, wheat spikes from field grown plants will be assessed for non-invasive digital phenotyping of spikelet and grain mapping using the APPF CT scanner.

Module 2: Identification of Lines with Reduced Frost Sensitivity

Field experiments in different locations will be conducted over the next 3-years, to observe the performance of selected lines.

These experiments will be complemented by controlled environments screening, to validate field results.

DPIRD Research Scientist Dr Brenton Leske will manage the site at Dale in WA.

The other locations selected for field experiments include Mintaro in South Australia and Wagga Wagga in New South Wales.

Partners/Collaborators

GRDC
CSIRO
Charles Sturt University

South Australian Research and Development Institute (SARDI)
Analytics for the Australian Grains Industry (AAGI)

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DPIRD experiment reveals the best techniques for water repellent sand at Moora

Chad Reynolds | Department of Primary Industries and Regional Development

Project name

Benefit of repeated amelioration

GRDC Code:

DAW1902-003RTX

Research funded by DPIRD and GRDC co-investment in soil amelioration and re-engineering project

Confronting soil water repellence

Soil water repellence is caused by an accumulation of waxy organic matter on the surface of soil particles and is more pronounced in sandy-textured topsoils.

This results in uneven wetting of the soil profile and leads to delayed or staggered emergence of crops, pastures, and weeds, which could potentially lead to diminished productivity.

Additionally, it triggers nutrient deficiencies as the dry repellent soil impedes nutrient uptake by plants, resulting in deficiencies in phosphorous, copper, zinc, and manganese. Various factors such as: dry autumns, dry sowing practices, reduced cultivation, and certain seeding methods exacerbate water repellence.

To address this challenge, researchers have tested agricultural practices such as improved furrow sowing techniques, soil wetting agents, occasional deep cultivation, and the application of clay spreading or clay delving methods over time.

Experiment methodology

This experiment was conducted on water repellent, yellow deep sand at Moora, with the aim to identify the best combination/s of clay application rate, method of incorporation and repeated strategic deep tillage, to optimise long-term crop production benefits.

It was laid out in 3 randomised blocks, with plots measuring 18m wide and 15m long.

The site was deep ripped to approximately 40cm prior to the claying and incorporation treatments being applied in 2016.

In the same year, subsoil clay was applied at different rates perpendicular to the direction of seeding, using a multi-spreader.

Clay spreading was followed by either no further incorporation or incorporation, from low to high degree of mixing, using:

1. Offset disc
2. Rotary spader (standard speed)
3. Rotary spader at half-speed for extra mixing

These were applied perpendicular to the clay spread strips in the direction of seeding. The site was sown with the four-year crop rotation of barley, lupins, wheat and canola.

In 2020 each plot was split for 3 new treatments:

1. Nil (original 2016 treatment only)
2. Deep ripped to 40cm
3. Deep ripped to 40cm then rotary spaded to 35 cm.

The same 4-year crop rotation occurred following the 2020 tillage treatments which were carried out prior to sowing.

Results

Crop establishment was clearly improved through the clay application but was even more evident through the spading tillage treatment.

This resulted in higher grain yield being achieved on these spading treatments every year that this experiment has been in operation.

For this repellent deep sand, spading has proven, over 8-seasons, to be the most effective and profitable amelioration method. This spading alone, without any clay applied, has resulted in a cumulative net benefit of $1480 per hectare profit when compared to the control treatment.

Repeat spading has had significant additional yield benefits and resulted in a further increased cumulative net benefit of just under $400 per hectare on top of the original spading treatment.

Project collaborators

Lawson Grains and manager Mark Drake for hosting and managing the site.

More information

Click **here** to read more in the Soil Quality: 7 Soil Water Repellence on Apple Books

Click **here** to read publication 'Assessing options for managing water repellent gravel soils'

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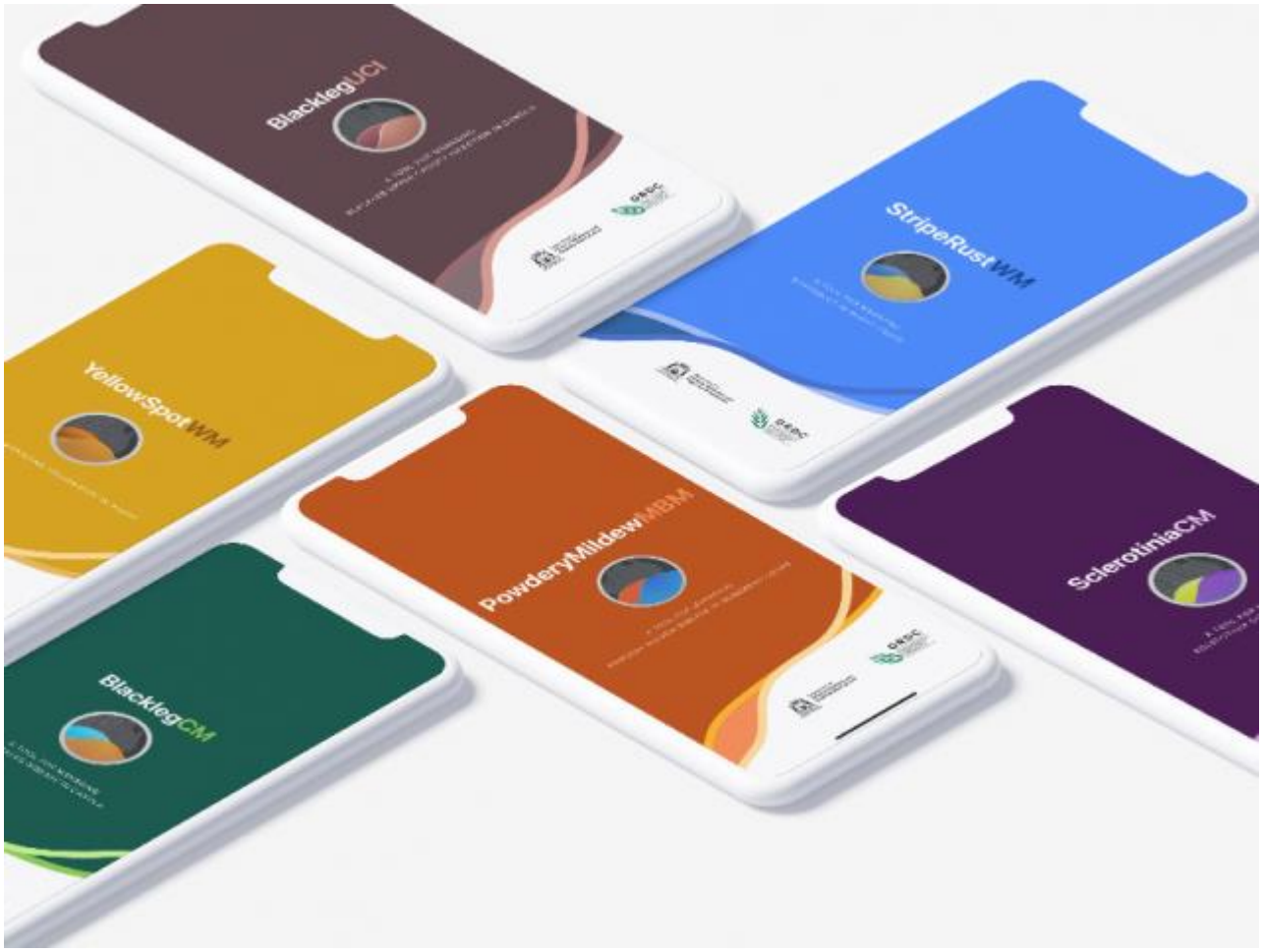

Empowering growers with tools to assist with disease management options

Project name
Disease epidemiology, modelling and delivery of management decision support tools

GRDC Code
DAW2112-002RTX

Harnessing technology for crop health
Stable grains production requires management of major diseases in cost effective ways, reduce the overuse of fungicides, and help prevent fungicide resistance from occurring.

With increasing disease pressure due to changing pathogen virulence, climatic conditions, and farming systems, a need to develop robust decision support tools to enable growers to make informed, timely disease management decisions that are economically viable was identified.

To tackle this, researchers from the Department of Primary Industries and Regional Development (DPIRD), with support from the Grains Research and Development Corporation (GRDC), in collaboration with national experts have developed a suite of decision support tool applications.
This national project conducts detailed epidemiology, disease management and validation experiments targeting yellow leaf spot, stripe rust and Septoria tritici of wheat, net blotches of barley, Sclerotinia and blackleg crown canker and upper canopy infections of canola in all relevant grain growing regions across Australia.

After careful analysis and modelling, a decision support tool is created.

Each tool has been developed to effectively capture best management practices for foliar fungal diseases while ensuring fungicide spray decisions are economically viable and within the fungicide resistance management guidelines.

The accuracy of these tools and information is ensured through detailed epidemiology and collaborative testing performed across Australia.

The apps are designed with accessibility in mind and are compatible with both Android and Apple devices, with most tools being available on both phone and tablet devices.

Users can email reports directly from the app to consultants, growers and experts, ensuring timely and informed decision-making.

In addition to the pathogens, above a tool for powdery mildew of mungbean is now available and prototypes for ascochyta blight in chickpea and sclerotinia in lupin are in development.

A blackspot of field pea risk forecast is delivered during April-June each year.

What's included?

Within the suite of digital foliar disease management tools, several features are provided, these include:

BlacklegCM: Specialising in blackleg crown canker management in canola, this tool offers up-to-date crown canker resistance ratings for all canola varieties, while facilitating comparisons between different fungicide options.

This tool is currently only available for use on tablet devices and is used for fungicide management decisions made pre-sowing through to the vegetative stage of the crop.

UCI BlacklegCM: Tailored to manage blackleg upper canopy infection in canola, this app takes into account a myriad of factors, including location, costs, yield benefits, grain prices, and seasonal conditions, to provide estimates of financial returns for fungicide decisions made at the early bloom stage of the crop.

SclerotiniaCM: Focusing on the management of sclerotinia stem rot in canola, this tool empowers users to input specific paddock data and recent weather conditions, thus facilitating informed decisions regarding fungicide application up to the 50% bloom stage of the crop.

PowderyMildewMBM: Dedicated to managing powdery mildew in mungbeans, this app acknowledges the influence of seasonal conditions and aids in decision-making regarding fungicide spraying.

This tool is designed for use in the Qld and northern NSW production areas.
StripeRustWM: Targeting stripe rust management in wheat crops, this app assesses occurrence of the disease in the area, disease severity, yield loss, and economic return across a range of fungicide strategies, factoring in costs, grain prices, and prevailing seasonal conditions.

It is mostly used in the eastern states but can be used in Western Australia to manage our sporadic outbreaks of stripe rust.

YellowSpotWM: Geared towards the management of yellow spot (tan spot) in wheat, this app considers a plethora of factors, including paddock selection, variety, seasonal conditions, prices, and management options, to provide outputs tailored to individual cropping circumstances.

The development and rigorous field testing of these apps have been undertaken by DPIRD in collaboration with plant pathology experts from various institutions, including Agriculture Victoria, Marcroft Grains Pathology, the New South Wales Department of Primary Industries, the South Australian Research and Development Institute, Queensland Department of Agriculture and Fisheries, University of Southern Queensland, University of Queensland, University of Melbourne, and CSIRO.

Through this collaborative effort, these tools have been refined to serve as an asset for growers, navigating the complex landscape of disease management in modern agriculture.

Funding partners / project collaborators
Grains Research and Development Corporation (GRDC)

More information
Click **here** for more about this project
Click **here** to read GRDC GroundCover article on this project

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New soil management options lift crop yields in WA's eastern wheat belt

Wayne Parker, Glen Riethmuller, David Hall, Rushna Munir and Dr Ed Barrett-Lennard (©2024 DPIRD)

Project name
Increased grower profitability on soils with sodicity and transient salinity in the eastern grain belt of the Western Region

GRDC Code
DAW1902-001RTX

Improving soil health at the forefront

Sodic (high sodium content) and dispersive clay soils (soil that breaks down into fine particles when exposed to water) cover approximately 2.3 million ha in Western Australia's (WA) low rainfall zone within the eastern wheatbelt.

Dispersed clay blocks soil pores, resulting in decreased water infiltration, storage, and leaching.

For clay soils in low rainfall environments, limited water infiltration and leaching results in the accumulation of salts deposited in rainfall (transient salinity) and the retention of toxic ions including boron. Each of these constraints limit water availability to crops.

Strategies for higher yields

The goal has been to provide updated techniques to half of the affected growers, reducing risks and boosting profits.

This involved testing soil management methods to increase grain production in low rainfall areas.

Experiments were conducted in the northern (Devils Creek, Canna), central (Merredin) and southern (Grass Patch, Ravensthorpe) wheatbelt over four years to explore various soil amelioration techniques that either increase water infiltration and/or decrease soil evaporation.

The findings indicate that certain practices, including micro water harvesting with waterproof membranes and mineral mulches, have shown promise in increasing grain yield and improving soil conditions each increasing average grain yield by 0.5 - 0.6 t/ha across more than 15 experiments.

Mico water harvesting involves harvesting water from the inter row into the seeded row. This requires mounding the inter row and applying a waterproof membrane to shed water.

Membranes including fully biodegradable polymers gave significant yield increases and showed promise as an alternative to plastic sheeting to shed water. No yield benefit was found for the mounds without the membrane.

Mineral mulches halved soil evaporation and significantly increased grain yield at almost every site where the treatment was applied. Mineral mulches are a long-term solution with the economics showing that the yield benefits would need to persist for more than 10 years.

One of the surprising findings was that many of these sodic and alkaline clays are unresponsive to gypsum.

While initial results from gypsum applied in furrow (100 kg/ha) showed large responses at Merredin, this was not replicated at several other sites.

This highlights the need for better techniques to identify soils likely to respond to gypsum. Current techniques that infer gypsum response from soil chemistry (i.e. exchangeable sodium percentage) are not always correct.

Techniques that objectively measure the amount of clay dispersed in the presence of differing rates of gypsum are currently being investigated.

Despite subsoils having high strength that would be considered root limiting, deep tillage alone, or with certain amendments, had no impact on grain yield.
The research also highlights the complex interactions between soil chemistry, clay dispersion, and crop yield, emphasising the need for further understanding and refinement of soil management techniques.

Additionally, economic analyses suggest favourable returns on investment for certain practices, such as gypsum application on responsive soils and mineral mulching.

The takeaway

Managing sodic soils in low rainfall regions where profit margins are low is challenging, the project has highlighted that large gains in production can be achieved by more effectively storing rainfall and reducing soil evaporation.

As a result of variable responses to gypsum, better methods of identifying gypsum response soils have been identified and are being evaluated.

Deep tillage did not improve grain yields on sodic clay soils in any of the field experiments undertaken across the wheatbelt.

While this project has concentrated on soil amelioration, we are also aware that advances in crop breeding which are also occurring have the potential to further boost grain yields on sodic and alkaline clay soils.

The project also emphasises the importance of collaboration with national and international researchers, to advance knowledge in soil management practices.

Funding partners / project collaborators

Grains Research and Development Corporation (GRDC)
More information
Click **here** to read more about this project.
Click **here** to read more in the Soil Quality: 8 Sodic and Alkaline Soil on Apple Books.

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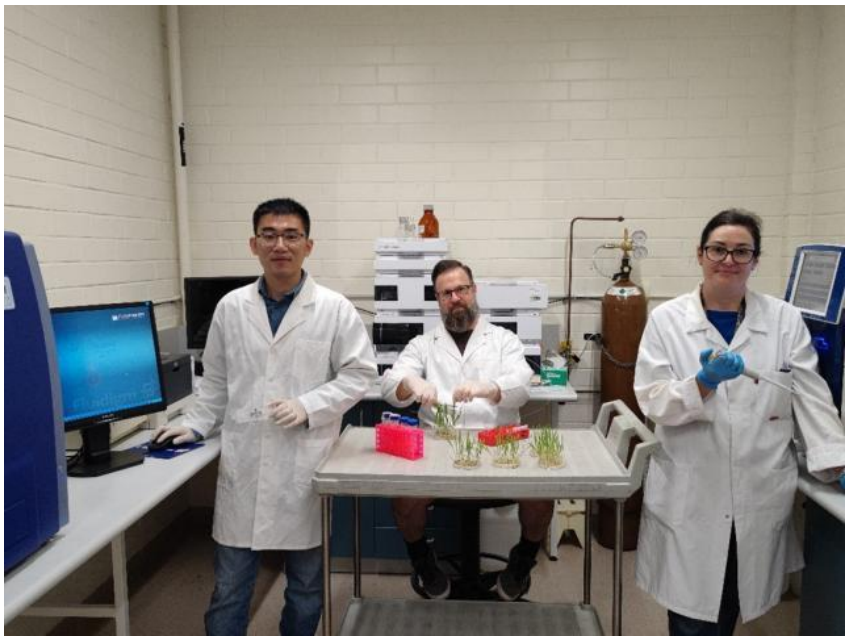
Meet the Molecular Genetics team in the Genetic Improvement Portfolio



Dr Yong Han, Julian Van Der Zanden, Esther Walker

The Molecular Genetics group is adapting cutting-edge genomics, genetics and biotechnology approaches to pinpoint the genetic control of important agronomic traits and manipulate such genes to improve crop performance and resilience.

Key activities include developing gene silencing techniques for rapid gene function validation, introducing gene editing technology to Western Australia's major grain crops for precision breeding, and using molecular markers for crop variety, purity and hybridity tests. Headed by Senior Research Scientist Dr Yong Han, who joined the Department of Primary Industries and Regional Development (DPIRD) in April 2021, this group works closely with other researchers within the department and Western Crop Genetics Alliance at Murdoch University. Other dedicated staff include Research Scientist Esther Walker, who commenced in November 2002, and Technical Officer Julian Van Der Zanden, who joined recently in February 2024.

Gene silencing for rapid function validation
Unlocking the genetic mystery of key traits such as flowering time, nutrient use efficiency and stress tolerance in crops is always restricted due to complex genomes and lack of gene validation approaches.

Nowadays, genetic mapping can locate the regions associated with such traits, but the causal genes remain unknown, and therefore, breeders cannot use diagnostic markers for accurate selection.

The group has developed RNAi technology to induce gene silencing in wheat, barley and lupin.

Several plant virus-based vectors have been tested on different hosts and successfully applied for gene function studies.

Typically, the experiment can be completed within months, and the engineered virus can infect almost all landraces and commercial varieties.

Since the methodology is transient, it's rapid and cost-effective compared to conventional genetic transformation approaches.

The gene silencing method was used to investigate barley Gibberellin 2-oxidase genes and revealed their diverse functions in regulating plant height, flowering time and seed size.

It's an excellent example of showcasing how robust the technique is.

The research finding was published in the highly-ranked scientific Journal of Advanced Research in January 2024, with co-investment from the breeding company InterGrain.
Gene editing for targeted mutation creation and trait improvement
Gene editing tools like CRISPR/Cas9 have revolutionised the field of genetics, allowing scientists to make targeted changes to a genome with unprecedented accuracy and efficiency.

One of the main advantages of gene editing over traditional breeding methods is that it allows for the precise modification of specific genes, meaning scientists can target genes known to play crucial roles in stress tolerance or other desirable traits and make changes to those genes only without disturbing other agronomic characters.

Recently, the group successfully established a highly efficient and genotype-independent barley gene editing platform that allows gene targeting in Australian commercial barley varieties.

The platform has been employed to improve key agronomic traits, including nitrogen use efficiency, flowering time, plant stature, coleoptile length and seed size.

Such materials with enhanced yield potential and climate resilience are invaluable for future variety breeding and commercialisation to increase grain growers' profitability and the industry's sustainability.
The novel genes identified by gene editing techniques hold great potential for genetic improvements. The studies were published in highly esteemed international journals over the last few years.

The group also published review articles discussing the promise of using gene editing to improve tolerance to abiotic stresses and soil constraints in wheat and barley.
Yong was also invited to panel discussions to explore the opportunities of new breeding technologies at the 2022 AusBiotech and 2024 GRDC Grains Research Update.

Molecular markers for genetic research and breeding

Modern DNA sequencing techniques have given rise to a complete knowledge of the DNA sequences of crop cultivars.

This has allowed for a relatively small number of markers to be pinpointed that are always found in any given cultivar.

Not only variety identity but hybrids between these cultivars can also be identified. The technique has been used in wheat and Triticale to identify individuals that are true hybrids from the crossings of various parent combinations.

These true hybrids are desirable in plant breeding and will be progressed further for doubled haploid or recombinant population production, while plants that are not hybrids but are selfings can be discarded at an early stage.

Recently, the team made another exciting application of DNA markers to identify true hybrids in a breeding program involving the forage tree Leucaena.

DPIRD breeders have successfully generated hybrid Leucaena trees that are excellent forage and sterile (unable to produce viable seeds).

This sterility is important as it will prevent this vigorous tree from becoming an environmental weed.

Once developed, it's a reliable, rapid and cost-efficient way of identifying traits, purity, or hybridity.

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Industry News: AEGIC Chief Economist Ross Kingwell wins Seed of Light award

Ross Kingwell

Australian Export Grains Innovation Centre (AEGIC) Chief Economist Ross Kingwell is the deserving winner of the prestigious 2024 Seed of Light award.

The Grains Research and Development Corporation (GRDC) presents Seed of Light honours each year to industry leaders who make exceptional contributions to research and development in Australia's grains industry.

Professor Kingwell is a leading agricultural economist with more than 45 years' experience, including as a foundational leader with AEGIC since its inception in 2012. AEGIC Executive General Manager Courtney Draper said Professor Kingwell's impact on the Australian grains industry was hard to overstate.

"It's fair to say that Ross's reputation within our industry is just about second to none," Ms Draper said.

"Ross has earned enormous respect across Australia for his outstanding economic analysis and communication skills.

"Ross has a remarkable talent for clearly articulating the real-world value of his insights to growers and industry in an engaging and practical way – as anyone who has heard him speak can attest to."

Ms Draper said Professor Kingwell had a genuine respect for grain farming, developed over decades of interactions with growers in WA and across the country.

"Ross is also a very active mentor to the next generation of agricultural economists," she said.

“Importantly, he is deeply valued and respected within the AEGIC team as a warm and generous leader who has made many invaluable contributions to the development of AEGIC over the years.”

Professor Kingwell was presented with the GRDC Seed of Light award for the western region at the 2024 GRDC Grains Research Update, Perth on 26 February 2024.

Professor Kingwell began his career with the WA Department of Agriculture in 1978 and joined AEGIC at its launch in 2012. He is also a Professor with the University of Western Australia.

AEGIC is an initiative of the Western Australian State Government and Grains Australia.

About AEGIC

The Australian Export Grains Innovation Centre (AEGIC) is an independent organisation that helps position Australian grain as the preferred choice in international markets.

AEGIC does this by:

Understanding the needs of grain customers.

Identifying and supporting grain market opportunities.

Educating customers on the benefits of Australian grain.

Innovating to develop new solutions and high-value uses.

This helps the Australian grains industry breed, classify, grow and supply grain that markets prefer.

AEGIC’s primary beneficiaries are Australian grain growers, and the impact of AEGIC’s work spans the whole grains supply chain: from the grower in Australia, whose grain is valued internationally, to the consumer who enjoys excellent noodles, baked products and beer made from Australian grain.
