Spotlight

ON COTTON R&D

AUTUMN 2021

Revolutionaries: bringing innovators to stamp out spray drift

Native tree planting using drones

A new era in pest detection arrives

CRDC

Ian Taylor

In the Spotlight

Welcome again readers as we turn our *Spotlight* on 2021.

While 2020 threw some interesting challenges our way, the work continues at CRDC and with our partners, as you'll see through the pages of this edition.

Firstly, we're making new inroads, tapping into innovators and problem solvers through new initiatives including the research and development corporation collaboration Agricultural Innovation Australia, and the Federal Government's Business Research and Innovation Initiative. We're excited to be a part of both these initiatives. We'll take a look at these programs in detail in this edition, while in our next edition, Winter 2021, we'll dive deep into how CRDC is driving innovation. Stay tuned!

Also in this edition, we include several articles on innovative technologies that CRDC is investing in as they come to the field. These exciting developments include a new pest detection app, which will change the way we monitor insects, and new yield prediction software. CRDC has not only supported the development of the software, it has supported much of the foundational research which drives the technology. We were also pleased to collaborate with CSIRO's Data61 on the On Farm Experiment app, using data through a CRDC Grassroots Grant. Once released, this will be a game changer for growers wanting to do on-farm trials.

These applications are reflective of two of our key focuses for 2021 – increased commercialisation and digital transformation. CRDC and our research partners are currently seeking partners to take these technologies to the commercialisation phase: the next step towards ensuring real, tangible benefits for growers and industry.

The use of drones to revegetate cotton farms is another example of our goal of delivering impact via innovation: this time for the improvement of biodiversity and sustainability.

Sustainability continues to be an overarching priority for CRDC and the wider industry in 2021. In conjunction with Cotton Australia, this year the Sustainability Working Group will be working to finalise the PLANET. PEOPLE. PADDOCK. sustainability targets. Sustainability expert Chris Cosgrove has been assisting with this process: in this edition he shares with us what the targets means for the cotton industry, and why it is important we work collectively to achieve them. I encourage all readers to read the 2019 Sustainability Report (available on our website). After all, at its core, sustainability is about staying in business.

Finally, in this edition, we bring you the latest research on a new disease – a new strain of wilt we hadn't seen before. Our pathologists have been kept busy studying the cause and origin of the disease, known as reoccurring wilt, through support from CRDC. We will be bringing you more on this disease as it comes to light.

For now, we hope you enjoy the read.

Ian Taylor
CRDC Executive Director

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CRDC
COTTON RESEARCH AND DEVELOPMENT CORPORATION

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Our vision: A globally competitive and responsible cotton industry.
Our mission: To invest in RD&E for the world-leading Australian cotton industry.

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MELANIE JENSON

ON THE COVER: Solving the issue of spray drift is one of the cotton industry's wicked problems, leading to innovative new ways to tackle it.

Want to see more of Spotlight?

This edition can be viewed online at: www.crdc.com.au

COTTON NEWS

FEATURES

Be alert to suspect symptoms

COTTON pathologist Duy Le works for NSW DPI at the Australian Cotton Research Institute near Narrabri.

Duy leads the CRDC-supported project to evaluate efficacy of novel chemistries, biocontrol agents and management practices to control alternaria and black root rot in cotton.

The annual disease surveys in NSW are also a part of Duy's role as a pathologist. He said the newly discovered reoccurring wilt was found in two cotton fields in NSW this season.

"The presence of this disease in two new locations and taking into account we inspect only a sample of fields across NSW – tells us that knowledge about the disease epidemiology is still limited and the disease can occur in any field," Duy said.

"I would strongly advise crop managers to closely monitor the crop and send any suspect plants for testing.

"CRDC is supporting this diagnostic service, and it has been integral in our work to identify this pathogen and in our ongoing research to define management and long-term effects.

"Our pathology teams really need to know where this pathogen is to identify how it may have evolved and how it spreads."

See articles on page 11 for more.

We're going to have to wait for the industry's most anticipated catch-up for another year.

Conference committee looks to 2022

IN light of continuing uncertainty due to COVID-19, Cotton Australia and the Australian Cotton Shippers Association (ACSA) have decided to postpone the Australian Cotton Conference until August 2022.

Conference chair Fleur Anderson said the boards of both organisations met in February to make the final difficult decision to postpone the event.

"The decision not to run this year came down to two key reasons: the significant financial risk exposure to both not-for-profit organisations and uncertainty about the type and quality of event that could be conducted, given the restrictions currently and possibly in place," Fleur said.

"This was a very difficult decision and it's made us realise just how important and valuable the cotton conference is to our industry.

"However the current climate we're living with – border closures, hot spots, social distancing, venue restrictions, caps on numbers, international and inter-state travel limits and lockdowns that can occur at any moment – has meant the risk is too great that the conference may not go ahead or be severely limited in some way."

The committee hope that by August 2022 the COVID-19 vaccine program will be in place, borders will be open, international travel may have resumed and they can put on the calibre of event that delegates, sponsors and exhibitors have come to expect.

"No-one is more disappointed than Cotton Australia, ACSA, the Cotton Conference Committee and our contractors that work very hard to put on a great show every two years," Fleur said.

"The boards are currently considering some smaller, regional events for this year that would take the place of conference, so that we may still come together as an industry."

For more
www.australiancottonconference.com.au

Paving the way for innovation

INNOVATORS across Australia have answered the call to help solve one of broadacre agriculture and the cotton industry's most persisting challenges – how to stop drift.

Australian start-ups and small businesses answered the call from the Australian Government's Business Research and Innovation Initiative (BRII) which supports early-stage development of solutions to challenges put forward by government agencies – including Research and Development Corporations (RDCs).

One of these challenges, successfully submitted and now managed by CRDC is **'**Is it possible to revolutionise agricultural spray application?'

Six successful applicants were announced in January, each receiving a grant of up to $100,000 to further develop their ideas and test feasibility. The most successful may be eligible for a grant of up to $1 million to develop a prototype or proof of concept.

The successful innovators are: Advanced Agricultural Systems Pty Ltd; Bard AI Pty Ltd, Interlate Management, LX Design House Pty Limited Services Pty Ltd, Spray Safe & Save Pty Ltd and Teknomika Pty Ltd. Together they will share in $587,297 funding through the government's initiative.

CRDC R&D Manager Susan Maas

developed the challenge application for BRII and says the six innovative businesses bring a diverse range of ideas to the table.

"We put out a challenge to find new approaches with innovative technology solutions to improve applicator capacity and reduce spray drift," Susan said.

"We are seeing applications ranging from brand new technology to a focus on the effect of water quality, and we're really excited to see what has emerged from the three-month feasibility and testing period, which is just finishing.

"It's such a novel way to find solutions to industry issues that can affect us at many levels.

"It opens up a whole new group of people, and we're also tapping into innovations that are already in existence, modifying and applying them to our unique issues."

Minister for Industry, Science and Technology Karen Andrews said this initiative is giving Australian businesses with clever ideas the opportunity to develop them further, with the potential of creating products that will benefit the community and the Australian economy.

"This is another good example of the Government working with businesses to develop solutions to important challenges," the Minister said.

"We had a record 220 applications for this BRII round, showing how competitive the process is – and competition produces results."

In addition to the spray application challenge proposed by CRDC, four other challenges have been funded under this BRII round. GRDC was successful with its challenge of 'Turning farm crops into a renewable hydrogen source'. One of the firms involved is a Queensland renewable energy start-up which will test the feasibility of using grain crop residues to manufacture hydrogen and biochar.

Other successful BRII challenges are turning office trash into energy treasure; counting fish using advanced technologies; and automating the detection of whales at sea.

For more
www.business.gov.au/BRII

New innovation company ramps up

CRDC is looking forward to working more closely with other agricultural industries to drive innovation, through the newly formed Agricultural Innovation Australia Ltd (AIA).

The organisation was formalised in October 2020, with CRDC and its fellow Research and Development Corporations (RDCs) to create a new not-for-profit company to drive cross-sectoral research, leverage private sector investment and target transformational innovation.

Australia's agriculture industry is world class, due in part to efforts of the RDCs, but facing increasingly complex challenges require new approaches, new ways of working and new strategic responses.

In February, AIA appointed the chair and two directors to the inaugural board. Bernie Brookes (chair), Dr Anne Astin and Heather Stacy bring experience from across government, private and industry sectors.

Minister for Agriculture, Drought and Emergency Management the Hon. David Littleproud MP said this is an exciting next step as the board ramps up to drive unprecedented collaboration and coordination of investment in agricultural innovation this year.

"AIA is an element of the Australian Government's new National Agricultural Innovation Agenda, contributing to Delivering Ag2030," the Minister said.

"Innovation is the key to enabling Australian agriculture to meet its target of becoming a $100 billion sector by 2030.

"The biggest productivity gains will come from long-term, transformational R&D, which will be a focus of AIA's investments in research and innovation.

"AIA will also seek co-investors, including from the private sector, for its research and innovation investments to deliver even greater impact for Australian agriculture."

AIA will be managed by an independent, skills-based Board, and invest in strategies that address shared challenges and opportunities to deliver transformative outcomes for the agriculture sector.

For more
www.aginnovationaustralia.com.au

Creating opportunities in the North

COLLABORATION on RD&E and building capacity will be a priority as Northern Australia moves forward to develop broadacre cropping industries.

CRDC R&D Manager Susan Maas and Grains Research and Development Corporation (GRDC) North's Senior Regional Manager Gillian Meppem met with the Cooperative Research Centre for Developing Northern Australia (CRCNA) staff at their head office in Townsville to discuss progress on current and potential future collaborations. The partnership has so far co-invested more than $2.4 million in cropping projects across Northern Australia to test the viability of these crops in topical northern regions. GRDC has co-invested in four broadacre cropping projects, three of which are in Far North Queensland, while the fourth includes additional investment with the CRDC in the Northern Territory.

"For a thriving broadacre cropping industry to be maintained, we need to develop integrated farming systems that are sustainable and flexible to the variability of the tropical environment," Susan said.

"This meeting showed that there continues to be strong support for collaboration and we are working with the CRCNA who are well positioned to connect the different sectors in the North."

The need for increased human capacity to support a thriving broadacre cropping industry including cotton and grains was high on the agenda at the meeting.

"We are talking about capacity across the supply chain – from RD&E to agronomy and processing – and in the early stages of an industry in a new region, there just aren't the experienced or skilled people there to fill these needs," Susan said.

"The take-away from the meeting was that we should address this together.

"If people with experience in cotton and grains are at a premium in the North, developing capacity to support both industries would be an option, for example."

"Ensuring local growers have relevant, realtime data and information..."

In Townsville to talk all thing Northern were CRCNA's Queensland project manager Dr Ian Biggs, CRDC's Susan Maas, GRDC's Gillian Meppem and CRCNA CEO Jed Matz.

The CRCNA *State of the North 2020* report, released at the Developing Northern Australia conference in Rockhampton last November, highlighted both the enormous potential for the development of broadacre cropping across northern Australia as well as key challenges.

CRDC will be working with the CRCNA to develop future opportunities based on the identified solutions from the report. Opportunities include developing integrated farming systems with a focus on profitable business models, rather than a commodity.

The report also identified post-farm gate processing development linked to integrated farm enterprises, for example, a regional cotton gin supplying seed to cattle enterprises, or including sorghum as a source of cattle feed, either as grain post-farm gate into cattle feedlots, silage or in processed form.

CRCNA CEO Jed Matz said the collaborations between the CRDC, GRDC and the CRCNA highlight the importance of regionally-based trials which build the knowledge and confidence of researchers, growers and investors.

"In building these projects we ensured a critical component was information sharing across each of the projects," he said.

"We wanted to ensure the teams were sharing knowledge about what works well and what does not work and how challenges have been resolved.

"This was important because this goes to the heart of capacity building and ensuring local growers have relevant, real-time data and information to inform their future decisions and business planning."

The CRCNA is supported by funding from the Australian Government Department of Industry, Science, Energy and Resources and the Cooperative Research Centre Program, along with the Western Australian, Queensland and Northern Territory Governments.

For more

State of the North 2020 report:
www.crcna.com.au/resources/publications/state-north-2020

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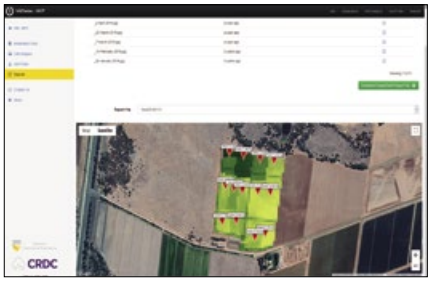
Improving yield prediction field by field

IN-SEASON yield prediction potentially enables improved agronomic management and planning for the sale of crops and insurance contracts. Yield is generally estimated using rules of thumb and manual boll counts.

Existing approaches for automated yield prediction typically involve linking multi-spectral satellite images of the field with in-season weather conditions and historical yield measurements. However, the relationship between spectral response and yield are site and season-specific and significant data collection and model development are required to identify relationships for each variety of cotton and soil type.

According to Dr Alison McCarthy from the University of Southern Queensland (USQ), there is potential to improve yield prediction by using crop production models, calibrated using available field data, and infield imagery to provide more detailed crop features over satellite imagery. The software VARIwise has been developed to combine in-season imagery with crop production models to provide yield prediction throughout the season. UAV or infield camera imagery is collected for each management zone as identified from vegetation index surveys, yield maps or satellite images.

This research is being conducted by Alison as a part of the Smarter Irrigation for Profit Phase 2 project, led by CRDC and supported by funding from the Australian Government Department of Agriculture, Water and the Environment as part of its Rural R&D for Profit program.



The software VARIwise has been developed that combines in-season imagery with crop production models to provide yield prediction throughout the season.

USQ's Alison McCarthy has been working with the cotton industry to improve yield prediction software.

VARIwise has been evaluated at a Darling Downs site to identify the most influential parameters on yield prediction accuracy. Parameters evaluated included weather and soil property data sources, and frequency and timing of machine vision data collection for plant feature tracking. This comparison indicated that in-field soil data was more important than on-farm weather data, and that the accuracy improved as the machine vision capture frequency increased and the season progressed.

Evaluations were conducted at one site in Goondiwindi and 16 sites in Griffith in the 2017-18 and 2018-19 seasons in collaboration with the CottonInfo team. Phantom 4 UAV imagery was collected every two to four weeks at each site between January and harvest to calibrate the crop model. The sites had varying levels of fruit removal, hail damage and heat stress.

In the 2017-18 Griffith trial, yield prediction errors against final yields were 10.2 percent in January, six percent in February, 2.5 percent in March, and 0.5 percent at picking. In the 2018-19 Griffith trial the errors were 18.8 percent in January, 4.9 in February, 9.5 in March, and 10.1 percent at picking.

In the 2018-19 Goondiwindi trial, yield prediction errors were 8.7 percent in February, 5.9 in March, 7.1 in April and 2.6 in May. The prediction errors at Griffith were higher in the 2018-19 season than the 2017-18 season because the sites experienced hail and heat stress that were not currently represented within the VARIwise crop model.

Further trials are underway to refine the yield prediction approach using a new crop production model developed from weather data, satellite imagery and crop growth assessments that can be automated with machine vision. This will reduce the calibration requirements of the existing crop production model. In addition, the USQ research team is working with CRDC to develop a commercialisation strategy for the research.

For more

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Consultant Emma Ayliffe worked with the SVCGA to enhance their knowledge via a Grassroots Grant.

Giving back to growers at grassroots

CRDC has announced six 2020-21 Grassroots Grants recipients, with initiatives in store for cotton communities from the Northern Territory to the most southern valleys.

Included are crops tours for growers to different regions, including the Northern Territory, along with helping growers and farms become digitally ready.

Grants of up to $10,000 are available to cotton grower associations (CGAs), which are designed to create and drive relevant small projects. It's been a successful initiative for CRDC, with R&D General Manager Allan Williams encouraging CGAs to continue to get on board.

"We continue to see value for growers being generated from these grants," Allan said.

"Programs undertaken through the grants can help identify broader issues and needs of growers.

"The ability to create regionally-specific value is key.

"No two growing areas are entirely the same: the topography, climate, water delivery, resistance management plans, infrastructure, insect pressure, disease status, soil type, and season length all vary, sometimes more widely than others.

"Grassroots Grants offers a way to address the regional uniqueness of issues and strengths.

"We've even seen grant projects lead to larger projects or successful funding applications for further research."

Applications open annually on July 1, and are reviewed on a first-come first-serve basis, so now is the time to get thinking about a project! Applications close November 30 or when funds have been allocated. Interested applicants must read the program's Guidelines for Applicants and return a completed Application Form to CRDC via research@crdc.com.au. Applications should include a timeline, accurate costings, the likely learning outcomes, and the overall benefits of the project for the industry.

For more:
www.crdc.com.au/for-growers/community-grower-support

When is water too dear?

SOUTHERN Valley Cotton Growers Association (SVCGA) also applied to the CRDC Grassroots Grants program for funding to build knowledge and answer questions about the return on investment on water at different price points, and the impact of final irrigations on yield.

The growers wanted to understand the return on investment for extra water, in the context of the southern growing environment and when water prices are high. Former industry researcher Steve Buster undertook final irrigation trials in the 2018–19 cotton season, which the CGA felt was critical to continue in order to improve southern cotton farming systems.

The experiments were undertaken by consultant Emma Ayliffe.

"The return on investment of the final irrigation in the 2019–20 season was an interesting study but unfortunately the results were affected by significant rainfall in early March, and the eastern sites showed no significant differences in yield," Emma said.

"However, there are key take home messages from the second year of this trial."

Emma found that cutting out irrigations in early February is yield limiting, even in a cooler wetter finish.

Southern growers get the goods from grassroots

GRASSROOTS grants are once again providing cotton growers with valuable tools to sustain their businesses.

Southern Valley Cotton Growers Association (SVCGA) in partnership with the Irrigation Research & Extension Committee (IREC) have received funding through CRDC's Grassroots Grant program to help members improve their digital readiness and capability across on-farm technology, computing and software.

The funding is enabling SVCGA to offer the two-part project to 25 growers, including a one-on-one farm visit from an ag tech expert, and attendance at a full day workshop.

During the two-hour farm visit, the expert will make sure all software is updated and ensure the office set-up is correct and so geared for maximum efficiency. This farm visit also includes a machine audit to identify what machinery and implements are used as well as the associated screens.

During the workshop, activities include data standardisation, as well as learning and performing the steps to capture, store and share ag data collected from various sources such as MyJohnDeere and spray rig software.

SVCGA chair Paul Cleton said this was also an opportunity for growers to share learnings, failures and successes with others.

"We all create a vast amount of data from our farms and this project will ensure we are set up to capture, store and use this data correctly," he said.

Growers Julie and Dave Bellato are some of the first growers to undergo the farm visit from the ag tech expert.

MELANIE JENSON

Grassroots Grants can address regionally-specific issues. The Southern Valley CGA wanted to know more about the economics of buying water to finish crops, according to SVCGA chair Paul Cleton.

"We found the farm visit really useful," Julie said.

"We learned about different options for technology, which can be used to improve decision making in our business.

"It was very beneficial and the consultant was really professional."

IREC Executive Officer Iva Quarisa said this is a fantastic opportunity for cotton growers to take the first step in making the most of their ag data and making sure they are set up to succeed.

SVCGA and IREC have collaborated on a number of projects in the past. This is the second Grassroots Grant that SVCGA and IREC have delivered.

"These Grassroots Grants are just fantastic. They empower our CGA and enable us to implement locally relevant projects which benefit all cotton growers in our region," Iva said.

For more
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This finding is supported by results from both years of the trial. When the weather is cooler and trending towards damper, there is no yield benefit in continuing to irrigate into mid-March. Two sites had a slightly inverse trend of more irrigation resulting in a slightly lower yield. Other key findings were:

- Final irrigations when coupled with significant rain events produce poorer quality fibre.
- An inverse relationship between the number of irrigations and micronaire was seen at the eastern-most sites (4 and 5).
- Site 4 had an estimated $88/bale discount at the grower standard (final irrigation in mid-March) and no discount when there were two less irrigations (final irrigation in mid-February).
- A final irrigation in early March can result in a positive return on the investment in extra water. Site 1 saw a six percent yield increase between the cutting out two irrigations (final irrigation in mid-February) and cutting out one irrigation (final irrigation in early-March). So, if water is priced $300/ML, 0.8 ML/ha applied would cost approximately $240. The yield increase of six percent on a 10 bale/ha crop, assuming lint price at $600, would result in a return of $360/ha.

For more
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Running on-farm experiments about to get a whole lot easier

DATA collected through a CRDC Grassroots Grant has aided CSIRO scientists developing a tool to make sure growers' on-farm trials are rigorous and useful. The data was collected through a grant project with Southern Valley Cotton Growers Association (SVCGA). Crop consultant Emma Ayliffe undertook the trials for SVCGA over two seasons, investigating the impact of timing of last irrigations on profit and fibre quality in the Murrumbidgee Irrigation Area (MIA) region.

The data from the trials helped CSIRO to test its On-Farm Experiment (OFE) analysis tool under development through CSIRO's Digiscape Future Science Platform. The technology will help farmers tailor paddock-by-paddock management through on-farm experimentation and analytics. It will allow farmers to explore existing data and refine farm management questions, plan an operational farm-scale experiment, implement that experiment and analyse the outcomes – without the need for small plot experiments.

CSIRO's Rose Brodrick is part of the development team and says one of the challenges faced by farmers when undertaking trials on their commercial fields is the balance between practicality and experimental rigour. Rose has run scientific on-farm experiments at ACRI and in collaboration with cotton growers on private farms over many years as part of her research with CSIRO.

"Farmers often want to test their own or others' theories in on-farm trials, but they've said to me that sometimes they feel there is not a high enough level of certainty in their results," Rose said.

"Further to this, based on discussions with growers through our association with the SVCGA trial, we were sure that building an app is something they'd find very useful and gives them and their consultants more confidence in the experimental design and therefore the result – one that isn't so 'random', that they can then base sound management decisions around."

The data growers collect can reliably be used to make management decisions.

The data from SVCGA's trials has been invaluable.

"When it comes to the analytics stage, we can find there is not enough data or the right type of data," says co-developer Ross Darnell of CSIRO's Data 61.

"CRDC and growers gave permission to use the data from the SVCGA trials as a test for the tool, and this allowed us to test with a real trial and real data – which are the type of collaborators we really need."

"Farmers are always experimenting," Rose said.

"It was enjoyable talking to growers and seeing how enthusiastic they are to look into on-farm experiments, so we are really excited about developing this app.

"It will help give users the steps to design an experiment, as you can do very powerful experiments on-farm very simply if you have the tools, which this app provides.

"Importantly, it will help develop experiments that don't require a statistician from CSIRO to help with the analytics!"

For more

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The plethora of precision agriculture technology in large farming systems, sensors, spatial layers and the availability of historical records has enabled farmers to consider running their own experiments to answer questions about their farming practices, specifically for their fields. However collecting large amounts of data generates its own problems. Turning data into information to enable decision making requires a suite of analytical tools and acceptable user interfaces.

In particular, there is a lack of technology that integrates information sources across the whole-of-farm enterprise scale, with design, implementation and evaluation of farming plans. The OFE app aims to address this opportunity.

"We're working on developing a prototype software system that will represent different spatial scales (for example plots, blocks or paddocks), different farmer actions (variety planted and management options, for example fertiliser applied) and the different machinery used," says Senior Designer Martijn Mooij of Data61.

"The system will link external data sources to these visual interfaces for farm planning and analytics.

"Farmers will be able to use the software to explore existing data and refine farm management questions, plan an operational farm-scale experiment, implement that experiment, and analyse the outcomes.

"Once completed, the data and analytics will be fed back into the software system and be available for subsequent on-farm planning. These experiments will typically involve a small number of treatments (such as variety x management options) and be simpler than complex field trials."

The app is in the protoype stage and CSIRO is looking for partners that may be interested in helping deliver this concept to growers.

Record samples sent for disease diagnosis

COTTON growers and consultants are key to helping fight a new disease of cotton.

Record numbers of plant samples have been sent for disease testing since a call to action was put out last season with the discovery of a suspected new wilt. Cotton pathologists have determined the plants were affected by a newly described disease they have named reoccurring wilt. Research is ongoing to identify the cause and pathogen of reoccurring wilt, with plant samples sent from the field integral to the success of this work.

On behalf of the cotton industry, CottonInfo's biosecurity technical lead Sharna Holman of QLD DAF thanked growers and agronomists for their fantastic response sending plant samples to cotton industry pathologists.

"These samples, in fields showing suspected reoccurring wilt symptoms, will assist with determining the potential extent of the issue across cotton growing regions," Sharna said.

"Following calls to action late last year to send in samples of diseased plants, we have had record number of samples sent in this season for disease diagnosis," Sharna said.

"This great response not only helps build our knowledge of reoccurring wilt, it has also provided correct identification for crop managers of endemic diseases such as Verticillium and Fusarium wilt," said QLD DAF pathologist Dr Linda Smith, who is leading the research.

"This is crucial information when determining appropriate management strategies to reduce the severity of those diseases.

"There is a lot of Fusarium wilt being observed this season as a result of conducive weather conditions (wet and cool).

"It has been seen earlier this season than previous seasons in NSW with severe hot spots evident in some fields.

"This is a reminder that we can't be complacent about this disease and its management in seasons where we don't see external symptoms.

"The Fusarium wilt pathogen remains viable in soils for a very long time, with the potential to cause significant losses under conducive conditions where inoculum load is sufficient."

Research into reoccurring wilt will be ongoing, and Linda and the team will provide up-to-date information and details from the ongoing investigation as it becomes available.

"Our late season disease surveys will give us greater insight into the extent to which this disease is present cotton fields across regions," Linda said.

It is still important for growers and agronomists to be on the lookout for any suspicious reoccurring wilt symptoms in crops, as all stages of the crop appear to be affected, and if seen, or unsure, to contact your local state pathologist or CottonInfo REO to organise a collection for diagnostics.

Reoccurring wilt symptoms include:

- The odd plant or patches of plants that wilted and suddenly died with dead leaves usually remaining on the plant (above)
- Reoccurring patches of dying plants getting larger over past seasons with no explanation for plant death eg seasonal conditions
- Dying plants amongst healthy plants
- Bronzing of leaves and petioles
- Reddening of the roots and root decay, ie if plant is pulled out of the soil, the taproot snaps due to root decay

DUY LE

- Stem cuts show profound gray, reddish vascular discoloration and often divided into V-sections (images above)
- Stem canker/lesions may be present

For more

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Another word for ‘good business’

Australian cotton growers have known for decades that in many ways, ‘sustainability’ is just good business. For example, compared to 1992, growing a bale of irrigated cotton now takes 48 percent less water and 97 percent less insecticide. Growing cotton with less water and insecticides is obviously good for the business bottom line, but it also helps preserve the environment for the next generation of cotton growers and protect the industry’s licence to operate. It’s a win-win says Chris Cosgrove, who is assisting with the industry’s sustainability work.

Win-win outcomes are what the nine *PLANET. PEOPLE. PADDOCK. Sustainability Framework* targets are aiming to achieve. That's because sustainability is not a random list of nice things to do. It manages what is important to customers and other people outside the industry, and to the industry as a whole. If we do it well, we improve in the areas we know are important to the people our industry relies on, and we gain real benefits as well.

In other words, sustainability isn't just about doing the right thing. It's also about creating value now, and handing the next generation thriving farms and a successful industry.

Industry value

More and more, sustainability is a must-have for customers of food and fibre; it's just part of doing business. Levi Strauss, Country Road, IKEA and most other brands feature sustainability on their website home page. For customers, showing we manage what is important to them and their consumers helps keep Australian cotton a fibre of choice. With other fibres strongly promoting their own sustainability, this creates value from keeping markets, or opening new markets.

Sustainability for the Australian cotton industry means running profitable and efficient businesses while creating environmental, economic and social value. It also means being accountable to stakeholders for the industry's actions and impacts.

It also reduces the risk of social licence impacts. PLANET. PEOPLE. PADDOCK. involves talking to customers and others outside the industry about what they expect of Australian cotton. It makes sense that if we talk often and honestly to the people we rely on – like customers, potential workers, or regulators – we will be more alert to risks (and opportunities). By showing we manage what is important to them, we are more likely to have those people want to buy Australian cotton, or want to work for us, or want to support us.

Direct grower value

By talking to people inside and outside the

industry, we have identified nine areas we know are most important to all stakeholders.

We are now setting five-year targets (for 2024 and 2029) for these nine areas.

While the targets are important to people outside the industry, achieving them also has the potential for direct benefits to growers and the industry. This is what the emerging five-year targets look like (see table below), and some of the ways they may create value for growers.

Of course, these benefits can only be gained if the industry is serious about sustainability, has a plan to keep improving, and is transparent.

PLANET. PEOPLE. PADDOCK. is our framework to do this.

Importantly for the industry, PLANET. PEOPLE. PADDOCK aims to manage what's important and communicate progress on Australian cotton's sustainability, without putting extra time or cost on growers.

Proven programs such as *my*BMP, CottonInfo and focused R&D will continue to drive industry improvement across all farm operations. If monitoring of sustainability progress shows any of the target areas need to improve, more effort will be applied through these programs.

Growers are simply asked to continue to use these critical programs, and if needed, to rise to the challenge of improving performance in areas that benefit them and the entire industry.

For more
Chris Cosgrove
chris@sustenanceasia.com

PLANET	PEOPLE	PADDOCK
#1. WATER ■ **Draft 5-year target:** 12.5% increase in water use efficiency. ■ **Potential value:** increased climate resilience and reduced input costs. Water costs were 20% of average expenses in 2018-19. **#2. PESTICIDES** ■ **Draft 5-year target:** 5% reduction in environmental impact. ■ **Potential value:** reduced input costs. Chemical costs were 7% of average expenses in 2018-19. **#3. CARBON FOOTPRINT** **#4. BIODIVERSITY** **#5. SOIL HEALTH** ■ **Draft 5-year target:** Common metrics for these are being developed with other farm sectors. Targets will be set when these are in place. ■ **Potential value** (carbon footprint): increased soil health, reduced input costs. Fertiliser, electricity and fuel were 19% of average expenses in 2018-19. ■ **Potential value** (biodiversity): reduced input costs from less insecticides. ■ **Potential value** (soil health): increased productivity, increased farm value, increased climate resilience.	**#6. WORKPLACE** ■ **Draft 5-year target:** Zero fatalities. ■ **Draft 5-year target:** 30% reduction in serious injuries. ■ **Potential value:** reduced time and cost from injuries. Injury claims were $3.4 million in 2018[1]. ■ **Draft target:** Training and diversity targets will be informed by national agriculture and cotton industry workplace strategies being developed in 2021. ■ **Potential value:** increased ability to find and keep workers, and train for the skills of the future. **#7. WELLBEING** ■ **Draft 5-year target:** A coordinated cotton community wellbeing strategy developed with other industry, government and community stakeholders by 2024. ■ **Potential value:** increased quality of life.	**#8. PRODUCTIVITY** ■ **Draft 5-year target:** 12.5% increase in irrigated cotton yield. ■ **Potential value:** increased innovation; quality and yield maintained without increasing environmental impacts. **#9 PROFITABILITY** ■ **Draft 5-year target:** Rate of return for farms growing cotton is sufficient to support financially resilient businesses. ■ **Potential value:** Ability to reinvest in the business, increased financial resilience. **NB:** Targets are draft, and will be finalised in future months.

1 The median annual cost of cotton farm injury claims in the three years to 2018.

Summary of stakeholder responses to draft sustainability targets

More than 350 stakeholders inside and outside the industry provided feedback on draft targets in stakeholder consultation to develop the PLANET. PEOPLE. PADDOCK Sustainability Framework.

Responses showed stakeholders are broadly supportive of draft targets. In addition to this broad endorsement of targets, a number of other themes were evident in stakeholder responses:

- The draft targets are bold, but they should be. Falling short of an ambitious target is viewed by most as better than easily reaching an easy target, as long as there is a genuine intent to reach the target and people are kept informed of actions being taken.
- Context is important. Data should be reported at regional level where feasible, as well as at industry scale. Complex topics like water and pesticide use and the methodologies for measuring data also need to be clearly explained so people understand the issues, and how progress is being measured.
- Collaborate. There are many opportunities to leverage work inside and outside the industry, and to coordinate with others to avoid duplication – other researchers, other sectors, and other countries or industries. The industry is doing this already, and will continue to do so.
- Be credible. The data behind targets, and the plan to achieve them, need to be credible. If we don't yet have the right data to set targets and measure progress – as is the case for some areas like greenhouse gas emissions, soil health and biodiversity – we should wait. This is what we are doing. We are currently working with other industries in these areas, and will finalise cotton industry targets when this work is done.

Central Queensland's Ross Burnett (at right, with brother Nigel) is the grower representative in the Sustainability Working Group.

He says while PLANET. PEOPLE. PADDOCK. is setting some bold targets, the Australian cotton industry and its growers are well placed to achieve them.

"Stewardship of our industry is very important," Ross said.

"From a grower's perspective, it's protecting our right to farm."

Ross said it isn't just customers and end users of Australian cotton looking for evidence of sustainability.

"Growers are at the forefront of this feeling too," Ross said.

"I think growers are always striving to do the best they can with the tools we currently have.

"Sustainability isn't just about the environment, there's also the people and business elements and it all ties in together.

"Stepping up to meet these targets growers are not alone and will be fully supported by industry RD&E and extension.

"This might require some changes, but our businesses are always evolving over time: it is inevitable.

"I think this framework implements change and creates opportunities, therefore improving how we currently farm and continue to be more sustainable.

"It's for the next generations, to give them the opportunities to farm in a better environment – which is a sustainable one."

Drones fly into revegetation game

Coleambally cotton grower Bernard Star with members of the Dendra Systems team.

In an Australian first, large drones have been used to broadcast native seed from the air as part of pioneering revegetation trials underway on cotton farms in the NSW Riverina.

Dr Rhiannon Smith from the University of New England (UNE) is leading the research to compare the effectiveness of different revegetation techniques for germination and establishment, as well as cost-effectiveness.

The research centres on revegetation to establish native plant corridors in heavy clay soils in semi-arid regions, where cotton is mainly grown in Australia.

Approximately 37 hectares of native tree seedlings and seeds have already been planted at trial sites near Coleambally and Griffith, using three different revegetation methods: tubestock seedling planting, direct seeding with a ute or tractor, and drone seeding.

As well as the Riverina sites, revegetation trials are also planned for the Namoi Valley.

Overall, 75 hectares of field trials will be established, and at each location alternating rows will be planted using the three different revegetation methods.

UNE has partnered with international land rehabilitation and biodiversity restoration experts, Dendra Systems for the drone plantings. The seeding trials are the first-time drone technology has been used for revegetation in Australian cotton landscapes. Dendra has previously used drones for reforestation projects in Canada, Myanmar, New Zealand, and the UK, and in Australia for mine site rehabilitation.

Rhiannon weighing the seed mixture, made up of twelve different locally-collected native plant seeds before adding it to the drone for aerial broadcast. The seed mix included acacias, eucalypts, and a combination of salt bushes.

"Our research is comparing different technologies for native revegetation in semi-arid clay floodplains," Rhiannon said.

"It is exciting to investigate the use of drones to aerially broadcast native seed on the ground surface given its potential to cover large areas quickly at the optimum time for planting.

"Aerial seeding with large drones is cutting edge technology, and the machinery needs to be carefully managed by professionals.

"At the Coleambally and Griffith sites, a pilot, assistant pilot, and engineer helped us spread locally-sourced native seed mix from the air using drones.

"The drones were navigated along set paths of distribution, carrying a payload of about 8 kg

of seed and bulking agent at a time. The seed weight and flow levels were monitored to give us the optimum planting density for the ground distribution.

"Each flight was approximately six minutes, covering a kilometre at a time, before returning to base to replace the batteries and reload."

Rhiannon says her research would assess the germination success and cost-efficiency of this new drone technology against more traditional tubestock and direct seeding methods.

"These trials are all about assessing and evaluating revegetation options to determine the most efficient and cost-effective options for use in cotton landscapes," she said.

"Using drones for revegetation in these heavy clay soils may have some practical advantages over conventional direct approaches. More ground can be covered faster with a minimal ground-based footprint compared to that of seeding and planting methods using tractors or utes.

"Drone aerial seeding may also allow operators to access proposed revegetation sites quickly after a flood or significant rainfall event, potentially increasing the success rate of using seed as opposed to tubestock."

As well as conducting the drone trials, UNE welcomed local cotton growers to observe and learn more about the new technology and the process of revegetation. Twenty people attended the demonstration days with significant interest shown in the drone equipment as a possible new farm revegetation option.

"Growers have been loving these revegetation trials, and the large drones are capturing a lot of attention," Rhiannon says.

"There are a range of reasons growers are interested in farm revegetation, from biodiversity benefits to building their social licence, and illustrating sustainability credentials.

"Revegetation confers broader benefits through ecosystem service provision, like natural

pest control, carbon sequestration, prevention of erosion, providing shade and shelter for stock, wind breaks, and improved micro-climates.

"Most cotton growers have areas on their farms that aren't productive for crop production, and many are interested in making those parts available for revegetation."

The native revegetation trials are part of the Cotton Landcare Tech Innovations 2021 project, funded by CRDC and the National Landcare Program, aiming to help Australian cotton better report on and improve on-farm biodiversity.

The information garnered across the revegetation trials will contribute to developing new and improved decision-making tools for cotton growers to carry out revegetation projects on their farms to strengthen biodiversity in cotton landscapes.

If you would like to learn more about the revegetation trials, drone demonstrations, or biodiversity and restoration opportunities on your farm, contact CRDC NRM R&D Manager Stacey Vogel.

For more
Stacey Vogel
stacey.vogel@crdc.com.au

Coleambally cotton grower Bernard Star offered a section of his farm for the revegetation trials after seeing benefits from expanding ecological corridors.

"We have taken part in a few revegetation projects, including on this farm where we have participated in a couple of native vegetation corridor projects, linking up the state forest and natural waterways," he said.

"This trial site is on the edge of the Coleambally Irrigation area. It is not very productive for cotton but could be valuable for revegetation to enhance the whole area.

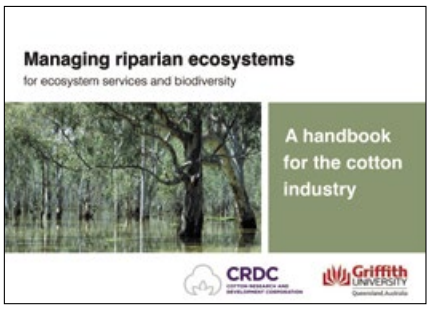
"We have previously carried out direct planting and seeding projects, but I wanted to see the drone technology in action and see how effective the outcomes will be using this new technology.

"If successful drones could be useful by having less disturbance and being able to deliver straight after a big rainfall event where we could really take advantage of the soil moisture.

"Trials such as this UNE one are really important to support and participate in, as ultimately they will increase our options for plantings in the future, and improve integrated pest management options."

Benefits of soil fungi in revegetating old fields

A CRDC project with Griffith University investigated what human and natural drivers impact ecosystem function and the provision of ecosystem services, in particular which management strategies best promote and maintain ecosystem function and services.



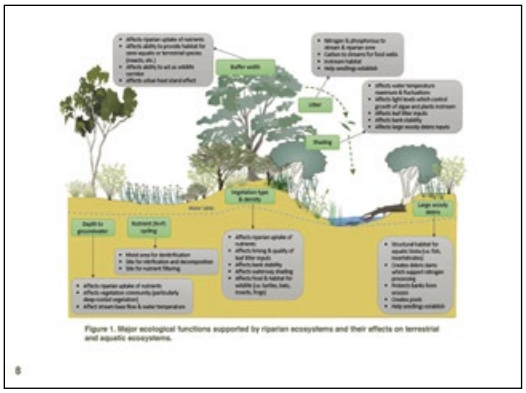
The key outcomes were recently published in the handbook *Managing riparian ecosystems for ecosystem services and biodiversity – a handbook for the cotton industry*.

The handbook outlines the importance of riparian vegetation connectivity for native fauna's survival and its provision of ecosystem services to farmers and the environment, such as natural pest control provided by birds and microbats. The handbook is broken up into two parts. The first part synthesizes current understanding of riparian ecosystems, their functions, ecosystem services and the main factors influencing these. The second part of the handbook provides users with information concerning management of riparian ecosystems including guidelines for monitoring and evaluating riparian ecosystem management.

Griffith University Honours student Reuben de Cocq van Delwijnen's work was also included in the handbook. Reuben investigated the role of fungi in revegetating retired cotton fields at sites used by CRDC researchers in previous natural resource management and riparian projects.

Soil fungi are one important element of soil health as they can assist plants with water and nutrient uptake, especially when these are scarce, however, very little is known about soil fungi, especially in regard to their potential influence on vegetation regrowth in semi-arid floodplains.

Reuben found that soil fungal communities varied greatly between old fields and remnant vegetation with more fungal species present in remnant patches of vegetation compared to old fields. The addition of local leaf litter to old field soils in the short-term, however, did not directly



increase soil fungal diversity.

"Nevertheless, increased soil fungal diversity did promote seedling establishment by increasing seedling biomass," Reuben said.

"The drivers and mechanisms promoting soil fungal diversity in this landscape, however, remain unknown."

This study demonstrates that soil fungi can play a key role in successful revegetation of old fields in semi-arid floodplains. Further study is required to understand the underlying drivers and mechanisms of soil fungal dynamics, an understanding of which could contribute to the development of cost-effective methods for large-scale revegetation in these environments to benefit both biodiversity but also landowners by restoring soil productivity.

"Maintaining and improving the condition of biodiversity in cotton landscapes is essential to maintaining the ecosystem services provided by native vegetation such as riparian zones," CRDC's R&D Manager Stacey Vogel said.

"The Managing Riparian Ecosystems handbook provides an important resource that improves our understanding of riparian ecosystems function and how management can influence its function and the delivery of ecosystem services to cotton communities and farms."

For more

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Taking care of the future

The participants in the latest edition of the Australian cotton industry's premier leadership initiative – the Australian Future Cotton Leaders Program (AFCLP) – have been announced.

The leadership program, delivered by Cotton Australia and CRDC, is run every two years, with this year's program being the seventh time it has been staged.

The program is best suited to emerging leaders actively working in the Australian cotton industry who want to progress their leadership skills.

Cotton Australia CEO Adam Kay said a combination of growers and researchers had been selected for this year's AFCLP.

"The applicants we had for this year's program were the strongest we have ever observed, which highlights the depth of leadership potential we are fortunate to have within our industry," he said.

"Our selection panel had the challenge of choosing just 15 participants, and I am confident the AFCLP will help shape those people in their work guiding the Australian cotton industry through the decades ahead.

"I thank everyone who applied to be involved, and I congratulate those who have been selected and wish them well on this journey."

Adam said the AFCLP will provide the cohort of participants with the opportunity to grow as individuals and as a group.

"One of the great things about this flagship program is it empowers each individual participant to flex their leadership muscle in a way tailored to their strengths, while also binding the group of participants in a collegial, constructive way where they become a powerhouse of ideas for our industry," he said.

"We immensely value our industry's people, and I'm extremely confident this group of emerging leaders will help shine a light for the entire cotton industry for years to come."

CRDC Executive Director Dr Ian Taylor said the program would take on extra importance in 2021.

"Last year's pandemic and crises highlighted to us the value of good leadership, and how when our leaders bind together in the face of adversity and share ideas in an agile and positive way, the hurdles we all need to climb become just that bit smaller," Ian said.

"I believe this program, with its face-to-face forums, an interactive online discussion forum, one-on-one coaching, an individual project, and integration with industry activities, will empower our emerging leaders to dream big and strive for greater success.

"I wish them well on their leadership journey and look forward to working with them as we build a stronger Australian cotton industry."

MELANIE JENSON

Gunnedah based farmer and consultant Rob Weinthal is looking forward to the next stage of his ag journey.

Australian Future Cotton Leaders Program 2021 participants:

- Nicole McDonald, Melbourne, VIC
- Joe Briggs, Coleambally, NSW
- Sally Ceeney, Warren, NSW
- Patrick Fillipi, Sydney, NSW
- Jess Lehmann, Canberra, ACT
- James Traill, Moree, NSW
- Richard Gray, Moree, NSW
- Charlie Clark, Goondiwindi, QLD
- Alexandria Galea, Emerald, QLD
- Will Jackman, Moree, NSW
- Chris Hutchinson, Moura, QLD
- Matthew Anning, Springsure, QLD
- Rob Weinthal, Gunnedah, NSW
- Melinda Swift, Warren, NSW
- Kimberley Fawkes, Dalby, QLD

MELANIE JENSON

Making wellbeing an industry priority

There is growing recognition globally that sustainable, responsible agricultural industries need to monitor and report on their social outcomes, in additional to the more traditional focus on environmental and economic outcomes.

An increasing number of rural industries in Australia and internationally are investing in research to understand their social outcomes. This includes understanding the health and wellbeing of those working in the industry and its supply chain and customers, the social capital built in rural communities as a result of the presence of agricultural industries, and the social contributions made by industries both to the communities they operate in and more broadly to the general community.

The integration of social and wellbeing considerations into the Australian cotton industry's sustainability targets is identified in the CRDC's Strategic Plan. Wellbeing is also a target area in the industry's sustainability targets: PLANET. PEOPLE. PADDOCK.

As part of its commitment to the Strategic Plan, CRDC engaged the University of Canberra's (UC) Regional Wellbeing Survey team to undertake research to develop a framework for monitoring wellbeing for the Australian cotton industry. The project began in 2019 and will run until June 2022.

The aim of the research is to develop a framework that can be used to support quantitative measurement of progress towards meaningful social wellbeing outcomes for the Australian cotton industry, both for those in the industry and for the communities in which the industry operates. The framework will support monitoring of wellbeing to identify areas in which the industry is achieving its social targets and those where intervention can be used to further improve social outcomes.

Through April and May last year, the project invited representatives from all sectors of the Australian cotton industry, as well as community representatives, to take part in phone consultations to discuss wellbeing priorities and the key factors that influence wellbeing outcomes for people in the industry and the broader community.

The findings from the consultation helped identify the cotton-specific wellbeing indicators included in the University of Canberra's Regional Wellbeing Survey (RWS) which was implemented in late 2020. The survey responses from those working in the cotton industry and living in cotton-growing areas will provide baseline data to evaluate social wellbeing indicators for the industry.

In the next phase of the project the focus will be on analysing the Regional Wellbeing Survey data followed by industry and community consultation workshops (hopefully some of which will be face-to-face) to present and discuss findings.

The workshops will take place between June and August 2021. The aim is for the workshops to facilitate stakeholder input as part of the critical review of the preliminary wellbeing indicator framework for the Australian cotton industry.

More details about the workshops and how to participate will be provided by CRDC R&D Manager Rachel Holloway closer to the time.

For more

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Leading causes of on-farm injury: tractors and quads

Many hazards and activities that cause injury and fatality are shared across farms and fisheries in Australia's primary industries.

The Rural Safety and Health Alliance (RHSA) is a cross-sectoral collaboration between nine Rural Research and Development Corporations: AgriFutures Australia, Australian Eggs, Australian Pork Limited, Australian Wool Innovation, CRDC, Dairy Australia, Fisheries Research and Development Corporation, Grains Research and Development Corporation, and Meat and Livestock Australia.

A newly released report by the Alliance has showed that of the 34 hazards identified, nearly half (16) were common to all 12 sectors represented by the RDCs, and 24 were present across at least 75 percent of the sectors.

The most recent data (2014-15 to 2018-19) shows that across nine sectors represented by the RDCs there were:

- 26 fatalities involving tractors and 34 for quads.
- 19 fatalities for mobile plant (excluding tractors/quads).
- 26 fatalities involving ute/car/truck/side-by-side vehicle.

The report also highlights the cotton farming activities that have resulted in a fatality. These were irrigation, farm structure maintenance, vehicle maintenance, spraying, and travel while working.

The findings support co-investment by RDCs, including CRDC, to address high risk activities on farms. The report also informs the RSHA partners of sector-specific priorities for Work Health & Safety (WHS) investment and can guide producers to focus on priority hazards and risks. The comprehensive evidence in the report will be used by the RSHA to invest in priority projects to reduce the burden of death and serious injury on Australian farms.

Agriculture had the highest fatality rate in 2019 according to Safe Work Australia.

MELANIE JENSON

The cotton industry is looking for methods of improving WHS on farms, however it's not a new concept for the industry. The 2018 Australian Cotton Conference included a full session of speakers addressing WHS and sharing their experiences, including Worksafe Qld Safety Ambassador and rugby league great Shane Webcke, who said "I lost my dad in a workplace incident, so I know first-hand that family and loved ones are the most important reason for work safety".

The persistent human cost of death, injury and ill health in agriculture and fishing is significant. The economic burden of this is conservatively estimated at $840 million (2014-2019).

Workers compensation data across sectors showed that there is a relatively consistent pattern involving injuries caused by people being hit by moving objects, body stressing, vehicles, falls, trips and slips.

There is some evidence of variation with cropping sectors (grain, cotton, fodder) more likely to have mobile plant as the leading agency of injury or death, while the large animal sectors (beef, dairy, horses, pork, sheep), were more likely to involve animal, human or biological agencies. Silos were identified as an additional hazard across 10 sectors, causing three deaths.

CRDC R&D Manager Rachel Holloway says one of the keys to addressing WHS is having solid evidence from which interventions can be developed and promoted, which is the first recommendation from the RHSA report.

The cotton industry currently provides support for managing WHS through the *my*BMP program WHS module with resources and templates to help growers manage WHS hazards on cotton farms.

"However this research highlights the need to review the existing resources and to share stories about how growers and employees are managing these issues on farm," Rachel said.

The four key recommendations in the report were:

- Initiate cross-sectoral implementation addressing key risks.
- Improve mental health and wellbeing. (The cotton industry is currently assessing wellbeing and health in cotton's regional communities through the National Regional Wellbeing survey and via its PLANET. PEOPLE. PADDOCK. Sustainability Framework).
- Establish an expert panel to assist with provisions of advice on future WHS technology developments.
- Conduct further research through RSHA to support a program of work to assess and reduce the negative impacts of fatigue on WHS in the agricultural and fishing sectors.

These recommendations will be discussed at the next RSHA Steering Committee meeting and be used to determine priority research for the cotton industry and agricultural sectors. Further information on the RSHA WHS project can be found at www.rsha.com.au.

For more

Rachel Holloway
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New era in pest detection

Technology to revolutionise in-field insect monitoring is ready for use this season.

The Cotton PestDetect App is a digital tool to assist with sampling for silverleaf whitefly nymphs and cotton aphids by providing image-derived insect counts using a phone camera.

PestDetect is used in conjunction with the new decision support tool (DST), which came into use this season. The DST, developed by QLD DAF's Dr Richard Sequeira is based on sampling SLW nymphs rather than adults.

The app has been developed with support from CRDC by Dr Derek Long and Dr Alison McCarthy from the University of Southern Queensland (USQ) in partnership with QLD DAF and CottonInfo IPM Technical Specialist Dr Paul Grundy. It counts SLW nymphs and integrates this information with crop development and pest density thresholds to assist the user to make better-informed management decisions. Using geotagged image analysis, the smart phone photos also allow users to create maps of where pests may be building more rapidly on individual farms or fields. It can also enable timely, impartial measurement of the efficacy of insecticides.

The app had an initial test run last year, during which thousands of photos were taken by researchers and agronomists, which were used to improve the accuracy of the app and to build in new features.

"The biggest of those new features is the automatic plotting of results on the latest decision support tools," Alison said.

"The app automatically records the accumulated day degrees for each field based on the provided GPS location, and so you can see the latest results for that field as soon as you are finished taking photos."

A beta version of the app has been released for this cotton season, and the development team is inviting all interested growers and consultants to try it out when sampling for whitefly and aphids in the coming weeks. To access the app, contact Derek Long, who will create a user account and link.

For more

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Derek Long
derek.long@usq.edu.au

The app refines the monitoring process dramatically and reduces the likelihood of human error. Nymphs have always been a preferred target for SLW sampling due to their lack of mobility and indication of the next emerging generation. However, their small size and random distribution on the leaf has made them difficult to sample effectively, hence the threshold for SLW historically focused on the winged adults and a presence or absence binomial sampling strategy. Counting SLW nymphs instead of adults will give a better picture on the impact of beneficial insects and spray applications, and will also better assess future population trends, instead of just the current outgoing adult population.

As the app enters its second season of beta testing, CRDC, USQ and QLD DAF are seeking commercial partners to bring the finished app, and its innovative technology, to growers and consultants. An expression of interest (EOI) document outlines the requirements for interested parties to participate in the commercialisation process. The EOI can be found at the CRDC website: www.crdc.com.au/for-researchers/applying-for-funding#eoi. Applications close March 31, 2021.

Crop Consultants push ahead with face-to-face events in 2021

A legacy of 2020 is that we have all become quite comfortable with online meetings and catching up on missed recorded events in our own time.

Technology has served us well and will continue to do so into the future. As busy business owners however, it is important that we invest time in quality professional development.

"Networking and information sharing in person is more valuable than ever" is the message from Crop Consultants Australia Director and Goondiwindi agronomist David Kelly who, along with his fellow CCA Directors, is in the process of finalising the content for CCA's 2021 face-to-face events.

After the 2020 hiatus on face-to-face events, COVID restrictions permitting, CCA will host their annual two-day seminar in Narrabri on June 23-24 this year.

It will be two years since the group has met, and David makes the point that the planned agenda reflects the vastly different seasonal conditions that many of Australia's key cropping regions have experienced since 2019.

In keeping with the CCA focus on timely delivery on innovative research to support independent consultants, the agenda is not driven by delivery of existing research projects. Instead, members have regular opportunities throughout the year to suggest relevant topics that will contribute to current seasonal decision making.

This year, speakers and panel discussions will focus on the latest management strategies including the overseas experience with fall armyworm and mirids. Irrigation scheduling and the latest technology to support in field decision making will also be high on the agenda as will disease management for pulses and cereals.

As a professional development group for independent agronomists, CCA also plans to run two specialised regional workshops in 2021 which will be livestreamed for members outside the regions. The first, a business management masterclass in Goondiwindi on September 9 will provide participants with an opportunity to assess software options, HR tools and resources to help take the headache out of day-to-day business management.

The following week, on September 16, the event in Griffith will showcase 'Crops less planted.'

"At this event we will be providing speakers and information sources on many of those crops we hear about, but on which information is not as readily available," Dave said.

"We aim to have a first-hand insight from consultants and growers who have experience in the production and pitfalls of less mainstream crops and varieties."

Registration to CCA events is open to all. At a time when we are all looking to reconnect at a personal level, growers, researchers, consultants, and broader industry members are encouraged to mark the dates in their diaries and register their interest online.

Information on the events, including a link to register on the invitation list is available at www.cropconsultants.com.au/events/.

Information hub makeover

If you've visited the CottonInfo website this year, you might've noticed some changes.

CottonInfo is still delivering the latest in cotton research (plus tools, events and info) to help growers boost productivity, profitability and best practice, albeit with a new look!

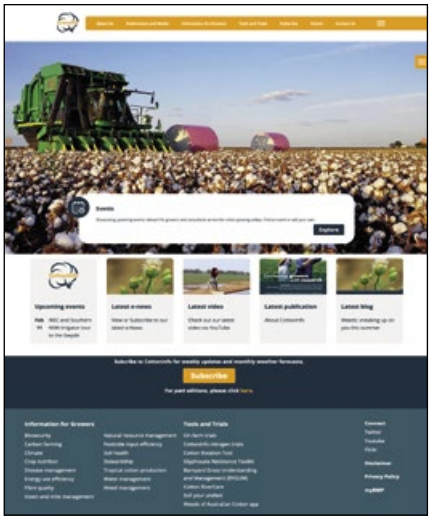
On the site, you'll find information about each of the important areas CottonInfo covers:

- nutrition
- soil health
- water management
- pesticide use efficiency
- energy use
- climate
- biosecurity
- disease and insect management
- natural resource management
- stewardship
- fibre quality
- weed control

There's a host of tools, like the new silverleaf whitefly decision support tool, the cotton rotation tool, the glyphosate resistance toolkit, the Barnyard Grass Understanding and Management tool and the Weeds of Australian Cotton app – all designed to help you navigate some of the most difficult on-farm issues.

The website gives users the ability to track the latest on-farm cotton RD&E trials to find out what research is being investigated near them, as well as see the local biodiversity in and around their farm via the new *Managing Biodiversity in Cotton Landscapes* guide.

The website also houses all the CottonInfo fact sheets, case studies, ID guides, paks and manuals – from the Australian Cotton Production Manual and the Pest Management Guide, through to specific ID guides for the various types of wilt – plus all the blogs and newsletters.



From this site you can also jump through to Inside Cotton: the cotton industry's library of all RD&E reports.

Whatever you need to know about cotton research, the CottonInfo website has you covered: www.cottoninfo.com.au.

Attracted to building a better industry: moth busting with Magnet

The Australian cotton industry's integrated pest management (IPM) systems are the best in the world, largely due to the calibre of the scientists who have been involved.

This excellence in research capacity is supported and extended by the collaborative nature of sectors of the Australian cotton industry, with the aim of enabling Australian cotton growers to grow the best fibre in the world. The recent approval for use of the Magnet 'attract and kill' chemistry for use in resistance management for transgenic cotton is an example of this culture.

Pupae busting has been a mainstay of protecting the Australian cotton industry since the 1990s, well before the transgenic era. By controlling overwintering pupae underneath the crop, resistant *Helicoverpa* do not get the chance to emerge and breed, delaying the development of resistance. Pupae busting then also became a critical part of the resistance management plan (RMP) for the transgenic crops and continues today.

In years when there is early winter rainfall, or where the conditions are extremely dry, effective soil disturbance to destroy these pupae can be challenging and lead to poor compliance and putting the technology potentially at risk. Growers who would like to plant rotation crops directly after picking have to destroy their existing beds and then attempt to reform a suitable seedbed. This can take weeks causing rotation crop yield losses and even additional irrigation water.

Magnet has originated from novel work by Professor Peter Gregg, Dr Alice Del Socorro and the team from the University of New England in the late 1990s.

Of pure curiosity and research

Originating from novel work by Professor Peter Gregg, Dr Alice Del Socorro and the team from the University of New England in the late 1990s, Magnet insect attractant was developed as a novel approach to target a part of the *Helicoverpa* life cycle that had largely been ignored: the adult or moth stage.

On emergence from pupation, moths are driven to mate and to seek out a nectar feed; the only other source of energy a moth has are the fats it accumulated as a larva and any nectar it can find in the landscape. Studies had shown that the more nectar a female moth has access to, the more successful she is in producing offspring.

Peter and his team identified several plant volatiles and feeding stimulants which mimic the type of odours that *Helicoverpa* moths use to find nectar-rich flowers. This phase of the project involved fundamental research, often in collaboration with scientists in other Australian research organisations and overseas, in the USA, China and Norway.

By creating a blend of these ingredients and adding a small amount of an insecticide, Peter and his team discovered that moths would be attracted to and killed by this mix. Further, it was found that by applying strips of the blend through a field, up to 95 percent of moths in the crop could be attracted and then killed.

"Since only about one percent of the field was physically treated, impacts on beneficial insects were minimised and costs were comparable with the cheapest conventional insecticides," Peter said.

Major research collaboration

In the early 2000s the team's research was picked up by the Cotton Co-operative Research Centre, as part of the program to generate novel approaches to controlling *Helicoverpa*. As this product had commercial potential, AgBiTech became involved as the commercial partner, and with intensive work Magnet insect attractant gained full Australian Pesticides and Veterinary Medicines Authority (APVMA) registration in 2009.

With the success of the later generation transgenic crops in controlling *Helicoverpa*, the use

Magnet insect attractant was developed as a novel approach to target a part of the *Helicoverpa* life cycle that had largely been ignored: the adult or moth stage.

of Magnet declined, along with that of conventional insecticides. At this time, work was undertaken to confirm whether Magnet could be used at the end of the growing season to remove the moths that lay the eggs that become the larvae which carry the resistance genes as pupae under the crop.

From 2012-15, a CRDC and AgBiTech-supported project looked at Magnet as a substitute for pupae busting in the Upper Namoi Valley. This work pioneered the concepts of moth busting, but subsequent work on the ecology of *Helicoverpa* showed that pupae busting was not needed if crops were defoliated by March 31 since diapause was not established by that time.

"With the high retention rate of Bollgard cotton, a large proportion of cotton in Northern NSW is defoliated by this time so the Magnet strategy is likely to be primarily in the southern and eastern regions," Peter said.

Southern cotton expansion

With the bourgeoning expansion of cotton into the southern regions, the risk of early rainfall added significantly to the chance of poor compliance to pupae destruction and potentially putting the critical transgenic technology at risk. In response to this risk, and demand for alternatives that might also support timely planting of rotation crops, 2016 saw the recommencement of large-scale research on Magnet for RMP work.

With two further years of small-scale commercial pilots as mandated by TIMS (Transgenic Insect Management Strategy), and with the support of Bayer, the use of Magnet was approved and added to the Bollgard 3 RMP as an 'attract and kill' option.

Industry-developed tool made new

For use as the 'attract and kill' option for the Bollgard 3 RMP, three applications of Magnet (with the small amount of insecticide added) a week apart are required between February 10 and March 1. This is applied by air in narrow bands, spaced 72 metres apart. Once these applications are confirmed as completed, then there is no need for any soil disturbance for RMP compliance. The approach is called 'moth busting' by analogy with the earlier 'pupae busting' technique.

Overnight successes require strong foundation

When Peter Gregg and his research team started to investigate the question "what are moths attracted to?" little did they know that 23 years later, it would lead to a new tool that would help not only protect a critical technology but would also give growers new flexibility in their cropping systems.

"The discovery and development of Magnet just goes to show how important it is to have research programs that are not afraid to support new areas of investigation and experimentation," said CRDC Executive Director Dr Ian Taylor.

While commercialised and sold by AgBiTech, royalties are returned to the cotton industry for the volumes sold. Philip Armytage was CEO with the Cotton CRC while Magnet was under development

and is currently General Manager for AgBiTech in Australia.

"For the Australian cotton industry, Magnet came to commercialisation just a little too late, as the transgenic crops were taking off and were starting to really control *Helicoverpa* well," he said.

"This project to bring Magnet back as a key resistance management tool for the industry that invented it has been a great example of always keeping an open mind and trusting the science."

A win for growers and resistance management

The ability to utilise a method other than physical soil disturbance provides not only options to growers, but also helps ensure effective resistance management. For growers who encounter early winter rainfall or have late crops, being able to meet their RMP commitments, even if the soil is too wet or too dry to cultivate is a great win for compliance. It also provides options for being able to direct drill rotation crops straight into the standing cotton stubble, providing value to the grower while still adhering to the RMP.

While the benefit of using Magnet as an 'attract and kill' option is most obvious to growers in the southern and eastern regions of the industry, in subsequent seasons other valleys and potentially late planted dryland could also benefit. In this 2020-21 season a significant proportion of the cotton planted in the southern regions have opted in to use the Magnet 'attract and kill' option.

New technology: new pests

While initially developed for controlling *Helicoverpa* in cotton, sweet corn and green bean crops, it was observed that moths from many species in the same family are attracted to it. In 2005, Peter and Alice, working with American colleagues, had shown the potential of 'attract and kill' with plant volatiles for the pest fall armyworm (*Spodoptera frugiperda*). AgBiTech successfully tested Magnet two years ago in Brazil on this pest before its detection in Australia in January 2020. It was shown to be highly effective under light-to-moderate insect pressure and in June this year, an emergency use permit was issued by the APVMA for the use of Magnet on fall armyworm in Australia. Global registration work is underway by AgBiTech for Magnet, primarily targeting fall armyworm.

For more

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Sero-X approv

Research into bio-pesticides initially aimed at controlling insect pests of cotton has led to a new weapon against a serious disease.

Sero-X was approved in late 2020 for use in managing Verticillium wilt, giving growers another tool to manage this disease which has the potential to cause serious economic damage. The agent reduces the formation of the microsclerotia of *Verticillium dahliae*, the pathogen causing Verticillium wilt.

Developed by Wee Waa company Innovate Ag, Sero-X was first registered by the Australian Pesticides and Veterinary Medicines Authority for use against *Helicoverpa*, silverleaf whitefly and green mirids in 2017. It is a world first peptide-based bio-pesticide that is safe for beneficial insects including bees, lady birds and spiders as well as humans. It contains a type of peptide known as cyclotides, that are responsible for disease control both in butterfly pea and once extracted, in Sero-X as well.

"It's remarkable that a plant can produce such effective compounds to protect itself against insects and diseases – and even more amazing we can extract these peptides to formulate a product that can provide the same protection to other crops," Innovate Ag Director Nick Watts says.

The amazing ability of the butterfly pea plant (*Clitoria ternatea)* was discovered by one of the cotton industry's longest serving researchers, Dr Robert Mensah at NSW DPI. The discovery came during the course of Robert's research in the early 2000s into biological insect control agents. In his trials, Robert noticed that the butterfly pea plant was not attacked by insects. Since then, more than 60 different insecticide and antifungal bio-active compounds have been characterised within the plant.

"Cyclotides from other plants have been shown to have both anti-bacterial and anti-fungal properties," Nick said.

"We began work in 2016-17 with NSW DPI cotton pathologist Dr Karen Kirkby and her team to discover that Sero-X was effective in reducing levels of *Verticillium dahliae* microsclerotia in the soil."

Sero-X is a long-term strategy to manage

ed for Verticillium management

MELANIE JENSON

Trials were undertaken at 'Strathguyle' Mungindi by the NSW DPI cotton pathology team, including the late Peter Lonergan, Sharlene Roser and Karen Kirkby (second from right) with farm manager Andrew O'Connor and Innovate Ag's Deanne Stanfield.

Verticillium, by significantly reducing propagules in the soil.

"By inhibiting the microsclerotia developing on the tissue we can reverse the spread of verticillium wilt over time: this is a long-term management tool as opposed to a silver bullet," Nick said.

It is applied as a foliar spray at three key times in the season to focus on inhibiting the development of microsclerotia on infected plant tissue returning to the soil.

However, is it possible to eventually completely remove the pathogen?

"Field trials and research continues – but particularly with a tough disease like Verticillium wilt we can't claim to completely remove the pathogen," Karen said, who had been searching for a control option for growers since 2010, under various projects including with CRDC.

"What we know from the study is that in wet years (that are conducive to disease) we can reduce the inoculum build-up from the current crop.

"In dry years when disease is less severe inoculum build-up is significantly reduced.

"The most effective use of this tool will be in fields with low propagules (inoculum levels) as we saw significant reduction in our trials under those conditions and it gives the best chance of reducing the losses associated with the disease over time.

"This is not a stand-alone treatment and should be used in conjunction with industry best practice guidelines, for example plant high V-rank varieties, control weeds, and incorporate trash quickly after harvest.

"It's a brand-new management strategy and with industry support we'll continue to learn more."

The Sero-X innovation highlights the importance of foundational science.

As part of CRDC's collaboration with Wine Australia under the Department of Agriculture, Water and the Environment's Rural R&D for Profit (RRDP) program, Karen's research improved methods for quantifying inoculum and highlighting how levels change through the wetting and drying of the soil, along with the germination of microsclerotia in the soil.

"Karen has a deep understanding of inoculum in the soil from the huge amount of work she undertook in the RRDP project," CRDC's R&D Manager Susan Maas said.

"As part of the research Karen tested tonnes of soil to gain this knowledge and data and a detailed understanding of the lifecycle of *Verticillium dahliae* which now informs thinking in how to try new approaches to this problem."

For more
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Understanding the economic potential of robots

Autonomous farm machinery is increasingly viewed as a key factor in changing the paradigm of conventional agriculture, allowing a shift away from ever increasing crop machinery sizes to swarms of smaller agricultural robots, or agbots as they are known.

The predicted benefits of agbots include improved productivity relating to key inputs such as labour, energy, and chemicals, as well as yield improvements from improved crop management and reduced compaction.

With the increasing commercial availability of agbots and the widely predicted benefits, it is timely to understand the economic potential for agbot adoption in the Australian cotton industry.

As part of their CRDC funded project, Ag Econ economists have investigated the economic potential of integrating agbots into farming operations, including through Queensland-based SwarmFarm Robotics. Because of the early stages of development and adoption for the technology there is a lack of farm level adoption analysis relevant to the cotton industry. To address this gap, Ag Econ undertook an analysis of the application of agbot spraying platforms in a representative farming enterprise.

"We analysed the agbot with the spray system because that is currently the only commercially available attachment/system that suits a cotton farming system," Ag Econ Principal Economist George Revell said.

"However, there are other attachments and systems being developed."

The agbot platform in the analysis is fitted with a 12m boom and 1000L tank. The agbot is leased on a three-year agreement that includes system support

Darling Downs cotton grower Jamie Grant, with his leased SwarmBot. Jamie is an early adopter of a SwarmFarm SwarmBot, and he says the robot has integrated well.
"Weed management has been an immediate benefit. We would usually have to leave the odd weed, but the robot maintains full weed control. New technologies (like auto refill) should allow the robots to drive further benefits particularly with labour productivity."

and major servicing.

The agbot sprayer was compared separately to two other spraying systems;

1. a self-propelled (SP) sprayer with a 24m boom and 2300L spray tank.
2. a tractor with a 12m three-point linkage spray boom and 1200L spray tank.

Discounted cash-flows were used to compare changes in income and costs for the two scenarios to identify if the use of agbots was economically justified. The changes in costs related to labour, fuel, maintenance, herbicide chemicals, and avoided capital costs, while the income changes related to changes in yield.

To ensure equivalent spray timeliness Ag Econ took into consideration the number of agbots that would replace each conventional machine.

The results showed that, to avoid delayed spray applications, two agbots would need to be leased to replace the SP sprayer and one agbot would need

Average costs and benefits per year of lease	2 x Agbot Sprayers v SP Sprayer	1 x Agbot Sprayer v Tractor Sprayer
COST	Average $ / year	Average $ / year
Agbot	$112,890	$56,445
RTK GPS access	$901	$450
Spray system	$18,929	$9465
Total capital cost	$132,720	$66,360
BENEFITS	$ / year	$ / year
Machinery capital cost	$20,476	$26,657
Fuel cost	($20)	$1271
Maintenance cost	$4077	$4284
Spray labour cost	$4466	$9516
Refill labour cost	($2769)	($1189)
Herbicide cost	$22,123	$22,123
Crop income	$180,117	$180,117
Contracting costs	$0	$2182
Total benefits	$228,470	$244,963
IMPACT		
Net present value	$95,750	$178,603
Benefit cost ratio	1.72	3.69

* All figures are present value reflecting a 5% discount rate.

Table 1. Baseline results

"Right from the beginning we have had enquiries from the cotton industry. Robots aren't so much about automation as they are about better farming systems. Robots are about making the most of every opportunity in a season. They allow farmers to change their whole approach to crop management"

- Andrew Bate, founder and CEO SwarmFarm Robotics.

to be leased to replace the tractor sprayer tasks.

The results indicated that switching to agbot spraying could be economically feasible for both scenarios (Table 1 and Graph 1).

For both scenarios, the economic viability of agbot usage was largely dependent on increased crop income from yield gain, followed by reduced machinery capital costs, and reduced chemical costs.

Potential yield benefits were assumed to be from a combination of factors such as improved weed control due to timeliness of spraying, a reduction in compaction, and reduced effects of phytotoxicity from more effective spray application. Further research is required to understand the extent to which a yield benefit could be realised from using an agbot.

For both scenarios, there was a net decrease in total spray labour costs despite increased refill labour costs due to the more frequent spray tank refills and additional spray passes. The additional spray passes led to an increase in overall fuel use for the agbots compared to the SP sprayer which has the highest fuel efficiency per hectare of the three systems.

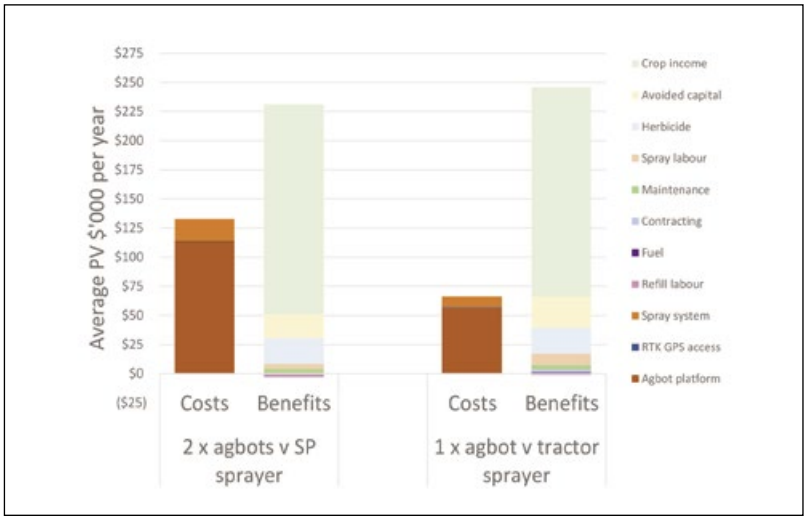
In contrast, even with additional spray passes, agbot spraying generated average fuel savings compared to the tractor sprayer which has the lowest fuel efficiency per hectare of all three systems.

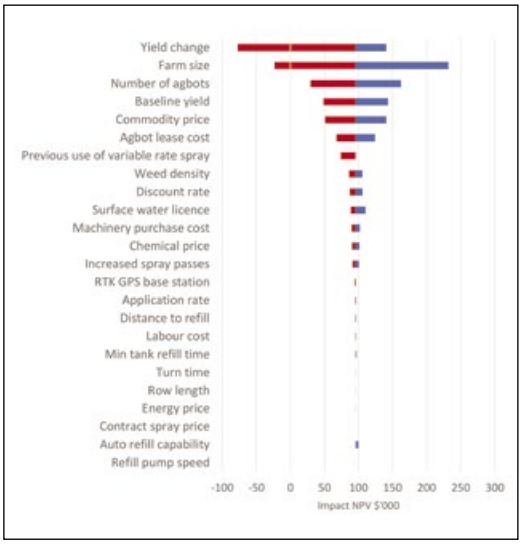
Of all variables, the analysis was most sensitive to the yield change and farm size.

This was particularly true for the SP sprayer scenario (Graph 2), where a minimum 12 percent yield increase, or a minimum farm size of 530ha was needed to make the investment viable with a net present value (NPV) above zero.

In contrast, for the tractor sprayer scenario, zero yield benefit was the only scenario that made the investment unviable; however, this was marginal, with less than one percent yield change needed to be economically viable according to the NPV

Graph 1. Baseline results: Costs and benefits.





Graph 2. Agbot v SP Sprayer. Potential upside (blue) and downside (red) from changes in the underlying variables. A yield increase below 12 percent, or a farm size below 530ha made the investment unviable (NPV<0). (See the full report for details and critical values.)

rule (NPV>0). Of note, a much higher yield change would likely be required to meet individual farmers acceptable hurdle rates.

"Every farm is different, but these results give a general indication that an agbot can be a worthwhile investment if it results in a yield improvement," Ag Econ's Janine Powell said.

Overall, the analysis showed that agbot sprayer technology can be a viable economic technology for adoption in a cotton farming system: however, these results were heavily influenced by a number of factors that will differ between farming operations, and as with any decision, farmers should closely review agbots in their own operational context before investment.

In particular, while yield benefit was the largest benefit for both scenarios, it was also the most uncertain variable given the complex interaction of factors affecting crop yield.

As an example, the continued use of heavy conventional machinery for other field operations may offset the potential yield benefit derived from agbot use. However, while this analysis only evaluated agbot spraying to reflect currently available commercial systems, the use of agbots for other field operations would provide greater support for yield benefits by removing additional heavy axle-load machinery while also generating additional operational benefits (avoided capital cost, fuel, labour, maintenance). This longer-term scenario fits in with the overall vision of agbot developers and proponents to redefine the current farming system.

For more

Australian Farm Business Management Journal

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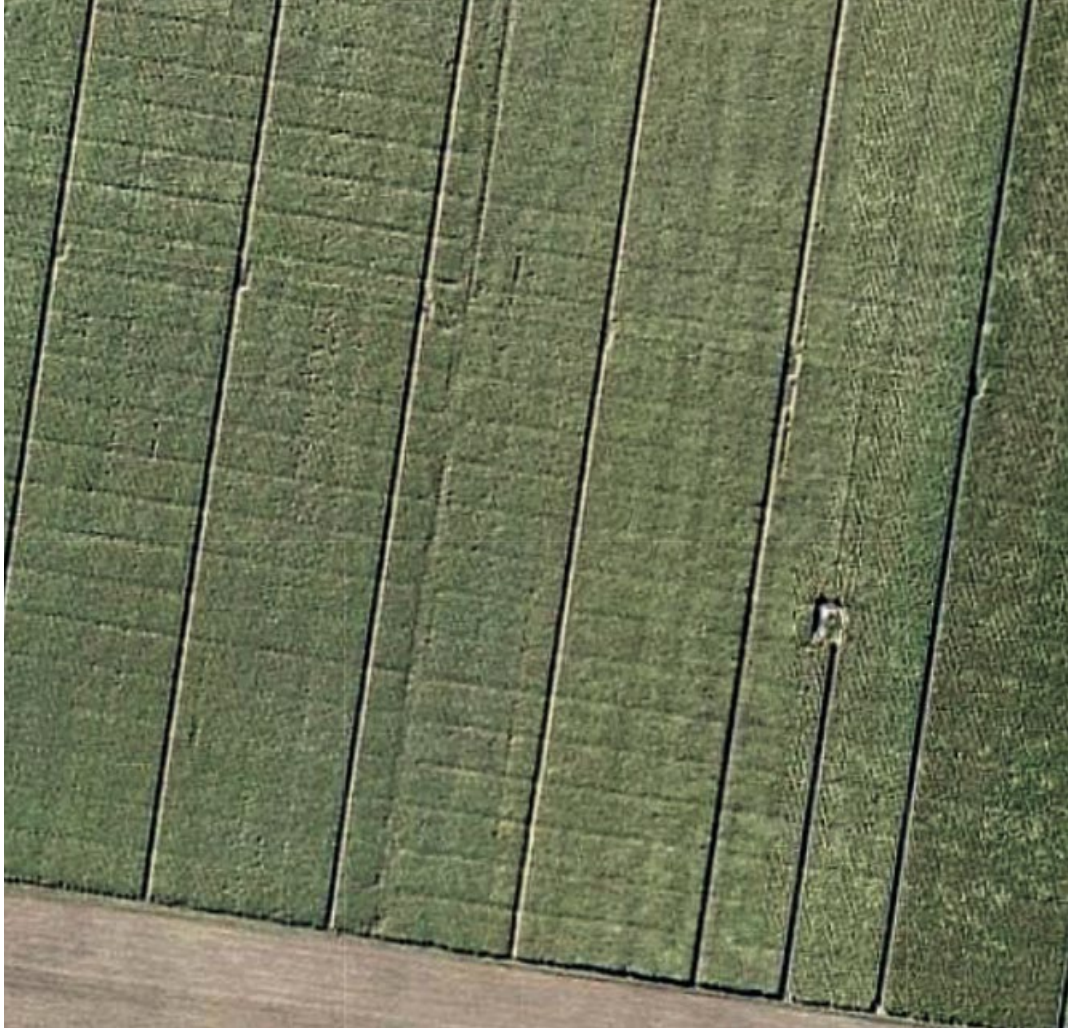

Aerial view of a cropping field after redesigning of irrigation layout (rows -top to bottom) were redesigned perpendicular to the previous configuration (left to right). The poor crop growth is clearly visible over the previous inter-row configurations (left to right).

Keeping soil health on the level

Cotton growers know that variability in soil characteristics can lead to variability in yield. While soil is naturally variable, the development, redevelopment or redesigning of a farm (which includes cut and fill or laser levelling and altering row configurations) can increase soil variability further.

A project supported by CRDC is seeking to understand what causes yield variability in fields across NSW. A part of this research includes identifying key factors growers need to consider before undertaking earthworks within fields.

Irrigation paddocks are laser levelled and redesigned to improve irrigation efficiency, but may create greater yield variability within the field. Research shows that soil organic carbon decreases with soil depth in all soils and that sodicity increases with depth in some locations (Figure 1D). Removing topsoil via laser levelling can therefore expose the subsoil with lower organic matter and higher sodicity, which can lead to drainage issues. Figure 1D indicates the variability in sodicity levels in topsoil and subsoil across multiple locations within a field which can potentially result after a laser levelling operation.

"These areas may also experience reduced nutrient status, as many subsoils are also depleted of nutrients such as phosphorus," says NSW DPI Soil Scientist Guna Nachimuthu.

"Varying or uneven settlement of deposited soil, particularly in the built-up section of a field, can compound these issues and cause potential waterlogging.

"Most of the time, these problems can be rectified to some extent by setting aside the surface soil during laser levelling and then using it to refill the top after the redesign of the field is completed.

"Gypsum application to the exposed sodic soil and subsequent leaching can help to minimise the problems."

Guna says an accurate cut and fill map of the paddock needs to be developed and may assist with gypsum decisions, and that variable rate fertiliser application could complement those maps to rectify nutritional problems. However, the

interaction of sodicity with drainage can still lead to patchy crop growth and it might persist for several years until the surface soil improves in soil organic matter and any nutrient imbalances are corrected.

"Options to improve soil organic matter after laser levelling may include the addition of organic manures, crop residue return, cover cropping and minimising the length of fallows," Guna said.

NSW DPI Senior Research Scientist Graeme Schwenke says removing the organic matter-rich topsoil will limit the soil's potential to mineralise nitrogen (N), which was shown by the late Ian Rochester to account for 70 percent of the crop uptake. As a consequence, the crop growing in these cut areas may show signs of reduced N supply and could benefit from efforts aimed at rebuilding soil organic matter.

Variability in sodicity levels of topsoil and subsoil across multiple locations within a field.

University of New England Soil Biologist and CottonInfo soil health technical lead Oliver Knox suggests exposing soil with low soil organic carbon may change microbial activity in the zones where the topsoil is removed or reduced.

"Soil microbial activity occurs throughout the profile, but is higher in the upper profile where organic matter is available," Oliver said.

"Moving soil from the upper profile around, when laser levelling, can therefore affect microbial activity and nutrient cylcing."

Changing row configurations

Improving crop water use efficiency can lead to altering an outdated irrigation layout to minimise water losses. However, careful consideration is warranted when altering the row configurations as inter-row soil compaction can impact crop growth and yield in subsequent years (see image previous page).

Oliver said it might take up to six wetting and drying cycles (with drying sufficient to form deep cracks between wetting cycles to open up what scientist Arthur Hodgson termed the 'throttle zone') in cotton-growing, self-mulching vertosols to rectify the compaction naturally.

"However, a combination of deep ripping and cereal rotation crops, which lead to a drying cycle with deeper cracks, can accelerate the alleviation of compacted zones after redesigning of the field," Oliver said.

While there are no perfect solutions for issues emerging as a result of laser levelling or re-configurating rows, growers need to be aware of underlying soil characteristics such as sub-soil sodicity and its impact on drainage after laser levelling and consideration should be given to minimise such impacts.

For more

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Figure 1D

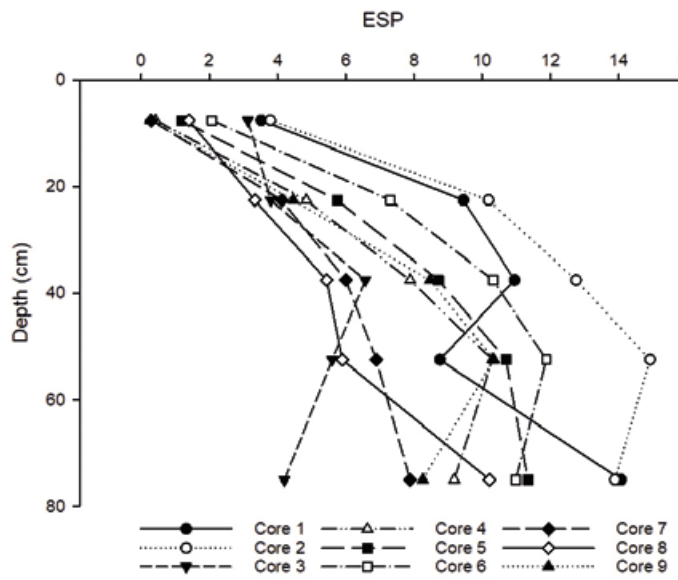


Figure 1A

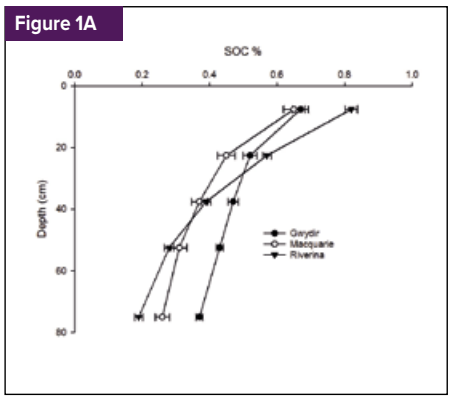


Figure 1B

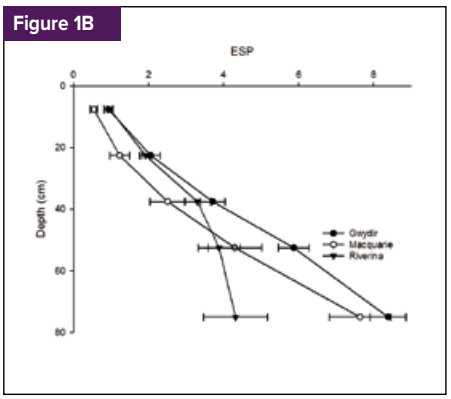


Figure 1C

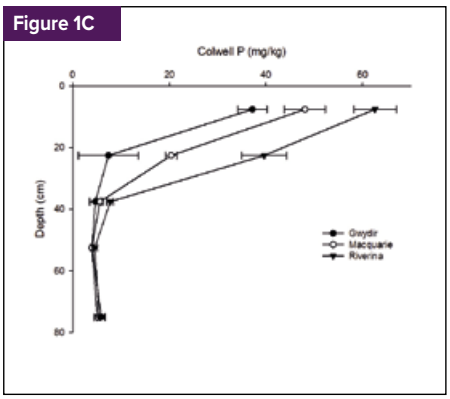


Figure 1A – soil organic carbonpercent (SOC); Figure 1B – exchangeable sodiumpercent (ESP or sodicity).
Figure 1C – Colwell P (mg/kg) values averaged over multiple soil cores in Gwydir (18 cores), Macquarie (36) and Riverina (69).

Know your soil before you dig

The plains of the Namoi Valley were ideal for developing irrigated agriculture, however alluvial sediments from prior stream channels can lead to deep drainage issues.

Old stream channels can become problematic as a source of water loss via deep drainage, particularly if channels or storages are built over them. This is because the clay content is smaller than 40 percent.

In a perfect world, surveys would be undertaken prior to planning and earthworks to avoid permeable soils where possible. However, when a large proportion of the cotton country was developed, especially in the Namoi, the technology was not available.

This means that growers today need methods and technology to identify these potential leakage sites throughout the channel system if losses are suspected to be occurring.

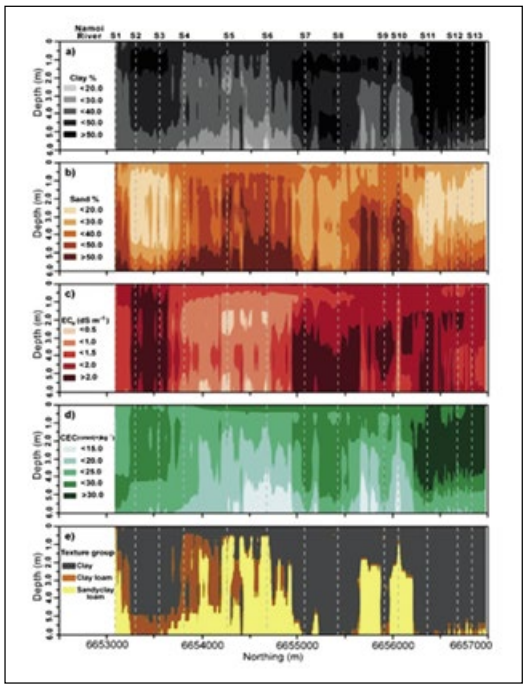
Honorary Associate Professor John Triantafilis of the University of New South Wales' School of Biological, Earth and Environmental Sciences says for growers to manage the water loss, methods need to be developed that can enable a cheap and efficient soil physical and chemical characterisation of their channels, so appropriate management strategies can be recommended to them. He's developed a method, by using a revolutionary 2D imaging approach to identify these leakage hotspots.

Through a CRDC project, John and his team studied a four-kilometre section of a supply channel in the Namoi Valley. Using EM instruments, they collected electrical conductivity data. Using the data they then selected and drilled 13 holes, six metres deep, taking a sample in every metre. Soil physical properties (ie. clay and sand percentages) and chemical properties such as cation exchange capacity were then determined in the laboratory.

By using cutting-edge software, the scientists were then able to make a relationship between modelled electromagnetic survey data and the soil physical and chemical properties. The results are akin to an MRI scan of the soil (as shown) including clay, sand and silt along with soil texture.

Moreover, they found they could identify leakage areas by identifying the location of the permeable, sandy clay loam soil types. Specifically, the prior stream channel is evident where clay content is less than 40 percent and between drill holes 4 and 6. Because of the low clay content and higher sand content, the soil hydraulic conductivity would be high and enable deep drainage from the channel.

In addition, chemical properties, such as cation



exchange capacity can indicate the ability of soil to shrink and swell. In this channel, and again between drill sites 4 and 6, the CEC was less than 20 which indicated the soil has poor shrink swell capacity.

Furthermore, the electrical conductivity of saturated soil extract (ECe) indicates where deep drainage may be occurring, because non-saline areas where ECe shows small values indicate recharge areas where water is being lost.

"A similar approach as we used can identify leakage zones within channels in the rest of the Lower Namoi Valley with the same or similar calibrations developed to enable prediction in other cotton growing regions," John said.

"Techniques need to be developed for delineating the spatial variability of soil properties that directly influence the hydraulic characteristics of the soil beneath supply channels.

"Once an area such at that identified here is located, follow up soil physical characterisation can occur to confirm that a problem exists. Once confirmed, remedial work can begin to either line the channel in the area of the prior stream with an impermeable membrane (bentonite sheet) or with concrete.

"Alternatively, a new channel could be constructed across a more suitable terrain."

For more

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The Madden-Julian Oscillation – why we need to keep it close

First recognised in the early 1970s, the Madden-Julian Oscillation or MJO is an intra-seasonal fluctuation or 'wave' of moist air occurring in the tropics. There is strong year-to-year variability in MJO activity, with periods of strong activity followed by long periods in which the oscillation is weak or absent.

For those of us relying on wet season rainfall during our cotton growing season, this certainly is worth investing the time to understanding its function, and how it drives the weather models and ultimately when we get rain and heat waves.

Spotlight enlisted CottonInfo climate technical lead and Ag Econ economist Jon Welsh to share his insights into this important climate driver for the cotton industry.

Although the MJO is widely regarded by researchers as a phenomenon that organises the climate impacting monsoon regions into wet and dry circulation, there is evidence to suggest that this influence extends deep into NSW and Queensland summer cropping areas.

An example of this was the autumn of 2020 which saw a very active and strong MJO to Australia's north. In Southern NSW during that year, a cloudier, wetter finish to the season had repercussions for cotton yield and fibre quality.

Understanding the MJO and how this rotating pulse of moist air can change our fortunes in summer cropping areas, as well as how science can help prepare for its arrival, is a good idea for growers.

Back to basics – what is the MJO?

The MJO is a coupled ocean-atmosphere phenomenon that, when it is active, organises tropical atmospheric circulation into regions of enhanced and suppressed convection. The MJO is the dominant source of intraseasonal climate variability in the tropics, accounting for around 50 percent of cloud cover variance, although the intensity can vary from year to year.

Deep convective anomalies associated with the MJO first appear over the Indian Ocean and will reach the Western Pacific about two weeks later. The MJO signal dissipates as it propagates eastwards over cold sea surface temperatures in the eastern Pacific before it reforms again in the tropical Atlantic. Figure 1 shows how the centre of this envelope of moist air and convection moves from west to east through Phases 1-8.

Can we predict the MJO to prepare for wet or dry events?

Due to its slowly evolving nature, accurate prediction of the MJO is fundamentally related to our ability to monitor the feature and to assess its relative position and strength.

Dynamical models generally do not predict the MJO well, partly because of the inherent difficulties that remain regarding the correct mathematical treatment of tropical convective (rainfall) processes.

Meteorologists use a variety of data and analysis techniques to monitor, study, and predict the formation and evolution of the MJO. These analyses are often displayed in time-longitude format to reveal the evolution, amplitude or strength

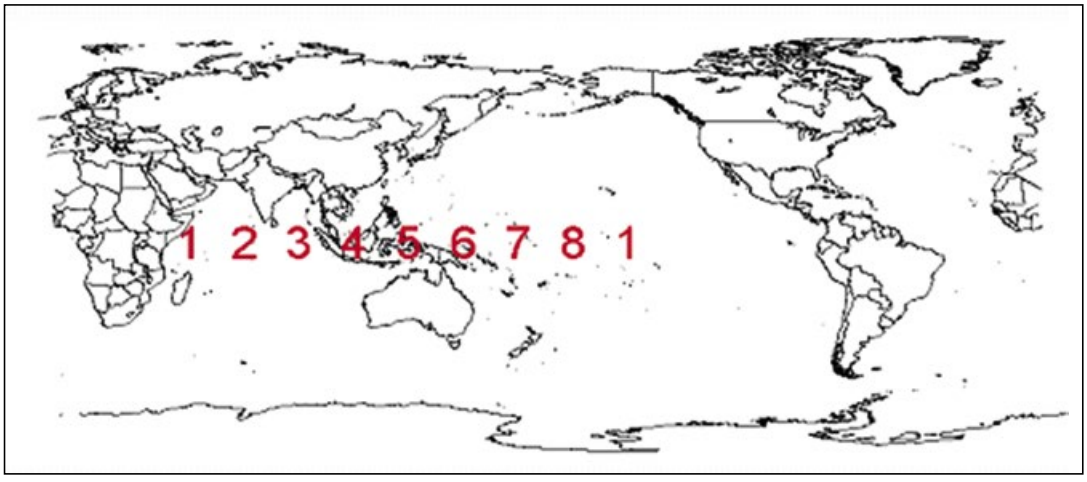

Figure 1. Tracking the various phases of the MJO can help distinguish periods of wet or dry during the wet season. Phases 5-6 depict the influence of the MJO over the Australian region.

and location of the MJO-related features.

Typical time-longitude sections are produced for (1) Outgoing Longwave Radiation (OLR), which is a satellite-derived measure of cloudiness, tropical convection and rainfall, (2) velocity potential, which is a derived quantity that isolates the divergent component (lifting and sinking) of the wind at upper levels of the atmosphere, (3) upper- and lower-level wind anomalies and (4) 500-hPa height anomalies to represent the atmospheric responses in mid-latitudes.

The US government agency NOAA release weekly commentary on the behaviour of the MJO which is very useful in interpreting phase diagrams and when Australia might experience wet or dry phases.

What about ENSO state – can that help determine MJO activity?

There is evidence that the interannual variability of the MJO is partly linked to the ENSO cycle. Strong MJO activity is often observed during weak La Niña years or during ENSO-neutral years, while weak or absent MJO activity is typically associated with strong El Niño episodes.

The Phase diagram forecast (Figure 2, green line) shows a very active MJO in January 2020, when the MJO bought a much-needed change and cooler, wetter weather to inland areas of the east coast following an extended period of extreme drought during 2019. Subsequently, the MJO remained active for the first half of 2020 and set many cotton areas up for a bumper winter crop. When the MJO is well telegraphed, such as this event in Figure 2, farm operations can prepare in advance of a change in weather conditions.

What to watch

When the ENSO state (La Niña/El Niño) is in decline during the summer months and influence is reduced, its then prudent to shift focus to the behaviour of the MJO.

In the last decade, an active MJO has resulted in bringing moisture to parched areas of cotton growing regions in NSW and Queensland. In the driest years, such as 2013-14 and 2016-17 the MJO was not active at all and temperature records were recorded through a most inhospitable summer growing season.

When the phases of the MJO are discernible, the phase predictor diagram can be very useful in adapting and modifying in-season farm management operations.

In a recent interview with Dr Matt Wheeler, who developed the MJO measurement, he suggested the MJO will have even more impact on traditional cotton growing areas, as the tropics move further south in a changing climate.

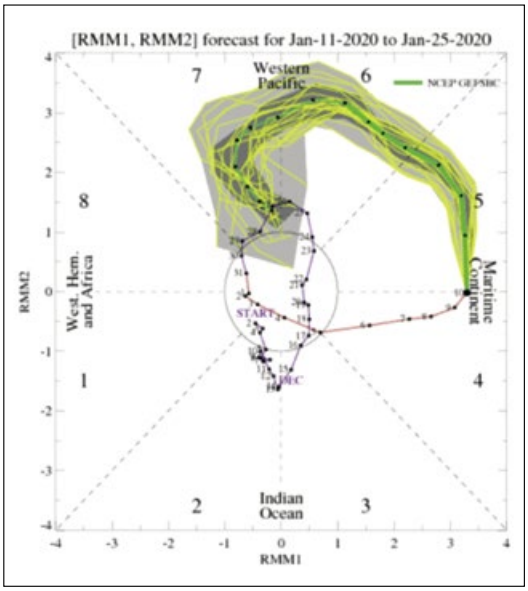

Figure 2. The MJO predictive phase diagram, where impact on Australia occurs in Phases 5-6 during our wet season (source NCEP (US) 2020).

Tools on hand for growers

For a more practical interpretation of the MJO, the Climate Kelpie website has a series of animations, explaining climate drivers.

The Climate Kelpie website was developed by MCV – the Managing Climate Variability R&D Program. Led by Meat and Livestock Australia, CRDC is a partner with Sugar Research Australia, AgriFutures Australia and the Grains Research and Development Corporation.

MCV has two projects underway, both supported by the Australian Government Department of Agriculture, Water and the Environment as part of its Rural R&D for Profit Program. The Seasonal Forecasting project focuses on improved use of seasonal forecasting to increase farmer profitability. The Forewarned is Forearmed project – which also involves Wine Australia and Australian Pork in addition to the MCV partners, aims to deliver direct value to farmers by providing forecasts of extreme climate events, thereby equipping them with the information and tools to be forewarned and prepared.

Outcomes from the research, a suite of climate tools, webinars, climate and forecasting knowledge and information for farmers can be found on the Climate Kelpie website.

For more

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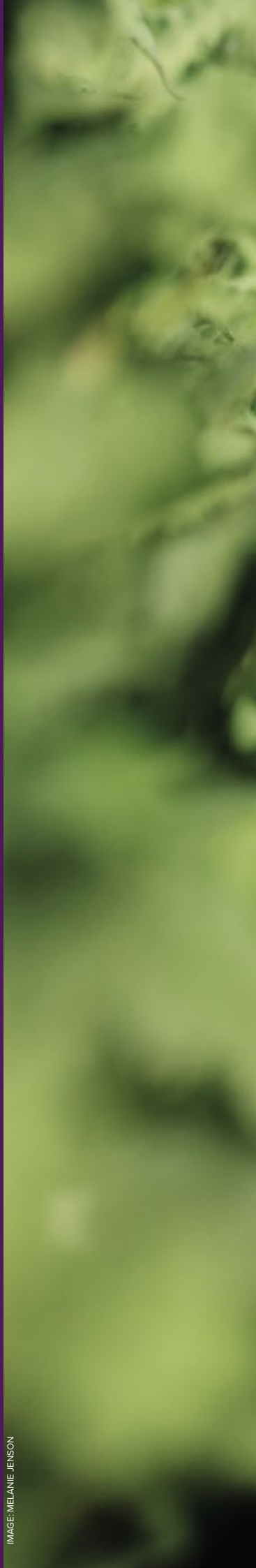

IMAGE: MELANIE JENSON