Department of Primary Industries and Regional Development
GOVERNMENT OF WESTERN AUSTRALIA

Protect Grow Innovate

Grains Convo

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Contents

Improving oat yields in Western Australia through the Yield per se Project

Project name

Building grain yield (without neglecting physical grain quality) in milling oats through a better understanding of source and sink relationships and developing a targeted selection toolbox for future breeding gains.

Funded by

Western Australian Processed Oats Growth Partnership (POP), a State Government initiative.

Targeting yield growth

Western Australia (WA) is a global player in oat production, accounting for 90 per cent of Australia's processed oat exports and 70 per cent of raw oat exports, with the trade of both from WA accounting for approximately 10 per cent of world trade.

However, despite the region's dominance in the global market, the genetic yield potential of milling oats has gone stagnate over the last two decades.

To address this challenge, the Yield per se project, launched in 2022, aims to improve oat yields without compromising physical grain quality.

The project is a collaboration between the Department of Primary Industries and Regional Development (DPIRD) and InterGrain, and is funded by the Western Australian Processed Oats Growth Partnership (POP) through the Grain Industry Association of WA (GIWA).

Driving genetic gains

Oat production in WA has experienced minimal genetic gain since the release of the Bannister and Williams varieties in 2012.

The genetics of these oats were developed in the late 1990's and although these varieties were initially a step-change in yield, further improvements have been slow.

One important reason for the stagnation of oat yields is that oat genomic resources are not as developed as in other major cereal crops (e.g. wheat and barley).

Consequently, the oat industry has missed the wave of technological advances to enhance yield potential, such as marker-assisted breeding and genomic selection.

Furthermore, the attributes which should be selected and improved to boost oat's yield potential and adaptability are not yet clearly defined, particularly for WA growing conditions.

The Yield per se project seeks to reverse this trend by developing a targeted selection toolbox for oat breeding, with the ultimate goal of raising WA's oat yields to levels comparable with wheat and barley.

Project objectives

The primary objective of the project is to increase the rate of yield genetic gain in milling oats grown in WA by focusing on the source and sink relationships that drive yield formation.

Aligned with the broader goals of the POP project, this one specifically aims to:

- Develop a breeding toolbox that accelerates genetic gain through a better understanding of environmental interactions and physiological traits.
- Boost the yield per hectare (t/ha) of oats.

Unlocking the potential of oat genetics

The project involves field-based phenotyping of both Australian and international oat germplasm to investigate the source and sink dynamics in WA's unique environments. A core panel of up 60 lines were assessed by DPIRD in the first year, rising to 72 in the second year and 108 lines in the third year.

These lines were examined in detail for yield components, grain quality, and several key physiological parameters.

The core panel represents oat germplasm developed in Asia, Australia, Brazil, Canada, Europe, USA, and the UK. Fifty of the lines are common to all 3 seasons.

The physiological traits measured include a dissection of the panicle structure, photosynthetic parameters, grain growth, water soluble carbohydrate storage and mobilisation and radiation use efficiency.

A sub-set of six Australian varieties of the core panel, representing a 20 per cent yield contrast, were phenotyped by DPIRD in more detail for source and sink relationships using canopy shading, defoliation, and de-graining techniques, to investigate if oats are more source or sink limited under WA growing conditions.

The project will gather comprehensive data across a range of environments, which will be crucial for identifying key traits that improve adaptation and yield potential in WA's oat-growing regions. Detailed phenotyping has occurred at Yerecoin and York, with less detailed phenotyping at Wongan Hills, Merredin, Corrigin, Narrogin, Popanyinning, and Holt Rock.

Additionally, a diversity panel of around 600 international oat lines are being evaluated for agronomic fit, grain yield and quality by InterGrain.

Key outputs and breeding impacts

One of the major expected outcomes of the project is the identification of different environment types in WA, which will allow for more targeted breeding strategies.

Currently, variety recommendations in WA are based on broader Agzones, but the identification of target environments will enable breeders to make more precise selections tailored to specific environments. Furthermore, this information will help InterGrain optimise where it places its selection sites.

By the end of the project, a selection toolbox will be developed to help breeders identify and advance elite genotypes that demonstrate high grain yield and quality in WA's oat-growing regions.

This toolbox will be used to guide future breeding decisions, including the use of physiological crosses that combine complementary traits for yield improvement for the target environments.

The project also seeks to address potential trade-offs in breeding for yield.

By analysing the trade-offs, the breeding toolbox will ensure that new oat varieties not only yield more but also maintain or improve key quality traits.

Long-term impact on the oat industry

Although the project is expected to make significant strides in understanding and improving oat yield potential, the timeframe of the project alone will not solve the problem of stagnant yields.

However, by providing a foundation of knowledge and tools, the project will enable breeders to continue making genetic gains in the years to come.

In the long term, the project aims to help the WA oat industry produce better-adapted and higher-yielding oat varieties with stable grain quality suitable for milling.

These advancements will strengthen the industry's competitiveness on the global stage and ensure that WA remains a leading exporter of high-quality oats.

Take home messages

- Grain yield of oats have gone nowhere in nearly 20 years – the Yield per se project is pulling apart the oat plant to work out why
- This fundamental research will guide oat breeders in improving the yield gain of oats to be at least equivalent to wheat and barley

More information

Read more about the Processed Oat Partnership **here**

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Managing Ice Nucleating Bacteria with chemical treatments for protection

Paper name

Strategies for Frost Protection in Cereal Crops: Assessing the Efficacy of Ice Nucleation Inhibiting Bactericides and Cryoprotectants

By Chaiyya Cooper

Frost impact on crops

Widespread frost damage can significantly impact Western Australia's (WA) grain crop, costing the industry $1.25 billion in 2016 and $740 million in 2019.

A key factor that increases the risk of frost damage is the presence of Ice Nucleating Bacteria (INB).

The Department of Primary Industries and Regional Development (DPIRD) research scientist Chaiyya Cooper presented the latest research results at the 21st Australian Agronomy Conference which ran from October 21-24, 2024.

These bacteria live in the environment, especially on older or decaying leaves in cereal crops.

INB can cause ice formation at higher temperatures, due to a special protein they produce called the Ice Nucleating Protein (INP).

This ice formation has the potential to spread and damage the sensitive parts of cereal crops, reducing yield.

To reduce frost damage, several strategies have been tested.

In this study, DPIRD researchers evaluated 2 types of products:

Bactericides – Chemical agents designed to kill or inhibit bacteria.
- Cuprous Oxide and Zinc Oxide (Cu+Zn)
- Potassium Soap with Silicate (K-Soap)

Cryoprotectants – Substances that help plants tolerate freezing temperatures.
- Cryo-E
- Cryo-F

These products were tested to see if they could prevent ice formation caused by INB and ultimately reduce frost damage in wheat and barley crops.

Field trials

In 2023, field trials were conducted in a frost-prone area of Dale in WA, which is known for its frost-prone conditions.

Wheat and barley were planted at different sowing times to increase the chances of frost occurring during the reproductive stage of the crops.

Bactericides were sprayed on the crops just before the expected frost events, cryoprotectants were applied at key growth stages to help the plants better tolerate cold conditions, while a control plot with no treatment was also included, to compare the results.

Monitoring the damage

Researchers measured the ice nucleation activity of the crops by collecting and freezing leaf samples at regular intervals.

Researchers also evaluated the sterility of the florets (the flowering parts of the plants), which indicates how much frost had affected the crop’s ability to produce grain.

Leaf samples

The leaf samples showed that the bactericides had some effect in lowering the freezing temperatures.

For example, wheat treated with Cuprous Oxide and Zinc Oxide had a freezing point of -5.3°C, which was lower than untreated plots.

This reduction in temperature means the treated leaves required colder conditions to freeze, potentially reducing the risk of frost damage.

Floret sterility and yield loss

The sterility of the florets provides an indication of potential yield loss.

The results showed that one of the bactericides (K-Soap) caused higher sterility, likely due to its effect on water spread on the plants, increasing frost impact.

However, the mild frost events during 2023 made it difficult to clearly differentiate the effectiveness of the different treatments on reducing frost damage.

Looking to the future

The field trials showed that the Cu+Zn bactericide was the most effective at lowering the freezing point of leaf tissues, which suggests it has potential to reduce frost damage.

However, more testing is needed to confirm this.

In the meantime, future research will focus on establishing a clearer correlation between INB activity, frost damage, and yield loss.

With an increase of 1°C in frost tolerance estimated to result in an 8 per cent yield increase, these findings will offer valuable solutions for growers facing frost-prone conditions.

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DPIRD researcher offers insights into soil testing and liming for the summer

The importance of managing soil pH in Western Australian (WA) agriculture has been acknowledged by recent research and grower surveys, highlighting trends in lime application and soil amelioration strategies.

With the growing need to maintain healthy soils for crop production, the Department of Primary Industries and Regional Development (DPIRD) soils team, including Research Scientist Alice Butler, has conducted research highlighting the importance of liming and its role in agriculture.

Decline in lime usage

In 2023/24, there was a notable decrease in lime sourced from Lime WA suppliers, down 16.5 per cent from the previous year.

This drop, while significant, may reflect shifts in grower practices.

Many growers may be transitioning from recovery liming (used to increase soil pH) to maintenance liming, as there has been a general improvement in soil pH across topsoil and subsoil layers.

Estimating the requirements

Lime application is primarily driven by two factors: the removal of alkalinity through harvested crops, and the addition of acidity via ammonium-based fertilisers.
In crops such as wheat, barley, canola, and lupins, specific amounts of lime are required to replace alkalinity removed in grain (eg. the alkalinity removed by a 3-tonne wheat crop would necessitate 27kg of lime).
Additional lime is required to counter the acidification resulting from the use of ammonium-based fertilisers at seeding and top-up nitrogen.

A rough way to estimate the amount of lime application is by using an alkalinity removal

factor of 0.15 tonnes of lime per tonne of wheat, barley, or canola, and 0.1 tonnes for lupins.

However, this may need to be increased in a high rainfall environment where leaching is more likely.

A 6-year crop rotation, for example, may require up to 2.69 t/ha of lime to sustain soil pH (Table 1.).

However, the quality of the lime, soil type, and environmental factors will influence the exact requirement.

Strategies

Research highlights the importance of understanding soil type when applying lime. Different soil types (such as sandy loam and sandy gravel) acidify at different rates under crop production.

For example, sandy loam soil may require only occasional lime application, while sandy gravel soil, which is more prone to acidification, may require more frequent liming. Yield maps have also shown that productive areas of a paddock often require more lime, reinforcing the need for targeted liming strategies (Figure 1).

As part of the last GRDC-DPIRD co-investment into soil research (2019-2024) two surveys of WA grain growers were completed.

Surveys were undertaken by Research Solutions and agricultural consultant businesses Planfarm and Farmanco to understand and benchmark soil amelioration practices.

Research Solutions carried out a longitudinal study where growers were surveyed in both 2019 and 2024 to understand how they were undertaking mechanical amelioration and to see if there had been any changes within the 5-year period.

Survey results provided insights into how lime was being applied.

Many of these growers applied extra lime before conducting deep tillage or soil inversion, which helps incorporate lime deeper into the soil profile, addressing issues such as subsoil acidity.

Growers typically apply 2 t/ha of lime before tillage, followed by a top-up application of 2 t/ha 1-2 years later.

In cases where extensive liming (6-8 t/ha) had already been done, no additional lime was required before tillage.

Research Scientist Alice Butler said incorporating lime into deeper soil layers through practices like soil inversion or deep ripping has proven effective to address soil pH issues, especially in soils with subsoil acidity.

“This approach has produced long-term improvements in crop performance, with some farms reporting a 20 per cent increase in grain yields.”

The survey found that soil amelioration had a positive financial impact, with farms practising mechanical amelioration gaining an additional $100/ha annually. And liming is considered to be a key part of the overall soil amelioration strategy.

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The role of sharing farm data for making better management decisions

Paper name

LEAP – optimising whole farm lime application as a use case to demonstrate the benefits of farm sharing data

Written by DPIRD Principal Research Scientist Balwinder Singh.

Enhancing crop management

Making timely and complex decisions in Western Australian farming systems is crucial for the long-term viability of the multi-billion-dollar broadacre grains industry.

Digital technologies can support farmers to make data-informed decisions that can improve the quality and quantity of their production, and precision placement of inputs.

This project, conducted by researchers from the Department of Primary Industries and Regional Development (DPIRD) was profiled in a paper by DPIRD Principal Research Scientist Balwinder Singh, and presented at the 21st Agronomy Society Conference on October 21-24, 2024.

It aimed to demonstrate how sharing farm data with researchers can lead to the development of better digital tools, such as data analysis and visualisations, that can benefit growers.

With advancements in how data is collected, there is more information available in the agricultural sector every year.

However, for this data to be of benefit, researchers and technology providers need readily available access to it.
This often requires farmers to give up control of their data, and in some cases, they may feel as though their privacy is at risk.

To truly unlock the benefits of sharing data, it's important to build trust between researchers and farmers, ensuring data is shared in a secure and mutually beneficial way.

To address these concerns, DPIRD researchers created a data-sharing system called Extrata, which allows service providers to access farm data and use it to create tools that offer valuable insights for growers.

Lime application was selected as the use case for the Extrata platform, demonstrating the value of sharing data off farm records.

An API-based decision support tool, named LEAP, was created for optimising whole-farm lime application aimed at providing security, privacy and trust.

The LEAP tool builds on DPIRD and GRDC's popular iLime app, based on the Optlime model.

LEAP builds on the iLime app by optimising lime application across the whole farm, rather than considering individual paddocks.

It uses data from multiple sources to run millions of possible management scenarios, helping farmers make better decisions about soil management.

It was designed with privacy in mind, ensuring that farmers' data is securely handled and used only for its intended purpose.

The method

LEAP collects farm data, such as the farm's location, soil quality, and crop history, and uses simulations to provide lime recommendations for each paddock.

It runs several different scenarios to see the likely outcomes of different lime strategies. These results are then sent back to the grower through the Extrata platform.

By automating the process, LEAP ensures that farmers receive timely, accurate recommendations based on their specific farm conditions.

To get the best results, LEAP needs specific data from the farm, such as the location of each paddock, recent crop yields, and soil characteristics.

Growers can also provide additional data (fertiliser usage and lime costs) to get more customised recommendations.

The testing process

Researchers tested LEAP using a sample dataset with information from several farms across WA.
The results showed that applying lime as recommended by LEAP led to better financial outcomes and improved soil health over 20 years.

For example, one farm saw a significant increase in cash flow by using 4 tonnes of lime incorporated into the soil at 20 cm depth.

DPIRD Principal Research Scientist Balwinder Singh has researched in this paper, the value of using digital tools and sharing data to help farmers make better decisions.

By building trust and ensuring data is handled securely, farmers can benefit from the insights provided by advanced technologies like LEAP.

This will support the long-term success of farming in Western Australia.

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Meet the President of the Australian Society of Agronomy

Dr Ben Biddulph is currently serving a term as the President of the Australian Agronomy Society.

In the mid-1970s, a small group began advocating for the creation of an Australian Society of Agronomy.

They raised the idea during Grassland and Cereal Agronomy Conferences, highlighting the need for such an organisation.
Key figures, including Mr. Dennis de Kantzow and Dr. Bruce Sutton from the University of Sydney's Department of Agronomy and Dr. Jim Davidson from CSIRO, took the lead in this initiative.

This led to two meetings held in 1978-79, hosted by Professor Mike Norman at the University of Sydney.

The meetings brought together a diverse group of participants from various organizations, with representation from each Australian state.

Today, the Society runs a biannual conference which rotates around Australia and comprises of over 500 members, including academics, consultants, government officials, universities, research institutions, and private-sector professionals.

This year's was held in Albany in Western Australia's Great Southern, from October 21-24. Ben said the national team of past committees have laid a strong foundation which he aims to build on.

“I hope to do this by challenging and transforming current practices encouraging and engaging the next generation of curious and progressive industry professionals to think broadly and take new knowledge from a range of sources to apply it to their commercial production systems who will carry our legacy forward,” he said.

As well as his term as President, Ben is the Chief Primary Industries Scientist at the Department of Primary Industries and Regional Development.

His career at the department has spanned over 2-decades, mainly in cereals abiotic stress tolerance and is well known nationally for his frost research.

As Chief Scientist, his work now involves working internally and externally with DPIRD's grains, farming systems, livestock, horticulture and aquacultures strategic partners in the WA primary industries.

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AEGIC's wheat sensations at Perth Royal Show

How do Australia's wheat experts ensure Aussie wheat makes top quality noodles, bread and cookies?

The answer is sensory assessment, and it's a crucial part of ensuring new wheat varieties meet the needs of consumers both in Australia and in Asian markets.

Sensory assessment is not just about taste.

Appearance, colour, mouthfeel and texture are all extremely important to consumers – especially in Asia, a region which accounts for about 70% of Australian wheat exports each year on average.

Wheat experts from the Australian Export Grains Innovation Centre (AEGIC) demonstrated the sensory assessment of delicious udon and ramen noodles, Asian style bread, and cakes and cookies at the Perth Royal Show between 21-28 September 2024.

Three times each day, the grain gurus showed the process of making and assessing products for our discerning Asian markets – including taste tests for the public.
About 10,000 people took the opportunity to sample AEGIC's products during the Royal Show week.

Sensory assessment is one of many important functions that AEGIC performs on behalf of Australian grain farmers to help position Australian wheat as the preferred choice in international markets.

"AEGIC provides a vital link between consumers in export markets and the Australian grains industry," AEGIC Executive General Manager Courtney Draper said.

"AEGIC's highly trained experts have a deep understanding of what customers around the world want from Australian wheat and other grains.

"Our market insights, technical lab expertise and market education programs help the industry breed, classify, grow and supply grain that markets prefer."

Exports are a crucial part of the Australia's wheat industry, with between 65%-80% of the total Australian wheat crop exported each year to countries including China, Indonesia, Vietnam, Japan, Philippines Korea and many more. Asia accounts for about 70% of these exports.

On average, 28 million metric tonnes (mmt) of wheat is produced in Australia each year, with WA the largest wheat producer at 10.4 mmt.

AEGIC is an initiative of the WA State Government and Grains Australia, and is a delivery partner for Grains Australia's market insights and market education services.

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.

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