

6th AUSTRALIAN COTTON RESEARCH CONFERENCE

NARRABRI, NSW
26-28 AUGUST 2025



Innovation

from the ground up

Foreword

On behalf of the conference organising committee and the Association of Australian Cotton Scientists (AACS), it gives me great pleasure to welcome you to the 6th biennial Australian Cotton Research Conference. This year the conference will be held Tuesday 26th to Thursday 28th August 2025 at the Crossing Theatre in Narrabri. After 12 years the conference is returning to its origins in Narrabri where the vision and drive of the newly formed AACS and the then conference Chair, Mary Whitehouse and her committee, made the first Australian Cotton Research Conference a reality. A lot has changed since 2013 – back then there wasn't a single talk mentioning artificial intelligence!

Which brings me to the theme of this year's conference: 'Innovation from the group up'. The success of the Australian cotton industry has been realised through innovation over the decades. Underpinning this innovation is the research that has solved industry problems through developing new ideas, methods, and products. The creativity, knowledge and adaptability of those working in cotton science has seen the cotton industry through numerous challenges and changes. While advances have been made, the cotton industry still faces challenges today. Like in the past, research and innovation remain a foundation for the success and longevity of the Australian cotton industry. The conference will showcase these innovations, from the soil where we grow our cotton, up to our international cotton markets. It really is events such as this that highlight that when it comes to innovation in the Australian cotton industry, the sky is the limit.

Something that has not been a limitation to this conference is the generous support of our sponsors. The conference wouldn't be what it is without their support, particularly our Gold Level sponsors: the Cotton Research and Development Corporation (CRDC) and Cotton Seed Distributors Ltd. (CSD). We also have Silver Level sponsors, CSIRO and Bayer, and Bronze Level sponsors, The University of Sydney, The University of Western Sydney, and the Australian Plant Phenomics Network, Cotton Incorporated and the Narrabri Shire Council. Thanks to this support, and the hard work of a group of dedicated committee members, we've put everything in place to allow you to communicate your science and establish and build your research networks, all in a fun and inclusive environment.

In delivering this conference, we've kept with the AACS's philosophy of giving everyone who wants to present a chance to do so. To give your research maximum exposure we have avoided concurrent sessions, but at the cost of talk lengths. I hope that exposure to all 170+ attendees, not just a small subset, is more valuable than that extra 5 minutes of airtime.

Finally, the success of the conference is due to the input from many, many people – in particular the organising committee. Many thanks to you all. It is important to give a special shout out to the commitment and tireless effort of the current AACS vice-president Tonia Grundy and President Iain Wilson.

I'm looking forward to the intellectual stimulation that the conference will bring, meeting some of you for the first time and catching up with others. So, prep your slides, practice your talk, travel safe and we'll see you in Narrabri.

Enjoy the conference!

Warren Conaty

Chair, 2025 Australian Cotton Research Conference

2025 ACRC Committee:

- Warren Conaty, CSIRO (Chair)
- Tonia Grundy, Qld DPI
- Kristen Knight, Bayer
- Oliver Knox, CSD
- Guna Nachimuthu, NSW DPIRD
- Robert Sharwood, Western Sydney University
- Warwick Stiller, CSIRO
- Tim Weaver, University of Sydney
- Iain Wilson, CSIRO
- Megan Woodward, CottonInfo

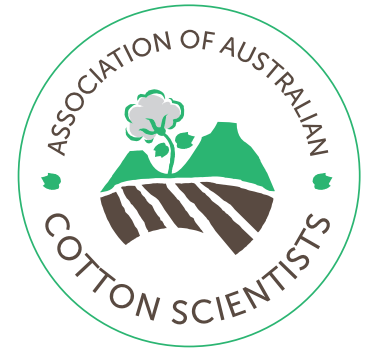
About AACCS

The Association of Australian Cotton Scientists was formed in September 2012. Membership of the association is available to those involved in activities related to Australian cotton research.

The Association aims to advance Australian cotton science by encouraging collaboration across agencies and disciplines, promoting cotton research as a profession and encouraging student involvement.

The Australian Cotton Research Conference serves as a platform for cotton researchers to present and discuss concepts, key issues and the latest findings in research relevant to the Australian cotton industry, and cotton research community. It also encourages networking and collaborations and installs a sense of enthusiasm for our research.

The Association would like to acknowledge and thank the AACCS committee members for 2025: Iain Wilson (President), Tonia Grundy (Vice President and Website coordinator), Warren Conaty (Treasurer), Megan Woodward (Secretary and Social media coordinator), Kristen Knight and Duy Le.



At this conference

The AACCS Annual General Meeting (AGM) will be held at 8:30 on Thursday 28 August (prior to Session 7). All conference delegates are welcome to attend as AACCS membership is included as part of conference registration.

AACCS life members are awarded in recognition of their contribution to the scientific community and scientific knowledge of cotton in Australia. New life members for 2025 will be announced at the Conference dinner on Thursday evening.

Also announced at the Conference dinner will be the AACCS award recipients for 2025. Awards encompass the values of the Association (innovation, collaboration and impact), within three categories: Service to Cotton Science Award, Early Career Scientist Encouragement Award, and Scientific Publication Award.

See the previous winners and read about our life members under the 'About us' tab at the AACCS website www.australiancottonscientists.org

Past conferences

8-11 September 2013 at Narrabri NSW

'Promoting inquiry, networking and collaboration in the Australian cotton research community'

8-10 September 2015 at Toowoomba QLD

'Science securing cotton's future'

5-7 September 2017 at Canberra ACT

'Cotton science delivering impact'

28-30 October 2019 at Armidale NSW

'Taking cotton research to new heights'

2021 conference was cancelled due to COVID

An online seminar series was organised as a substitute - see www.australiancottonscientists.org/aacs-seminar-series for more information.

5-7 September 2023 at Toowoomba QLD

'Australian cotton science – continuing to lead'

Proceedings from past AACCS conferences can be found at www.australiancottonscientists.org/previous-conferences

Conference events

Conference sessions will be held at the Crossing Theatre, with social events held elsewhere:

- Welcome function at the Narrabri Bowlo (176 Maitland Street)
- Twilight tour BBQ at the Australian Cotton Research institute (ACRI)
- Conference dinner at the Narrabri RSL.

Conference venue

Nestled beside the picturesque Namoi River, The Crossing Theatre stands as a striking contemporary conference venue.

It has a large onsite carpark and is easily accessible with a wide ramp running from the carpark to the main entrance.

117 Tibbereena Street | www.crossingtheatre.com.au



Conference dinner venue

Narrabri RSL is a relaxed country local club with ample parking, free Wifi, an ATM, and full TAB and Keno facilities and is home to the famous 'Outback Shack Restaurant'.

116 Gibbons Street | www.clubnarrabri.com.au/rsl-club



About Narrabri

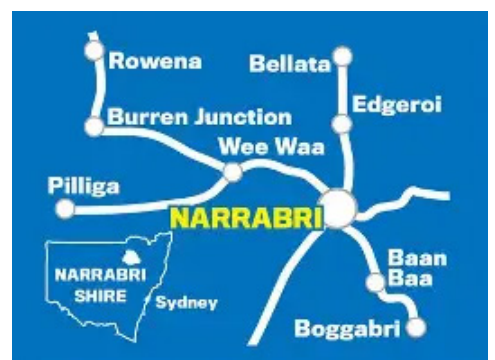
Narrabri is around 6.5-hour drive from both Sydney and Brisbane (the Newell and Kamlaroi Highways run through Narrabri Region). You can also catch the train from Sydney (about 7.5 hours). Link Airways operates from Narrabri to Brisbane three days a week and Narrabri to Sydney three days a week. Other airlines fly into Moree Airport and you can rent a car for the one-hour drive north.

There's plenty of wonderful things to do in and around Narrabri:

- Learn about the town's colonial history at the Narrabri Old Gaol Heritage Museum.
- Visit the CSIRO's Australia Telescope Compact Array (a short drive west), where six dish antennas on a railway track work like one huge antenna exploring the universe. Entry to the observatory is free and there are exhibits and films.
- Enjoy a taste of nature at the magnificent Mount Kaputar National Park (a short drive east). The Sawn Rocks walking track is a reminder of Mount Kaputar's volcanic past and the panorama from the Mount Kaputar Summit lookout is breathtaking. This easily accessible spot also has picnic tables.
- If you enjoy water sports, Yarrie Lake (near the Pilliga Forest) is popular for swimming, fishing/yabbying and boating. You can also take a tour at Narrabri Fish Farm, the largest freshwater fish farm in NSW.

Tourism information:

- visitnsw.com/destinations/country-nsw/moree-and-narrabri-area/narrabri
- explorenarrabriregion.com.au/visit



Australian Cotton Research Conference 2025 - program summary

Monday 25th August

- 12:00 Cotton in future farming systems workshop (organised separately to the Conference program)
6:00 **Welcome Reception** at Narrabri Bowling Club from 6 pm

Tuesday 26th August

Registration desk open from 7:30 (tea and coffee from 8 am)

- 8:30 Housekeeping and **AACS Welcome**
9:00 **Session 1 Let's start at the very beginning: genetics and more**
Plenary by Jonathan Wendell
10:00 Morning tea
10:30 **Session 2 Data makes the world go round**
Plenary by Alison Kelly
12:30 Lunch
1:25 **Session 3 Balancing water, nutrients and growth**
3:20 Afternoon tea
3:50 **Session 4 From the ground up**

Wednesday 27th August

Registration desk open from 7:30 (tea and coffee available)

- 8:00 Housekeeping
8:05 **Session 5 From integrated management to beyond the paddock**
Plenary by Mary Whitehouse & Sharna Holman
10:30 AACS life members morning tea
11:00 **Session 6 What's next? The path from innovation to commercialisation**
Plenary by Anthony Hawes
1:00 Lunch
2:00 Board busses for ACRI 'Twilight tours' (Site tours from 2:45)
5:30 **BBQ dinner at ACRI**
7:00 Busses depart for Narrabri

Thursday 28th August

Registration desk open from 7:45 (tea and coffee available)

- 8:25 Housekeeping
8:30 **AACS AGM**
9:00 **Session 7 Impact on and in the cotton industry**
Plenary by Paul Grundy
10:00 Morning tea
10:30 **Session 8 Thinking like a plant**
12:30 Lunch (and 'Student and new cotton researchers networking' event)
1:30 **Session 9 Disease detectives**
3:10 Afternoon tea
3:35 **Session 10 New horizons: natural resources and the northern frontier**
6:30 **AACS Awards Dinner** at Narrabri RSL from 6:30 pm

ACRC sponsors

Gold sponsors

The **Cotton Research and Development Corporation (CRDC)** is proud to have supported the Australian Cotton Research Conference since its very beginning, reflecting a long-standing commitment to science, innovation, and industry excellence.

As a partnership between the Commonwealth Government and the Australian cotton industry, CRDC drives cutting-edge research, development and extension (RD&E) to boost productivity, profitability, and sustainability on-farm and beyond.

CRDC's continued sponsorship of the Conference highlights its dedication to Australia's scientific community and its vital role in delivering world-class research that powers a globally respected cotton industry.

All CRDC investments are guided by Clever Cotton; CRDC's Strategic RD&E Plan for 2023–28 which is focused on three pillars: Paddock, People, and Planet, and spanning nine key investment areas.

Cotton Seed Distributors (CSD) has been supplying the Australian cotton industry with high quality seed since 1967, and supporting the science that has underpinned the industry since 1971.

That support continues in various forms to this day, including our proud sponsorship of the annual Cotton Researcher of the Year Award, and supporting the AACS.

The science that has backed the industry has always flourished in a collaborative environment, so CSD hopes the conference provides plenty of networking opportunities for attendees. Remember that when it comes to fostering 'Innovation from the ground up', CSD offers you more than just seed.

Silver sponsors

CSIRO Agriculture and Food provides science-based solutions to challenges right across the agrifood and fibre sectors, including in cropping, livestock, aquaculture, horticulture and food innovation.

Our world-class work in cotton supports improved productivity in the Australian cotton industry through the provision of genetic and crop management solutions. Genetic solutions (varieties) are bred through the application of modern breeding technologies with improved yield, fibre quality, protection from major diseases and insect pests. Management solutions include applications in crop agronomy, novel inputs and crop modelling. CSIRO has been a Silver level sponsor of the Australian Cotton Research Conference since its inception in 2013.

Bayer is a global enterprise that has had a local presence in Australia since 1897. Bayer has a long-term commitment to the health and nutrition of all Australians, with core competencies in the life science fields of health care, nutrition and crop science.

A proud partner of the Australian cotton industry, Bayer helps growers improve efficiency, manage herbicide resistance, and reduce environmental impact through advanced plant science, stewardship expertise, and sustainable crop solutions.

Bayer's investment in local research, including facilities like the Toowoomba Research Facility, ensures that Australian cotton growers have access to world-leading traits and technologies tailored to local conditions. For further information visit crop.bayer.com.au.



Bronze sponsors

The **Sydney Institute of Agriculture (SIA)** brings together research from across the University of Sydney and contributes valuable knowledge to the agriculture and food sector. By leveraging multi-disciplinary expertise, cutting-edge infrastructure, and strategic partnerships, SIA is positioned to tackle the sector's toughest challenges. The University of Sydney conducts extensive cotton research across Australia, spanning a wide range of disciplines. Recently, the University secured the relocation of its cotton production course to Narrabri where it also hosts a long-term dryland farming systems experiment that includes cotton.



The **Hawkesbury Institute for the Environment** was established to support research excellence and innovation through collaboration with colleagues at Western Sydney University, as well as nationally and internationally. HIE's research aims to provide innovative solutions for protecting the environment, preserving biodiversity, ensuring food security, and the sustainable use of natural resources. HIE has a strong focus on delivering new solutions to the cotton sector by understanding germplasm responses to climate change and to use this knowledge to design climate-adapted germplasm that ensures a sustainable approach to help fortify Australia's cotton industry.

WESTERN SYDNEY
UNIVERSITY



Hawkesbury Institute
for the Environment

Cotton Incorporated is a United States of America not-for-profit organisation dedicated to providing resources and research assistance to help companies develop and market superior, innovative, and profitable cotton products. Cotton Incorporated is providing sponsorship in the form of travel expenses for our international plenary speaker, Prof. Jonathan Wendell (Iowa State University).



The Australian Plant Phenomics Network (APPN) is dedicated to advancing crop research by investing in cutting-edge technologies, expert knowledge, and robust data resources. We provide researchers with access to world-class plant phenomics infrastructure spanning all major cropping environments across mainland Australia. At the University of Sydney, APPN operates from our expansive research station in Narrabri, offering a comprehensive suite of field phenotyping and remote sensing capabilities. Through our nine national nodes, we're committed to supporting the cotton industry—both in this region and across the country—with innovative tools and insights to drive productivity and sustainability.



Narrabri Shire Council is proud to support the Australian Cotton Research Conference through a concessional rate for use of The Crossing Theatre. Situated in the Namoi Valley – one of Australia's oldest cotton-growing regions – Narrabri is also home to the Australian Cotton Research Institute. Cotton is a defining part of the region's identity, shaping its communities, economy and innovation, and Council is proud to support an event that celebrates and advances this vital industry.



Other acknowledgments

Cotton Australia is the peak grower body for the Australian cotton industry, representing cotton farmers. It is a non-profit organisation responsible for advocacy, implementation of the industry's sustainability program, education and the Cotton to Market program which engages with customers throughout the supply chain. Cotton Australia has contributed 100% Australian cotton plenary speaker gifts for the 2025 conference.



Australian Cotton Research Conference 2025 program

Monday 25 August

Cotton in future farming systems workshop (organised separately to conference)

6 pm **Welcome reception** at Narrabri Bowling Club from 6 pm

Tuesday 26 August

7:30 Registration desk open (tea and coffee from 8 am)

8:30 Housekeeping and **AACS welcome** (including 'Welcome to Country' by Eddie Trindall, on behalf of the Gomeri Narrabri people)

9:00	Session 1. Let's start at the very beginning: genetics and more	CHAIR: Rob Sharwood
	Plenary: The fabric of a family tree: a journey through the evolutionary history of cotton	Jonathan F. Wendel
	The cotton breeders' little secret: molecular selection in Canberra	Xiaoqing Li
	Leveraging pan-genome structural variation annotation to enhance genomic prediction in the Australian cotton program	Samuel Craig

10:00 **Morning tea**

10:30	Session 2. Data makes the world go round	CHAIR: Susan Maas
	Plenary: Making your stats sizzle	Alison Kelly
	APSIM next generation cotton: a new model for temperate and tropical production systems	Tiemen Rhebergen
	Spatial data analytics and advanced modelling for disease prediction and management in Australia	Kingsten Okka
	Can UAV phenotyping revolutionise cotton breeding?	Xuesong Li
	Potential for deep learning for early detection and discrimination of verticillium and fusarium wilt in cotton	Neeraj Anand Sharma
	Weaving the threads together: ensemble learning to enhance genomic prediction on cotton	Zitong Li
	Quantifying cotton growth rate from multispectral UAV imagery at plot scale	Francesca Devoto
	Can genomic selection fast-track the development of rain-grown cotton varieties?	Qian Feng
	Large language models (LLMs): can they enhance agricultural research?	Jiazhe Lin
	Comparison of spatial soil moisture sensing technologies	Issac Halling
	Opportunities to utilise eddy covariance to explore water and carbon dynamics in Australian cotton systems	Zach Brown
	Like sands through the hourglass, so have weed numbers changed through time: results from surveys across northern cotton regions of Australia	Eric Koetz

12:35 **Lunch**

1:30	Session 3. Balancing water, nutrients and growth	CHAIR: Iain Wilson
	Benchmarking of water productivity and water sustainability of rainfed cotton in Australia	Malem K McLeod
	Optimising bankless channel cotton layouts in Southern NSW	Wendy Quayle
	Water and nitrogen run-off in southern NSW bankless channel irrigated cotton systems	Gerardo Torres
	Application of novel biostimulants enhance cotton growth, production and water use efficiency	Bhagya Samarasinghe
	Irrigation mapping and monitoring using Earth observation data for cotton farming in Australia	Rajitha Athukorala
	Predicting microplastics release from polymer-coated controlled-release fertilisers into soil using machine learning	Akila Ravindran
	Disentangling vapour pressure deficit effects: independent roles of temperature and humidity in cotton leaf gas exchange	Mick Bange
	Quantifying crop stress using continuous canopy temperature monitoring in semi-irrigated skip row cotton	Rose Roche
	Towards low-cost cotton irrigation management through canopy temperature forecasting	Stephen Rogers
	Unravelling the complexity of limited water decisions	Sarah Dadd
	Accelerating agricultural innovation: the role of the Australian Plant Phenomics Network	William Salter

3:20 **Afternoon tea**

3:50	Session 4. From the ground up	CHAIR: Kristen Knight
	Hic sunt leo et dracones	Oliver Knox
	False-wireworms and cotton: pest damage and efficacy of insecticides	Jamie Hopkinson
	Soil organic carbon levels in three Australian cotton production regions: effects of historical climate and field management	Daowei Sun
	Comparative assessment of soil carbon and chemical properties under treated effluent irrigation and dryland management in Vertosols	Guna Nachimuthu
	Uncertainty in nitrogen fertiliser management of cotton crops	Peter Thorburn
	How cotton growers deal with uncertainty in nitrogen fertiliser management and optimisation options	Michelle Miller
	Buried 'Down Under': nitrogen cycling microbes in cotton soils	Gupta Vadakattu
	Effect of enhanced efficiency fertilisers (EEFs) on cotton lint yield under a bankless irrigation system	Elindre Lamprecht
	Enhanced Efficiency Fertilisers (EEFs) in Cotton: More Profit from Nitrogen (MPfN) project summary	Graeme Schwenke
	Soil compaction: A story rooted in science, solutions and sustainability	Blake Palmer

Wednesday 27 August

7:30 Registration desk open (tea and coffee available)

8:00 Housekeeping

8:05	Session 5. From integrated management to beyond the paddock	CHAIR: Tim Weaver
	Plenary: Looking forward, looking back: lessons and perspectives from both early career and senior scientists!	Mary Whitehouse & Sharna Holman
	Bt resistance in <i>Helicoverpa</i> spp. with a genetic lens: A good news story hidden in complexity	Amanda Padovan
	A new Herbicide Resistance Management Strategy for Australian cotton	David Thornby
	Quality seeds for a resilient crop: a novel lab-based assay for cottonseed vigour	Taryn Hunter
	The economic benefits of composting textile waste: process mapping and optimal location	Rajkishore Nayak
	SHIFT: The impacts and learnings from an RD&E project focused on workforce development	Nicole McDonald
	Accelerating precision-breeding through gene-networks for better genomic prediction: cotton fibre quality traits as a case study	Colleen MacMillan
	Cotton to the scaling up of carbon dot production: a review on carbon dots derived from cellulose-based materials	Wenjing Chen
	Translational research at the Future Fibres Facility	Dylan Hegh

10:30 AACS life members morning tea

11:00	Session 6. What's next? The path from innovation to commercialisation	CHAIR: Tonia Grundy
	Plenary: Translating research into industry impact	Anthony Hawes
	Introduction of ThryvOn®; the journey of bringing a new cotton trait to market (almost)	Kristen Knight
	Lessons from commercialisation of cotton sensing technology research	Alison McCarthy
	Turning cotton genomics into real-world impact	Qian-Hao Zhu
	Mapping cotton soil-borne disease within fields with satellite imagery and machine learning	Abhasha Joshi
	Post-consumer textile waste as a reliable source of recycled cotton	Arun Chandra Manivannan
	Launching WAMITT (the Weed Action Management Integrated Threshold Tool) to the Australian cotton industry	Graham Charles
	Micro-credentials for building capacity in the cotton industry	Tim Weaver*

1:00 Lunch

2:00 Board busses to ACRI for Twilight Tour

2:45 Site tours begin

5:30 BBQ dinner at ACRI from 5:30 pm

Busses depart for Narrabri at 7 pm

Thursday 28 August

7:45 Registration desk open (tea and coffee available)

8:25 Housekeeping

8:30 AACS AGM

9:00	Session 7. Impact on and in the cotton industry	CHAIR: Warren Conaty
	Plenary: The secret to impactful research? Nail the fundamentals!	Paul Grundy
	Global Issues for cotton, and how they may impact science	Brooke Summers
	What works? Evaluating interventions to attract young people in cotton	Patricia Colusso

10:00 Morning tea

10:30	Session 8. Thinking like a plant	CHAIR: Oliver Knox
	Handling the heat: photosynthetic diversity among linted cotton species	Demi Sargent
	In-field monitoring of long-season cotton in Central Queensland	Nicholas Stewart
	Managing growth in cotton under future climate conditions: effectiveness of plant growth regulators	Katie Broughton
	Climate change impacts on cotton maturity days across the U.S. cotton belt region	Chiranjibi Poudyal
	Systems biology approach to cotton stress tolerance: integrating morphology, physiology, proteomics and transcriptomics perspectives under heat and drought	Garima Dubey
	Cotton micronaire determined by seed imbibition date, latitude and in-crop temperatures	Tim Weaver
	Visible mechanical damage of cotton seed	René van der Sluijs
	Cotton-based smart textiles towards sustainable innovation	Xin Wang
	Update on <i>Verticillium dahliae</i> alternate hosts	Linda Scheikowski
	Evaluating the farm-level and industry-wide value of host plant resistance in cotton under verticillium wilt pressure	Yunqing Xu
	Host plant resistance in cotton: is there any progress?	Iain Wilson

12:30 Lunch (a 'Student and new cotton researchers networking lunch' will also be held in the Exhibition Room, see Rachael Holloway for more information)

1:30	Session 9. Disease detectives	CHAIR: Warwick Stiller
	Developing strategies to combat emerging pathogen threats in U.S. cotton production	Kaitlyn Bissonnette
	Pathogenicity of <i>Berkeleyomyces basicola</i> and <i>Berkeleyomyces rouxiae</i> to cotton	Chi Nguyen
	Characterisation of <i>Berkeleyomyces rouxiae</i> , causing cotton black root rot disease	Anil Poudel
	The good, the bad and the ugly: identifying verticillium wilt resistance	Xian Yu
	Revolutionising cotton disease assessment: from manual methods to modern solutions	Manish Kumar Patel
	Reoccurring wilt of cotton, uncovering the pathogenesis of <i>Eutypella</i> species	Dinesh Kafle
	Characterisation of <i>Eutypella</i> spp. causing reoccurring wilt in cotton	Muhammad Zahaib Ilyas
	Pathogen suppression assay: a strategic tool for managing soilborne diseases in cotton	Gupta Vadakattu
	Fusarium wilt: the 'Down Under' story. Now with whole genome sequencing!	Ángel Popa-Baez
	Aiming for the bullseye on target spot management in tropical cotton: insights from 2025 fungicide screening trials	Samuel Krekeler
	The battle for the Dawson: can sunn hemp be cotton's underground hero?	Harry Gaston

3:10 Afternoon tea

3:35	Session 10. New horizons: natural resources and the northern frontier	CHAIR: Guna Nachimuthu
	Greenhouse gas emissions of the Australian cotton sector	Maartje Sevenster
	Evaluating IPCC emission factors using field-measured N2O emissions in cotton cropping systems in the U.S.	Nithya Rajan
	Impacts of landscape connectivity on bat activity in cotton and value of acoustic monitoring technology: benefits for natural pest suppression	Maggie Campbell-Jones
	A five year study using birds to monitor biodiversity on a North West NSW farm	Guy Roth
	Measuring biodiversity on cotton farms - a science based and cost effective methodology to align with global sustainability frameworks	Andrew Davidson
	Enhancing the resilience of the Northern Territory's rain-fed cotton; a comprehensive approach to yield prediction and water management	Jyothi Bhandari
	Challenges and prospects of cotton farming in the tropics: lessons for northern Australia	Getahun Kassa
	Northern Survivor: can we outwit, outplay, and outlast <i>Spodoptera litura</i> ?	Sharna Holman
	Closing statements	

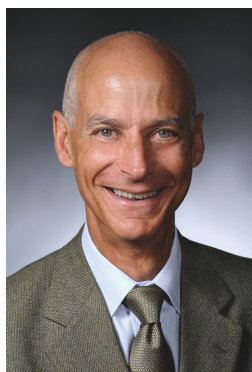
6:30 AACS Awards Dinner at Narrabri RSL from 6:30 pm

*Presenter is not the primary author

Plenary speakers

The fabric of a family tree: a journey through the evolutionary history of cotton

Cotton has a remarkable evolutionary history that began with transoceanic dispersal events some millions of years ago. Still today, new species are being discovered or resurrected. The cotton genus (*Gossypium*) consists of about 50 species, including two diploid and two polyploid species that were each independently domesticated thousands of years ago. This natural evolutionary diversification, followed by parallel strong directional selection under domestication, provide a model framework for exploring the comparative basis of domestication, the origin of form and of diversity in nature, and the evolutionary consequences of genome doubling.



Jonathan F. Wendel is Distinguished Professor in the Department of Ecology, Evolution, and Organismal Biology at Iowa State University. His research focuses on mechanisms underlying plant genomic and phenotypic diversify, with a special focus on the phenomenon of whole genome doubling, or polyploidy. Most of his ~340

publications focus on the cotton genus (*Gossypium*), in which two diploid and two polyploid species were each independently domesticated thousands of years ago. This natural evolutionary diversification, followed by parallel strong directional selection under domestication, provide a model framework for exploring the comparative basis of domestication, the origin of form and of diversity in nature, and the evolutionary consequences of genome doubling. His research has helped shape the field, as documented in citation metrics (Google Scholar 55,000 citations; h-index of 113). Professor Wendel's contributions have been recognized in all three major domains of professorial life: Master Teacher (2005) for his role as graduate mentor and educator; Outstanding Achievement in Departmental Leadership (2009), for leadership excellence during his 16 years (2002-2017) as department chair; and Distinguished Professor (2012) for national research prominence. His work has garnered national recognition, including election as an AAAS Fellow (2010), Distinguished Fellow of the Botanical Society of America (2015), Distinguished Scholar, Crop Science Society of America, (2015), the American Academy of Arts and Sciences (2023), and the United States National Academy of Sciences (2023).

Making your stats sizzle

To have impact, research results need to be reputable and replicable. Being able to support (or disprove) that hypothesis with solid numbers is the cornerstone of research. So why do most of us equate statistics with a trip to the dentist – necessary but thoroughly unpleasant? Dr Alison Kelly will lead you by the hand through the wonderful world of statistics and probability. She will highlight the importance of sound statistical practice, especially that of robust research design and rigorous analysis, and will provide an overview of key statistical concepts and advances in the field as well as the next frontier in statistics.



Alison Kelly began working as an Applied Biometrician at the Department of Primary Industries, Queensland, Australia in 1987 and completed her PhD in Statistics on a part-time basis at the University of Queensland. She has worked extensively on statistical applications in the agricultural sphere, with her practical interests revolving around spatial analysis of field trials, statistical genetics,

multi-phase experimental design for laboratory studies and high-dimensional spectral and sensing data.

Alison has had a close collaboration with the Grains Research and Development Corporation in Australia and in 2015, she obtained the GRDC Seed of Light award for outstanding scientific communication, making statistics accessible to a broad range of agricultural research scientists. More recently, Alison has joined the Qld Alliance for Agriculture and Food Innovation (QAAFI) Institute at the University of Queensland, and is currently a Theme Leader of Predictive Agriculture for Improved Productivity and Value. One current project highlight is working on a Gates Foundation funded collaboration in Ethiopia. In this project, Alison trains and mentors biometricians and crop breeding teams in implementing modern statistical methods for plant breeding research at the Ethiopian Institute of Agricultural Research.

Translating research into industry impact

Many working in research are motivated by a desire to develop innovative science that ultimately enacts change in the world. However, research impact has, and arguably continues, to be measured by publication metrics. As a consequence of this disconnect, funding bodies and research organisations have an increased desire for realised industry impact. Anthony Hawes, company founder of AgBiTech, will share some of the common pitfalls when translating research to industry impact. Through case studies based on experiences highlighting success and failures, he will highlight what researchers should be thinking about at the inception and during the life of research projects to give the best chance of success surrounding impact.

Anthony will also share expected timelines required to translate a research idea to a product or management/policy change. This plenary is a must see for all researchers who want their research to extend beyond a journal publication.



Anthony Hawes is the Founder and CTO of AgBiTech, a global agricultural biotechnology company specialising in baculovirus-based insecticides and attract-and-kill products for caterpillar pest control in field crops and horticulture. With over 20 years of experience translating scientific research into commercial products, Anthony

has led continual major innovations in large-scale insect production and biological pest control. He is passionate about achieving real-world impact through in-house R&D, industry collaboration, strategic development, and on-farm implementation.

The secret to impactful research? Nail the fundamentals!

Impactful field research requires not only technical expertise, but also curiosity, hard work, an in-depth understanding of the farming system, and the development of constructive relationships within both the scientific community and the broader industry. Dr Paul Grundy is one of the Australian cotton research community's senior scientists. In this presentation, Paul will outline examples of research that he has been involved with and highlight the fundamental aspects for success. This talk will challenge you to think about how you approach research and what you could do differently in your situation to deliver impactful research for the Australian Cotton Industry.



Paul Grundy is a Principal Research Scientist with the Queensland Department of Primary Industries and a Technical Lead with CottonInfo for both IPM and Northern Australia. For the last 25 years, Paul has worked on a wide range of pest management and agronomy projects across all cotton growing regions, from Griffith in southern NSW to the Ord

in northern WA. Paul received the Australian Entomological Society's Phil Carne prize in 2002 for his PhD research and has also received two major cotton industry awards: the Chris Lehmann Young Cotton Achiever of the Year (2007) and the Cotton Seed Distributors Researcher of the Year (2017); the latter for research done in collaboration with Dr Stephen Yeates of CSIRO. He also served as President of the Australian Association of Cotton Scientists from 2017 to 2023.

Much of Paul's work has been field-based applied research focussed on developing improved techniques for cotton production and pest management. A highlight of his career has been investigating production strategies to reduce the negative impacts of climatic risks in Central Queensland. Growers who adopted practices arising from that research saw average yield increases of 25-35%, with those gains reflected in regional production statistics since 2017. More recently, he has worked on improving production strategies for northern Australia and sought to re-affirm more sustainable practices for early season IPM in high yielding Bollgard® 3 systems.

Looking forward, looking back: lessons and perspectives from both early career and senior scientists!

Research is constantly evolving and changing- to the point where scientists are at times forced to be the ultimate career contortionists. Furthermore, as a direct result of science outputs, the industries that our research serve also change. Therefore, we stand to learn a lot from our experienced, senior researchers. But in our ever-changing world, it is also valuable for our emerging leaders, who enter research with enthusiasm and new perspectives, to respectfully question the advice of our scientific sages. We also know that there's more constants in life than death and taxes, where some challenges and opportunities stay the same. Either way, we have substantial technical and soft skills to learn from new perspectives and the experiences of others.

This plenary is a double act, brought to you by senior animal behaviourists Dr Mary Whitehouse, and soon-to-be-Dr Sharna Holman. Mary has a diverse background in terms of research foci, industry and location all thread together with a common theme of animal behaviour. Sharna has worked in the cotton industry in research extension and is studying her PhD on the survival of *Spodoptera* sp. in Bollgard cotton systems in Northern Australia. Through sharing their research experiences and outputs, Mary and Sharna will paint a picture of where we have come from, and where we are going to in terms of integrated pest management and cotton industry challenges, as well as the skills and behaviours we need for the future.



Mary Whitehouse has nearly 40 years of research experience and over 100 publications, reports and conference proceedings with over 2500 citations. She started her career in behavioural ecology, working on thieving spiders in New Zealand, then moved onto ant wars in Venezuela, followed by social spiders in Israel. This led to

studying Integrated Pest Management (IPM) in Australian cotton where she worked for 20 years from 2001 to 2021, exploring predator/prey interactions and the factors that can make an IPM system successful in an industry. She then applied the insights gained from working on IPM in cotton to other systems, including Australian urban environments, the New Zealand pastoral system, the Australian macadamia industry, and managing varroa mites in bees. She is now able to come full circle and use her experiences of IPM in other industries to re-examine the tool of IPM in today's Australian cotton industry.



Sharna Holman is a Development Extension Officer with the Queensland Department of Primary Industries and a Technical Lead with CottonInfo for Biosecurity and Disease. She is also finalising a PhD thesis investigating the survival of *Spodoptera litura* (cluster caterpillar) in cotton crops in northern Australia. Sharna's

cotton career began with a CRDC Summer Scholarship at ACRI in Narrabri, working with Dr Mary Whitehouse on Bt resistance in *Helicoverpa punctigera*. In the decade since, she has been based in both central and southern Queensland and has recently spent several cotton seasons undertaking trial work at Kununurra in WA, supporting the sustainable expansion of cotton in northern Australia. Sharna has been instrumental in driving industry-wide awareness of the importance of farm biosecurity practices, with more than 50% of Australian cotton farms now adopting a farm biosecurity plan. In recognition of her contribution to the industry, Sharna received the CRDC 2024 Chris Lehmann Young Cotton Achiever of the Year award. Sharna's approach of blending practical field engagement with scientific research is strongly focused on building industry resilience through improving pest management and on-farm biosecurity preparedness.

Conference abstracts

Abstracts are arranged alphabetically by primary author, with the presenter at this conference indicated in bold.

Irrigation mapping and monitoring using Earth observation data for cotton farming in Australia

Rajitha Athukorala^{1,2}, Joost Brombacher³, Steven Wonink³, Brian Jackson⁴, and R. Willem Vervoort^{1,2}

¹ARC Industrial Transformation Training Centre in Data Analytics for Resources and Environments, Sydney; ²School of Life and Environmental Sciences, The University of Sydney; ³eLEAF B.V., Amersfoort, The Netherlands; ⁴WaterTechnology Pty, Ltd., Notting Hill, Victoria

Water availability is a key constraint for cotton and grain production in Australia, making efficient irrigation critical for sustainable agriculture. With climate change intensifying water stress, the need for timely, scalable monitoring of irrigation practices is more urgent than ever.

This two-fold presentation highlights advances from two EO-based projects: the completed WaterSENSE and ongoing REINFORM. Funded by the EU's Horizon 2020 programme, WaterSENSE developed tools for near real-time irrigation mapping, including the ETLook evapotranspiration algorithm (Pelgrum et al., 2012), a Hydrological Similar Pixels algorithm for irrigation quantification (Brombacher et al., 2022), and radar-based rainfall products.

Building on these outputs, REINFORM explores several EO-based approaches to improve field scale irrigation monitoring. Among these is a novel method for predicting irrigation volumes using Sentinel-1 SAR and Generalised Additive Model. The approach detects changes in backscatter between irrigated cotton fields and reference plots identified using NDVI from Sentinel-2. It addresses Sentinel-1's irregular revisit times by dynamically segmenting time series to allow continuous predictions. Inputs include rainfall and ET data from WaterSENSE. Data processing is done using the Google Earth Engine Python API (Gorelick et al., 2017), and model fitting in R using mgcv. Early results show strong out-of-sample performance and promising potential for scalable application.

Keywords: irrigation, evapotranspiration, sustainable, earth observation

Disentangling vapour pressure deficit effects: independent roles of temperature and humidity in cotton leaf gas exchange

Mick Bange¹, Katie Broughton², David Tissue³, Candy Theerasutthikul³, Renee Smith³, Rob Sharwood³ and Paxton Payton⁴

¹Cotton Seed Distributors; ²CSIRO; ³University of Western Sydney; ⁴USDA

Understanding physiological impacts of vapour pressure deficit (VPD) are critical for predicting crop responses to climate change. This study uniquely examined how identical VPD values, generated from distinct combinations of air temperature and absolute humidity, affect leaf photosynthesis, stomatal conductance, and transpiration in cotton. Plants were cultivated under controlled glasshouse conditions at varying soil water contents. Leaf gas exchange was quantified with a Licor-6800 photosynthesis system across diverse VPD levels systematically manipulated via independent variations in air temperature and humidity.

Results revealed significant variability in responses at identical VPDs, driven primarily by differing humidity and temperature combinations. Transpiration and stomatal conductance increased at higher temperatures compared to equivalent VPD at lower temperatures, demonstrating substantial variations (e.g., transpiration ranged from 6.3 mmol at 24.8°C to 11.0 mmol at 36.2°C at VPD=2.0 kPa for well-watered and 5.7 to 9.0 mmol for water stressed plants in similar conditions). Photosynthesis showed a nuanced interaction with these factors, indicating complex internal CO₂ dynamics mediated by stomatal behaviour. This study underscores the inadequacy of VPD alone as an indicator of environmental stress, highlighting the necessity to explicitly consider its constituent temperature and humidity factors for understanding physiological responses in varying climates.

Keywords: leaf gas exchange, temperature, humidity, vapour pressure deficit

Enhancing the resilience of the Northern Territory's rain-fed cotton; a comprehensive approach to yield prediction and water management

Jyothi Bhandari^{1,2}, Stephen Xu^{1,2}, Dylan Irvin², Edward Mwando^{1,3}

¹Research Institute for Northern Agriculture, Faculty of Science and Technology, Charles Darwin University; ²Research Institute for the Environment & Livelihoods, Faculty of Science and Technology, Charles Darwin University; ³Department of Agriculture and Fisheries, Katherine Research Station

Australian cotton offers high profitability and the potential to become a cornerstone crop in the Northern Territory (NT). Rainfed cotton in the NT depends on wet season rainfall, making it less water-intensive but more vulnerable to variable rainfall than irrigated systems. This research aims to improve understanding of cotton's flexibility to water availability under NT's rainfed conditions and support the development of a resilient production system. It will examine how changes in physiological and morphological traits across growth stages relate to post-wet-season water use and water use efficiency. The project will also assess the role of mulches and soil amendments in conserving soil moisture and enhancing cotton establishment.

Field trials will include frequent physiological and morphological measurements, along with volumetric and isotopic analysis ($\delta^{18}O$, $\delta^{13}C$) to quantify water use. Simulations will assess how soil temperature and moisture affect germination. The study will also investigate the impact of mulching and amendments on soil moisture, temperature, and yield. The research will (1) quantify key physiological and morphological processes, (2) assess how soil moisture dynamics affect cotton growth, and (3) evaluate soil management strategies to improve establishment. Findings will guide irrigation strategies and promote sustainable, water-efficient cotton production in northern Australia.

Keywords: unfavourable rainfall, drought, waterlogging, extreme temperature, seed establishment, physiological measurements, mulch, water use efficiency.

Developing strategies to combat emerging pathogen threats in U.S. cotton production

Kaitlyn Bissonnette

Cotton Incorporated

Comprehensive research efforts aimed at combating emerging and re-emerging pathogen threats in crop production with experts ranging from basic to applied sciences are often difficult to coordinate at the public level. Further complicating these efforts are extreme weather events, changing climatic conditions, and shifting production ranges. One such reemerging disease complex in the United States is areolate mildew present in the southeastern and mid-southern cotton producing states. Globally, this disease is prominent in Brazil and is comprised of the same combination of species; however, the disease areolate mildew also manifests in other regions of the world varying only in the predominant pathogen causing disease. Prior to 2017, areolate mildew remained localised to a focused area in three U.S. states but has since expanded into nine states.

Researchers in eleven states with expertise in plant breeding, extension plant pathology, and molecular plant pathology have come together to evaluate and address the impacts of this disease on cotton production and to develop solutions for growers both locally and globally.

Keywords: pathology, areolate mildew, emerging threats

Managing growth in cotton under future climate conditions: effectiveness of plant growth regulators

Katie Broughton¹, Mick Bange¹, David Tissue², Candy Theerasutthikul^{2*}, Renee Smith^{2*}, Kris Bogdanoff^{*}, Chris Nunn¹, Sandra Williams¹

¹CSIRO Agriculture and Food, Narrabri; ²Western Sydney University, Richmond NSW; *Presently working with other organisations

Climatic changes have already occurred throughout Australian cotton regions and future climate scenarios predict higher atmospheric CO₂ concentrations and increased temperatures, presenting both challenges and opportunities for adaptation and optimisation of Australian cotton systems.

Elevated CO₂ (640 ppm) and warmer temperatures (36/22°C day/night) significantly enhance vegetative biomass growth in cotton but negatively impact reproductive biomass, potentially affecting yield. Plant growth regulators such as mepiquat chloride (MC) and aminoethoxyvinylglycine (AVG) could manage vegetative growth and fruit retention under these changing conditions.

Experiments conducted in controlled glasshouse conditions showed MC application (600 ml ha⁻¹ and 900 ml ha⁻¹) effectively controlled vegetative growth at ambient temperatures; however, its efficacy diminished under combined elevated temperature and CO₂ conditions. AVG application increased vegetative biomass but reduced fruit biomass significantly, indicating unintended developmental impacts on cotton fruit. Additionally, both growth regulators influenced leaf-level physiology—MC reduced stomatal conductance and improved water-use efficiency, while AVG reduced photosynthesis and water-use efficiency initially, but effects moderated over time.

These findings suggest adjustments to current management practices using growth regulators may be necessary to optimise cotton production under anticipated future climates.

Keywords: agronomy, mepiquat chloride, physiology

Opportunities to utilise eddy covariance to explore water and carbon dynamics in Australian cotton systems

Zach Brown, Mark Kitchen, Darin Hodgson, Ben MacDonald

CSIRO

Water availability fundamentally constrains cotton production. Maximising fibre yields while minimising water use poses a challenge for Australia's cotton production. While non-irrigated cotton fields could be an opportunity to minimise water use, irrigated production maximises yields through reduced water stress.

Quantitative comparison of physiological performance between irrigated and dryland practices remains limited and is a key step to assessing the trade-offs associated with cotton production in Australia. Eddy covariance towers are one such way to measure water use efficiency and partition land surface exchange of carbon into net primary productivity, gross primary productivity (total carbon uptake), and ecosystem respiration (carbon emission).

Here, we present preliminary findings from flux towers deployed at dryland and irrigated sites and provide an overview of the work we plan to accomplish with these measurements.

Keywords: eddy covariance, carbon cycling, water use efficiency

Impacts of landscape connectivity on bat activity in cotton and value of acoustic monitoring technology: benefits for natural pest suppression

Maggie Campbell-Jones¹, Susan Fuller², Paul Roe^{2,3} and Stuart Parsons^{1,4}

¹University of the Sunshine Coast; ²Queensland University of Technology; ³James Cook University; ⁴University of Canterbury

Pest suppression by insectivorous bats is estimated to save the cotton industry millions of dollars annually, however there is limited information available to farmers on attracting and supporting these species.

This study aims to assess the effects of landscape connectivity on insectivorous bat diversity and activity on cotton farms. We will also examine the importance of integrated pest management (IPM) strategies and other key habitat features, such as woodland patches and watercourses. Eighteen passive acoustic monitors have been placed on cotton farms in the Gwydir Valley, New South Wales. We placed the acoustic monitors at the boundary of cotton fields and terrestrial vegetation (6 sensors) or riparian areas (6 sensors), and within cotton monocultures (6 sensors). Artificial intelligence-based software is being used to map the activity of bat species known to provide pest control services in cotton.

We will be presenting preliminary results from the 2024/25 cotton growing season and outline future project outcomes; including the development of novel acoustic sensors embedded with the artificial intelligence-based software. The long-term goals of this project are: (1) to demonstrate the value of measuring on-farm biodiversity using novel wireless acoustic monitors, and (2) provide farmers with additional pest and land management strategies, including improving landscape connectivity, with the support of the Cotton Research Development Corporation (CRDC).

Keywords: biodiversity, landscape connectivity, integrated pest management

Micro-credentials for building capacity in the cotton industry

Stephen Cattle, **Tim Weaver** and Guy Roth

The University of Sydney

The University of Sydney is launching a new cotton production course funded by the Cotton Research and Development Corporation (CRDC) in 2026, comprising of a series of micro-credentials. The micro-credentials aim to build skills and capacity across the Australian cotton industry. The series of courses will commence with three targeted micro-credentials in 2026, each addressing key areas of current cotton production. Final topics will be determined through consultation with industry stakeholders by the Cotton Course Advisory Committee, consisting of industry professionals. Potential focus areas include cotton agronomy, digital and data, and advanced agronomy.

Each micro-credential will deliver ~50 hours of learning via a blended format of in-person, hands-on training based at the University's Narrabri campus. The in-person sessions will include field practicals, data labs, and production workshops. Course development and delivery will be led by University of Sydney academics in collaboration with Cotton Seed Distributors (CSD), with support from CottonInfo and other industry experts.

The program, targeting new industry entrants, growers and consultants, will launch in 2026. Participants will earn a digital certificate for each completed micro-credential.

Keywords: education, cotton, micro-credentials

Post-consumer textile waste as a reliable source of recycled cotton

Arun Chandra Manivannan¹, Logeshwaran Panneerselvan¹, Gunasekhar Nachimuthu² and Thava Palanisami¹

¹Environmental Plastic Innovation Cluster (EPIC), Global Innovative Centre for Advanced Nanomaterials (GICAN), College of Engineering, Science and Environment, The University of Newcastle, NSW, ²NSW Department of Primary Industries, Australian Cotton Research Institute, Narrabri

Cotton is a high-value natural fibre whose primary use is in the clothing and fashion. However, driven by fast fashion trends, and impulsive buying behaviour clothing consumption increased resulting, higher demand, and significant carbon footprint associated with cotton cultivation and processing. Despite its resource intensity, nearly 90% of post-consumer cotton ends up in landfills, representing a critical loss of valuable material and further burdening the environment.

Recovering cotton from post-consumer textile waste offers a promising opportunity to reduce reliance on virgin cotton, alleviate pressure on agricultural systems, and lower overall emissions. Yet, current recycling technologies do not effectively return cotton to fibre form for textile-to-textile recycling; instead, they often degrade cotton into lower-value products or pulp. Moreover, these existing methods can contribute to microplastic contamination in both recycled products and the environment.

In our work, we are developing a novel hybrid recycling approach that enables closed-loop recovery and reuse of cotton fibres, while minimizing contamination and reducing emissions. Through life cycle assessments and emission factor analyses, this approach aims to position post-consumer cotton waste as a reliable, circular resource, ultimately supporting a more sustainable and resilient textile industry.

Keywords: post-consumer textile waste, recycled cotton, closed-loop recycling, life cycle assessment

Launching WAMITT (the Weed Action Management Integrated Threshold Tool) to the Australian cotton industry

Graham William Charles¹ and David Francis Thornby²

¹NSW Department of Primary Industries and Regional Development; ²Innokas Intellectual Services

A project to define a weed threshold model for cotton was initiated by Dr Ian Taylor in 2002 and continued by Dr Graham Charles for more than a decade. It ultimately included assessing weed competition on more than 4500 plots, with weeds established at or post-crop emergence, and removed at predetermined points during the season. Weed and crop density, height, leaf area, and biomass were measured at each time of weed removal.

A basic weed management threshold model developed from a subset of this data was released to the Australian cotton industry in 2008. However, analysing the full data set proved to be challenging before changing to R statistical software in 2016, leading to the publication of a series of papers. The work began with a simple model showing that the impact of weed competition on cotton yield is a function of weed height and biomass. Differences between weed species and types (from a Noogoora burr to a barnyard grass) are just a function of weed height and biomass.

Later, more complex models have led to the development of WAMITT, the ultimate guide to the timing of weed controlled in cotton and the potential yield losses from delaying control. WAMITT enables growers to make weed control decisions after comparing the predicted yield reduction without control to the cost of the proposed control tactic. It allows growers to explore scenarios including the timing and level of weed competition, varying the timing and cost of weed control and projected crop yield.

Keywords: weed control, threshold, competition, yield loss

Cotton to the scaling up of carbon dot production: a review on carbon dots derived from cellulose-based materials

Wenjing Chen¹, Hong Yin², Ivan Cole², Shadi Houshyar¹ and Lijing Wang¹

¹School of Engineering, RMIT University, Melbourne; ²School of Engineering, Australian National University, Canberra

Carbon dots (CDs) are luminescent carbon nanoparticles with fast and cheap synthesis approaches. They have significant applications in biomedical, sensing, energy, agricultural, and environmental fields due to their remarkable optical, physical, biological, and catalytic properties. Numerous studies have focused on utilising cellulose-containing waste as a renewable precursor for CDs synthesis to minimise environmental waste, while large-scale synthesis remains a significant challenge.

This review summarises and analyses the latest progress on the synthesis approaches, properties and applications of CDs derived from various types of cellulose-based waste materials. Notably, after comparative analysis considering raw material availability, cellulose purity, ease of pre-treatment, and consistency in CD quality, cotton-based wastes with up to 90% cellulose content, simpler methods on both pre-treatment and synthesis methods and relatively consistent performance of CDs, show the greatest potential for industrial production. However, the barriers include the complexity of the synthesis and purification processes, as well as the energy consumption due to the high-temperature and high-pressure conditions. These challenges are critical to address for transitioning CDs from laboratory research to practical applications.

Keywords: cotton, scaling up, carbon dots, cellulose-based materials

What works? Evaluating interventions to attract young people in cotton

Patricia Colusso, Nicole McDonald and Amy Cosby

CQUniversity

Young people are vital to the ongoing development and implementation of agricultural technology and the viability of rural and regional communities, with their enhanced engagement and retention offering the potential to boost on-farm profitability, sustainability, value chain competitiveness and adaptive capacity in Australian cotton farming. A CQUniversity project, funded by CRDC, investigated how industry can attract and retain young people on farms and into cotton careers.

High school is a critical time for career choices, influenced by exposure and knowledge provided by teachers. A pilot project aimed to evaluate cotton industry knowledge and perceptions of six high school classes and their teachers across NSW, ACT, and QLD. The project consisted of three touchpoints across different interventions: 1) Industry-designed lesson plan delivered by the teacher, 2) CQUniversity Agri-tech incursion, and 3) Excursion to a local cotton enterprise. An initial pre-survey was collected, followed by post-surveys after each intervention, to evaluate the effectiveness in engaging, and developing students' knowledge and perceptions. It was hypothesised that interactive interventions such as incursions and excursions would have a greater positive effect on knowledge and perceptions. This presentation will discuss our findings and provide recommendations for future engagement, providing industry with the opportunity to take a targeted approach on attracting and inspiring high school students into cotton careers

Keywords: young people, cotton industry, cotton careers, high school students, intervention

Leveraging pan-genome structural variation annotation to enhance genomic prediction in the Australian cotton program

Samuel Craig

CSIRO, Monash University

Proposed project: A recently generated cotton pan-genome of over ten elite Australian lines will soon reveal thousands of structural variants (SVs) that likely influence yield and quality traits. To translate this high-resolution catalog into existing breeding data, we must link pan-genome SVs to the 9 K DArT SNP array used by CSIRO to genotype its lines. The 9 K array, while cost-effective, can only 'see' SVs in very strong linkage disequilibrium (LD) with its markers; rare or independently segregating SVs may be entirely missed, creating blind spots in genomic prediction models.

First, we will quantify SV 'taggability' by calculating LD between each pangenome SV and its nearest 9 K SNP, determining which variants are well or poorly detected by the array. Next, we will estimate prediction loss by fitting genomic prediction models, with and without proxy SV information, to assess how untyped SVs constrain yield-trait accuracy. Finally, we will pilot inference strategies that could operate on the existing 9 K data, such as ancestral recombination graph methods that infer untyped SVs from shared haplotype patterns to infer untyped SVs without requiring additional genotyping resources.

By identifying which SVs the 9 K array misses and evaluating the prediction accuracy gains from inferred variants, this proposed work will guide more accurate, cost-effective genomic prediction strategies for Australian cotton breeding.

Keywords: structural variants, SV, pan-genome, pangenome, SNP array, linkage disequilibrium, LD

Unravelling the complexity of limited water decisions

Sarah Dadd, Malem McLeod and Daowei Sun

NSW DPIRD

In an environment increasingly characterised by unpredictable rainfall and variable water availability the CRDC DAN2203 Limited Water Decision Support (LWDS) project explored how growers manage irrigation when crop evapotranspiration demands are not fully met. Defining this as partial irrigation the project undertook a comprehensive evaluation of how partial irrigation is applied within the Australian cotton industry, focusing on how growers manage water and scenarios where it is adopted. Due to increasing climatic variability and water scarcity, the project identified agronomic and irrigation management practices under these constrained conditions.

Drawing on grower experience and historical data, the project describes key strategies adopted over the past three decades, including water budgeting, strategic irrigation scheduling and agronomic interventions such as row configuration, cultivar selection, and nutrient management. The project also explored more abstract factors such as the effect of labour availability on water management decisions.

While partial irrigation has demonstrated potential to enhance water productivity, the analysis highlights confounding factors such as inconsistent terminology, variability in water application volumes, and difference in row spacing.

This project was made possible through collaboration between the CRDC, NSW DPIRD, and the generous contributions of cotton growers.

Keywords: limited water, water decisions

Measuring biodiversity on cotton farms – a science based and cost-effective methodology to align with global sustainability frameworks

Andrew Davidson¹, Michael Petter¹, Shannon Mooney¹ and Stacey Vogel²

¹Southern Queensland Landscapes; ²CRDC

There is increasing pressure on cotton and other agriculture industries to measure biodiversity (and other sustainability) impacts and set priorities grounded in science. The PLANET. PEOPLE. PADDOCK. goal is to improve biodiversity condition on farms and across the cotton landscape.

The Mapping Woody Vegetation Project provided a response to the Cotton Industry's desire to set baselines and identify condition priorities for biodiversity for inclusion in the sustainability framework.

The Project provided a methodology using GIS to measure the following 2020 baseline benchmarks on cotton properties across Australia:

- the extent of regulated woody vegetation
- the area of significant connected nodes on regional linkages.

The aim was to develop a pragmatic and cost effective but robust process that aligns on-farm actions not just to regional priorities, but also to three major emerging global frameworks: Science Based Targets for Nature, the Post-2020 Biodiversity Framework and Taskforce for Nature Related Financial Disclosures.

A series of workshops, technical meetings and grower consultation beginning in June 2022 supported the concept that the area of woody vegetation on cotton farms in hectares was an acceptable indicator of biodiversity on cotton farms. The project funded through CRDC in collaboration with Southern Queensland Landscapes NRM produced an innovative product with direct economic and environmental benefits to the cotton industry.

Keywords: biodiversity, cotton, sustainability framework, science based targets for nature, taskforce for nature related financial disclosures, mapping

Quantifying cotton growth rate from multispectral UAV imagery at plot scale

Francesca Devoto¹, Davoud Ashourloo¹, Yan Zhao¹, Ruizhu Jiang¹, Rakesh Awale², Michael Bell², Tim McLaren², Carlos Camino³, Michael Bange⁴, William Woodgate⁵, Scott Chapman² and Andries Potgieter¹

¹The University of Queensland, Queensland Alliance for Agriculture and Food Innovation, Brisbane; ²The University of Queensland, School of Agriculture and Food Sustainability, Brisbane; ³Lab. Geo-information Science and Remote Sensing, Wageningen University, Netherlands; ⁴Cotton Seed Distributors Ltd, Wee Waa, NSW; ⁵The University of Queensland, School of Environment, Brisbane.

Recent advances in remote sensing offer new opportunities to monitor cotton's complex growth dynamics under varying genetic, environmental, and management ($G \times E \times M$) conditions. Traditional measurements of plant height and biomass are laborious and limited in scale, making it difficult to support timely, data-driven decisions. To address this, eight multispectral UAV images were captured over a cotton trial at the University of Queensland (2023–2024 season) and plot-level vegetation indices (VIs) were extracted. A Savitzky–Golay filter was used to reconstruct smooth VI growth curves across growing degree days. From each curve, shape metrics for single and multi-date (i.e. daily average growth rate (GR) and area under the curve (AUC)) were calculated. Different machine learning models (i.e. support vector regression, random forest, and gaussian process regressor) were trained to predict final plant height, aboveground biomass, and lint yield. Models achieved strong accuracy: $R^2 = 0.83–0.86$ and $RMSE = 0.04–0.05$ m for height; $R^2 = 0.85–0.86$ and $RMSE = 0.72–0.78$ Mg/ha for biomass; $R^2 = 0.79–0.84$ and $RMSE = 118–134$ kg/ha for yield. These results demonstrate that UAV-derived VIs and SG-based growth metrics provide a scalable, accurate framework for real-time monitoring and prediction of key cotton traits.

Keywords: cotton canopy traits, timeseries analysis, machine learning, remote sensing

Systems biology approach to cotton stress tolerance: integrating morphology, physiology, proteomics and transcriptomics perspectives under heat and drought

Garima Dubey¹, Demi Sargent¹, Brian J. Atwell², David Tissue¹, Warren Conaty³, Zhonghua Chen⁴ and Robert Sharwood¹

¹HIE, Western Sydney University; ²Macquarie University; ³CSIRO Agriculture and Food, Narrabri; ⁴University of Adelaide

Cotton, a sub-tropical crop and the world's leading source of plant fibre and by-products, faces major challenges from climate-induced heat and drought stress. Domesticated cotton varieties exhibit limited resilience due to genetic bottlenecks, whereas wild relatives offer untapped genetic diversity and adaptive traits. This study aims to identify and understand the underlying photosynthetic, cellular transport, biochemical, and molecular mechanisms that contribute to drought tolerance in wild cotton species. We adopt a comprehensive systems biology approach by integrating morphological, physiological, proteomic, and transcriptomic analyses to unravel the complex stress response mechanisms in wild cotton species exposed to drought. Preliminary findings reveal that wild cotton species exhibit superior tolerance through physiological and biochemical adjustments that enhance resilience to drought stress. RNA-seq and proteomics analysis have identified differentially expressed genes and proteins associated with key regulatory pathways. Further investigation into aquaporins, which are critical for solute, CO₂, and water transport, will clarify their role in environmental adaptation in wild cotton species. These findings will not only provide valuable insights into cotton's stress adaptation mechanisms but will also help identify potential targets for the developing climate-resilient, high-yielding cotton cultivars through advanced breeding strategies.

Keywords: drought, heat stress, cotton, wild cotton relatives, proteins, aquaporins

Can genomic selection fast-track the development of rain-grown cotton varieties?

Qian Feng, Pierce Rafter, Iain Wilson, Zitong Li, Warren Conaty

CSIRO Agriculture and Food, Canberra

To future-proof the Australian cotton industry, there is a need to increase the productivity of rain-grown cotton production. Such a future, with a greater emphasis on rain-grown production systems, may necessitate the development of new varieties better matched to rain-grown production systems. Genetic selection for high performing plants could fulfill this role but would first require an understanding of the relationship between environmental conditions and crop performance. To achieve this, we use various statistical approaches (including multi-layer group-lasso and Bayesian generalised additive model selection) to quantify the impact of environmental parameters (i.e., covariates, including rainfall, temperature, humidity, and solar radiation data) on fibre yield and quality traits of rain-grown cotton. These covariates are then used to account for environmental and/or genotype-by-environment interaction effects in genomic prediction models. We observed that environmental covariates had a significant impact on the performance of genomic prediction models, where some environmental covariates simultaneously affected multiple traits. Conversely, the proportion of the modelled genetic effects were smaller, and no genotype-by-environment interaction was observed. In this talk, the results of this study will be interpreted to determine the potential use of genetic prediction tools in breeding decisions when developing new rain-grown cotton varieties.

Keywords: rain-grown cotton, genetic selection, statistical approaches, genotype-by-environment interaction

The battle for the Dawson: can sunn hemp be cotton's underground hero?

Harry Gaston¹, Gail Spargo¹, Linda Smith¹, Dinesh Kafle¹, Shiming Liu², Warwick Stiller² and Paul Grundy¹

¹Queensland Department of Primary Industries; ²CSIRO

Sunn hemp (*Crotalaria juncea*) has been used overseas as a cover crop for nematode suppression and nitrogen fixation. This legume has not been readily available in Australia until recently when AGF seeds were granted import approval for planting seed in 2022. Reniform nematodes (*Rotylenchulus reniformis*) are a serious pest of cotton and were first detected in the Dawson Valley in 2012. This pest has caused considerable yield loss with the only control measure having been crop rotation with non-host species like sorghum. However, the forfeiture of a cotton crop to accommodate a low value summer grain crop that provides temporary relief for 1-2 seasons at best on high value irrigation country is uneconomic.

Recent research has explored the use of sunn hemp as a short-term cover crop, grown between cotton crops for nematode suppression. This may become part of an integrated farming system that could also include future cotton varieties with resistance to reniform nematodes.

This presentation will introduce you to Sunn hemp and share the results of recent research in CQ where it has successfully suppressed nematodes resulting in improved cotton yield. Finally, the talk will also consider its potential to be utilised as a dual-purpose cover crop in warm regions for the purpose of pest suppression, nitrogen fixation and soil health.

Keywords: reniform, sunn hemp, cover crops

From waste to resource: technological and biological insights into textile composting systems

Tarun Grover, Lijing Wang, Rajiv Padhye and Raj Kishore Nayak

RMIT, Melbourne

Textile composting is emerging as a sustainable solution to divert growing textile waste from landfills, combining technological advancements and biological processes for efficient decomposition. This review examines the four key stages of textile composting—

(1) waste collection, (2) sorting, cleaning, and shredding, (3) the composting process, and (4) compost quality assessment—highlighting the interplay between technology and biology. Innovations in automated sorting systems demonstrate superior efficiency over manual methods, particularly for industrial-scale operations, while shredding technologies balance precision (manual) and scalability (mechanical).

Biologically, aerobic and anaerobic composting methods are critically evaluated. In-vessel aerobic systems excel in decomposing natural fibres like cotton and flax, yielding agriculturally viable compost, whereas vermicomposting—despite its ecological benefits—shows limited efficacy for most textiles. Anaerobic digestion, though valuable for biogas production, lags in textile degradation due to prolonged retention times and incomplete fibre breakdown. The study further outlines standardised testing protocols to ensure compost safety and agronomic utility, bridging technological processing with biological outcomes. Ultimately, integrating advanced sorting and shredding technologies with optimised aerobic composting—particularly in-vessel systems.

Keywords: textile waste, aerobic composting, anaerobic digestion, biodegradation, circular economy

Comparison of spatial soil moisture sensing technologies

Isaac Halling, Joe Foley and Alison McCarthy

University of Southern Queensland

Soil moisture assessment is a critical input to improve irrigation scheduling, water use efficiency, and sustainability in broadacre agriculture. However, there can be significant variability in soil moisture across fields and existing sensors typically only measure a single point. Multiple soil moisture sensing technologies have been demonstrated that enable spatial sensing, for example, the Geonics EM38 Mk2 which uses electromagnetic induction and the Skaha Labs P-band Polarimeter which uses P-band polarimetric radar. Both devices represent advanced tools for non-invasive soil moisture assessment, and have different sensing mechanisms and deployment methods, i.e. the EM38 is towed over a field while the polarimetric radar can be drone-mounted.

This research, supported by a CRDC Summer Research Scholarship, aims to evaluate and compare the performance of these sensors. The project focuses on how effectively each device detects and maps soil moisture under real-world conditions, particularly in the high-clay Vertosol soils of cotton-growing areas in the Darling Downs region, and identifying the practical benefits and limitations of each sensor. The study involves field deployment, data collection, and comparative analysis of spatial resolution, depth sensitivity, accuracy, ease of use, and responsiveness to variable moisture levels. Findings from this research will support more informed decisions about soil moisture monitoring tools in Australian cotton systems.

Keywords: soil moisture assessment, sensor comparison, spatial variability

Translational research at the Future Fibres Facility

Dylan Hegh, Sarmad Aslam and Chris Hurren

Deakin University

The Future Fibre Facility at the Institute for Frontier Materials, Deakin University, is a nationally significant, open-access pilot-scale research and development hub for cotton innovation. Supported by the Australian National Fabrication Facility (ANFF), this facility offers integrated capabilities spanning the textile value chain – from polymer synthesis and fibre processing, through yarn spinning and fabric manufacturing, and finally deconstruction, and reuse.

Our infrastructure enables the processing of small quantities through to pilot-scale production that simulates industrial conditions, bridging the gap between research and commercial application. The facility supports Australia's sovereign manufacturing capability by enabling value-added prototyping for the Cotton industry. In this presentation I will highlight how we work closely with the Future Fibres Hub to engage with industry to deliver practical solutions and drive innovation, to support the Australian cotton sector both domestically and internationally.

Keywords: manufacturing, cotton spinning, deconstruction

Northern Survivor: can we outwit, outplay, and outlast *Spodoptera litura*?

Sharna Holman¹, Paul Grundy¹, Helen Spafford² and Michael Furlong³

¹Queensland Department of Primary Industries; ²Western Australia Department of Primary Industries and Regional Development; ³University of Queensland

Bollgard® 3 was anticipated to provide greater protection against a wide range of lepidopteran pests. However, since its introduction in northern Australia in 2017, *Spodoptera litura* larvae have been intermittently observed surviving in crops. The ability of larvae of all instars to survive has raised questions about the factors enabling survival, their potential to complete development, and broader implications for pest management.

Despite its historical importance in the Ord River Irrigation Area, our understanding of *S. litura* in Bollgard® 3 cotton remains limited. This raises a critical question: what factors explain the intermittent survival of *S. litura* in Bollgard® 3 fields in northern Australia?

Investigating this question is critical for the sustainability of Bt cotton as the cotton expands across northern production systems. This presentation will examine how the survival of larvae reflects a combination of biological susceptibility, behavioural movement, and environmental conditions, and consider the implications for integrated pest management in cotton crops across northern Australia.

Keywords: pest management, northern Australia

False wireworms and cotton: pest damage and efficacy of insecticides

Jamie Hopkinson and Jacob Balzer

Queensland Department of Primary Industries

There are several arthropod species that can negatively impact crop establishment and seedling vigour. Many of the current insecticides applied to control these pests are unlikely to be available in the future. Due to concerns over the impact these insecticides have on human health and the environment, many are under or scheduled for regulatory review by the APVMA. Therefore, the immediate challenge is to find suitable replacements to ensure cotton growers are not adversely impacted by these pest species and have safe insecticides to use. A significant challenge is to understand the biology of these insects and identify opportunities to adopt IPM tactics that may reduce the industries reliance on insecticides.

Currently we are learning to mass rear some of these insects in the laboratory, study their biology and develop bioassays to evaluate the efficacy of insecticides. This presentation will briefly describe the life cycle of establishment pests and highlight recent research completed by the DPI Entomology team.

Keywords: false-wireworms, insecticides, entomology

Quality seeds for a resilient crop: a novel lab-based assay for cottonseed vigour

Taryn Hunter¹, Brett Ross², Warwick Stiller¹ and Shiming Liu¹

¹CSIRO Agriculture and Food, Narrabri; ²Cotton Seed Distributors, Wee Waa

Seeds play a vital role in cotton production –they're essential for starting the growing season, determining lint yield, and serving as valuable sources of oil and protein. The quality of planting seeds directly affects how well plants establish after sowing, which in turn influences crop growth, productivity, and resource use throughout the season. In agriculture, this seed quality is referred to as seed vigour – the seed's physiological ability to emerge quickly and uniformly and develop into healthy seedlings under a wide range of field conditions.

Cotton is notorious for its poor seed and seedling vigour. Traditionally, vigour has been assessed using the standard cool germination test developed in the 1960s. However, this method is no longer effective for distinguishing between modern cotton varieties and advanced breeding lines, especially those with smaller seed sizes. This presentation introduces a refined laboratory test designed to more accurately measure cottonseed vigour. It provides evidence of the test's improved sensitivity and reliability and demonstrates how it can better predict field performance under both suboptimal and optimal planting conditions. Further development and adaptation of this new test will support future genetic improvements and breeding efforts to enhance cottonseed vigour, ultimately helping to produce and supply higher quality planting seeds for cotton growers.

Keywords: seed vigour, germination test, planting seed quality, plant stand

Characterisation of *Eutypella* spp. causing reoccurring wilt in cotton

Muhammad Zahaib Ilyas¹, Linda Smith², Sadegh Balotf¹, Sambasivam Periyannan^{1,3}, Levente Kiss¹ and Cassy Percy¹

¹Centre for Crop Health, University of Southern Queensland, Toowoomba ;

²Department of Primary Industries, Dutton Park; ³School of Agriculture and Environmental Science, University of Southern Queensland, Toowoomba

Species of the genus *Eutypella* are known to cause wood canker and dieback in multiple plant species worldwide. In late 2021, *Eutypella* spp. were identified as the causal agent of sudden wilting and death in cotton plants in Central Queensland, Australia. This was the first report of *Eutypella* spp. as the pathogen of cotton, globally. The disease is referred to as reoccurring wilt, as it reoccurs at the same site in subsequent seasons. The disease has now been reported in multiple cotton-growing regions in both Queensland and New South Wales, raising concern for growers. This project aims to advance understanding of the novel *Eutypella* spp. responsible for this emerging cotton disease using genomic and metabolomic approaches. Cultural characterisation revealed that *Eutypella* spp. produce slow-growing, low-density, white to white-creamy mycelium on artificial media. Pycnidia development was slow under ambient laboratory conditions but accelerated from four months to under four weeks in medium with carnation leaves. BLASTn search of ribosomal DNA internal transcribed spacer (ITS) sequences of *Eutypella* spp. revealed less than 90% similarity to *Eutypella scoparia*, the closest known species-level match. This research also seeks to provide insights into the geographical distribution of *Eutypella* spp. and explore metabolic interactions that may reveal synergistic or antagonistic relationships with other pathogens, thereby guiding the development of effective management strategies.

Keywords: *Eutypella* spp., cotton reoccurring wilt, genomics, metabolomics

Mapping cotton soil-borne disease within fields with satellite imagery and machine learning

Abhasha Joshi¹, Patrick Filippi¹, Thomas Bishop¹, Tim Weaver¹ and Rob Long²

¹The University of Sydney; ²Crown Analytical

Verticillium wilt (*Verticillium dahliae*) is a significant threat to cotton production in Australia. The soilborne fungus infects the vascular systems of cotton plants, disrupting water and nutrient flow, leading to symptoms such as vascular discoloration, leaf wilting, and defoliation, resulting in yield loss. At present, the prevention and control of verticillium wilt is difficult once it infects the vascular system, however, information about its prevalence can help estimate its potential impact on the quantity and quality of cotton yield and inform decisions about future crop rotations. This study predicts verticillium wilt incidence by integrating publicly available satellite imagery, weather data, and pre-season inoculum levels measured in fields. The analysis was conducted across eight cotton fields in New South Wales, Australia, with known background levels of verticillium wilt. The cotton plants were sampled on a rough grid at intervals of approximately 120 to 140 metres within each field. A data-driven approach was used and interpretable machine learning to understand key variables driving the spatial distribution of disease. We used 5-fold cross-validation and leave-one-field-out validation to assess model performance. The results demonstrate the effectiveness of satellite imagery in capturing within field variability in verticillium wilt infections and highlight the importance of pre-season inoculum levels in determining disease incidence.

Keywords: verticillium wilt, machine learning, mapping

Reoccurring wilt of cotton, uncovering the pathogenesis of *Eutypella* species

Dinesh Kafle¹, Linda Scheikowski¹, Gupta Vadakattu² and Linda Smith¹

¹Queensland Department of Primary Industries (QDPI); ²Commonwealth Scientific and Industrial Research Organisation (CSIRO)

The reoccurring wilt disease is a relatively new name to the Australian cotton industry. This study confirmed the finding that the *Eutypella* species causing the reoccurring wilt disease is a new and previously unidentified fungal species. Genetic characterisation revealed four novel species of the genus *Eutypella* within the Diatrypaceae family, causing the disease. Along with the progress in characterisation of these novel species, it is important to understand their etiology and pathogenesis.

Through a series of field and glasshouse trials, we have attempted to uncover the pathogenesis and dispersal mechanism of this disease. It was found that the infected crop residue plays an important role in carrying over the disease inoculum for the next season. The wounding of plant tissue appears to serve as a pathway for fungal inoculum to enter vascular tissue, as evidenced by the disease caused by the piece of growth media (PDA) with *Eutypella* mycelium when applied to a stem wound incision. On the contrary, such mycelium grown on the PDA media did not cause any disease when added to the soil close to a cotton stem without plant injury. It was also determined that the seed from infected plants doesn't transmit the disease to the next generation, confirming it's not seedborne.

Field-based research is underway to understand the dispersal pathway of the pathogen further, as the search for aerial spores continues with the help of passive spore traps deployed in several cotton fields.

Keywords: wilt disease, reoccurring wilt, *Eutypella* spp., inoculum, pathogenesis, dispersal

Challenges and prospects of cotton farming in the tropics: lessons for northern Australia

Getahun Kassa, Kamaljit Sangha, Brett Murphy and Muhammad Sohail Mazhar

Charles Darwin University

Cotton is the world's most widely grown fibre crop, providing a livelihood for over 100 million households globally. However, its environmental impact has become a growing concern. There has been a growing interest in expanding cotton production in northern Australia's Northern Territory in recent years. This study systematically reviewed published research articles in tropical regions to provide insights into the socioecological risks, challenges, and prospects of cotton production for growers and policymakers. We analysed peer-reviewed articles published between 2005 and 2024 using qualitative and quantitative approaches (gross margin and break-even analysis).

We found that cotton production in tropical regions faces significant hurdles, including extreme and unpredictable climate conditions, biodiversity loss, high carbon and water footprints, rising production costs, and social (health) risks. While organic and rainfed cotton have been proposed as eco-friendly alternatives to irrigated cotton, their lower yields raise concerns about long-term economic viability. We estimate that for rainfed cotton, a yield of 9–12 bales per hectare is needed to offset the environmental opportunity cost of land clearing. Given the low yield of rainfed cotton, averaging 4 bales per hectare in the Northern Territory, the opportunity cost of cultivation would be substantial, as it comes at the expense of potential earnings from the emerging Australian Government's Nature Repair Market.

Keywords: cotton, environmental footprint, organic cotton, rainfed cotton, tropical region

Introduction of ThryvOn®; the journey of bringing a new cotton trait to market (almost)

Kristen Knight

Bayer Crop Science

Bayer has developed a new generation of lepidopteran and sucking pest-protected cotton through conventional breeding of Bollgard 3 ThryvOn cotton with XtendFlex technology containing the cry1Ac, cry2Ab genes and vip3A genes (Bollgard 3) and the cry51Aa2.834_16 genes (ThryvOn). This trait was tested to assess the efficacy of ThryvOn cotton against target pest thrips species tomato thrips, onion thrips and western flower thrips (*Frankliniella schultzei*, *Thrips tabaci* Lindeman and *Frankliniella occidentalis* (Thysanoptera: Thripidae)).

This presentation will outline the science and process required to commercialise a genetically modified cotton trait, and the plant health benefits of the interaction of the trait in the presence of the key pest.

Keywords: GM cotton ThryvOn

Hic sunt leo et dracones

Oliver Knox

CSD

Take a step in any field and you are trampling on billions of bacteria, kilometres of fungi and a plethora of invertebrates. The ones we know most about are those that we consider problems for our production systems, but these are normally the minority. What if we could capitalise or assist the majority to silence the problems in the population?

Legislative changes in Europe, reported public opinion and the human species thirst for knowledge means our current production system will change, but are we ready?

For decades the search for beneficial biologicals has involved isolation, identification, classification, formulation and evaluation, with the majority resulting in failure. Newer technologies and techniques to date have only ramped up this process. To capitalise on nature's potential to enhance crop production we need to start thinking outside the box. So what might we find out there?

Keywords: soil biology, biologicals, screening

Like sands through the hourglass, so have weed numbers changed through time: results from surveys across northern cotton regions of Australia

Eric Koetz and Graham Charles

NSW DPIRD

Opportunities exist in northern Australia to expand cotton growing regions, but what are the ramifications for weed management? A number of risks which include the potential for soil and residual herbicides to contaminate rivers and the reef, and for northern weeds to develop herbicide resistance are potential hurdles for the industry. Heavy reliance on glyphosate now in areas with weed populations already resistant is concerning.

A project with funding from CRDC and NSW DPIRD to undertake a base-line assessment of weed pressure via field surveys and face to face meetings in the cotton regions of the Northern Territory, far north Queensland (FNQ), and Western Australia were conducted in 2023, 2024 and 2025. It is essential to understand the issues around weeds in the north to enable a management plan to be developed for this area.

Results from the surveys indicate that there is already resistance to glyphosate in the WA and NT cotton regions and other herbicidal modes of action are required to maintain clean fields. Weed numbers in Katherine have increased from the initial survey and are impacting cotton yield. In the Ord region, numbers have also increased but at a slower rate and weed pressure is still within agronomic thresholds. After high numbers initially in FNQ, the introduction of pre-emergent residual herbicides has delivered an impressive reduction in weed numbers.

Keywords: weed survey, herbicide resistance

Aiming for the bullseye on target spot management in tropical cotton: insights from 2025 fungicide screening trials

Samuel Krekeler, Linda Smith and Paul Grundy

Queensland Department of Primary Industries

Target spot, caused by *Corynespora cassiicola*, is a foliar fungal disease that can afflict cotton production in Australia's tropical regions. In the pursuit of potential management options, the performance of various fungicide treatments, including Merivon® and Belanty® (currently under minor use permit), Orius® 430, Product A, and a positive control product, used internationally, were assessed. Efficacy was measured by scoring severity in terms of disease progression and target spot-induced leaf senescence resulting in premature defoliation.

Results showed that Merivon® (fluxapyroxad + pyraclostrobin) and the positive control achieved the lowest defoliation across several trial sites (e.g. 4.5–10.4% vs 27–38.9% in untreated controls). Product A was statistically comparable to the positive control, although defoliation was numerically higher. Belanty® (mefentrifluconazole) showed variable efficacy, while Orius® 430 (tebuconazole) lacked efficacy. Yield impact was evaluated at one site in Queensland, but no significant treatment effect was detected, due to spatial variability and poor weather conditions that caused extensive fruit shedding.

Across all sites, disease onset occurred after canopy closure despite abundant rainfall prior, suggesting canopy development is a key driver for target spot epidemics. Future research aims to better understand canopy factors in relation to disease outbreak and to quantify yield impact to support an integrated disease management approach.

Keywords: target spot, *Corynespora cassiicola*, foliar fungal disease, fungicides, crop protection, disease management

Effect of enhanced efficiency fertilisers (EEFs) on cotton lint yield under a bankless irrigation system

Elindre Lamprecht¹, Luis Paulo Ratke², Jon Baird³, Richard Flavel¹, Graeme Schwenke² and Guna Nachimuthu²

¹University of New England (UNE); ²NSW Department of Primary Industries and Regional Development (NSW DPIRD); ³GRDC

Nitrogen (N) is the major fertiliser input for cotton grown in Australia. Improving the nitrogen use efficiency (NUE) is at the forefront of the cotton industry. Enhanced efficiency fertilisers (EEFs) are designed to be more efficient by releasing N to match the crop demand. However, limited research has been conducted on the impact of EEFs on NUE in irrigated cotton systems, particularly regarding their recommended application rates.

To investigate whether N rates can be reduced when using EEFs without compromising yield, a field trial was conducted in St George. The trial included five treatments: an unfertilised control; a grower standard rate (GR) of 285 kg N/ha using urea; and a reduced rate (GR minus 35% = 184 kg N/ha) applied using urea, eNpower (Urea+DMPG), and Centuro (Urea+pronitridine). Results indicated that at the reduced rate (184 kg N/ha), there was no significant yield difference among the three fertiliser products—urea, eNpower, and Centuro—with an average lint yield of 9.17 bales/ha. The Centuro treatment produced the highest total dry matter at 16.17 t/ha, although this did not translate to the highest yield. This was followed by eNpower with 14.78 t/ha and GR with 12.61 t/ha.

Additional research is needed to optimise the application rates of EEFs to enhance both agronomic performance and economic returns in irrigated cotton systems.

Keywords: nitrogen (N), nitrogen use efficiency (NUE), enhanced efficiency fertilisers (EEFs), irrigated cotton, lint yield

The cotton breeders' little secret: molecular selection in Canberra

Xiaoqing Li, Jackie Oliver, Haylee Martin, Sophie McGinnes, Leah Grundon, Luke Kilpatrick, Heidi Clements, Qian-Hao Zhu, Iain Wilson

CSIRO

Australian cotton varieties rely on a complex suite of genetically modified (GM) traits for pest and weed management, alongside an expanding portfolio of disease and pest resistance genes. Here at CSIRO's Black Mountain laboratories in Canberra, we apply advanced molecular tools to accelerate the breeding process and enhance the precision of varietal improvement.

DNA markers are routinely used to rapidly identify plants carrying genes or genomic regions associated with desirable agronomic traits. These molecular 'cheat sheet' enable breeders to efficiently stack, or pyramid, multiple traits (including GM, disease and pest resistance, and fibre quality) into elite varieties. Antibody-based assays complement DNA markers by monitoring the expression and function of key proteins, providing an additional layer of selection accuracy.

Without molecular selection, the introgression of numerous traits into a single variety would be impractical. Beyond marker-assisted selection, we are also leveraging cutting-edge technologies such as gene editing and Traitomic to accelerate the discovery and deployment of rare and beneficial mutations.

In summary, molecular tools are now central to modern cotton breeding, enhancing both the efficiency and precision of developing high-performing and resilient Australian cotton varieties.

Keywords: cotton breeding, molecular selection, GM traits, disease and pest resistance, fibre quality, DNA markers

Can UAV phenotyping revolutionise cotton breeding?

Xuesong Li¹, John Schwager², Connor Cassidy², Warren Conaty², Shiming Liu², Warwick Stiller², Iain Wilson¹, Lars Petersson³, Vivien Rolland¹

¹CSIRO Agriculture and Food, Canberra, ACT; ²CSIRO Agriculture and Food, Locked Bag 59, Narrabri, NSW; ³CSIRO Data 61, Canberra, ACT

UAV technology equipped with modern imaging sensors is reshaping field phenotyping by delivering rapid, non-destructive, and scalable measurements. When combined with modern analytics, including artificial intelligence, this imagery can provide objective and high-throughput estimates of traits to guide breeding decisions.

This presentation will highlight three practical case studies – monitoring early crop establishment, estimating biomass, and characterising canopy structure – to demonstrate how aerial data reduces manual labour and reveals plant and canopy structural variations at an accuracy and scale beyond traditional measurements. These advances will enable an increase in the rate of genetic gain for these three, difficult-to-measure traits of interest. By outlining the benefits and practical challenges, we will show how UAV phenotyping can propel more informed and data-driven progress in Australian cotton breeding.

Keywords: UAV, phenotyping, computer vision

Weaving the threads together: ensemble learning to enhance genomic prediction on cotton

Zitong Li¹, Shiming Liu², Xuesong Li^{1,3}, Iain Wilson¹, Qian-Hao Zhu¹, Warwick Stiller², Warren Conaty²

¹CSIRO Agriculture and Food, Canberra, ACT; ²CSIRO Agriculture and Food, Narrabri, NSW; ³Australian National University, Canberra, ACT

Genomic prediction (GP) shows great potential for predicting economically important cotton traits. GP models produce a genomic estimated breeding value (GEBV), which can empower breeders in their strategic selection of superior cultivars- particularly at the early stages of a breeding program when phenotype accuracies are low.

A diverse range of statistics approaches- including Genomic Best Linear Unbiased Prediction, Bayesian regression, and deep learning- have been proposed for GP. However, their performance often varies depending on the specific datasets and traits under analysis. Moreover, due to the complex interplay of data characteristics and trait-specific factors, identifying the most suitable GP method for a given dataset is often not straightforward. Therefore, we developed an ensemble learning (EL) based approach for GP. The method operates in two separate stages. In the first stage, a range of GP methods were applied independently to analyse the data. In the second stage, the GEBVs estimated by the different GP methods are combined and trained using a 'mega learner'. This then generates 'mega GEBVs'- the final output.

Using large-scale cotton genomic prediction data from the CSIRO cotton breeding program, EL has demonstrated more stable and robust performance compared to individual prediction methods. This talk will highlight these findings and the potential of ensemble strategies to enhance prediction accuracy and reliability in practical breeding applications.

Keywords: cotton breeding, genomic selection, machine learning and AI

Large language models (LLMs): can they enhance agricultural research?

Jiazhe Lin¹, Zitong Li² and, Xuesong Li²

¹Australian National University; ²CSIRO

Large language models (LLMs), such as ChatGPT, represent an advanced form of artificial intelligence (AI) specifically designed to comprehend and generate human language. Built upon deep learning architectures and trained on extensive text datasets, LLMs excel at contextual retrieval, information summarisation, and responding to complex queries through a technique known as prompting. Recently, LLMs have emerged as novel tools across numerous disciplines, notably in protein structure and genetic function prediction.

Agriculture, inherently interdisciplinary and continually embracing technological innovation, stands poised to benefit significantly from the integration of LLMs. This talk explores the application of LLM technology in agricultural research, using cotton breeding as a practical case study. We specifically examine how LLMs can enhance genomic prediction (GP), a critical method in plant breeding used to estimate economically significant traits based on genetic data. Traditional GP models typically rely solely on DNA markers, thereby overlooking rich, yet unobservable genomic insights such as functional annotations.

We propose a novel framework that integrates LLM-generated annotations with traditional GP methods. Preliminary results indicate notable improvements in predictive accuracy for key traits like lint yield, demonstrating how incorporating LLM-driven annotations can deepen biological understanding and enhance prediction efficacy in agricultural research.

Keywords: large language model (LLM), artificial intelligence (AI), genomic prediction (GP), cotton breeding, functional annotation, trait prediction

Accelerating precision-breeding through gene-networks for better genomic prediction: cotton fibre quality traits as a case study

Colleen MacMillan, Ángel Popa-Baez, Zitong Li, Lissette Perez, Kerensa McElroy, Shannon Dillon, Warren Conaty
CSIRO

Cotton breeding programs continue to innovate to improve economical traits such as fibre quality and yield for the highly competitive commodity market. Many programs include phenotype selection, GM traits, transitions towards marker-assisted selection, and very recently also genomic-prediction (GP) and genomic-selection approaches. This also includes ongoing efforts to expand the genetic basis and variation of cotton improvement programs. In this talk we focus on precision-gene based-breeding of target traits as a way to accelerate GP for supporting GS-based breeding pipelines. While this holds a significant opportunity it is also a challenge due to the difficulty of rapidly sourcing valuable and validated genetic variants; it is also a particular challenge when traits are complex such as that of cotton fibre quality i.e. length, strength, elongation, maturity, and micronaire.

The case-study we present uses biology-informed fibre gene-networks to identify clusters of genes, and their SNP variants, working together to generate target traits. Extra weighting is given to these targets in GP models for improving GP-accuracy. Such inclusion of specialised cotton fibre gene-expression networks and expert knowledge into GS models improved prediction accuracy by up to 5%. We discuss how we can deploy such biology-informed gene networks to further accelerate precision breeding.

Keywords: fibre quality, gene-networks, genomic-prediction, precision, breeding, length, strength, elongation, micronaire

Lessons from commercialisation of cotton sensing technology research

Alison McCarthy¹, Susan Maas², Paul Grundy³, Derek Long¹

¹University of Southern Queensland; ²Cotton Research and Development Corporation; ³Queensland Department of Primary Industries

Automated machine vision tools can reduce reliance on workforce labour for agronomic scouting and potentially increase productivity and improve crop management decisions involving pests, crop growth, crop rotations and irrigation scheduling. Research and development for these technologies involves conceptualising and developing novel tools to address challenges, and working with business managers and commercial partners to protect intellectual property and translate these tools to commercial products for adoption by industry and impact. Commercialisation can be the most critical but challenging component of technology research and development due to each commercialisation being unique and dependent on the type of technology (e.g. software or hardware) and market size (and therefore potential commercial partners).

The University of Southern Queensland has developed canopy temperature sensing algorithms, an insect monitoring App and crop monitoring technologies that are at various stages in the commercialisation pipeline. These experiences have identified lessons and recommendations for researchers to aid the pathway to adoption of technology research in the future, including strategies for technology selection and handover and considerations for background intellectual property use. These also have implications for research outside of technology. Case studies will be used to highlight these learnings.

Keywords: agricultural technology, adoption, impact

SHIFT: The impacts and learnings from an RD&E project focused on workforce development

Nicole McDonald, Jo Eady, Chantal Corish and Amy Cosby
CQUniversity

The SHIFT Project is an action research initiative aimed at addressing critical workforce development challenges in the Australian cotton industry, with a focus on improving the non-technical skills of on-farm teams. Against a backdrop of labour shortages, technological change, and demographic shifts, the project sought to translate prior research into practical, evidence-based resources to support workforce attraction, retention, and development.

At the 2023 AACS conference, we presented on the co-design process for a series of guides on priority non-technical skills. Since then an extension program and evaluation of the SHIFT project has been conducted. The evaluation consisted of interviews with cotton growers involved in the co-design process ($n = 12$), and a survey of a convenience sample of cotton growers who participated in the zoom extension activities ($n = 18$), and those who had signed up for SHIFT updates but who did not attend any activities ($n = 6$). Participants were asked about the usefulness of their experiences, how the program may have supported knowledge transfer or practice change, and provided comments about the ongoing need or changes required for future engagement. Hear more about what the project team learned while working with cotton growers on the 'people' part of their enterprises, what worked, what didn't, and what we can do to support workforce attraction, retention and development, and workplace sustainability in the future.

Keywords: workplace sustainability, workforce development, social science, non-technical skills development

Benchmarking of water productivity and water sustainability of rainfed cotton in Australia

Malem K. McLeod and Sarah Dadd

NSW Department of Primary Industries and Regional Development, Tamworth

Rainfed cotton, grown in summer-dominant rainfall regions, contributes up to 22% of the annual production of Australian cotton. In 2024, it accounted for 19.13% of the total production. The Australian cotton industry has benchmarked the water productivity of irrigated cotton since the 1990s. Benchmarking allows the industry and growers to evaluate performance, set and monitor target, and identify best practices to optimise yield and water use.

Water productivity benchmarking for rainfed cotton commenced in the 2023 harvest year when 28 farms surveyed and continued in the 2024 harvest year with 32 farms surveyed. Farm records (yield, rainfall, and management) were used to calculate water productivity, expressed as the crop water use index (CWUI, bales/ML). Soil water measurement is lacking under rainfed cotton, and several assumptions were used to estimate changes in stored soil water to calculate crop water use (effective rain + soil water).

The relationship between yield or CWUI and water use forms yield or water productivity envelopes. For the 2023 season, the average rainfed cotton lint produced per megalitre (ML) of water used was 1.01 ± 0.05 bales (range: 0.45—1.56 bales/ML). The top 20% of farms produced 1.19 bales/ML or greater. For the 2024 season the average was 1.13 ± 0.06 bales/ML (range: 0.60—1.85 bales/ML), and the top 20% of farms produced 1.49 bales/ML or greater. This presents an opportunity to improve water productivity on most rainfed cotton farms.

Keywords: water productivity, crop water use index, rainfed cotton

How cotton growers deal with uncertainty in nitrogen fertiliser management and optimisation options

Michelle Miller and Zelalem Lema

CSIRO Agriculture and Food

The Australian cotton industry holds a vision of leading sustainable cotton production globally, and optimising nitrogen use will be one of the industry's major frontiers of innovation and improvement to this end. Despite decades of RD&E in irrigated cotton, optimising nitrogen use efficiency (NUE) remains a persistent challenge. We conducted in-depth interviews with growers, managers, and consultants to understand their perspectives on N use decisions and options for optimising NUE.

We used three lenses (innovation systems, transitions, and adoption) to inform our approach and to understand socio-economic, biophysical, and institutional drivers of N use decisions. We explored industry strategies to optimise NUE to reduce cotton's environmental footprint while maintaining yield and profitability. We also sought feedback on a novel insurance concept being used to optimise nitrogen use in Australian sugarcane production.

We found that industry decisions are shaped by complex and interrelated factors often overlooked in conventional extension methodologies and policy approaches. We propose a suite of system interventions to be co-designed with industry stakeholders, including the insurance concept alongside management, industry, and policy approaches. Our findings contribute insights to innovative risk management and offer practical actions for scientists, policy and industry actors seeking more sustainable nitrogen use for a reduced environmental footprint.

Keywords: nitrogen use efficiency. sustainability. greenhouse gas emissions. crop management. risk management

Comparative assessment of soil carbon and chemical properties under treated effluent irrigation and dryland management in Vertosols

Guna Nachimuthu, Blake Palmer, Andy Hundt, Ross Palmer, Graeme Schwenke, Daowei Sun

NSW Department of Primary Industries and Regional Development

Effluent water reuse for irrigation supports circular economy goals by turning discarded water into a valuable resource. To ensure sustainable crop production and limit environmental risks, the soil in these fields must be carefully monitored and managed.

In this study, we compared the soil (Vertosol) properties of adjacent irrigated (6) and dryland (2) fields at Federation Farm (Namoi Valley) during 2023-2024. The irrigated fields followed either a cotton-cereal or legume rotation, while the dryland field rotation included cotton, cereals and legumes. Fields irrigated with treated wastewater were found to have higher soil organic carbon (0.60% in irrigated vs 0.29% in dryland), electrical conductivity (EC), and sodicity (exchangeable sodium percentage: 15.1% in irrigated vs 7.3% in dryland) throughout the 100 cm soil profile, indicating a salt accumulation from over 24 years of effluent use. Soil pH was also more alkaline in the top 40 cm of irrigated soils. Fields irrigated with treated wastewater also showed higher Colwell P and DTPA extractable Zn. Colwell P in the topsoil (0-20 cm) of dryland soil was well below the critical value (<6 mg/kg) for a P response for both cotton and grains. The cotton lint yields for irrigated systems ranged from 10-12 bales/ha in recent years.

Overall, while changes in plant nutrition (P, Zn) are positive, the increase in potential constraints to production (EC, ESP) need to be addressed for long-term productivity at the site to continue.

Keywords: effluent, irrigation, soil carbon, sodicity, cotton

The economic benefits of composting textile waste: process mapping and optimal location

Rajkishore Nayak¹, Vinh Thai² and Amanpreet Singh²

¹RMIT University Vietnam; ²RMIT University Melbourne

Textile waste management is a major problem in Australia as around 500,000 tons of textiles are discarded annually into landfills, which have the potential to be converted into compost.

Our novel project (based on desktop research) established standard routes for transforming 100% cotton textile wastes into organic compost. The project applied Center of Gravity (CG) model for selecting the optimal location within Australia to establish locations for waste processing by minimising the transportation cost, reflected by minimising the integration of cargo volume-distance between collection areas and the processing facilities, and subsequently to agricultural farms.

We identified vermicomposting to be the most effective and nutrient-rich method for composting cotton textiles. This method yields compost higher in nitrogen, phosphorus, and potassium (NPK) compared to its other counterparts. Vermicompost also retains nutrients longer than traditional compost and provides essential macro and micronutrients, including vital NPK to plants more rapidly. Both qualitative analysis (with environmental factors, land and operational cost) and quantitative analysis (with waste distribution model) were employed to identify composting locations, followed by the CG model identifying the best location. Meanwhile, upon considering inbound and outbound integration volume and distance, Young emerged as the most fitting site, Ravensworth and Terrey Hills followed closely respectively.

Keywords: circular economy, cotton textiles, biodegradation, optimal location, centre of gravity model

Pathogenicity of *Berkeleyomyces basicola* and *B. rouxiae* to cotton

Chi P.T. Nguyen, Duy P. Le

NSW Department of Primary Industries and Regional Development, Narrabri

Black root rot (BRR) caused by soilborne fungus *Berkeleyomyces rouxiae* is a pandemic seedling disease in cotton in New South Wales. *B. rouxiae* is morphologically indistinguishable from *B. basicola*, originally described under *Thielaviopsis basicola*.

Both *Berkeleyomyces* species have been reported on multiple host crops; however, in Australian cotton, only *B. rouxiae* has been recovered from BRR-affected plants. This biased recovery is theorised to reflect differing levels of virulence between *B. rouxiae* and *B. basicola* on cotton, though little is known about pathogenicity of *B. basicola* in this crop.

In this study, we observed a degree of host preference between the two species. Both were highly aggressive to cotton when inoculated at 10⁴ spores/mL, but at 10³ spores/mL, *B. rouxiae* (originally from cotton) was more aggressive to cotton than *B. basicola* (originally from carrot), and vice versa.

In co-inoculation assays, infection by both species was detected directly in diseased cotton seedlings (cv. Sicot 714B3F and Sicot 746B3F) using a newly developed duplex PCR assay; however, only *B. rouxiae* was re-isolated from the seedlings. This suggests that traditional diagnostic methods, such as pathogen isolation, may not be sufficiently sensitive to detect all *Berkeleyomyces* species in field samples.

The developed duplex PCR assay provides a robust tool to detect and monitor the prevalence and distribution of both pathogens in the field.

Keywords: *Gossypium hirsutum*, disease surveillance, simultaneous detection, molecular diagnostics

Spatial data analytics and advanced modelling for disease prediction and management in Australia

Kingsten Okka¹, Ravinesh Deo¹, Sambasivam Periyannan¹, Linda Smith², Adam Sparks³

¹University of Southern Queensland, ²Department of Primary Industries, ³Curtin University

Australian cotton production is increasingly threatened by plant diseases, requiring innovative solutions for effective risk prediction and management. This PhD research will harness spatial data analytics, spatiotemporal modelling, and advanced machine learning to improve disease surveillance and forecasting. By integrating historical disease incidence data, climatic and environmental variables, remote sensing, and terrain attributes, the study aims to model disease dynamics across Queensland and New South Wales and in recently established cotton farms of Northern Territory and Western Australia.

Key outcomes will include spatially explicit risk maps, tools for early disease detection, and simulation of outbreak scenarios under varying climate conditions. These innovations will support proactive crop protection strategies and align with national goals for sustainable, data-driven agriculture. This work is supported by the Australian Cotton Disease Collaboration (ACDC).

Keywords: cotton disease modelling, spatial analytics, machine learning, GIS, remote sensing, sustainable crop protection.

Bt resistance in *Helicoverpa* spp. with a genetic lens: a good news story hidden in complexity

Amanda Padovan¹, Andy Bachler¹, Kristen Knight², Susan Maas³, Nicola Cottee³, Rick Horbury², Graham Head², Tom Walsh¹ and Sharon Downes¹

¹CSIRO, ²Bayer, ³CRDC

Effective resistance management is critical to the success of Bt cotton in Australia and monitoring the insect populations for resistance is important for achieving this outcome. Resistance to individual Bt toxins has remained low since the introduction of Bt cotton to the Australian landscape in 1996.

Recently we have developed and validated molecular resistance monitoring tools to address the costs of bioassay-based monitoring, which is hugely labour and time intensive. Whilst very promising, especially given the success in conventional pesticide resistance monitoring, the benefits of molecular monitoring for Bt resistance haven't been realised. We developed PCR and whole genome sequencing based methods to detect known Bt resistance alleles but when we applied these methods to samples with known phenotype, we rarely found the associated genotype, which is surprising. We investigated our collection and found that individual Bt resistance alleles were difficult to detect in samples collected at the same time and place. We then added a long-read sequencing approach which reveal a fraction of the genetic complexity underlying Bt resistance.

These results show there is no evidence of selection for individual Bt resistance alleles, that Bt resistance alleles are not spreading throughout the population and ultimately that the RMP is very effective at limiting Bt resistance in the southern cotton growing regions. Does Northern Australia cotton change the risk of Bt resistance?

Keywords: Bt resistance, genetics

Soil compaction: a story rooted in science, solutions and sustainability

Blake Palmer^{1,3}, Guna Nachimuthu², Stephen Cattle³

¹CottonInfo; ²NSW DPIRD; ³Sydney University

Mechanisation has increased cotton farm operational efficiency. However, soil structural decline consequential of the use of heavy machinery under extreme climate events, resulted in the evolution of the research to improve the understanding on the dynamics and impacts of soil compaction and inform management strategies. Following reports of compaction-induced yield reductions around Warren, NSW, soil physics research in the mid-1970s-80s identified soil compaction as a production constraint and developed a management framework focusing on Recognise, Repair, and Prevention/Control principles.

In the 1990s research focused on controlling compaction, including traffic management and refining the understanding of permanent beds. From the late 2000s to early 2010s, with the adoption of round module cotton pickers, research shifted to understanding the impact of heavier harvest equipment (JD 7760 ~32T vs basket cotton pickers ~20T) on soil strength.

Recent research identified that compaction in modern cotton farming systems can cause yield reductions of 27%. In modern irrigated cotton systems, complete prevention of soil compaction is not always possible. Compaction induced water limitations will likely impact the subsequent seasons crop. Current research is focusing on the most water-efficient crop rotations which can bioremediate soil compaction and will integrate into cotton farming systems.

Keywords: soil health, soil compaction, crop rotation, tillage, water use efficiency, agricultural mechanisation

Revolutionising cotton disease assessment: from manual methods to modern solutions

Manish Kumar Patel¹, Lucy Egan², Michael Salim¹, Vivien Rolland¹, Warren Conaty², Warwick Stiller²

¹CSIRO Agriculture and Food, Canberra; ²CSIRO Agriculture and Food, Narrabri

Verticillium wilt poses a significant threat to the Australian cotton industry, with potential yield losses reaching up to 50%. While on-farm strategies play a significant role in disease management, the development of resistant varieties remains the most viable long-term solution. A major bottleneck in this effort is the detection and quantification of verticillium wilt infection to identify resistant germplasm. The current method involves manual counting of infected plants through field observations of vascular browning in the stems after harvest. This method has limitations, including the high cost of manual labour, environmental constraints, operator bias in scoring and the difficulty of up-scaling phenotyping efforts.

This talk will highlight the journey of transitioning from manual scoring to a field-deployable computer vision solution. We present a high-throughput computer vision solution to identify and quantify verticillium wilt infection in cotton stems. This advanced imaging pipeline eliminates operator bias, minimises running costs, and circumvents the limitations of manual labour, enabling breeders to screen tens of thousands of lines rapidly and consistently. Additionally, the system is easily deployable across multiple locations, supporting wide-scale breeding efforts. This presentation will highlight the progression from manual stem counting to automated high-throughput imaging and modelling to expedite the development of resistant cotton varieties.

Keywords: high-throughput phenotyping, verticillium wilt, cotton disease, computer vision

Fusarium wilt: the ‘Down Under’ story. Now with whole genome sequencing!

Ángel David Popa-Baez

CSIRO

Fusarium oxysporum f. sp. *vasinfectum* (Fov) is a devastating cotton pathogen. Australian Fov strains are distinguished by their ability to infect plants without nematode interaction and are genetically distinct from global Fov, classified into two vegetative compatibility groups (VCG-01111 and VCG-01112).

Here, we present telomere-to-telomere gapless genome assemblies of a historical isolate for each Australian Fov VCG. Phylogenetic analysis indicates that the Australian Fov lineages diverged from other known Fov genomes over 3.6 million years ago, while VCG-01111 and VCG-01112 separated approximately 1.1 million years ago. Comparative genomics analysis identified four accessory chromosomes unique to the Australian isolates. Functional annotations revealed 14,495 and 15,342 genes in VCG-01111 and VCG-01112, respectively, with accessory chromosomes containing significantly fewer coding sequences than core chromosomes. Ortholog analysis uncovered unique gene clusters enriched in key metabolic pathways, pathogenicity, and cell division processes. Additionally, we identified several novel lineage-specific peptides unique to the Australian isolates.

This comprehensive genomic characterization provides the first insights into the unique evolutionary history of Australian Fov, distinguishing them from global Fov races. Our findings lay the foundation for understanding the genetic factors, which makes Australian Fov among the most aggressive cotton pathogens worldwide.

Keywords: Fusarium wilt; *Fusarium oxysporum* f. sp. *vasinfectum*, comparative genomics, chromosome-level assembly, Australian FOV isolates, pathogen evolution

Characterisation of *Berkeleyomyces rouxiae*, causing cotton black root rot disease

Anil Poudel¹, Alexandros Georgios Sotiropoulos¹, Levente Kiss¹, Duy Le², Sadegh Balotf¹ and Sambasivam Periyannan^{1,3}

¹Centre for Crop Health, University of Southern Queensland, Toowoomba; ²New South Wales Department of Primary Industries and Regional Development, Narrabri; ³School of Agriculture and Environmental Science, University of Southern Queensland, Toowoomba

Cotton is one of the major cash crops in Australia since the 1960s, contributing significantly to the agricultural economy. *Berkeleyomyces rouxiae*, a soilborne fungal pathogen, is the causal agent of black root rot disease in cotton that significantly impacts crop productivity in Australia, especially in NSW.

This project is to develop a qPCR assay to accurately and rapidly detect and quantify *B. rouxiae* in soil and plant materials without requirement to obtain *B. rouxiae* cultures, which is recalcitrant. Additionally, the project seeks to expand our knowledge of the pathogen's biology and pathogenicity through host range studies and explore the use of self-extracellular DNA as a potential strategy for disease control. Based on single nucleotide polymorphisms (SNPs) found on the MCM7 sequences, a number of potential primer sets were designed for *B. rouxiae*. We are currently validating for their sensitivity and specificity.

Once optimised, the qPCR assay will be employed to quantify *B. rouxiae* biomass in host range trials, which are currently underway. Together, this study will provide a robust tool for pathogen surveillance, enhance understanding of host-*B. rouxiae* interactions, and explore innovative avenues for sustainable black root rot management.

Keywords: cotton, *Berkeleyomyces rouxiae*, black root rot, qPCR, self-extracellular DNA

Climate change impacts on cotton maturity days across the U.S. cotton belt region

Chiranjibi Poudyal, Nithya Rajan, Curtis B. Adams, Mahendra Bhandari, Robert Hardin

Texas A&M University

Air temperature critically influences cotton growth, with optimal development occurring between 15.5 °C and 32 °C. As global temperatures rise, the accumulation of growing degree day (GDD) accelerates, thereby shortening duration for cotton maturity days. This study investigated climate change impacts on cotton maturity days across the U.S. Cotton Belt using historical (1974-2023) and projected (2024-2073) air temperature data under Representative Concentration Pathway (RCP) 4.5.

Results showed an average of 18 days reduction in cotton maturity days to open boll stage over 100 years, primarily due to accelerated GDD accumulation. Regression analysis revealed a 1-day reduction in cotton maturity days for every 4 years. Spatially cotton maturity days decline by 17% on average across the entire Cotton Belt region. Arizona and New Mexico (Far west), and Texas (Southwest), showed additional reduction of 15%, 6%, and 3%, respectively. Such amplified decreases attributed to reduced precipitation and increased solar radiation due to less cloudy days. In contrast, the Midsouth and Southeast experienced only moderate reductions, due to higher cloud cover.

Based on these findings, there is a need to adapt future management strategies, such as adjusting planting dates and selecting cultivars with longer maturity periods to compensate for the impact of climate change on cotton phenology.

Keywords: US cotton belt, climate change impacts, growing degree days (GDD), cotton maturity days, phenological adaptation

Optimising bankless channel cotton layouts in Southern NSW

Wendy C. Quayle, Gerardo A. Torres Casierra, John W. Hornbuckle

Deakin University

Bankless channel surface irrigation layouts in the southern region have been rapidly adopted due to marked labour savings compared with syphon systems. Anecdotal information has indicated up to 30% reductions in water use. However, irrefutable evidence is sparse since these layouts have complex physical and operational features such as the interaction of flow between bays, inconsistent discharges to each bay and preferential and variable furrow discharge due to relative furrow elevation.

Rigorous measurement is required to develop metrics that gauge field water application and drainage for bay-bay irrigation uniformity, reduced losses through evaporation and minimal over irrigation. Furthermore, irrigation efficiency has important implications for nitrogen (N) use efficiency as it controls plant N uptake and environmental loss via periods of soil saturation, run-off and deep drainage.

Benchmarking indicates that the industry long term gross production water use index (GPWUI) is 1.06 ± 0.02 bales/ML and nitrogen use efficiency for southern systems is 9.8 ± 2.3 kg lint/kg N. The integrated water and nitrogen balances for two different commercial southern bankless layouts have been characterised through detailed water flow, soil moisture and ETC measurements in combination with nitrogen concentrations in water, soil and plant. Results suggest 20-30% above the average GPWUI and 8-15 kg lint/kg N with further opportunities for improvement when using water run urea.

Keywords: cotton, irrigation, water, nitrogen

Evaluating IPCC emission factors using field-measured N₂O emissions in cotton cropping systems in the U.S.

Nithya Rajan¹, Parjinder Sidhu¹, Bright Fafali Dogbey¹, Noriki Miyanaka¹, Sk. Musfiq Salehin¹, William Wheeler¹, and Steven Pires²

¹Department of Soil and Crop Sciences, Texas A&M University; ²Cotton Incorporated

Accurate quantification of nitrous oxide (N₂O) emissions from agricultural systems is critical for climate reporting and the development of mitigation strategies. The Intergovernmental Panel on Climate Change (IPCC) provides standardised emission factors widely used to estimate agricultural N₂O emissions. However, the applicability of these generic factors to specific cropping systems and management practices remains uncertain. This study investigates actual N₂O emissions from cotton (*Gossypium hirsutum*) production systems under multiple nitrogen management strategies, including manure application and conventional fertilisation.

Emissions are being continuously measured using automated chambers fitted with trace gas analyzers across experimental plots. In parallel, high-frequency N₂O flux measurements are being conducted in commercial-scale fields implementing both climate-smart and non-climate-smart practices. Preliminary findings suggest that field-scale N₂O emissions may not align with IPCC Tier 1 emission factors. As data collection continues, we aim to assess the accuracy and representativeness of IPCC estimates relative to measured emissions across diverse conditions. This work will contribute to refining emission factor applicability for cotton systems and provide insights into the mitigation potential of climate-smart practices in commercial production settings.

Keywords: emission factors, nitrous oxide

Predicting microplastics release from polymer-coated controlled-release fertilisers into soil using machine learning

Akila Ravindran, Arun Chandra Manivannan, Logeshwaran Panneerselvan, Thava Palanisami

The University of Newcastle

Agricultural microplastic pollution, primarily resulting from the extensive application of polymer-coated fertilisers (PCFs), has appeared as a significant problem. However, there is a lack of a comprehensive report regarding the influence of microplastics (MPs) derived from these fertilisers on agricultural soil ecosystems. Additionally, the degradation of these polymer coatings introduces MPs into the soil, contributing to long-term pollution, potential plant uptake, and risks to terrestrial ecosystems.

Despite growing concern, the release dynamics of MPs from PCFs under realistic field conditions remain poorly understood, with a notable absence of robust predictive models. This study addresses this critical gap by developing a computational framework to predict MP release into soils. Two modelling approaches are evaluated: (i) a mechanistic diffusion-based model representing polymer degradation and MP migration, and (ii) a data-driven Long Short-Term Memory (LSTM) neural network capturing temporal patterns from experimental datasets. Key environmental and material parameters such as soil temperature, moisture content, and polymer composition are identified and integrated into the models. Comparative performance assessment highlights the strengths and limitations of each approach in capturing complex release behaviours.

The findings underscore the potential of AI-enhanced modelling in forecasting MP pollution and guiding the sustainable design of next-generation PCFs to mitigate degradation in soil and environmental contamination.

Keywords: polymer coated fertiliser, microplastics, pollution, machine learning, AI modelling

APSIM next generation cotton: a new model for temperate and tropical production systems

Tiemen Rhebergen

CSIRO

Increasingly erratic weather and a changing climate are challenging cotton production in Australia, making grower adaptability essential for resilient and sustainable farming systems. Cropping systems models like APSIM (Agricultural Production Systems sIMulator) are valuable tools for exploring adaptation strategies.

While the original cotton module in APSIM performed well in temperate environments, it struggled in tropical regions due to distinct environment–physiology relationships that were not adequately captured by the model. To address this limitation, a new cotton model is being developed within APSIM Next Generation using the Plant Modelling Framework. It is being parameterised with data from both high-input, irrigated systems in temperate zones and low-input, rainfed systems in the semi-arid tropics, ensuring robust performance across diverse climates and soil types.

Once finalised, the model will enable evaluation of crop management strategies—including planting dates, rotations, irrigation, and nitrogen use—and allow assessment of production risks and environmental impacts, such as nitrate leaching and nitrous oxide emissions, under both historical and projected future climates and other resource constraints.

Keywords: APSIM, crop model, modelling, tropics, farming systems

Quantifying crop stress using continuous canopy temperature monitoring in semi-irrigated skip row cotton

Rose Roche, Michael Bange and Hiz Jamali

CSIRO and CSD

Australian cotton production in water limited situations often relies on semi-irrigated and skip row configurations. Effective management of these systems requires precise quantification of crop water stress to optimise water use and maintain yield stability.

Traditional soil moisture and weather-based approaches to estimating water use often fail to accurately represent stress due to placement of soil sensors in skipped rows and the need for accurate local weather data. This study explored continuous canopy temperature monitoring which estimated crop stress by measuring the hours of canopy temperatures exceeding crop-specific thermal thresholds. Experiments comparing solid, single skip, and 1-in-1-out row configurations across various irrigation timings revealed significant negative linear relationships between yield and accumulated stress hours. Improved relationships were developed when the amount of stress hours was adjusted accounting for hours that did not impact growth between irrigations. Importantly, the research highlights the stable relationship of the impact of accumulated stress hours regardless of timing of irrigation and stress during flowering. Findings demonstrated that continuous canopy temperature measurement effectively captures crop water stress in semi-irrigated systems, with potential to facilitate precise irrigation scheduling enhancing water use efficiency and productivity.

Keywords: skip row, stress, cotton, plant-based sensing

Towards low-cost cotton irrigation management through canopy temperature forecasting

Stephen Rogers^{1,2}, Warren Jin², Rose Roche² and Danielle Way^{1,3,4}

¹Research School of Biology, The Australian National University; ²Commonwealth Scientific and Industrial Institute (CSIRO); ³Department of Biology, University of Western Ontario; ⁴Nicholas School of the Environment, Duke University

The cotton industry is one of the fastest growing industries in Australia worth \$2 billion yearly. Water availability is a crucial limiting factor for Australian cotton production, making precision irrigation vital.

Most Australian cotton farmers use canopy temperature (Tc) - a key indicator of water-stress - forecasts to plan irrigation deliveries up to 7 days in advance. Despite widespread use, Tc forecasting remains underdeveloped and using time-series methods we improve Tc forecasts for 7-day-ahead predictions for stressful conditions (Tc > 28°C and for 'stress-hours' hours above this optimal Tc.) We address three forecasting problems: from a single sensor, on a farm with no sensors (transfer forecasting) and for an unknown sensor on the same farm (spatial forecasting). Forecasting for 1000 farms across Australia 2024-2025 cotton season improves at known locations (15-20%) and unknown locations (10-20%), particularly for stressful conditions. While for two farms a spatial forecast using 3 Tc sensors and a weekly thermal image with accuracy of having a sensor at the location for stressful conditions.

The implementation of spatial and transfer forecasting are novel and respectively enable differentiated irrigation management and management at farms without Tc sensors. This can enhance water-use efficiency and enable low-cost, sustainable practices. Overall, these results improve cotton Tc management and may provide great economic benefit to Australia's cotton industry.

Keywords: precision agriculture, spatiotemporal forecasting, machine learning

A five year study using birds to monitor biodiversity on a north west NSW farm

Guy Roth and Michael Dahlem

The University of Sydney

Farms play an important part in maintaining biodiversity of the Australian landscape. Conducting bird surveys is one way to measure biodiversity on farms as birds are known indicators of environmental health of agricultural landscapes.

Quarterly bird surveys were conducted on the 'Llara' farm at Narrabri between 2019 and 2024 in five different land use areas on the farm. 'Llara' farm is 1850 hectares in size where my BMP certified rainfed cotton, grain and cattle are produced. Over 11,000 birds were counted as part of the survey. In total 157 different bird species were observed during the surveys. Bird diversity calculated using Simpson's Diversity Index indicated the most diversity in areas on the farm where there was a water supply such as a farm dam and the homestead garden.

The total species count and bird numbers increased from 77 species in 2019 to 157 species by 2024 due to improved seasonal conditions and the end of the 2019 drought. The Australian Cotton Industry is committed to sustainable practices and having long term on farm data related to biodiversity is important for the marketplace as evidenced by recent cotton to market forums.

Keywords: biodiversity, birds, sustainability, natural resources, environment, cotton

Accelerating agricultural innovation: the role of the Australian Plant Phenomics Network

William Salter^{1,2}, Connor Cassidy^{1,2}, Bryn Collyer^{1,2}, Arden Burrell^{1,2} and Richard Harwood^{1,2}

¹The University of Sydney; ²The Australian Plant Phenomics Network

The Australian Plant Phenomics Network (APPN) is a national initiative driving innovation in plant science through advanced phenotyping technologies and collaborative research. This presentation provides an overview of the APPN's mission, infrastructure, and impact, with a focus on its newest node at the University of Sydney's Narrabri campus.

Strategically located in the heartland of Australian cotton research, the Narrabri node is uniquely positioned to support the cotton sector's evolving needs. Our field phenomics capabilities include drone-based hyperspectral imaging, LiDAR, thermal and high-resolution RGB systems, operated by skilled technical staff enabling high-throughput, non-invasive monitoring of crop performance. Complementing these aerial platforms is a suite of above- and belowground phenotyping tools, including gas exchange systems, porometers, spectroradiometers, handheld imaging devices, a soil coring rig, and a minirhizotron root imaging system.

Crucially, our node integrates these technologies with robust data science expertise in collaboration with the Sydney Informatics Hub, facilitating the processing, analysis, and contextualisation of complex phenomic datasets. This synergy of cutting-edge tools and analytical capacity empowers researchers to better understand genotype-by-environment interactions and accelerate trait discovery in cotton and other crops.

By embedding advanced phenomics within a key cotton-growing region, the APPN Narrabri node is poised to play a transformative role in supporting sustainable productivity gains and innovation across the Australian cotton industry.

Keywords: field phenotyping, hyperspectral imaging, LiDAR, remote sensing, data science

Application of novel biostimulants enhance cotton growth, production and water use efficiency

Bhagya Samarasinghe and Nijat Imin

School of Science, Hawkesbury Campus, Western Sydney University

Nitrogen (N) is a major plant nutrient, yet its inefficient uptake by crops leads to excessive fertiliser use, higher costs and environmental impacts. This study investigates the potential of two novel biostimulants; BS1 and BS2 to activate nitrogen demand signaling and enhance nitrogen use efficiency (NUE) in cotton.

Cotton seeds were germinated in pots within a controlled growth chamber and after seven days, seedlings were treated with foliar sprays of 1 μ M biostimulant solutions or a control, applied six times at one-day intervals. Measurements of chlorophyll content, photosynthetic rates, shoot lengths, fresh weights and Water Use Efficiency (WUE) were taken one week after the final treatment to evaluate the effects of biostimulants. Results showed significant increases in all measured traits in biostimulant-treated plants compared to the control group ($p < 0.01$). Chlorophyll content increased by 16.71% and 27.28%, corresponding to photosynthetic rate increases of 14.27% and 22.21% for each of the biostimulants. Fresh weight increased by 13.27% and 24.61%, while WUE improved by 17.21% and 37.52% for BS1 and BS2 treatments respectively.

These findings indicate that the novel biostimulants can significantly enhance cotton growth, production and WUE by promoting both physiological and morphological responses supporting further research into their mechanisms and broader agricultural use.

Keywords: biostimulants, fresh weight, nitrogen demand signaling, NUE, photosynthetic rate, WUE

Handling the heat: photosynthetic diversity among linted cotton species

Demi Sargent^{1,2,3}, Spencer M. Whitney³, Katrina Broughton², Susan Y. Jaconis^{2,4}, David Tissue¹, Michael Bange⁵, Warren Conaty² and Robert E. Sharwood¹

¹Hawkesbury Institute for the Environment, Western Sydney University, Richmond NSW; ²CSIRO Agriculture and Food, Narrabri NSW; ³Research School of Biology, Australian National University, Canberra ACT; ⁴Cotton Incorporated, Cary North Carolina, United States of America; ⁵Cotton Seed Distributors Ltd, Wee Waa NSW

There is increasing urgency for more productive and resource-use efficient crops to cope with changing climates. One possibility to improve crop productivity is to enhance photosynthesis.

Here, we studied four linted cotton species (*Gossypium hirsutum*, *G. barbadense*, *G. arboreum* and *G. herbaceum*) for diversity in the temperature response of Rubisco – the enzyme at the centre of carbon fixation. Compared with the model C₃-plant tobacco, each cotton Rubisco had a slower carboxylation rate, but had a stronger CO₂-affinity in response to temperature, with *G. hirsutum* Rubisco showing an advantage in selecting CO₂ over O₂ at temperatures above 20°C.

While the Rubisco enzymes were quite similar across the four cotton species, *G. herbaceum* Rubisco had higher carboxylation efficiency at temperatures above 15°C, potentially supporting up to 20% higher rates of photosynthesis than tobacco Rubisco at 35°C. However, leaf-level photosynthetic measurements at 28°C showed no significant variation in the net photosynthetic CO₂ assimilation rates, stomatal conductance, transpiration rate, intrinsic water-use efficiency, or photosynthetic electron transport rates between species. Additionally, modelling revealed 20% lower maximum Rubisco carboxylase activity (V_{cmax}) in *G. herbaceum* leaves compared to *G. hirsutum*.

Ultimately, the greater Rubisco kinetics of *G. herbaceum* did not confer higher leaf photosynthesis, possibly due to other factors such as internal CO₂ diffusion or ATP generation.

Keywords: photosynthesis, cotton, Rubisco, *Gossypium*, thermotolerance

Update on *Verticillium dahliae* alternate hosts

Linda Scheikowski and Linda Smith

Department of Primary Industries, Queensland

Verticillium wilt continues to be a major economic constraint to cotton production in Australia. Previous glasshouse studies conducted by Department of Primary Industries, Queensland confirmed numerous alternate hosts of *Verticillium dahliae*, the causal agent of verticillium wilt of cotton.

Further testing with isolates of both the defoliating and non-defoliating strains of *V. dahliae*, confirmed *Brassica carinata* as another alternate host. Characteristic disease symptoms developed in inoculated plants and the pathogen was able to be reisolated from diseased plants, demonstrating Koch's postulates. This is a relatively new crop option and its disease status to common soil borne diseases of cotton was largely unknown. In addition, results from previously reported glasshouse studies showed that winter cereals, wheat, barley, oats and triticale, were hosts of *V. dahliae* and the pathogen could be seed-borne in these crops that also supported development of microsclerotia. Growers are often observing little improvement in verticillium disease levels in cotton that follows a winter cereal rotation. Naturally grown wheat, as well as barley residues collected from *V. dahliae*-infected fields have recently been examined, and findings will be discussed in this presentation.

A greater understanding of the relationship between cereals and *V. dahliae* will allow more informed rotation choices to be made.

Keywords: verticillium wilt hosts

Enhanced efficiency fertilisers (EEFs) in cotton: More Profit from Nitrogen (MPfN) project summary

Graeme Schwenke¹, Guna Nachimuthu¹, Jon Baird² and Ben Macdonald³

¹NSW DPIRD; ²GRDC, ³CSIRO

The MPfN project investigated EEFs in several field experiments at ACRI and on-farm. Coating urea with a urease-inhibitor before broadcasting had no effect on crop growth or lint yield as irrigation followed within 1–2 days.

A separate on-farm case study found that timely irrigation dissolved broadcast urea and moved it into the soil, preventing ammonia volatilisation. There is no need for a urease inhibitor in this situation. A nitrification inhibitor (NI) applied with urea or anhydrous ammonia can maintain the fertiliser N in the soil as ammonium for several months, keeping it safe from N loss by nitrate denitrification. At ACRI, NI-coated urea did not affect lint yield compared to urea at the same rate, but the NI did reduce N loss by runoff in irrigation tailwater. At an on-farm N-rate response experiment, an NI applied with anhydrous ammonia worked well in the soil but high initial and mineralisable soil N meant no yield responses once above the nil N rate.

Polymer coated urea (PCU) trialled at ACRI gave similar outcomes to that of the NI-coated urea: no yield difference, reduced N runoff, more residual soil N. N release from three different PCU products buried in a cotton field soil showed that two of the three released N in a similar linear pattern to that observed in laboratory incubations. While this release pattern differs from the N uptake pattern of developing cotton plants, the slowed release could potentially eliminate the need for in-crop fertiliser application

Keywords: nitrogen, fertiliser, N losses

Greenhouse gas emissions of the Australian cotton sector

Maartje Sevenster¹, Nazmul Islam¹ and Tim Weaver²

¹CSIRO; ²Sydney University

Agricultural industries like cotton are developing strategies to reduce their greenhouse gas (GHG) emissions. Developing an industry-wide GHG baseline using reliable data is the first step towards reducing emissions and the recent 'Common Approach to Sector-Level GHG Accounting for Australian Agriculture' provides a standardised framework for GHG accounting for agriculture.

GHG emissions were found to be composed of 51% Scope 1, 2% Scope 2 and 47% Scope 3 emissions including ginning. The contribution of fertilisers, via emissions of manufacture and via soil emissions after application, ranged from 50% to 70% depending on year, with approximately a third of that from direct emissions of nitrous oxide. The contribution of dryland cotton to the GHG accounts is small, given the much lower production. However, in terms of GHG intensity per unit lint, dryland cotton performs similarly to irrigated cotton.

A range of interventions was assessed for theoretical mitigation potential, including some related to fertiliser manufacture and ginning ('off farm'). Hypothetical adoption scenarios over 2025-2050 were used to explore the effects of changes in electricity generation, energy efficiency and energy sources used on farm, of enhanced-efficiency fertilisers and of increased nitrogen fertiliser use efficiency (NFUE). Results suggest that more than 60% of emissions might be eliminated by 2050, if NFUE improvements can be achieved through agronomic RD&E, new technologies and incentives.

Keywords: GHG accounting, emissions, NFUE

Potential for deep learning for early detection and discrimination of verticillium and fusarium wilt in cotton

Neeraj Anand Sharma, Alison McCarthy, Linda Smith, Sambasivam Periyannan and Ravinesh Deo

University of Southern Queensland

Major cotton diseases such as verticillium wilt and fusarium wilt can lead to significant yield losses. Disease monitoring is used to assess management interventions and involves manual assessments and destructive sampling, which are labour-intensive and time-consuming. Sensing technology has demonstrated potential to detect visual symptoms of these individual diseases; however, this research is limited as multiple diseases can occur concurrently, and a system that identifies visual symptoms may not provide early warning of disease outbreaks, which would allow earlier management interventions for diseases. New research has commenced that will develop and evaluate an automated sensing system using deep learning to differentiate between verticillium and fusarium wilt diseases in early stages before visual symptoms show.

This presentation will present progress on a review of existing technologies and methodologies for early disease detection in cotton, and planning for conceptualising and developing deep learning models integrated with advanced imaging techniques to accurately identify diseases in glasshouse and field trials, with future potential to scale the system within precision agriculture frameworks. The methodology includes high-resolution imaging and hyperspectral data collection in both controlled glasshouse and field conditions. This research is expected to develop methodologies that could be adapted for multiple diseases and crops.

Keywords: agriculture, cotton disease, fusarium, verticillium, wilt

In-field monitoring of long-season cotton in Central Queensland

Nicholas Stewart

Cotton Seed Distributors

Long-season cotton (LSC) is a new management practice where the growing season is extended to produce a 2nd phase of flowering. LSC was necessitated by the challenging weather in CQ where picking often coincided with wet conditions. There are specific, RMP implications for these crops to ensure they do not compromise the trait technology. The aim of this study is to investigate the driving agronomic factors of highly-productive LSC crops.

Ten LSC fields were monitored each season from 2023 to 2025. In-crop monitoring consisted of plant mapping, leaf & petiole sampling and soil testing. Management practices such as quantity and timing of irrigations, fertiliser and other operations were also monitored. Yield and quality in the 1st and 2nd phase were also recorded. Flower tagging was also employed to track maturity of bolls.

On average, the time between cut-out and commencement of the 2nd phase is 640DD, or 55 days. There is little evidence that the length of the lag phase has any effect on final yield. Boll accumulation and flowering is identical in thermal time for the 2nd phase. As is the case with boll maturity. Additionally, different varieties had little affect on altering final yield. Furthermore, crops sown earlier, often yielded higher than later sown crops.

In conclusion, principles driving production in LSC are not dissimilar to traditional crops. Further work is required to determine the nitrogen use dynamics of this system.

Keywords: long season cotton, Central Queensland, day degrees.

Global issues for cotton, and how they may impact science

Brooke Summers

Cotton Australia

The Australian Cotton Strategic Roadmap is a plan for the Australian cotton industry's future to ensure it meets the emerging needs of customers, supports market access and remains globally competitive. This initiative was developed with oversight from Cotton Australia, the Australian Cotton Shippers Association and the Cotton Research and Development Corporation and is now in its operationalisation phase which includes extensive research.

Five key topics are addressed: Sustainable Cotton, Data, Traceability, Human Rights and Marketing - and the ways we manage these issues as an industry may directly affect the research, data and approaches we take to measure and manage progress.

So why do we need a Roadmap? And why now?

Australian cotton remains in demand due to its superior quality. However, the fashion and textile industry and the supply chains in which we operate are rapidly changing, with new and important drivers emerging. Legislation being passed in the European Union and other countries will see changing market access requirements including new demands for data, traceability and sustainably-certified cotton. Legislation focused on greenwashing will also require claims made about products be backed up by verified data and traceability. And investors are demanding more due diligence than ever before.

What have we learned so far, what action is being taken and how may these global issues affect the way science intersects with the needs of our customers in future?

Keywords: sustainability, market access, global markets, future proofing

Soil organic carbon levels in three Australian cotton production regions: effects of historical climate and field management

Daowei Sun, Blake Palmer, Andy Hundt, Ross Palmer, Graeme Schwenke and Guna Nachimuthu

NSW Department of Primary Industries and Regional Development

Soil organic carbon (SOC) is a key indicator of soil health, productivity, and resilience in agricultural systems. Maintaining or increasing SOC levels is essential for sustaining soil function and improving climate resilience in cotton production systems. However, SOC concentrations are shaped by a complex interplay of climate conditions and land management practices accumulated over time.

This study investigated how historical climate variables and field management practices relate to current SOC concentrations in three major Australian cotton production regions. Soil samples were collected from multiple fields across the Gwydir, Namoi, and Macquarie valleys and analysed for SOC at three depths (0-10 cm, 10-20 cm, and 20-30 cm). A retrospective survey documented field management histories - including crop rotation, fallow, irrigation, tillage, fertiliser application, and stubble management - spanning 2012 to 2023.

Results showed that average SOC concentrations consistently followed the regional order: Namoi > Macquarie > Gwydir across all depths. Stepwise regression analysis evaluated associations between SOC and both individual factors and their combinations, identifying the variables most strongly influencing SOC concentrations at different soil depths. These findings provide valuable insights to guide management strategies aimed at maintaining or enhancing soil carbon stocks, thereby building resilience in irrigated cotton landscapes.

Keywords: soil organic carbon, irrigated cotton production systems, climate variability, field management practices, agricultural soil health

Uncertainty in nitrogen fertiliser management of cotton crops

Peter Thorburn, Jody Biggs and Aswin Singaram Natarajan

CSIRO Agriculture and Food

Optimising nitrogen (N) fertiliser management is important for sustainability of the Australia cotton production. Achieving that goal would be helped if economic optimum N rates (N_{opt}) could be predicted at sowing.

To explore some predictors of N_{opt} we collated data on lint yield responses to N fertiliser applications from past publications, resulting in 61 N response curves. In those, N_{opt} ranged from 0 to >360 kg/ha and was poorly correlated with yield at N_{opt} (Y_{nopt}). Y_{nopt} explained only 16% of the variation in N_{opt} across studies, although in one study it was 38%. N_{opt} was also poorly correlated with presowing nitrate-N explaining up to 14% of the variations in N_{opt} in individual studies and 19 % when the data were combined. N_{opt} is also poorly correlated with Y_{nopt} in other crops, including sugarcane, because of the year-to-year variations in weather and environmental N losses. We hypothesise that weather variations could be causing the poor correlations in cotton crops.

If N_{opt} is highly uncertain, it makes good business sense for growers to apply high N rates to mitigate the risk of yield losses from N stress. Growers seeking to reduce N rates need novel approaches to mitigate that risk. One example is obtaining insurance against the risk of yield losses at lower N rates, which has been available in the sugarcane industry since 2022. If an insurance approach could be developed for cotton it might protect growers' income when they reduce N rates.

Keywords: economic optimum nitrogen rate, sustainability, greenhouse gas emissions, crop management, risk management

A new Herbicide Resistance Management Strategy (HRMS) for Australian cotton

David Thornby¹, Graham Charles², Jeff Werth³ and Eric Koetz²

¹Innokas Intellectual Services; ²NSW Department of Primary Industries and Regional Development; ³Department of Primary Industries, Queensland

Australian cotton's Herbicide Resistance Management Strategy (HRMS) was implemented in 2013 as a voluntary mechanism for slowing down and managing the then rapidly-worsening issue of glyphosate resistance in common weed populations.

The HRMS, with its simple '2+2' approach, was widely adopted, and weed control diversity in Australian cotton has increased substantially since its introduction. However, recent developments in both over-the-top herbicide capabilities in new varieties, and the emergence of resistance in herbicides other than glyphosate, necessitate the evolution of the HRMS to cover more than just glyphosate.

We redeveloped the HRMS using a similar approach to the 2013 version, using hundreds of simulations of multi-herbicide strategies in mixed weed populations, using the Diversity model. We present the new HRMS for 2025, and discuss the emerging state of industry regulation for herbicide tolerance traits and weed control.

Keywords: weeds, herbicides, herbicide resistance, regulation

Water and nitrogen run-off in southern NSW bankless channel irrigated cotton systems

Gerardo Torres, Wendy Quayle and John Hornbuckle

Deakin University

Up to 60,000 ha, ~14% of the national cotton crop is grown and irrigated in the southern region of NSW. About 50% of southern crops are irrigated using gravity fed bankless channel irrigation systems (BCIS).

Labour efficiencies compared with syphon systems have driven the rapid adoption of BCIS. However, there remains a lack of robust empirical farm-scale measurement that describes the water and nitrogen dynamics, that are necessary to evaluate input efficiency and optimise nitrogen management.

The main objective of this field-scale study was to measure the volume of water in and out between interconnected bays so that the water and nitrogen can systematically be estimated in each irrigation cycle. In the season 2024/2025, two sites on representative Riverina red-brown earth soils were evaluated. One with a reverse grade BCIS and urea water-run and the other with zero grade BCIS and broadcast urea. Volume data was estimated from velocity measurements using a handheld SonTek flow-tracker and applying the Velocity-Area method at each gate on the trial bays while simultaneously water samples were collected for Total Nitrogen concentrations.

The data revealed that water run-off of these BCIS are between 9% and 17% while nitrogen run-off was high in the urea water-run than the broadcast application, 28% and 9% respectively. These results suggest that urea water-run applications can be subject to optimization while conserving the same irrigation system efficiency.

Keywords: bankless channel irrigation system, water and nitrogen run-off

Buried 'Down Under': nitrogen cycling microbes in cotton soils

Gupta Vadakattu¹, Marcus Hicks¹, Thomas Carter¹, Mark Farrell¹, Dio Antille¹ and Tim Weaver²

¹CSIRO Agriculture and Food and ²University of Sydney

Different functional groups of microbes perform specific processes within the soil N cycle, with their activity modulated by soil, environmental and management practices. The amount of microbial biomass (MB) affects mineralisation-immobilisation processes. As N is a critical growth limiting nutrient for cotton, understanding how management impacts microbial-N cycling is essential.

This study investigated how microbial groups involved in soil N cycle respond to crop rotation and fertiliser application, in experiments on a transitional red brown earth in southern NSW and cracking grey vertosol at Narrabri. Results showed site specific differences in abundances of N cycling microbes and the amount of MB-C at both 0-10 cm and 10-30 cm depths.

At Narrabri, N cycling microbes were more abundant in 0-10 cm soils compared to 10-30 cm soils, this trend was not seen in the red-brown earth soil. Addition of N fertiliser increased the abundance of microbial groups involved in nitrification and denitrification and the responses varied between sites and depths.

The significant increase in nitrifiers, following fertiliser application, suggests rapid conversion of fertiliser N into nitrate N, while increased denitrifiers suggest denitrification losses even from deeper soils. High populations of non-symbiotic N₂-fixing microbes across depths indicate the potential for biological N inputs.

These findings will assist in developing more sustainable management practices through optimised fertiliser application and rotation strategies.

Keywords: N cycling, cotton, microbes, microbial biomass, denitrification, fertiliser

Pathogen suppression assay: a strategic tool for managing soilborne diseases in cotton

Gupta Vadakattu¹, Marcus Hicks¹, Stasia Kroker¹, Linda Scheikowski², Duy Le³ and Linda Smith²

¹CSIRO; ²Queensland Department of Primary Industries; ³NSW Department of Primary Industries and Regional Development

Verticillium dahliae Kleb. is a soilborne fungal pathogen causing verticillium wilt and significant yield losses in Australian cotton making it agronomically important. Effective control of soilborne diseases involves managing pathogen at different microsites in soil and different time periods (pre-season or in-crop).

Interactions between pathogen and microbial communities affect pathogen survival and growth during non-crop periods and in the rhizosphere influencing infection. Biological disease suppression mediated by soil microbiomes can influence pathogen for its survival and growth. A short-term soil-based laboratory assay using quantitative PCR has been standardised to quantify *V. dahliae* (ND and defoliating strains) suppression capacity of Australian cotton soils. Surface soils (0-10 cm) soils collected from established field experiments at ACRI, Narrabri, NorthStar in NSW and farmer fields in NSW and Qld were used. Assay efficacy was compared with one using a GFP-transformed non-defoliating (ND) strain.

The assay successfully quantified the impact of rotation crops and fallow on pathogen suppression potential (PSP) in crop rotation and cover crop experiments. Results from the assay also demonstrated the seasonal variation and the effects of amendments such as crop residues, C sources and fertiliser N on biological suppression against *V. dahliae*. The PSP assay protocol is potentially adaptable for other soilborne pathogens of cotton.

Keywords: verticillium wilt, pathogen suppression, microbiome, cotton, amendments, crop rotation

Visible mechanical damage of cotton seed

René van der Sluijs

Textile Technical Services & CottonInfo

A number of studies were conducted to determine the incidence and severity of mechanical seed damage caused by harvesting and ginning. Seeds were evaluated according to two methods; 1) as described by Mississippi State University and classified as per the Agricultural Research Service Production Research Report number 135, dated 1972 and 2) internal method used by Cotton Seed Distributors, in Australia.

In terms of harvesters, a limited number of trials indicated that in general, spindle harvesters tended to have a higher percentage of visible mechanical damage (VMD %) than stripper harvesters. More in depth and detailed trials showed that seed cotton delivered to the gin harvested by John Deere round module spindle harvesters tended to have a higher VMD % than that created in the gin. The VMD % created by the gin is very much dependent on the moisture content of the seed cotton, the variety, fibre quality as well as the gin stand settings.

Although the determination of VMD % is a subjective, tedious and expensive method it does provide worthwhile information, with the results achieved during these trials similar to those achieved almost six decades ago.

Keywords: cotton, seed, quality

Cotton-based smart textiles towards sustainable innovation

Xin Wang

RMIT University

Next-generation smart textiles are in high demand to address growing needs in consumers' wellbeing including protection, performance, communication and comfort while tackling challenges in sustainable developments.

Smart textiles development empowered by materials innovation has shown great potential in application as future textiles and great progress has been made in recent years.

This talk will overview some of the research work conducted in A/Prof. Xin Wang's research group in the field of smart textiles based on cotton textiles. Specifically, performance textiles, protective textiles, wearable electronics, sustainable natural dyeing on cotton will be reported. This talk will give some insights in future development of smart textiles from cotton towards sustainable development.

Keywords: cotton, smart textiles, sustainable innovation

Cotton micronaire determined by seed imbibition date, latitude and in-crop temperatures

Tim Weaver¹, Brint Gardner², Lauren Stevens², Michael Bange³, Chirs Teague³ and Stuart Gordon²

¹The University of Sydney, ²CSIRO, ³CSD

Environment and crop management can play an important role in determining upland cotton fibre quality. One of the important quality parameters is fibre micronaire, which is an indirect measure of fibre linear density (fineness) and maturity.

Predicting micronaire in-season would allow growers to make informed tactical and strategic decisions in their management to maintain/improve fibre quality, for example, at harvest time (picking). Appropriately timing harvest aid applications is one such example.

These predictions also have the potential to assist growers with marketing their cotton. A cotton yield prediction model, BARRY (Biometric Agronomy for Realising Representative Yield), was developed with the R programming language by Cotton Seed Distributors (CSD) and CSIRO using XGBoost (eXtreme Gradient Boosting) and crop data collected from CSD ambassador grower sites. BARRY was developed to equip growers with a tool to make informed in-crop decisions to maintain/optimize their yield (bales/ha). The same process was utilised to develop a predictive micronaire tool (i.e. an R Shiny web application, like BARRY) using the XGBoost package and achieved an r^2 of 0.842 and an RMSE of 0.18.

The main factors that influenced the micronaire predictions were seed imbibition date, latitude, number of hot days and average temperature from seed imbibition to defoliation. These variables support previous findings of temperature impacting micronaire, and how latitude reflected local practices.

Keywords: micronaire, XGBoost, model

Host plant resistance in cotton: is there any progress?

Iain Wilson¹, Melanie Soliveres¹, Patrick Moody¹, Ray Yuan¹, Zitong Li¹, Ángel Popa-Baez¹, Lucy Egan², Warwick Stiller² and Qian-Hao Zhu¹

¹CSIRO Agriculture and Food, Canberra, ACT; ²CSIRO Agriculture and Food, Narrabri, NSW

Cotton diseases continue to cause significant and widespread yield losses across the Australian cotton industry. Enhancing host plant resistance remains one of the most effective and sustainable long-term strategies to safeguard yield potential in elite cotton cultivars.

Recent advances in DNA sequencing technologies have revolutionised our ability to identify and exploit disease resistance, by enabling relatively low cost but high-quality genome sequences for cotton cultivars. This presentation will provide an update on recent molecular progress related to several key cotton diseases, highlighting how genomics-era tools and information are driving advancements in breeding for improved host plant resistance.

Keywords: host plant resistance, disease resistance, fusarium wilt, verticillium wilt, black root rot

Evaluating the farm-level and industry-wide value of host plant resistance in cotton under verticillium wilt pressure

Yunqing Xu

Australia National University

Verticillium wilt (VW) remains a persistent challenge to sustainable cotton production in Australia, with limited chemical control options and significant yield losses.

This project was developed to support data-informed variety decisions by quantifying the economic value of adopting host plant resistance (HPR) strategies. A bio-economic modelling framework was established, integrating predictive yield modelling with fibre-quality-adjusted revenue estimation using CSIRO's breeding data across varying VW conditions and adoption rates. Results indicate that a 20 percent increase in HPR adoption can enhance farm revenue by approximately 310 dollars per hectare in disease-affected areas, though with diminishing marginal returns at higher adoption levels. In disease-free regions, adoption may reduce short-term revenue, underscoring the importance of risk-based evaluation.

The model enables growers to assess trade-offs and long-term profit stability, while offering economists and industry stakeholders a scalable approach for evaluating the broader value of resistance strategies under evolving environmental and market conditions.

Keywords: cotton production, host plant resistance (HPR), bio-economic model, sustainable farming

The good, the bad and the ugly: identifying verticillium wilt resistance

Xian Yu, Warren Conaty, Shiming Liu, Warwick Stiller and Lucy Egan

CSIRO

Verticillium wilt is a major threat to Australian cotton production and although resistance mechanisms are complex and interact with the environment, the development of resistant cultivars is the most practical and sustainable approach to manage this disease.

High-throughput phenotyping methods for assessing cultivar resistance can provide a solid foundation for the subsequent incorporation of resistance into cultivars. This talk will focus on the development of a multifaceted screening approach to evaluate cotton varieties resistance to verticillium wilt. First, we evaluated field disease severity through multiple assessment methods: in-crop foliar symptom scoring, vascular discoloration scoring at crop maturity, tracking the movement of the pathogen in the crop canopy, and the quantification of pathogen DNA in leaf tissue. Second, we conducted growth room experiments under controlled environmental conditions, which aimed to reduce genetic-by-environment (GxE) interactions.

Specifically, both the field and controlled environment experiments indicate that a leaf disk assay can be used as a rapid and reliable method for early detection of verticillium wilt resistance. Importantly, this research bridges field observations and controlled environment experimentation, offering a more comprehensive understanding of resistance mechanisms. The findings support breeding and management strategies aimed at enhancing the resilience of the Australian cotton industry.

Keywords: cotton, verticillium wilt, screening

Turning cotton genomics into real-world impact

Qian-Hao Zhu and Iain Wilson

CSIRO Agriculture and Food

Breeding high-yielding and resilient cotton varieties is key to meeting current and future challenges to cotton production. Since the release of the first cotton genome (*Gossypium raimondii*) in 2012, major progress has been made in cotton genomics with the genomes of all cultivated cotton species - including thousands of obsolete and elite cotton varieties - and their wild relatives sequenced. Comprehensive genome analyses have deepened our understanding of the origin and evolution of cotton species and identified millions of genetic variants, including single nucleotide polymorphism, small indels, and large structural variations. Many of these genetic variants have been linked to important agronomic traits like yield components, fibre quality, and disease and pest resistance.

At the same time, advances in cotton genome resources and molecular technologies like genome editing and genotype-independent transformation facilitated functional genomics, leading to the identification of hundreds of genes with potential value for breeding. However, despite the stellar progress of cotton genomics and functional genomics, currently the discoveries have hardly been translated into real-world breeding gains.

This talk will explore why turning functional gene discoveries into improved cotton varieties remains a challenge, and how new strategies could help close the gap between genomics discoveries and variety performance in the field.

Keywords: genomics; functional genomics; fibre yield; fibre quality; pest resistance

Delegate list

Attendees at the 2025 Australian Cotton Research Conference come from a wide range of organisations and backgrounds. We hope the delegates enjoyed the conference and had the opportunity to network both with peers in their research area and wider afield.

Ramanathan Alaguraj	Janani Groups	Darin Hodgson	CSIRO
Diogenes Antille	CSIRO	Larissa Holland	Cotton Seed Distributors
Abby Armitage	Nutrien Ag Solutions	Rachel Holloway	CRDC
Rajitha Athukorala	The University of Sydney	Sharna Holman	QLD Department of Primary Industries
Jon Baird	GRDC	Emma Holmes	University of New England
Megan Baker	CRDC	Jamie Hopkinson	QLD Department of Primary Industries
Lachlan Balmain	CQUniversity	Taryn Hunter	CSIRO
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Mishal Bano	Western Sydney University	Brian Jackson	Water Technology Pty Ltd
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Julie Baz	University of Southern Queensland	Alison Kelly	The University of Queensland
Cindy Benjamin	Greenmount Press	Lisa Kelly	QLD Department of Primary Industries
Jyothi Bhandari	Charles Darwin University	Dallas King	Western Rivers Agriculture
Kaitlyn Bissonnette	Cotton Incorporated	Kristen Knight	Bayer Crop Science
Greg Bramley	CottonInfo	Noel Knight	University of Southern Queensland
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Zach Brown	CSIRO	Eric Koetz	NSW DPIRD
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Connor Cassidy	Australian Plant Phenomics Network	Xiaoqing Li	CSIRO
Arun Chandra Manivannan	University of Newcastle	Xuesong Li	CSIRO
Graham Charles	NSW DPIRD	Zitong Li	CSIRO
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Heidi Clements	CSIRO	Rob Long	Crown Analytical Services
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Nicola Cottee	CRDC	Elysia Mackay	Charles Sturt University
Sam Craig	CSIRO & Monash University	Gus MacLennan	Bayer Crop Science
Julian Craven	Australian National University	Hugh MacMaster	The University of Sydney
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Anne Rae	CSIRO
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Jack Sharp	Bayer Cropscience
Rob Sharwood	Western Sydney University
Rene van der Sluijs	Textile Technical Services
Linda Smith	QLD Department of Primary Industries
Jagan Somasundaram	Bayer Crop Science
Gail Spargo	QLD Department of Primary Industries
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Warwick Stiller	CSIRO
Jamie Street	CGS
Brooke Summers	Cotton Australia
Daowei Sun	NSW DPIRD
Steve Swain	CSIRO
Xinyue Tang	The University of Melbourne
Ian Taylor	Cotton Seed Distributors
Chris Teague	Cotton Seed Distributors
Peter Thorburn	CSIRO
David Thornby	Innokas Intellectual Services
Gerardo Torres Casierra	Deakin University
Farah Tsbitha	University of New England
Annabel Twine	CottonInfo
Gupta Vadakattu	CSIRO
Frank Valentine	MCA Agronomy
Donna Verches	Bayer Crop Science
Stacey Vogel	CRDC
Kirsten Vonhoff	University of Southern Queensland
Xin Wang	RMIT University
Warwick Waters	CRDC
Tim Weaver	The University of Sydney
Jonathan Wendel	Iowa State University
Peter White	Cotton Seed Distributors
Mary Whitehouse	Macquarie University
Allan Williams	CRDC
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