Department of
Primary Industries and
Regional Development

GOVERNMENT OF
WESTERN AUSTRALIA

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DPIRD Grains R&D
Stakeholder Update

May 2024 Edition

From Grains Director
Kerry Regan

Introduction

Hello, research and industry colleagues.

It is with great pleasure that we present the latest edition of the Grains R&D Stakeholder Update.

Over the past six months, we have engaged with research and industry colleagues through our successful annual DPIRD Grains Industry Day in Perth in December 2023, followed by the 2024 Grains Research and Development Corporation (GRDC) Grains Research Updates in February, which attracted a record 800 attendees.

Our team welcomed more than 170 industry stakeholders and collaborators to the DPIRD Grains Industry Day, where discussions centred around 2024 dry season management, carbon neutrality, farming system best practices, and herbicide efficiency.

DPIRD was once again well represented at the GRDC Grains Research Updates, showcasing our extensive expertise and research efforts, with 16 staff members presenting research findings or participating in panel discussions alongside industry stakeholders.

I'd like to acknowledge the achievements of our staff who took centre stage at the Research Updates. Research Scientist Robert Harrison received the GRDC Emerging Leader award for his research in legume and pasture agronomy, while Professor Ross Kingwell, lead economist at the Australian Export Grains Innovation Centre (AEGIC) and DPIRD stalwart, was awarded the prestigious GRDC Seed of Light award, which recognises excellence in facilitating the adoption of research outcomes, practices or technologies among growers and advisers through effective communication or extension.

We are excited about our new research endeavours and projects in 2024, which include DPIRD's commitment as a Tier 1 partner in the Zero Net Emissions Agricultural Cooperative Research Centre, leading the western node of the National Collaborative Research Infrastructure Strategy through the Australian Plant Phenomics Facility, and projects such as the National Grains Diagnostic and Surveillance Initiative.

Our SoilsWest and Western Crop Genetics Alliances with Murdoch University continue to thrive, and we have recommitted to future agreements. This will see an ongoing investment in translational science and development of expertise in barley, oats, and lupin pre-breeding, as well as more integrated soil research in WA.

We continue to work closely with our partners, the Grain Industry Association of Western Australia (GIWA) and Australian Export Grains Innovation Centre (AEGIC). AEGIC plays an important role for the Australian Grains industry, increasing its value and positioning Australian grain as the preferred choice in international markets. We are in the process of reviewing AEGIC's progress and setting a path for future investment. GIWA is leading the development of a WA Grains Industry Strategy for 2025–2035 and we hope our industry networks will participate and contribute to this collective roadmap.

Together, with our stakeholders, partners and collaborators, we:

- Research, develop, integrate, and deliver grain production technologies
- Facilitate and enable grains industry growth and adaptation

In every aspect of our work at DPIRD, we strive to create adoptable knowledge, practices and tools to sustainably ensure the viability of the WA grain industry.

If you have any feedback or need more information, please get in touch with me or the staff in our Grains team.

kerry.regan@dpird.wa.gov.au

www.agric.wa.gov.au/kerry-regan

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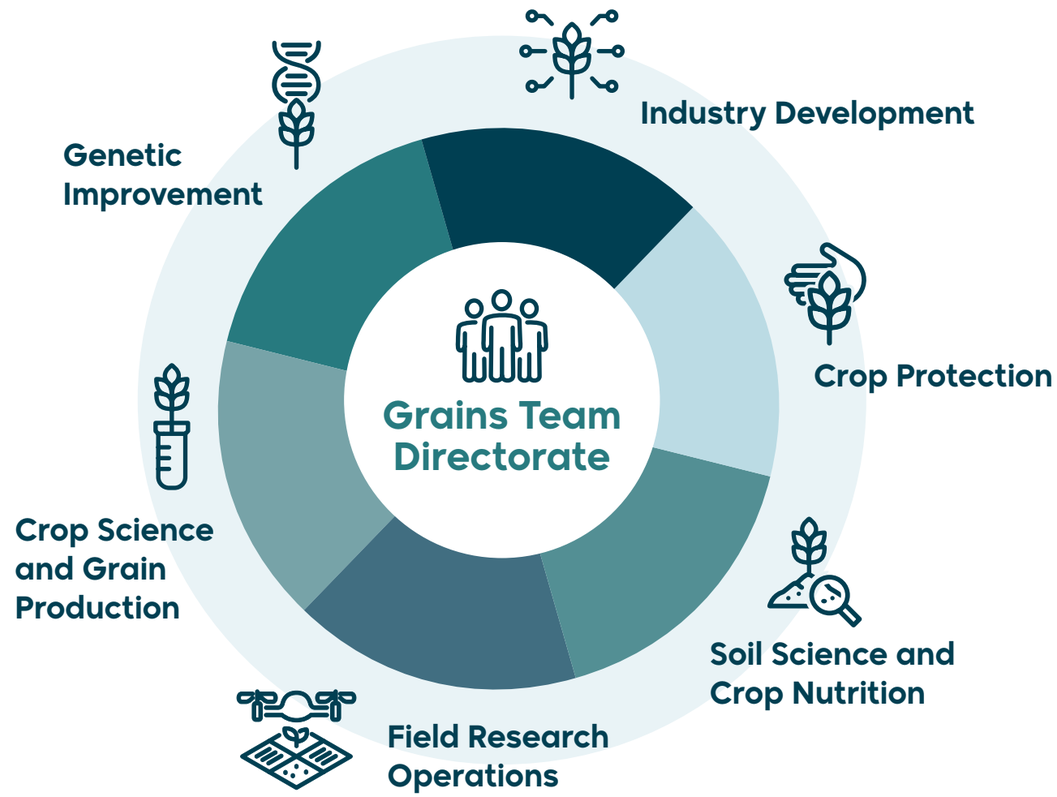
Acknowledgment of Country

The Department of Primary Industries and Regional Development (DPIRD) acknowledges the Traditional Custodians of Country, the Aboriginal people of the many lands that we work on and their language groups throughout Western Australia, and recognises their continuing connection to the land and waters. DPIRD respects the continuing culture of Aboriginal people and the contribution they make to the life of our regions and we pay our respects to Elders past, present and emerging.

Department of Primary Industries and Regional Development
+61 1300 374 731 | enquiries@dpird.wa.gov.au | dpird.wa.gov.au
ABN: 18 951 343 745

Priority R&D missions 2023–2027

DPIRD is embarking on a transformative journey in the grains industry, with a strategic focus on key research and development (R&D) missions. These missions represent the priorities driving innovation and progress in Western Australia's grains industry from 2023 to 2027. These key R&D missions underscore DPIRD's commitment to advancing the grains industry in WA, fostering sustainability, resilience, and profitability while embracing cutting-edge technologies and collaborative partnerships.



Resilient soils for evolving farming systems

- Ameliorate multiple soil constraints by partial or full management of the soil profile, understand the interaction of crop nutrition in ‘new’ soil, and maximise the longevity of increased soil capacity with evolving grain production systems
- Assess change in farming practice and soil condition to evaluate and continuously improve the adoption of research outputs for improved soil quality
- Respond to emerging global drivers (e.g. carbon economy, biological farming)

Integrated management of weeds, pests and diseases to reduce chemical use

- Early identification and tactical management of pests, weeds, and diseases.
- Effective, rapid, and cost- effective on-farm management strategies with reduced chemical use to minimise losses from pests, weeds, and diseases
- Integration of new technologies and strategies into farm and regional management packages for the WA Grains Industry

Improve the profitability, resilience, and sustainability of the WA grains industry with a 50% reduction in inputs (WAARC Grains Transformation Program)

- Low input cropping to manage weeds, pests and diseases using new technologies
- Biological nitrogen and diversifying the cropping system with grain and pasture legumes
- Increasing grain yield by improving water and nutrient use efficiency

Partnerships in oats and lupins to support industry growth

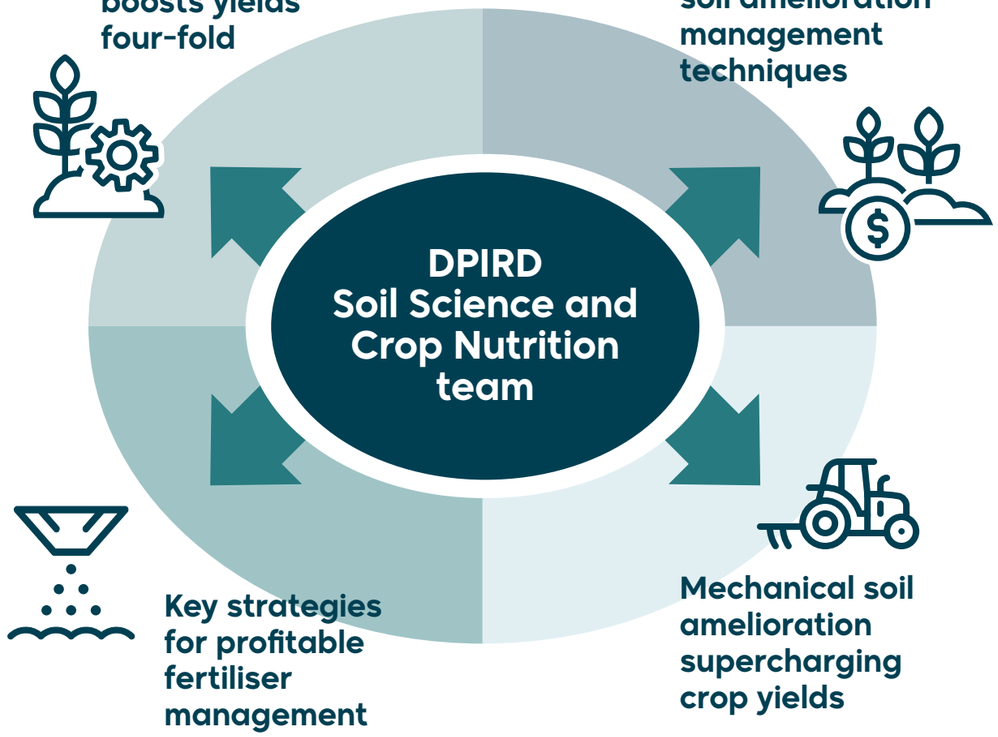
- Build on market opportunity for new products, product differentiation, value adding and/or premium markets
- Industry led with government support, through cash and in-kind contributions to support partnerships across the supply chain

Western Farming Systems initiative to increase whole farm profitability, reduce risk and increase adoption of agronomic and system innovations

- Identify and evaluate regionally appropriate system break options to optimise profit while keeping economic and environmental risk at acceptable levels.
- Develop strategies to capture maximum benefit from sowing opportunities whenever they occur from late March onwards.
- Provide industry with knowledge of the contribution of different components of cropping systems to overall greenhouse gas (GHG) emissions and management options to reduce emissions.

DPIRD Grains is revolutionising WA's cropping soils

Over the last three decades, DPIRD has led groundbreaking soil research and development to tackle the barriers in the soil restricting grain production. In a recent stride, DPIRD's Soil Science and Crop Nutrition team is wrapping up (the soil re-engineering ceases 30 June) up a series of innovative projects with co-investment from GRDC. These initiatives delved into soil management strategies aimed at boosting resilience, optimising crop water and nutrient utilisation, all while navigating the complexities of mounting heat and drought pressures.



Soil re-engineering boosts yields four-fold

Re-engineering soils to improve the access of crop root systems to water and nutrients stored in the subsoil

Project name

GRDC code: DAW1902-003

Cutting-edge soil profile re-engineering techniques led to a staggering four-fold increase in grain yields across multiple field experiments, defying previous yield expectations. The major grain crops, canola, wheat, and barley saw significant gains, showcasing the potential of re-engineered soils for transforming crop performance. Key findings also highlight long-term benefits of strategic deep tillage and the importance of tailored amelioration strategies for different soil types. Grower case studies underscore the need for careful assessment and monitoring, ensuring optimal results in soil amelioration practices. These breakthroughs herald a new era of sustainable and high-yielding grain cropping in WA and beyond.

Project unveils key strategies for profitable fertiliser management

Increasing profit from N, P and K fertiliser inputs into the evolving cropping sequences in the Western Region

Project name

GRDC code: UMU1801-006

The project aimed to enhance grain producers' profitability in the Western Region by optimising nitrogen (N), phosphorus (P), and potassium (K) fertiliser management, addressing industry concerns about inefficiencies and decision-making. Research revealed shifts in cropping systems changed the demand and supply needs for soil nutrients, highlighting the need for updated knowledge. Long-term positive balances for P have led to an accumulation of soil P while negative balances for K have led to greater K deficiency. Immediate project benefits included improved fertiliser decisions, notably for P and K on varied soils, and enhanced N simulation models. Future priorities were outlined for refining nutrient strategies, aiding producers and advisors in maximising crop yield and profitability in WA.

DPIRD Soil Science and Crop Nutrition team

Breakthrough soil amelioration management techniques skyrocket profitability and sustainability

Increasing farming system profitability and longevity of benefits following soil amelioration

Project name

GRDC code: DAW1901-006

This project on soil amelioration unveiled crucial insights for sustainable cropping on ameliorated soils. Key findings revealed that break crop rotations post-amelioration improved yield and grain quality, especially in bumper seasons and reduced the build-up of soilborne pests and disease maintaining larger amelioration benefits for longer. Late amelioration in June minimised erosion risk and optimised weed management, benefiting short-season varieties. Additionally, adopting long coleoptile varieties enhanced emergence and reduced weed density post-amelioration when soft soils and furrow infill can compromise seeding depth. These findings emphasise tailored approaches and careful management of crops on ameliorated soils for long-term farming profitability and environmental health.

Mechanical soil amelioration supercharges crop yields in WA

Nutrient re-distribution and availability in ameliorated and cultivated soils in the Western Region

Project name

GRDC code: DAW1801-001

This project explored the impact of mechanical soil amelioration on crop nutrient management in WA with intriguing insights. It revealed a synergy between deep ripping and K application, which, when exploited, significantly boosted crop yield response to applied K. The project delved into the complex dynamics of N fertiliser responses in varied soil conditions with greater N use efficiency on ameliorated soils and addressed strategic challenges in K application on sandy soils post-amelioration. These findings highlighted the necessity for targeted nutrient management strategies on ameliorated soils to maximise crop productivity.

Leading the way: Grain industry's latest tech

Electric weed control to tackle traditional chemical shortfalls

Innovative trials in Western Australia are showcasing the potential of electric weed control technology, marking significant progress in combating herbicide-resistant weeds.

Led by the DPIRD Grains team, in collaboration with AGXTEND and supported by GRDC, Wine Australia and the Cotton Research and Development Corporation, these trials are part of a pioneering project exploring the effectiveness of the AGXTEND XPower machine powered by Zasso™ under Australian conditions.

(From L–R) DPIRD Researchers Dr Catherine Borger, Dave Nicholson and Miranda Slaven

The XPower machine operates by generating high-voltage electricity that is directly applied to plants through mounted electrodes, disrupting cell walls and either killing the plant or inhibiting its growth. This approach offers a sustainable, non-chemical solution to weed management, crucial for addressing rising herbicide resistance.

Trials conducted over two years have demonstrated the efficacy of electric weed control, particularly against annual ryegrass, kikuyu, wild radish, capeweed and soursob. Notably, the technology has proven effective even against herbicide-resistant weed populations, showcasing its potential as an alternative to traditional chemical methods.

One of the key findings from the trials is the importance of adjusting application speeds or the 'dose' of electricity based on the type of weed, with broadleaf weeds being easier to control than grass weeds due to structural differences. This adaptability makes electric weed control a versatile option for various agricultural settings, including vineyards, where it has shown comparable results to herbicide application and outperformed mowing.

The ongoing success of these trials underscores the potential of electric weed control technology to revolutionise weed management practices in Western Australia and beyond, offering a sustainable and effective solution for farmers and land managers facing the challenge of herbicide resistance.

As the project progresses towards its completion in mid-2024, stakeholders anticipate valuable insights that could transform weed management practices, not only in Western Australia but also globally. This initiative marks a significant step towards sustainable and effective weed control methods in modern agriculture.

Contact:

Miranda Slaven
DPIRD Research Scientist

Miranda.Slaven@dpird.wa.gov.au

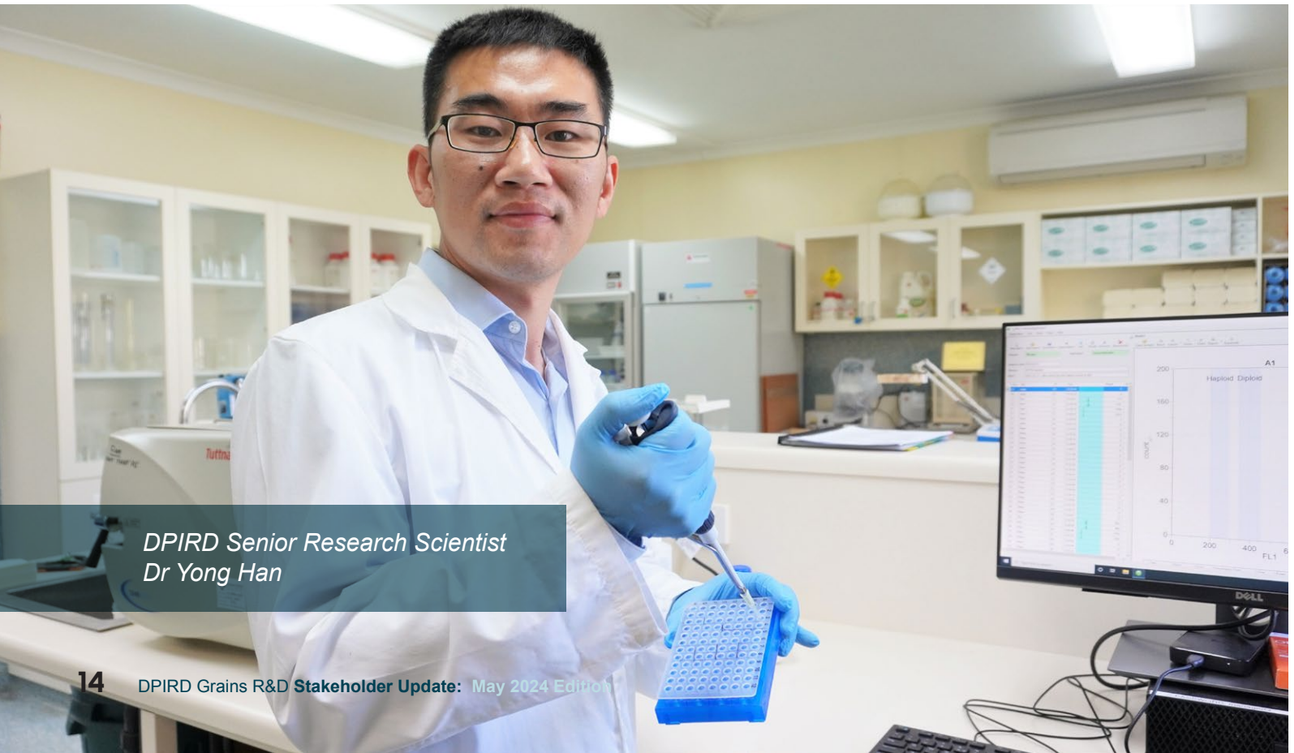
Silencing specific genes to unlock yield potential

DPIRD's Genetic Improvement team is at the forefront of agricultural innovation, harnessing RNA interference (RNAi) technology to revolutionise crop improvement.

Led by Senior Research Scientist Dr Yong Han, this dynamic group is collaborating with experts at Murdoch University to drive genetic advancements in Western Australia's major grain crops.

RNAi technology holds immense promise in understanding and manipulating gene functions swiftly and precisely. By silencing specific genes, researchers can unlock the genetic mysteries behind crucial agronomic traits like flowering time, nutrient efficiency, and stress tolerance. This breakthrough is particularly significant given the complexities of crop genomes and the limitations of traditional breeding methods.

The team's pioneering work in gene silencing has yielded remarkable results. Through RNAi, they've successfully targeted genes in wheat, barley, and lupin, unraveling their roles in plant height, flowering, and seed development.



DPIRD Senior Research Scientist Dr Yong Han

DPIRD Research Scientists Dr Yong Han, Esther Walker and Technical Officer Daniel Renshaw

This rapid and cost-effective technique not only expedites gene function validation but also enhances breeding efforts by providing valuable insights into gene functions and their impact on crop performance.

Furthermore, the Molecular Genetics team has embraced gene editing tools like CRISPR/Cas9, enabling precise modifications to specific genes for targeted trait improvements. This approach offers unprecedented accuracy and efficiency, empowering scientists to enhance traits such as nitrogen use efficiency, flowering time, plant stature, and seed size in Australian barley varieties.

The integration of molecular markers has also revolutionised genetic research and breeding. By leveraging DNA sequencing techniques, the team can identify true hybrids and desirable traits in crops like wheat, Triticale, and the forage tree Leucaena. This strategic use of molecular markers not only streamlines breeding programs but also safeguards against environmental concerns, such as preventing the spread of invasive plant species.

The Molecular Genetics team's groundbreaking research underscores their commitment to advancing agricultural sustainability and profitability. Through their innovative RNAi technology and genetic expertise, they're paving the way for resilient and high-yielding crop varieties that meet the evolving needs of grain growers and ensure a sustainable future for the industry.

Contact:

Yong Han
DPIRD Senior Research Scientist
Yong.Han@dpird.wa.gov.au

Meet the researchers making great strides in Grains R&D

At DPIRD, we are dedicated to driving innovation and excellence in the grain industry of WA. With a focus on turning challenges into opportunities, we strive to pioneer solutions that shape the industry's future. Our approach is grounded in a quest for knowledge and a steadfast dedication to making a tangible impact.

As researchers, we see ourselves as more than just contributors to the field; we are catalysts for change and advocates for sustainability. In all facets of our work, whether it's industry development, crop protection, soil science, agronomy or genetic improvement, we aim for excellence. Leveraging state-of-the-art technologies and scientific insights, we aim to unlock the full potential of our agricultural landscapes and support farmers in adapting to dynamic environments.

Our vision looks beyond current obstacles towards creating resilient solutions for the future. We are committed to building a brighter, more sustainable tomorrow for generations to come. Together with our stakeholders and partners, we have a commitment to excellence, sustainability, and prosperity.

Meet Tom Edwards

Tom Edwards is a DPIRD scientist spearheading research into how herbicides interact with the soil. His research concentrates on sandplain soils, which are widespread in the Western Australian wheatbelt. As a result of the pioneering research undertaken by DPIRD, these soils are increasingly being managed with strategic deep tillage, but this can change the fate of herbicides and potentially increase their efficacy. This problem inspired Tom's PhD research, which has developed new methods for measuring herbicides in soils to evaluate how soil type and management can impact their biological availability. His aim is to help growers optimise their weed control while mitigating the risk of herbicide damage.

Tom's journey in agriculture began while at university, where he investigated the importance of native soil biology in the rehabilitation soils post-mining. It was from here that he began a close collaboration with farmers and agricultural researchers, discovering how important agriculture was to sustainable land management. His research continues to rely on a close collaboration with farmers, and he is constantly inspired by their resourcefulness and commitment to continual improvement. As the completion of his PhD nears, Tom envisions a role mentoring and supervising DPIRD researchers who undertake post-graduate study, building on DPIRD's world-class applied soil science capacity. He is driven to contribute to a legacy of excellence and innovation in sustainable food production, preparing the next generation of scientists to tackle emerging challenges in agriculture. Tom's dedication and collaborative approach underscores his commitment to shaping a more resilient and productive agricultural landscape.

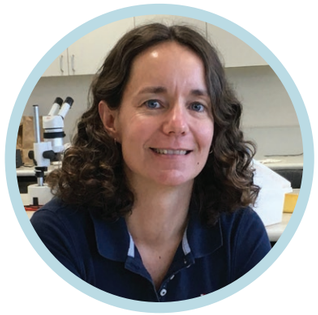
Learn more about Tom's work:

Articles

Researchgate

DPIRD Senior Research Scientist Tom Edwards (left) with Murdoch University Research Scientist Ben Arthur

Meet Dr Catherine Borger



Dr Catherine Borger, a Principal Research Scientist in Grains Research and Innovation at DPIRD, is a pioneering force in broadacre weed control research. Her work spans the vast wheatbelt region, from Geraldton to Esperance, focusing on addressing the ever-evolving challenges posed by weeds in agricultural systems.

Currently, Catherine's research centres on the dynamic landscape of weed management. With climate change and shifts in agronomic systems impacting weed ecology and herbicide efficacy, her projects delve into integrated weed management systems, online decision support tools, and alternative technologies. These initiatives aim to reduce chemical usage and carbon footprint while enhancing crop competitiveness and herbicide efficiency.

Catherine's motivation stems from the substantial impact of weed management on grower costs and agronomic systems. She views the evolving challenges posed by weeds as an opportunity to innovate and assist growers in adapting to changing landscapes effectively.

Her research goals are ambitious, with a focus on validating alternative weed control technologies to improve sustainability and reduce agriculture's carbon footprint. Catherine's team is dedicated to developing management strategies for problematic weed species influenced by climate change and validating decision support tools for practical implementation in the field.

Through her pioneering work, Catherine Borger is driving forward the frontier of weed science, paving the way for more sustainable and resilient agricultural practices in the future.

DPIRD Principal Research Scientist Dr Catherine Borger

Learn more about Catherine's work:

Article: Exploring the potential of electric weed control: a review

Article: Strategic tillage in Australian conservation agricultural systems to address soil constraints: How does it impact weed management?

Meet Dr Martin (Marty) Harries

Marty Harries, a Research Officer specialising in Crop Agronomy at DPIRD, brings a wealth of expertise to his role. As the Research Lead of the Western Farming Systems Project, a co-investment with GRDC, Marty oversees trials across the grainbelt, with a particular focus on the Northern Agricultural Region.

His current research revolves around farming systems agronomy, reflecting the evolving landscape of intensive cropping in cereals and canola. With a keen eye on profitability, Marty's project aims to manage weeds, diseases, and soil fertility through innovative crop and pasture rotations. His recent field trials, spanning diverse locations from Ogilvie to Wittenoom Hills, include large systems trials and investigations into the legacy effects of pulses, cereals, and oilseeds on wheat.

Marty's passion for this field is evident in his 25 years of experience as a Research Agronomist, culminating in a recent PhD showcasing the benefits of integrating broadleaf crops and pastures for improved water use efficiency in WA wheat crops. Looking ahead, Marty's research goals are ambitious yet impactful, aiming to deliver world-class research within the Western Farming Systems Project. His vision extends to adapting modern farming techniques to harness greater ecological benefits from diverse farming systems, paving the way for sustainable profitable dryland agricultural crop and pasture systems in the future.

Learn more about Marty's work:

Article: Refining Western Australian agriculture for sustainability and profit through 5-year project

PhD: Refining Western Australian agriculture for sustainability and profit through 5-year project

Project: Focus Paddocks Project – profitable crop and pasture sequencing

Project: Western Australian Farming Systems Project

DPIRD Researcher Marty Harries

Project summaries

To learn more about our priority projects, click on the links in the table below.

Title	Portfolio	Commodity						
		Cereals			Oilseeds	Lupins	Pulses	Other
		Wheat	Barley	Oats	Canola	Lupins	Chickpea/ faba bean/ field pea	
Genetic Improvement (Breeding better crops)								
Increasing wheat yield and yield stability through improved heat tolerance during grain filling	GI	✔						
Increasing stable lupin productivity through enhanced disease resistances	GI					✔		
Fast tracking the delivery of improved chilling tolerance chickpea for Australian growers	GI						✔	
NVT– Disease resistance	GI	✔	✔	✔		✔	✔	
Precision gene editing for targeted trait improvement in grain crops	GI	✔	✔			✔		
Doubled haploid production	GI	✔	✔					
Crop Science and Grain Production (Agronomic advancements)								
Enhancing frost tolerance and/or avoidance in wheat barley and canola crops through in-season agronomic manipulation	CSGP	✔	✔		✔			
Matching Pulse crop designs to site and expected seasonalconditions to maximise yield an profit: a crop ecophyiology approach	CSGP					✔	✔	
Western Australian Farming Systems	CSGP	✔	✔		✔	✔	✔	✔
Reducing risks to canola establishment through an integrated understanding of genetics, management, and environment	CSGP				✔			
Crop sowing guide	CSGP	✔	✔	✔	✔	✔	✔	✔
Overcoming the root phenotyping bottleneck in cereals	CSGP	✔						✔
Soil Science and Crop Nutrition (Improving Soils)								
Predicting Nitrogen Cycling and Losses in Australian Cropping Systems – Augmenting Measurements to Enhance Modelling	SSCN							✔
Re-engineering soils to improve the access of crop root systems to water and nutrients stored in the subsoil	SSCN	✔	✔		✔			✔
Prolonging profitability and longevity following soil amelioration	SSCN							✔
Increased grower profitability on soils with sodicity amd transient salinity in the easter grainbelt of the Western Region (P03)	SSCN							
On-farm soil acidity and nutrient management (Watering WA Clean Waterways)	SSCN							✔
Crop Protection (Protecting crops)								
Effective control of brome grass in the southern and western cropping zones	CP							✔
Epidemiology and management of Rhizoctonia in low and medium rainfall zones	CP	✔	✔					
Furthering grower knowledge and understanding of the scientifically unidentified 'Dongara weevil'	CP				✔			
Investigating systems for the control of Desiantha weevil in relation to resistance and biology in WA	CP				✔			
More effective control of pest snails in Australian grain crops	CP							✔
What is the best fit for Electric Weed Control in Australia?	CP							✔
Effective virus management in grain crops	CP							✔
Disease epidemiology, modelling and delivery of management decision support tools	CP	✔	✔	✔	✔	✔	✔	
National Grains Diagnostic and Surveillance Initiative (NGDSI)	CP							✔

CP – Crop Protection; SSCN – Soil Science and Crop Nutrition; CSGP – Crop Science and Grain Production; GI – Genetic Improvement; FS – Farming Systems

2024 project highlights

During the initial months of 2024, DPIRD Grains has made substantial strides in our research efforts, showcasing notable advancements aimed at addressing the dynamic challenges and opportunities within the grains industry.

The diligent work and expertise of our teams have resulted in impactful outcomes, poised to shape the future of agriculture with a focus on both productivity and environmental sustainability.

The following are some of the stories we have highlighted in our Grains Convo e-newsletter to showcase progress in various projects.

Click the links to read the stories in full.

- **Soil innovation drives increases in crop yield**
- **DPIRD research addresses trade-off between emissions and profitability**
- **Progress in canola Sclerotinia management research**
- **Strengthening wheat crops against frost**

Where to hear about our work

22–27 September 2024

3rd International Wheat Congress

The 3rd International Wheat Congress, taking place in Perth, Western Australia from 22–27 September 2024, is a global gathering of leading experts, researchers, policymakers and industry professionals to discuss advances in the field of wheat breeding, genetics, genomics and agronomy. The Congress provides a unique opportunity to share insights and exchange ideas, enabling industry professionals to stay updated on the latest global trends and innovations in the wheat industry.

21–24 October 2024

21st Australian Agronomy Conference

The Australian Agronomy Conference is the premier meeting that brings together professionals, researchers, and experts in the field of agronomy from around the country. It serves as a platform for the exchange of knowledge, ideas, and experiences that contribute to the advancement of sustainable agricultural practices.

10 December 2024

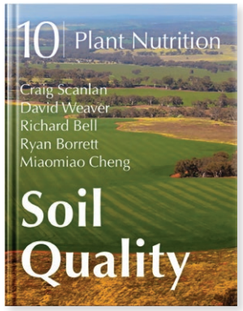
DPIRD Grains Industry Day

Journal papers 2024

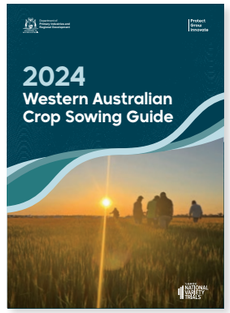
Crop Protection	Borger, C.P.D., Mwenda, G., Collins, S.J., Davies, S.L., Peerzada, A.M. and van Burgel, A. (2023) Burial and subsequent emergence and growth of rigid ryegrass (*Lolium rigidum*) and ripgut brome (*Bromus diandrus*) following strategic deep tillage. Weed Science	
	Hodgson, L.M., Rakshit, S., Lopez-Ruiz, F.J., Gibberd, M.R., Thomas, G.J. and Zerihun, A., 2024. Spatial Dependency in Stubble-Borne Pyrenophora teres f. teres and Influence of Sample Support Size on DNA Concentration and Fungicide Resistance Frequency. *Phytopathology, 114*(1), pp.269–281	
	Huston, D.C., Khudhir, M., Lewis, J., Collins, SJ., Jain, A., and Hodda, M. DNA barcoding of Australian cereal cyst nematode populations with comments on likely origin and taxonomy (Tylenchoidea: Heterodera). *Phytoparasitica* **52**, 14 (2024).	
Crop Science and Grain Production	Khondoker Ziaul Islam, David Murray, Dean Diepeveen, Michael G.K. Jones and Ferdous Sohel (2024) “LoRa localisation using single mobile gateway” Computer communications, 219, 182–193	
	Masoud Rezaei, Dean Diepeveen, Hamid Laga, Michael G.K. Jones and Ferdous Sohel (2024) “Plant disease recognition in a low data scenario using few-shot learning” Computers and electronics in agriculture, 219, 108812	
	Abderraouf Amrani, Dean Diepeveen, David Murray, Michael G.K. Jones and Ferdous Sohel (2024) “Multi-task learning model for agricultural pest detection from crop-plant imagery: A Bayesian approach” Computers and electronics in agriculture, 218, 108719	
	A.S.M. Mahmudul Hasan, Dean Diepeveen, Hamid Laga, Michael G.K. Jones and Ferdous Sohel (2024) “Object-level benchmark for deep learning-based detection and classification of weed species” Crop protection, 177, 106561	
	Angelika A. Pilkington, Brenton R. Clarke and Dean Diepeveen (2024) “Exact testing for heteroscedasticity in a two-way layout in variety frost trials when incorporating a covariate” Australian & New Zealand journal of statistics, 65, 4, 309–326	
	Khondoker Ziaul Islam, David Murray, Dean Diepeveen, Michael G.K. Jones and Ferdous Sohel (2024) “LoRa-based outdoor localization and tracking using unsupervised. Internet of Things 25, 101016	
Genetic Improvement	Cheng, J., Jia, Y., Hill, C., He, T., Wang, K., Guo, G., Shabala, S., Zhou, M., Han, Y., Li, C. (2024). Diversity of Gibberellin 2-oxidase genes in the barley genome offers opportunities for genetic improvement. *Journal of Advanced Research*	
	Jie Guo, Chenchen Zhao, Sanjiv Gupta, Greg Platz, Lisle Snyman, Meixue Zhou (2024) Genome-wide association mapping for seedling and adult resistance to powdery mildew in barley. *Theoretical and Applied Genetics* 137(3), 50 (16 Feb 2024)	
	Jellen E,N., Wight C, P., Spannagl M., Blake V, C., Chong J., Herrmann M, H., Howarth C, J., Huang Y-F., Juqing J., Katsiotis A., Langdon T., Li C,, Park R., Tinker N, A., Sen T, Z. (2024) A uniform gene and chromosome nomenclature system for oat (Avena spp.). *Crop & Pasture Science* 75, CP23247	
	Yong Jia, Jose Barrero, Jirui Wang, Michael Considine, Shingo Nakamura, Chengdao Li (2024) Seed Dormancy, Germination, and Pre-Harvest Sprouting, Volume II. Front. Plant Sci., Volume 15 – 2024	

Products for industry

The DPIRD Grains team is supporting industry to stay on the front foot with the latest innovations, pest and disease management, best practice, and farm planning. The following tools have been developed to assist growers in their day-to-day operations.



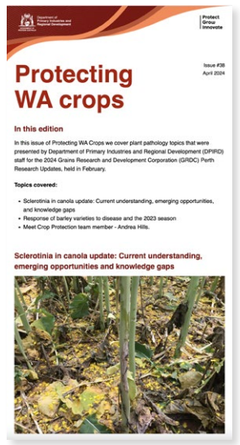
Soil Quality
ebooks



Crop Sowing Guide
ebook

Grains Convo
podcast

Pestfacts
newsletter



Protecting WA crops
newsletter

Grains Convo
newsletter

Reach out to the Grains team

Grains Research and Industry Development
Director: Kerry Regan

Crop Protection
Manager: Dr Helen Spafford

Soil Science and Crop Nutrition
Manager: Chris Gazey

Crop Science and Grain Production
Manager: Dr Bob French

Genetic Improvement
Manager: Dr Darshan Sharma

Industry Development
Manager: Alex Edward

Field Research Operations
Manager: Dr Gavin Sarre