Spotlight

ON COTTON R&D

WINTER 2022

BioClay breakthrough for whitefly control

$5.5m cross-industry investment to curb spray drift

The story behind record CQ yields

CRDC

Dr Ian Taylor

In the Spotlight

There are some big developments in cotton R&D we are very proud to showcase in this edition of *Spotlight*, highlighting the innovative nature of agriculture and our industry, our researchers and collaborators.

Creating vaccines for plants against pests – both disease and insect – is a game-changer for agriculture. The development of BioClay for use against silverleaf whitefly at the Australian Research Council's (ARC) Translational Hub for Sustainable Crop Protection comes as great news for the cotton industry. The Hub is being led by University of Queensland in collaboration with 15 partners, including CRDC and fellow RDCs GRDC, Wine Australia and Hort Innovation.

CRDC is also part of a ground-breaking project to address spray drift. The much-anticipated collaboration with GRDC and Goanna Ag was announced in March, with the first in a network of towers being installed in April. This represents the single biggest investment in CRDC's history and the most significant move to improve spray application via R&D.

R&D has also come to the fore with recent yields in central Queensland. News of yields above 23 bales per hectare is extraordinary and speaks to the ability of the industry – our researchers and growers – to adapt to climatic conditions to grow cotton. CRDC has long supported QLD DAF research in central Queensland to improve outcomes for growers, and the results have gone above and beyond our expectations. The story behind these yields is great reading in this edition.

The importance of growers being deeply involved in the industry's research has also been explored in a story from Wee Waa (Kamilaroi country) under the Smarter Irrigation for Profit Phase 2 program. When University of Queensland researchers were hamstrung by COVID-19 and couldn't get to 'Waverley', farm manager Andrew Greste and owner Steve Carolan stepped up and ensured the valuable research into irrigation automation and optimisation continued. We thank them – and all growers involved in research – for their commitment to cotton R&D, which in this case has the ability to see further improvements across the industry in water use efficiency.

We've also included another update on our PLANET. PEOPLE. PADDOCK Sustainability Framework in this edition, as we seek grower input into setting goals around soil health. The framework must reflect the ambitions of growers to achieve a more sustainable industry, and I urge crop managers to contact us to share your thoughts.

Speaking of our growers, we are also pleased to announce that two growers from diverse locations in the industry will participate in the Australian Rural Leadership Program's cohort 29. We look forward to watching their individual trajectories as they become leaders in our industry.

Cotton's people have always been considered our strength and CRDC is helping growers to become employers of choice through a new program – SHIFT – aiming to attract and retain the best and brightest in cotton.

We look forward to seeing you, and celebrating a return to more promising seasons, when we are finally together again at the Australian Cotton Conference in August.

Dr Ian Taylor
CRDC Executive Director

CRDC acknowledges Australia's Indigenous people as the traditional custodians of our country, and recognises their continuing connection to lands, waters and culture. We pay our respect to Elders past, present and emerging, and extend that respect to all Indigenous people.

Winter 2022

Spotlight is brought to you by Australia's cotton growers and the Australian Government through the publisher Cotton Research & Development Corporation (CRDC). CRDC is a research and development partnership between the Australian cotton industry and the Australian Government.

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:
A partnership delivering new technology in the war against drift. Goanna Ag Chief Operating Officer Tom Dowling, CRDC Senior R&D Manager Susan Maas and GRDC Manager Chemical Regulation Gordon Cumming.

Want to see more of Spotlight?

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

COTTON NEWS

FEATURES

ON THE COVER

Delungra (Kamilaroi country) dryland grower Charles Boileau features in one of the case studies within the 2022 Production Manual, talking about his approach to spray application and management.

Grab your copy of the ACPM

THE latest edition of the Australian Cotton Production Manual is hot off the press and covers the complete A to Z of cotton growing from 'adjuvants' to 'zero till'.

The manual is produced each year by CRDC and CottonInfo and is included with this edition of *Spotlight* for our subscribers. It is also available for download from the CRDC and CottonInfo websites and you can request additional hard copies from your local CottonInfo Regional Extension Officer.

All chapters of the Manual have been fully updated to reflect the latest research findings from the hundreds of research investments made by CRDC on behalf of the industry.

And, in this edition of the Manual, we've also included case studies of growers who are implementing the recommended *my*BMP best practices. The case studies are a chance to 'look over the fence' at what other growers are doing on their farms.

For more
Australian Cotton Production Manual
www.crdc.com.au/publications/australian-cotton-production-manual

Innovation in traceability rewarded

CSIRO research scientist Dr Xiaoqing Li, recipient of this year's CRDC-supported ABARES Science and Innovation Award, is helping to take cotton traceability to the next level.

Together with her colleagues in CSIRO's Novel Synthetic Plant Fibres team, Xiaoqing recently developed an engineered cotton germplasm, which produces a protein that does not exist naturally in cotton fibres.

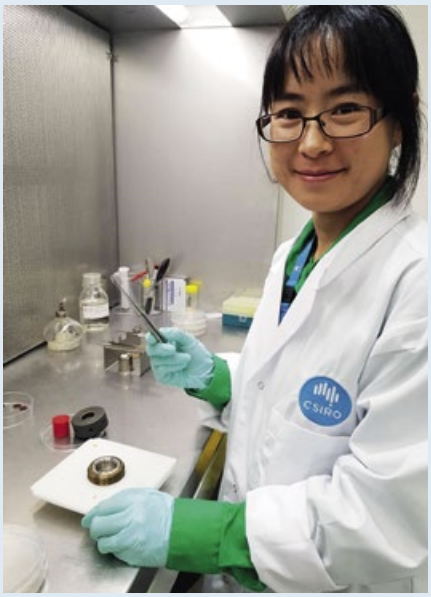
Through the Science and Innovation Award, Xiaoqing will now investigate whether this protein could be used to develop a method to trace cotton back to its original source.

She says her project fills a gap in the science.

"If this protein is stable and can be detected after fibre matures, we can possibly trace it from the beginning to the end of the life of the fibre," Xiaoqing says.

"We hope this work leads us in a new direction to developing plant-based tracing technology.

"Customers are seeking more sustainable products in the textile industry: grown in a sustainable way and manufactured under fair labour conditions.



"Unfortunately, without good traceability, it's hard to tell where the material comes from."

"Existing traceability techniques typically rely on special equipment and processing that is not easy to access, or on extra processing steps to attach materials on top of cotton fibres.

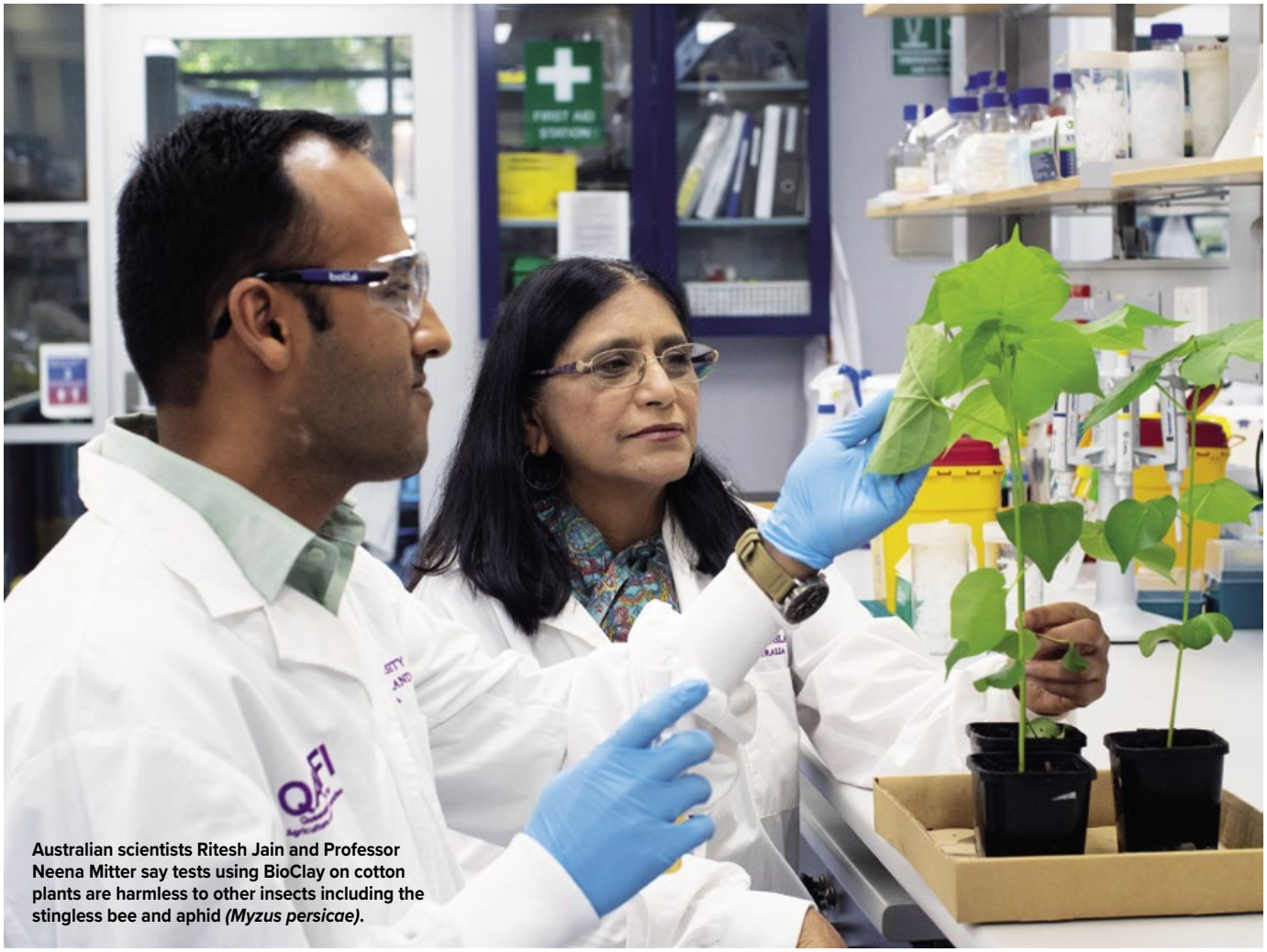
"Alternatively, physical records could be used but are cumbersome and can lack transparency."

Xiaoqing told *Spotlight* that the award came as a surprise, as she knew there were many great research projects and deserving applicants.

"I feel very lucky to receive this award. It's a great opportunity for our novel fibre work to be used in a new area that is important for the industry.

"I hope it leads to more research and development in plant-based solutions for the traceability of cotton fibre, as well as other agricultural products," she said.

For more
ABARES Science and Innovation Awards
www.awe.gov.au/scienceawards



Australian scientists Ritesh Jain and Professor Neena Mitter say tests using BioClay on cotton plants are harmless to other insects including the stingless bee and aphid *(Myzus persicae)*.

Game-changing spray to revolutionise world-wide pest control

AN environmentally friendly spray that targets and kills one of cotton's (and the world's) most damaging pests – silverleaf whitefly (SLW) – has been created by scientists at The University of Queensland (UQ).

The breakthrough is part of UQ's BioClay technology, a safe and sustainable alternative to chemical pesticides, which has been developed over the past decade by Queensland Alliance for Agriculture and Food Innovation (QAAFI) and the Australian Institute for Bioengineering and Nanotechnology (AIBN), with support from CRDC, Hort Innovation and Nufarm Ltd.

Research team leader Professor Neena Mitter said it was a game-changer for crop protection because it was effective against whitefly (*Bemisia tabaci*), responsible for the loss of billions of dollars in agricultural crops around the world.

"SLW is considered an invasive species in the United States, Australia, Africa and several European countries and attacks more than 500 plant species including cotton, pulses, chilli, capsicum, and many other vegetable crops," Neena said.

"The world of RNA is not just responsible for COVID-19 vaccines, it will also revolutionise the agricultural industry by protecting plants from viruses, fungi and insect pests."

"The insect lays eggs on the underside of the leaves and the nymphs and adults suck the sap from the plant resulting in reduced yields."

In addition, whiteflies also transmit many viruses which pose a threat to healthy crops.

Control of the pest has been difficult due to its ability to quickly develop resistance to traditional chemical pesticides.

The BioClay spray uses degradable clay particles that carry double-stranded RNA which enters the plant and protects it without altering the plant's genome.

"It is the first time the BioClay platform has been used to target sap sucking

insect pests," Neena said.

"When whiteflies try to feed on the sap, they also ingest the dsRNA, which kills the insect by targeting genes essential to its survival.

"The world of RNA is not just responsible for COVID-19 vaccines, it will also revolutionise the agricultural industry by protecting plants from viruses, fungi and insect pests."

To identify suitable gene targets, PhD candidate Ritesh Jain went through the global database of genome sequences.

"Initially, we had to screen hundreds of genes specific to SLW to see which ones would affect their growth," Ritesh said.

"Importantly, the dsRNA proved harmless when fed to other insects, such as stingless bees and aphids."

CRDC R&D Manager Susan Maas says SLW is a major pest of cotton globally due to its ability to contaminate and downgrade lint quality.

"This innovation will support the industry to maintain Australia's reputation for producing uncontaminated, high-quality cotton in a safe and environmentally friendly way," Susan said.

Hort Innovation research and development manager, Dr Vino Rajandran said the spray could give the industry another tool in its biosecurity armoury.

"It has the potential to save growers time and money and is a great example of industry levy investment in action," Vino said.

The researchers will now work with industry partner Nufarm Limited to test the whitefly BioClay formulation in real-world production systems.

Nufarm's Global Lead for Transformational Projects, Mike Pointon said the company was "proud to be partnering with these world leading scientists to develop cutting-edge technologies that bring new, alternative control options to farmers".

The research was published in the journal *Nature Plants* in mid-May.

For more
Professor Neena Mitter
n.mitter@uq.edu.au

Leveraging cutting-edge technology to control Verticillium

UNIVERSITY of Queensland (UQ) postdoctoral research fellow Dr Elizabeth Czislowski is working on developing crop protection technologies for Verticillium wilt of cotton at the Australian Research Council (ARC) Hub for Sustainable Crop Protection. The Hub is being led by UQ in collaboration with 15 partners, including CRDC and fellow Research and Development Corporations (RDCs) GRDC, Wine Australia and Hort Innovation.

Since 2021 Elizabeth has been working within Professor Elizabeth Aitken's group, largely focusing on getting antifungal bioassays and plant infection assays off the ground. This research has been done in close collaboration with Professor Neena Mitter's team at UQ's Queensland Alliance for Agriculture and Food Innovation (see previous story).

"The work to get these assays has been really interesting and rewarding as I have learned a lot about the infection biology of Verticillium and its interaction with cotton as a host plant," Elizabeth said.

"When I explain what my work is to my friends and family, a lot them assume that being a plant pathologist is about keeping plants alive but in fact the opposite is true.

"As a plant pathologist, I am intrigued by the micro-organisms that cause plant disease so I am really good at killing plants rather than keeping them alive.

"An important part of my PhD was studying the evolution of pathogenicity in the fungal pathogen of banana, *Fusarium oxysporum*, and current research is studying how these micro-organisms interact with their plant hosts.

"Working with plants and developing plant infection assays has been really important throughout my research career."

The ARC Hub for Sustainable Crop Protection is a world-leading consortium, evidenced by the development of BioClay for protection against silverleaf whitefly in cotton.

Elizabeth says the Hub is "all about leveraging really exciting, cutting-edge biology to solve some pretty big, real-world problems that our agricultural sector currently has to face".

"I am really excited and grateful to be given the opportunity to be part of the team working in the Hub and at UQ," she said.

Elizabeth and CRDC Director Ross Burnett at the ARC Hub during a visit by the CRDC and Cotton Australia boards.

"I didn't have a clear idea or plan for the kind of research project I would be working on when I finished my PhD.

"I have always been attracted to research that has real-life, industry focused outcomes that are underpinned by molecular biology.

"The ARC Hub for Sustainable Crop Protection resonated with my passion for research that can be translated from the lab bench to the field and help growers."

For more
ARC Hub for Sustainable Crop Protection
www.crophub.com.au

Spray hazard warning system breaks new ground

Cutting-edge technology, a new partnership and a $5.5 million investment by the cotton and grains industries has seen the installation of the first of 100 weather stations planned for NSW and Queensland cotton and grains regions, helping to solve the critical issue of spray drift.

The tower network will give users the ability to have forewarning of hazardous temperature inversions.

Through a five-year partnership with Australian agtech company Goanna Ag, announced in March, the investment will see the Grains Research and Development Corporation (GRDC) and CRDC develop a hazardous inversion warning system to give growers and sprayer operators real-time weather data and alerts about the presence of hazardous temperature inversions: a key element for the risk of spray drift.

The first tower in the network was installed in April at Goondiwindi in South-East Queensland (Bigambul country), with the entire system aiming to be up and running for the 2022-23 summer cropping season.

A study commissioned by CRDC and GRDC found that the warning system can increase chemical efficacy, improve labour and machinery productivity, and reduce the risk of spraying under hazardous drift conditions.

"Assuming successful uptake, the warning system could help the cotton industry avoid $40 million in losses and costs associated with spray drift over five years," AgEcon economist Jon Welsh, who conducted the study, said.

CRDC Senior R&D Manager, Susan Maas, said the major causes of drift damage are spraying at the wrong time, and having a poor understanding of inversions and other spray efficacy best management practices.

"The new warning system can predict hazardous inversions in advance," she said.

"This is novel technology and the predictive capabilities of up to 24 hours is also unique.

"Other weather monitoring systems that have been tested in the past simply measure the occurrence of an inversion at night, which has been known in a generic sense for a long time.

"The new warning system builds on breakthrough research, conducted and published by Dr Graeme Tepper and Dr Warwick Grace with support from GRDC and CRDC."

Goanna Ag will establish, operate and maintain the network of 100 Profiling Automatic Weather Stations (PAWS) across grain and cotton-growing regions of NSW, southern and central Queensland. The PAWS have remote sensing capability and new proprietary software to provide growers and spray contractors real-time weather data every 10 minutes.

CRDC's Executive Director Dr Ian Taylor said the partnership with Goanna Ag builds on six years of collaborative research and development from the two research and development corporations (RDCs).

"As research leaders, our organisations are committed to investing in research that supports improved on-farm practices and the sustainability of agriculture," Ian said.

"Spray drift is a significant issue for agriculture and the wider community and reducing its potential and impact is critical."

Being able to accurately identify the presence of hazardous temperature inversions will provide clear sign posts for growers and spray contractors. Currently regulations do not permit spraying agricultural chemicals when hazardous surface temperature inversions are present.

Hazardous surface temperature inversions occur when air temperature increases with height from the ground surface, leaving a layer of cool air trapped below warm air. In this situation droplets can remain suspended in the inversion layer in concentrated form and be carried

significant distances from the target area.

To help those applying pesticides, the network will provide a 24-hour forecast, broken into two-hourly segments of hazardous temperature inversions periods. In some cases, it may open up spray windows at odds with traditional rules of thumb.

GRDC Chair, Goondiwindi (Bigambul country) grain grower John Woods, said the warning system would improve on-farm decision making.

"Until recently, there has been no reliable and accurate method to determine when inversion conditions are hazardous for agricultural spraying using real time data," John said.

"These hazardous inversion conditions exist most nights of the year for undefined periods, so we need to have the ability to know exactly when they are occurring and stop spraying.

"The warning system will provide this critical information to help inform on-farm decision making.

"This is a clear example of GRDC working collaboratively with other RDCs and commercial partners to really deliver innovative, new technology for the agricultural industry as a whole."

Goanna Ag CEO Alicia Garden said the company was the ideal partner for this project, given they already run one of Australia's most comprehensive weather station networks.

"Every hectare of the NSW broadacre cropping belt is already within 25 kilometres of a Goanna Ag automatic weather station, providing local and accurate information to growers," she said.

"With this partnership, we will be delivering another 100 stations with additional critical information for spray hazard identification to the grain and cotton-growing regions of central and southern Queensland and NSW.

"Our speciality is providing essential information to growers on-farm via ag sensing technology. Through the creation of the hazardous weather warning system, we'll be applying this knowledge and technology to the important issue of spray drift."

For more
Goanna Ag
www.goannaag.com.au/spray-inversion-network

Darling Downs grower John Cameron (right) has travelled to the US to investigate herbicide management and is stalwart for best practice on his farm.

Embracing new knowledge while focusing on best practice

Long-time cotton grower John Cameron was involved with the tower's development at his farm on the Darling Downs (Barunggam country), where surface temperature inversions are common.

John has a particular interest in herbicide management. He is the Chair of the TIMS (Transgenic Insecticide Management Strategy) Herbicide Tech Panel. He has a long history of working with the industry to address weeds and herbicide management. John sat on the Cotton Australia Farming Systems panel, which advises CRDC on research priorities, for around six years and has only recently stepped down.

"These towers are providing valuable information for use before and during spray operations," John said.

"We needed the ability to scientifically and predictively identify an inversion, which the researchers have given us.

"While it gives us another tool to avoid spray drift, it also allows us to program spraying jobs more efficiently, as we can make the call earlier.

"It will also be useful in times when staff may or may not have the ability to identify an inversion being present and make the call to not spray.

"It also gives options because we know if an inversion is about we can possibly go to another area and spray."

John says they see a lot of inversion on the Downs.

"We already know that from late afternoon to early morning is dangerous, particularly the early morning inversion."

Best practice and correct equipment and set up are the overarching components of drift mitigation. John is suitably proud of the 50 centimetre drift profile he shares with his neighbours.

"The way we mitigate it is important," he said.

"A combination of wind direction, nozzle selection, boom height and pressure are the components of good spraying.

"Our drift profile is 50cm – it all comes down to equipping our gear correctly and being smart about how we manage our job.

"If it doesn't go where you need it to, you've done your money, done your pass and created a potential off-target hazard.

"So if we can make sure our on-farm management is best practice, the uptake and use of the information this network provides will add a really good extra layer to our armour."

PAUL GRUNDY

Central Queensland breaks yield records

Harvesting that commenced in early April indicates that a number of farms in Central Queensland (CQ) will produce yields well in excess of the previous world record of 18.5 bales/ha (unginnned), with estimates of up to 23.5 bales/ha from some fields near Emerald.

Spotlight spoke with QLD DAF's Paul Grundy about how these yields were possible and some of the considerations and potential risks involved.

High yields in CQ this season are predominantly a by-product of the planting window research, supported by CRDC, that demonstrated August planting was not only feasible but better avoided unfavourable climatic factors during flowering and boll fill.

However, record yields in some fields are due to a combination of unconventional agronomic management and exceptional seasonal conditions.

Over the last six to seven years a small number of mid-spring sown crops were 'grown on' following extensive weather damage from pre-picking rainfall in February. Rapid regrowth (which would normally pose defoliation difficulties) was retained to produce a second round of compensatory bolls that also improved fibre quality through dilution of the poorer quality weather-damaged lower canopy lint.

Crops with seven to eight bale/ha potential were improved to 11 to 14 bales of base grade quality crop picked in May or June. This approach can be risky, with the potential for secondary rain events, insect management difficulties and resistance management implications due to extended crop exposure to *Helicoverpa* generations.

Last year, as drought conditions continued in CQ, some growers with small acreages of

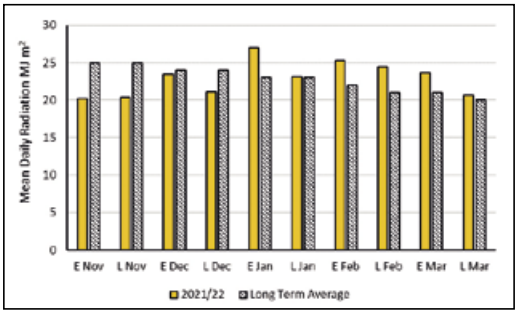


Fig 1. Solar radiation (Central Highlands) in half monthly periods for 2021-22 season compared to long term average.

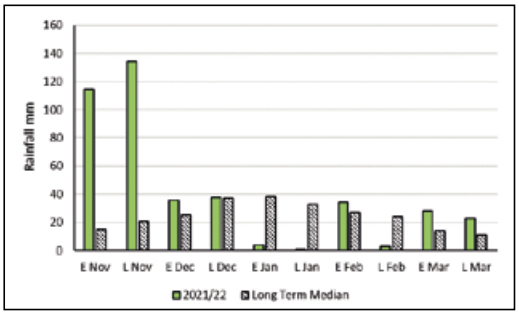


Fig 2. Rainfall (Central Highlands) in half monthly periods for 2021-22 season compared to long term median.

August-sown cotton gained additional minor water allocations mid-season from localised storm rainfall. Rather than sowing mungbeans or sorghum, several chose to apply the grow-on tactic in a different way and used the water on existing cotton to induce 'second flowering', applying additional nitrogen and water just after cut-out in early December.

Unlike weather-damaged grown-on crops, these fields had 11 to 13 bales/ha of undamaged cotton in place. The reduced assimilate demand of the opening bolls enabled rapid regrowth and production of new main stem fruiting branches. The risk of weather damage from rain or flooding is potentially very high in a La Niña year (as in early May this year), but remarkably 2021-22 produced near perfect conditions for crop growth.

November – normally the sunniest month in CQ – was partly cloudy with 200 to 250 mm of rain and cool conditions. Rain events were optimally spaced and crops responded well with slightly larger leaves and limited fruit shedding. In early January

conditions turned sunny with mostly well above average solar radiation through until late March, with little rain and a limited number of excessively hot days and nights.

Crops produced at least 10 additional fruiting branches (reaching 34 to 35 nodes) with many holding first and second position fruit. Mepiquat chloride was used to maintain a compact growth habit for the new nodes. High retention was enabled by a dynamic canopy.

The lower canopy, still intercepting valuable sunlight while being progressively freed of its adjacent boll load, complimented the assimilate production of the new leaves in the upper canopy resulting in each plant holding an additional 10 to 20 bolls. Lower canopy bolls that would normally tag out over time remained intact due to canopy protection and the absence of major rainfall. The combined boll load produced the very high yields picked in April.

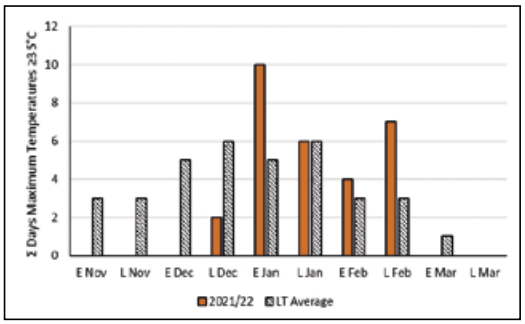


Fig 3. Number of days with maximum daytime temperatures ≥35°C in half monthly periods for 2021-22 season compared to long term average.

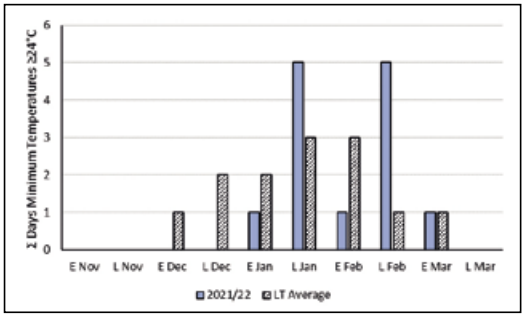


Fig 4. Number of days with maximum night-time temperatures ≥24°C in half monthly periods for 2021-22 season compared to long term average.

Parameters For QLD DAF trial site within a 23.5 bale field

- Sown August 3
- 11.4 plants per metre row
- First flower October 28
- Cut-out early December (158 fruit/m)
- Second cut-out mid-February (279 fruit/m)
- Total Nodes 34-35
- Defoliation March 21, 2022
- Harvest April 12 (221 days)
- Estimated Yield 23.5b/ha.

There are a number of considerations for this management approach in the longer term.

Ensuring viability of the Bt technology is a high priority for growers, and there has been proactive discussion with industry and Bayer relating to any potential risk to the technology from longer crops.

A change to the Bollgard 3 RMP has been approved by TIMS and submitted to the APVMA by Bayer that from 2022-23 growers who plan to grow a crop for a period greater than 230 days (sowing to picking) will be required to sow double the refuge area.

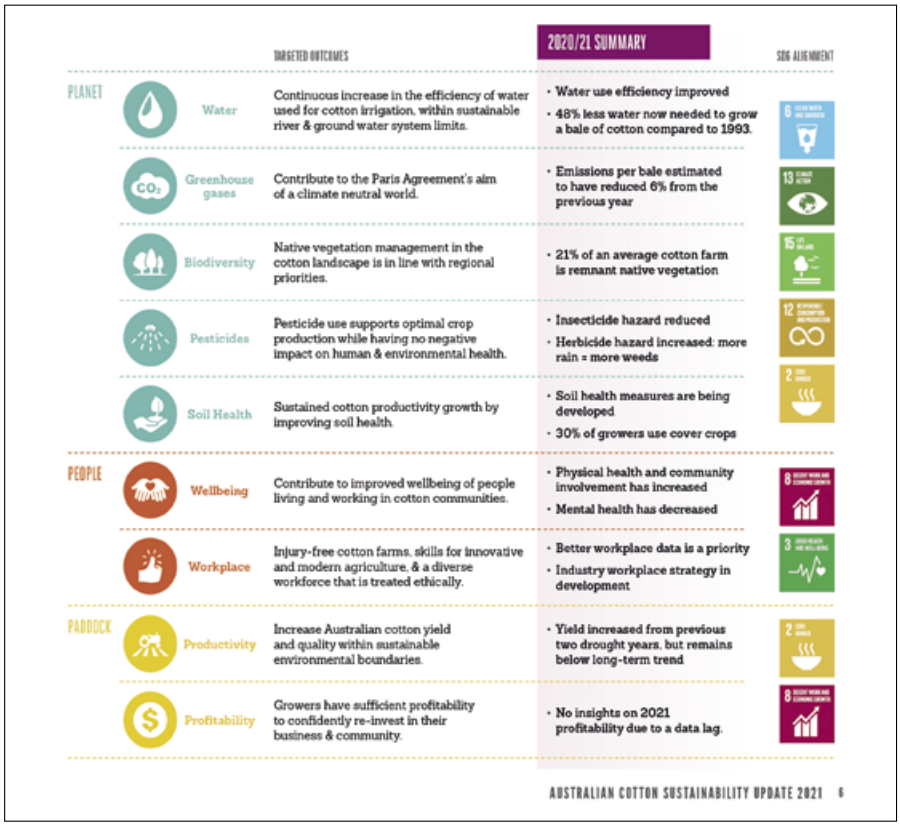
CRDC-funded research will also examine best practice management for these high yielding crops, with particular focus on pest management aspects and the role that cover or rotation crops might play to maintain soil health and fertility and balance the nutrient export of significantly higher yields.

RENEE ANDERSON

What a 23 bale crop looks like in the making.

Report on progress is important reading

CRDC and Cotton Australia have just released the inaugural annual progress update against cotton's key sustainability indicators, outlined in the PLANET. PEOPLE. PADDOCK. Sustainability Framework.



		TARGETED OUTCOMES	2020/21 SUMMARY	SDG ALIGNMENT
PLANET	Water	Continuous increase in the efficiency of water used for cotton irrigation, within sustainable river & ground water system limits.	• Water use efficiency improved • 48% less water now needed to grow a bale of cotton compared to 1993.	6
	Greenhouse gases	Contribute to the Paris Agreement's aim of a climate neutral world.	• Emissions per bale estimated to have reduced 6% from the previous year	13
	Biodiversity	Native vegetation management in the cotton landscape is in line with regional priorities.	• 21% of an average cotton farm is remnant native vegetation	15
	Pesticides	Pesticide use supports optimal crop production while having no negative impact on human & environmental health.	• Insecticide hazard reduced • Herbicide hazard increased: more rain = more weeds	12
	Soil Health	Sustained cotton productivity growth by improving soil health.	• Soil health measures are being developed • 30% of growers use cover crops	2
PEOPLE	Wellbeing	Contribute to improved wellbeing of people living and working in cotton communities.	• Physical health and community involvement has increased • Mental health has decreased	8
	Workplace	Injury-free cotton farms, skills for innovative and modern agriculture, & a diverse workforce that is treated ethically.	• Better workplace data is a priority • Industry workplace strategy in development	3
PADDOCK	Productivity	Increase Australian cotton yield and quality within sustainable environmental boundaries.	• Yield increased from previous two drought years, but remains below long-term trend	2
	Profitability	Growers have sufficient profitability to confidently re-invest in their business & community.	• No insights on 2021 profitability due to a data lag.	8

AUSTRALIAN COTTON SUSTAINABILITY UPDATE 2021 6

The annual update, which looks at the year ending June 2021, provides a snapshot of cotton's performance against the nine indicators – PLANET: water, greenhouse gases, biodiversity, pesticides and soil health; PEOPLE: wellbeing and workplace; and PADDOCK: productivity and profitability.

The annual updates are designed to fit between cotton's comprehensive five-yearly sustainability reports, giving important insights into progress, so the industry can keep track of areas performing well, and those that need more emphasis.

"The Sustainability Update 2021 shows that improvements have been seen in water use efficiency, a reduction in greenhouse gas emissions per bale and insecticide hazard, and an increase in both cotton yield and the physical health of people in cotton communities," said Chris Cosgrove, cotton's sustainability lead.

"On the downside, we've seen a reduction in mental health in cotton communities, and an increase in herbicide hazard as the result of a wetter season with higher weeds numbers and an increase in the use of residual herbicides."

What's does it mean for growers?

A long-term trend of improvement in many areas is something the industry can be proud of, says Chris. It also helps us tell a positive story to people who buy Australian cotton.

In terms of areas for improvement, across across the industry as a whole priority needs to be given to:

- **Reducing net greenhouse gas emissions** (per bale, and in total), by improving nitrogen fertiliser efficiency, reducing electricity and energy from fossil fuels, and keeping carbon in soil and in native vegetation.
- **Reducing herbicide toxicity and volume** where alternatives are available, such as via alternatives to residuals and use of optical sprayers, ensuring all changes are in line with cotton's resistance management strategy.
- Improving farm safety.
- Continuing to adopt practices to **improve soil health** by maintaining soil cover, reducing soil disturbance, maximising living roots, and maximising biodiversity above and below the ground.
- **Protecting biodiversity** on farms by avoiding native vegetation loss, preserving existing native vegetation, and restoring land to native vegetation to provide habitat for beneficials and native animals.

What is cotton doing to manage sustainability?

PLANET. PEOPLE. PADDOCK. is helping the Australian industry to be a global leader in sustainable cotton

production. It sets sustainability targets, coordinates a whole-of-industry strategy to achieve these targets, and engages with growers, the wider cotton industry, cotton communities, and important community groups on actions and progress.

Priorities for Cotton Australia, CRDC and the Sustainability Working Group to continue to improve the PLANET. PEOPLE. PADDOCK. Sustainability Framework are to:

- Improve the quality of our data. Collecting accurate industry scale data is a challenge for agriculture sectors around the world and is something the Sustainability Working Group is working on with other industries here in Australia.
- Contribute to national work to have a consistent approach to managing and measuring native vegetation and soil health. (See the following soil health article and stay tuned to *Spotlight* for more regarding native vegetation.)
- Continue to work with other industries to have consistency across sustainability frameworks, and to share ideas and resources to increase our ability to meet targets.

Along with the annual snapshot, CRDC and Cotton Australia have also released an online sustainability data pack with more detailed information and methodologies. This data pack will be kept updated in real time, to provide an important central source of information on cotton's sustainability progress. This is a new and important initiative.

"Providing transparent and frequent updates of progress is critical for building trust, and an essential part of any good sustainability program," Chris said.

"The CRDC-supported *Community Trust in Rural Industries* project clearly shows that demonstrating our responsiveness to the things that matter most to the community, along with our sound environmental management, are two of the most important things we can do to build trust in cotton."

For more

Australian Cotton Sustainability Update 2021

www.cottonaustralia.com.au/sustainability-reports

Grower feedback wanted on a new soil health framework

In this article, CottonInfo soil health technical lead and Associate Professor of Soil Systems Biology of the University of New England's Cotton Hub, Dr Oliver Knox, and cotton's sustainability consultant Chris Cosgrove discuss how the Australian cotton industry is planning to preserve and improve soil health.

Soil is the single most important asset for every farmer, everywhere in the world. Healthy soil is the foundation of all terrestrial life. It underpins the fertility and productivity of a farming business, providing plants with support and access to water, oxygen and nutrients. So it's no surprise soil health is part of the Australian cotton industry's sustainability framework PLANET. PEOPLE. PADDOCK.

The only problem is, there is no agreement on how to measure soil health (see *'We're bogged in soil's complexity'* breakout box next page.).

So, frustrating as it is, we could wait for a consensus on what specific soil health metric to use before we set an industry specific baseline and target. But instead of waiting and doing nothing, the cotton industry has undertaken extensive consideration of what constitutes soil health, how it might be managed or improved and what a framework to facilitate grower uptake of methods to improve or maintain their soil health might look like.

Just two principles for soil health on your farm

The framework we've developed aims to make the complexity of soil health simple. Instead of focusing on chemical, physical and biological properties of soil, or of numerous functions of soil, this framework focuses on the core principles farmers should follow when deciding what practices will improve soil properties and functions.

And there are really just two principles that need to be followed.

Soil health is defined by the National Soil Strategy as "the capacity of soil to function as a living system". So by extension, this means the principles for improving soil health are to:

- protect soil habitat – by maximising soil cover and minimising disturbance; and
- feed soil organisms – by maximising living roots and maximising biodiversity above and below the ground.

This new soil health framework shows how soil principles, practices, properties and functions are all linked. It also shows that dictating certain practices, or asking farmers to focus on improving a specific property or function of soil won't work. As the National Soil Strategy notes: "soil management practices must be flexible and tailored to support productivity and reduce soil degradation in different landscapes".

This principles-based approach gives flexibility for farmers to choose practices that fit the two soil health principles, and are appropriate for the differing geological, seasonal and land use conditions across different farms.

What do you think of this framework?

The framework aims to help growers improve soil health and plan for the future by drawing together as simply as possible the vast amount of thinking behind soil health.

It's new, and it is intended to help decision-making. We want to know what you think of this framework.

- Is it simple to understand?
- Does it help you choose practices that

will improve soil health and fit into your current farming system?
- Does it get you thinking about future changes – such as in paddock design, rotations, crop management, enterprise mix, or equipment and infrastructure – that will support productivity and soil health?

As well as talking to growers, the cotton industry is also using this framework to help shape the soil health conversation with scientists and peers in Australia and around the world, as we work towards that consistent understanding of soil health and how to measure it.

When growers and others have had a chance to provide feedback, we will update the *my*BMP soil health module to reflect this framework and use it to better tell our soil health story to consumers and to guide research investment decisions. If you would like to provide any comments, please contact Oliver Knox.

For more:
Oliver Knox
oknox@une.edu.au

We're bogged in soil's complexity

Soil is the most complex biological material on the planet. Healthy soil is a living, dynamic environment, full of microbial and macroinvertebrate life that help to recycle essential plant nutrients, improve soil structure, and control plant disease and pests. According to the UN Food and Agriculture Organisation, just one teaspoon of soil has more living organisms than there are people in the world.

All this complexity, right beneath our feet, has led to decades of discussion, debate and dispute about just what soil health is and how it should be measured.

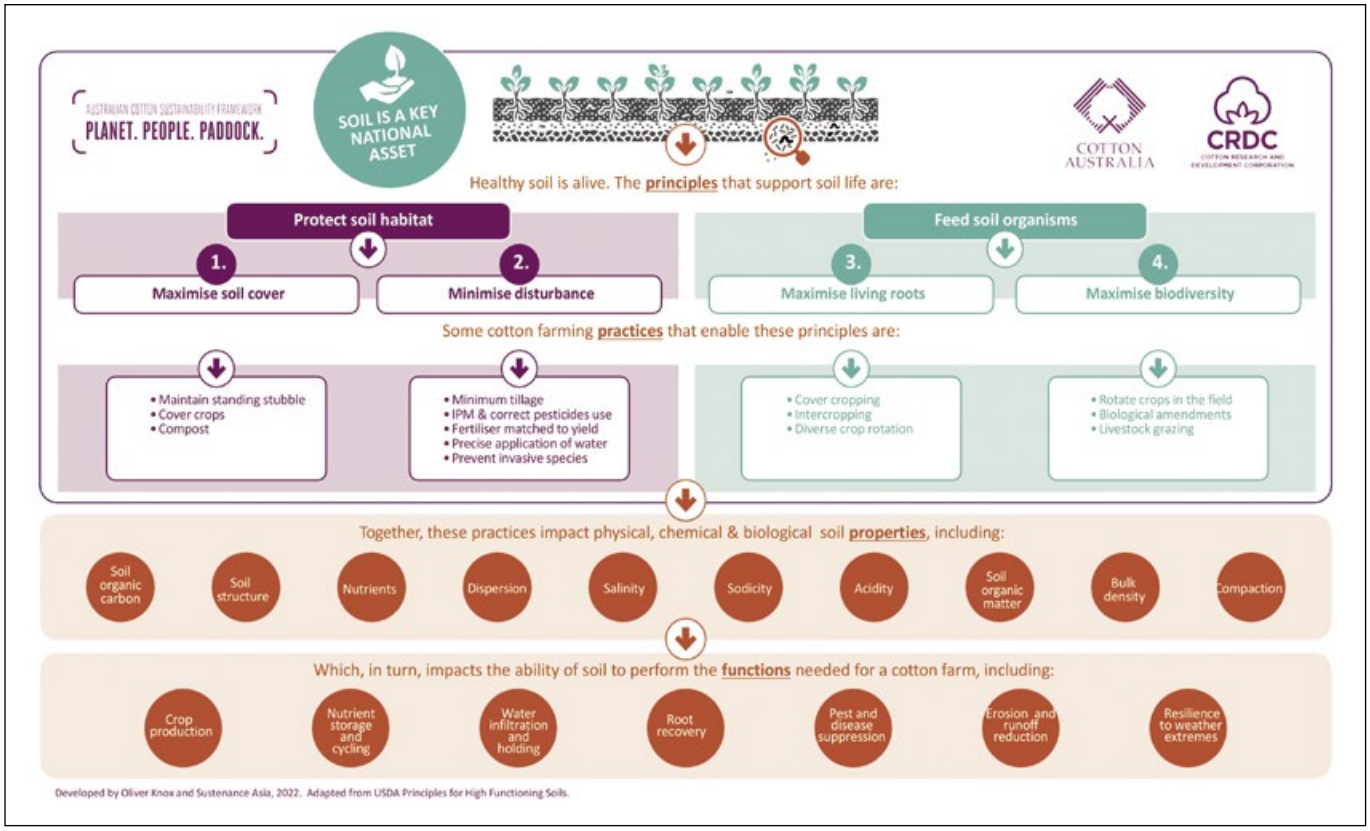
There is still no agreement anywhere – in Australia, or internationally – on how to measure 'soil health'. Most proposals to measure soil health focus on physical, chemical or biological soil properties. Others suggest measuring soil functions, like yield or water holding capacity.

All of these are valid, and the Australian cotton industry could just choose one of these – for example, the annual percentage increase in soil organic carbon – as its indicator for soil health, start to measure this at an industry scale, and set five-year soil health sustainability targets.

However, there is a big problem with doing this, because we must have consistency with other sectors. The last thing we want is for a farmer growing cotton to have one set of soil health metrics that the cotton industry is using, and then see different measures in future from the beef or sheep or grains industries, or from customers around the world who buy their cotton.

Creating nationally consistent indicators and methods to measure and report soil conditions is something the Australian Government's National Soil Strategy, released in 2021, aims to deliver, but this will take time.

While we wait for consistent soil health measures to be agreed – and actively contribute to those discussions – we are encouraging growers to continue to adopt practices that enhance the soils ability to function as a living system.



Ayla's horizon is in the North

A student passionate about the Australian environment and tropical agricultural systems is the 2022 cotton Horizon Scholar.

Ayla Christophers is studying a Bachelor of Agricultural Sciences at the University of Adelaide, and with support from CRDC will take part in the AgriFutures Horizon Scholarship program, gaining professional development opportunities and a valuable insight into the cotton industry. The Terrritorian says her high school years in Darwin (Larrakia country) sparked an interest in agriculture.

"I've always loved science and have found that agriculture is a great practical application of this," Ayla said.

"When I finish my degree, I would love to use my knowledge to address issues in Northern Australia such as food security, climate change and increasing the sustainability of agricultural practices.

"I'm really excited and grateful to have been selected to participate in Horizon with CRDC.

"It is a great opportunity and I am keen to learn more about the development of the cotton industry in Australia, particularly in the north, as I think it will have a big part to play in the region."

The AgriFutures Horizon Scholarship is awarded to students studying an agricultural undergraduate degree or a science, technology, engineering, maths/finance (STEM) degree with majors relevant to agriculture. In partnership with industry sponsors, the scholarship supports students studying full-time at an Australian university with a $5000 bursary per year for the final two years of their degree.

Professional development workshops and industry work placements aligned with the scholar's areas of interest and their sponsor's industry are a highlight for scholars. There are also opportunities to network and gain knowledge at a range of industry events, which Ayla is looking forward to.

"I feel privileged to be provided with guidance within the program and am very excited to meet new people though the networking opportunities the scholarship provides," she said.

"I'm looking forward to the mentoring aspect, and I hope to be at this year's Cotton Conference to meet people from across the industry.

"I really like hands-on work too, so after I finish studying I'd love to be able to use my passion for plants and people to work with farmers, as I believe science holds the key to sustainable agriculture."

First up, Ayla will start a placement with CRDC.

"It's super exciting," Ayla said.

"Rachel (Holloway) is going to help me make the most of my placement and tailor it to my specific interests by connecting me with people in the industry up north."

Rachel is CRDC's R&D Manager responsible for recruiting and supporting the Horizon scholars.

"During the selection process we were really impressed with Ayla's love of science and plants, and her passion to use knowledge to work with farmers," Rachel said.

"We hope to give Ayla an experience in the cotton industry that showcases opportunities, and creates a network of supportive people she can learn from.

"Attracting passionate people with an interest in science and research – like Ayla – to our industry is a key focus of CRDC's projects in building adaptive capacity. We support undergraduate scholars through programs like Horizon and our summer scholarships, and as they progress to become early career researchers we offer a PhD program, helping to create cotton's future workforce of scientists, extension officers, and R&D managers."

For more
Horizon Scholarship
www.agrifutures.com.au/people-leadership/horizon-scholarship

Farmers to the front for Nuffield

CRDC and Cotton Australia are urging cotton growers to apply to one of the country's most lauded programs for farmers, the Nuffield Scholarship.

The two organisations are co-funding one cotton industry scholarship for 2023. The successful cotton industry scholar will receive a $30,000 bursary to study a topic important to them and the wider industry. They will spend 14 weeks travelling over two years, tapping into Nuffield's global network of scholars. Recent cotton Nuffield recipients include current scholar and grower Fritz Bolten (also supported by ANZ), his fellow WA grower Luke McKay, plus NSW growers Richie Quigley, Tom Quigley, Billy Browning and Daniel Kahl and Qld growers Renee Anderson, Matt McVeigh and Nigel Corish. Their reports can be found on the Inside Cotton website (www.insidecotton.com).

These past scholars have investigated a diverse range of subjects in their Nuffield studies, including crop nutrition and soil health, workforce attraction, the value of cover crops, growing cotton in the north, and cotton's social license. Importantly, what they've learned in their studies doesn't just benefit their own farms and regions: one of the key elements of the program is information sharing to the broader industry.

Applications are open to cotton growers aged between 28 and 45. No tertiary education qualifications are required. Applications close Friday June 17, 2022 and the successful recipient will be announced at the Nuffield National Conference in September.

For more
Nuffield Australia
www.nuffield.com.au/how-to-apply

Cotton Conference rounds up exciting speakers and all the science

The agenda for the 2022 Australian Cotton Conference is taking shape with sessions, speakers and topics identified from across the cotton industry and the wider supply chain.

The agenda will include a mix of topics with a strong focus on science, technology and innovation as well as business and leadership. Kicking off with award winning speaker Lucy Bloom on the topic of 'doing business differently' and closing with renowned demographer Bernard Salt, the three-day event will cover topics as diverse as the industry itself.

Speakers will provide both technical research and practical farming advice, and external presenters will challenge and present new ways of thinking and innovative approaches to cotton challenges.

Delegates can expect to learn about soil health and carbon farming, smart irrigation methods that generate profit, on-farm robotics, cotton diseases and testing, new farm workplace cultures, the global cotton market, biodiversity, data, digital agriculture, fashion brands and the supply chain. With the Conference theme of 'here for good', sustainability and building community trust in cotton will also feature.

As always, registration costs will cover all meals, and a variety of social events will be on offer, providing a great opportunity to mingle and network after a four-year Conference hiatus. The Conference organisers encourage you to register now to take advantage of the early bird rates.

For more
Australian Cotton Conference
www.australiancottonconference.com.au/get-involved/register-now/

Meet you down innovation alley!

CRDC, the Australian Cotton Conference team and growAG will have a new initiative for attendees at this year's conference: Innovation Alley.
Attendees at the 2018 conference will remember Startup Alley, where 12 startups were hosted and pitched to a panel chaired by Shark Tank's Steve Baxter.
In 2022, the Alley will return, but with a focus on innovations and technologies invested in by CRDC and our fellow Research and Development Corporations (RDCs). 12 innovators will be hosted in Innovation Alley, including Goanna Ag and the spray hazard towers - the largest single investment CRDC has ever made (see story on page 7). You will find the 12 innovators in the Conference trade hall and speaking as part of the Conference agenda!

Yalari to benefit from industry generosity

Australian Cotton Conference chair and St George (Kooma country) cotton grower Hamish Macintyre has made his pick for this year's Conference charity: Indigenous education not-for-profit, Yalari.

Yalari offers secondary education scholarships at Australia's leading boarding schools for Indigenous children from rural communities and believes education is the key to generational change. Yalari has over 200 students currently on scholarships nationally and an alumni group in excess of 350 who are attending university, working or undertaking further study.

Waverley Stanley AM, the founding Director of Yalari, knows about the power of education from his personal experience. In 1980, as a young Indigenous boy living in the remote community of Murgon Queensland (Waka Waka country), he was given the opportunity to attend Toowoomba Grammar School (Barunggam country) for high school. It was this opportunity that started him on the Yalari journey. At Conference, Waverley will speak about the organisation's history, work and achievements.

The Conference organisers are hoping this year's donations will exceed the record of almost $50,000 raised for OzHarvest during the 2018 Cotton Conference, thanks to the generosity of cotton growers and Conference attendees.

For more
Yalari
www.yalari.org

Former CottonInfo REO Elsie Hudson setting up the long-term monitoring site in the Namoi Valley.

Long-term studies bring focus to biodiversity management

Long-term native vegetation monitoring sites established by CottonInfo Regional Extension Officers (REOs) are supporting landholders to improve biodiversity.

Since the CRDC-supported project began in 2020, five sites have been assessed and set up for monitoring, which is taking place seasonally over five years. Sites were chosen where land practice change aimed at improving biodiversity was planned or occurring. The REOs are tracking what the landholders put in place, challenges and gains for biodiversity and the farm business, and will share these journeys with the wider industry.

Regional natural resource management groups and universities are collaborating to assist REOs with monitoring, technical advice, and identify potential funding opportunities to assist landholders in implementing land practice change.

"While some form of management in riparian and floodplain ecosystems on cotton farms is common, among landholders there is often a lack of knowledge and understanding of the value and importance of ecosystem function and services," CRDC R&D Manager Stacey Vogel said.

"There is considerable uncertainty regarding what 'good condition' landscapes look like and the effectiveness of recommended biodiversity best management practices.

"This project is equipping landholders and REOs with increased skills and knowledge to identify vegetation and improve knowledge of what good condition native vegetation looks like and how management practices can impact positively and negatively on condition.

"This project will capture and demonstrate vegetation change occurring as a result of the implementation of best management."

On-farm changes planned or occurring include revegetation and regeneration, weed and pest control, and restricting grazing in the McIntyre, Namoi, Macquarie and Lachlan valleys and on the Darling Downs.

For more

Stacey Vogel
stacey.vogel@crdc.com.au

Building up the benefits of restoration

Susie and Jamie Grant are seeing wildlife return to an important ecological community on their property.

Since 2019 the Grants have been restoring 150ha of mainly riparian grasslands and woodlands along Jimbour Creek at 'Wyalong', on the Jimbour brigalow flood plains near Dalby (Barunggam country) in south-east Queensland. This area has become one of CottonInfo's long-term vegetation monitoring sites.

The Grants believe implementing and continually improving best practice is essential for the sustainability of their farms and business, whether it's pesticide management, work health and safety or riparian restoration. They've participated in the *my*BMP program for many years, achieving certification in 2016 and are signed on to the Better Cotton program.

Jamie says the integrated pest management (IPM) benefits they receive from the Jimbour Creek corridor are evident in that they've been able to harvest their refuge crops adjacent to the creek, but not surrounding fields further away.

"Jimbour Creek runs east to west, connecting the eastern Bunya Mountain foothills with the Condamine River, which provides an important corridor for fauna movement across the plains," Jamie said.

"It is an important habitat for local fauna including natural predators which are contributing towards our IPM."

Jamie says the restoration of Jimbour Creek is a long-term project and they didn't expect changes overnight.

"With the support of industry groups such as CottonInfo and frameworks like *my*BMP, we were confident it could be achieved slowly but surely," he said.

Initial work included an area-wide feral pig management plan and aerial shooting. Weed control has begun to increase native groundcover, reduce erosion and improve habitats for beneficial insects. Jamie says after 10 years of drought, the better season is also doing wonders to the country on its own.

To assist in planning the regeneration process, CRDC supported further ecological surveys, which included a surprise koala sighting and evidence of their movement through the grasslands.

"This was a rare sighting but hopefully it will become more common," Jamie said.

The regeneration site is listed as a threatened grassland community on alluvial black clays. A detailed floristic survey recorded no shrubs or trees (hence a grassland community) made up of 19 native species of grasses and 31 native forbs or other ground cover species. 20 per cent of the plot was non-native exotic weeds.

"This has provided insight into the seedbank and the flora that did and does still naturally exist in these communities, so the ecosystem can be restored to its natural state," CRDC's Stacey Vogel said.

Jamie agrees, saying the surveys provide knowledge to allow refinement of their management practices to encourage natural regeneration of native grasses and trees.

"The surveys have added to the information and knowledge they are accumulating about the landscape and its condition, and given us a starting point we can use to improve on," he said.

"Previous grazing, drought and weeds washed downstream have taken their toll.

"Improvement through restoration of this corridor is a win-win for landholders, biodiversity and the landscape – and that's the aim of this project."

Jamie and Susie Grant are working with CottonInfo and CRDC to monitor and regenerate this riparian zone on their farm.

Same exotics pests: changing entry pathways

Cotton's biosecurity plan update is underway, with the industry and government collaborating to review and develop the new *Biosecurity Plan for the Cotton Industry*. The review aims to ensure the industry can continue to prepare and respond to exotic pest and disease threats and ensure business continuity for cotton growers in the event of an incursion.

The review, coordinated by Plant Health Australia, is in consultation with the Industry Biosecurity Group, a select group of crop protection and biosecurity experts. The group comprises representatives from CRDC, Cotton Australia, CottonInfo, CSIRO, QLD DAF, NSW DPI, the Northern Territory Department of Industry, Tourism and Trade, and the Western Australian Department of Primary Industry and Regional Development.

Biosecurity planning identifies existing and emerging biosecurity risks to the industry, and assesses the risk of these pests entering Australia and the impact they could have to production.

The review of threat summary tables, which provides a ranking of the threat different exotic pests pose to industry, is key to the process. Each exotic pest, pathogen and weed is given an overall ranking based on four criteria: entry, establishment, spread potential and economic impact.

This review ensures all current information is assessed including changing circumstances that could change a pest's threat level. One of the main changes to an overall ranking is commonly due to changes in a pest's entry risk. Air and sea cargo are potential pathways for the entry of exotic pests, however changes to agricultural and merchandise import arrangements can affect the risk potential of certain pests entering Australia.

Industry biosecurity plans are used as a strategic framework to coordinate biosecurity activities and investment for Australia's cotton industry. Once complete, the *Biosecurity Plan for the Cotton Industry* will be available on the Cotton Australia and CottonInfo websites.

For more
Plant Health Australia
www.planthealthaustralia.com.au

Sentinels keep watch in cotton

In addition to monitoring insect pests, a trial national plant pest surveillance program may soon be on the lookout for a new disease of cotton.

Known as a Sentinel 5, the mobile and autonomous pest surveillance unit was stationed on a cotton farm near Whitton (Wiradjuri country) in the Riverina from late October 2021. The unit was developed under the iMapPESTS project, a collaboration between CRDC and fellow plant industry Research and Development Corporations (RDCs), led by Hort Innovation under the Department of Agriculture, Water and the Environment's Rural R&D for Profit Program.

CottonInfo's Kieran O'Keeffe has been collecting insect and pathogen samples from the unit for analysis by researchers at South Australia Research and Development Institute (SARDI), Agriculture Victoria Research (AVR) and the University of Queensland.

Data for key insects including green mirids, thrips and silverleaf whitefly has been shared through the iMapPESTS website and cotton-grower focus groups in the Riverina. The team at AVR will report on the biodiversity of insect trap samples, including the presence of key beneficials.

According to iMapPESTS project coordinator Shakira Johnson from AUSVEG, key pathogens of interest for cotton weren't targeted at this site, due to a lack of a specific assay to detect them. However, a key outcome has been that by working with researchers at SARDI's Molecular Diagnostics Centre general assays have been developed that have the potential to provide insight into the dynamics of an emerging disease of cotton, reoccurring wilt, caused by *Eutypella*.

QLD DAF cotton pathologist Dr Linda Smith is now working with SARDI to test samples from the Sentinel's cotton trial to investigate the capacity of the pathogen sampler onboard the unit to monitor for the disease.

Eutypella was found to be the cause of reoccurring wilt, which was first found in cotton crops in 2019. With support from CRDC, Linda and the pathology team undertook an emergency project to determine whether the pathogen was firstly exotic, which was ruled out; and secondly its identity. This included a coordinated industry effort with CRDC, Cotton Australia, CottonInfo, QLD DAF and NSW DPI pathologists working together in the initial response and with CSD and the CSIRO breeding team.

The research paper was recently published in the *Australasian Plant Pathology* journal.

Linda collaborated with CSD during the 2021-22 season in trials to examine resistance to reoccurring wilt in Sicot 714B3F, Sicot 74 B3F, Sicot 748B3F and Sicot 606B3F. They found no difference in resistance between varieties.

"Current research is focused on understanding the lifecycle of the pathogen and management options," Linda said.

"It is thought that infected cotton residues are a likely source of inoculum for this pathogen. "Therefore, research to confirm this and practices that aid breakdown of residues are being investigated."

For more
iMapPESTS
https://imappests.com.au
Linda Smith
linda.smith@daf.qld.gov.au

Genetic diversity of exotic pests uncovered to boost biosecurity

Viral diseases are a significant constraint to cotton production in many parts of the world.

In Australia, only one virus disease – cotton bunchy top – has been reported to cause economic losses. These have generally been sporadic and localised, but occasionally have been widespread. In the 1998-1999 season, cotton bunchy top virus (CBTV) caused losses of approximately $74m across the Australian industry. Severe but less widespread outbreaks occurred again in the 2010-2011 season.

Many of the most economically damaging virus diseases of cotton are still exotic to Australia, yet pose a significant biosecurity threat. In particular, cotton leaf curl disease (CLCuD) and cotton leafroll dwarf virus (CLRDV), which causes cotton blue disease, could cause serious economic harm in Australia as they have elsewhere around the world.

That's why the cotton industry, via CRDC, is supporting research and development focused on preparedness, by creating rapid testing technologies and collating knowledge about these viruses.

This research, led by QLD DAF's Murray Sharman, is part of a larger project Boosting diagnostic capacity for plant production industries which is a collaboration between Australia's plant Research and Development Corporations (RDCs), led by GRDC under the Department of Agriculture, Water and the Environment's Rural R&D for Profit Program.

Blue disease, caused by CLRDV, is a specific biosecurity focus for the cotton industry due to its frequency in cultivated cotton in one of our closest northern neighbours, Timor-Leste. This small island may seem a peculiar place to find cotton, however Murray says growing a few cotton plants was a common practice for the Timorese to make traditional fabrics. Three species of Gossypium are grown in Timor-Leste and these were found in at least some home gardens in most villages Murray visited. All three Gossypium species were found to host CLRDV which could pose a serious threat to Australian cotton.

As part of a previous CRDC project, Murray has made three trips to Timor-Leste to study the virus and learn more about its distribution and host range. He found CLRDV in more than 40 per cent of randomly sampled Gossypium species across many locations. While Murray found very high genetic diversity across the samples, it wasn't observed causing blue disease in cotton.

Dr Murray Sharman inspecting a *Gossypium barbadense* plant in Timor-Leste for virus symptoms. This was the most common of the three *Gossypium* species found in Timor-Leste and more than half the plants collected, tested positive for CLRDV but no plants had severe blue disease as found in South America.

"We know the virus is prevalent in Timor-Leste and very diverse, yet we haven't found the same strains that causes blue disease in South America or Thailand," Murray said.

"We found greater diversity in the virus genome across two valleys 20km apart in Timor-Leste, than is reported from about 2000km across South America.

"Cotton was once grown in enough quantity in Timor-Leste to make traditional fabrics but appears to be more of a garden plant now.

"CLDRV is vectored by the Australian cotton aphid and there is no seed transmission of the virus, so the aphid or infected plant needs to come into Australia to cause an incursion."

Murray said they're still unsure if the strains of CLRDV in Timor-Leste can cause disease in Australian commercial cotton or are able to break the resistance gene currently being used to protect cotton crops in South America. Cotton blue disease was limiting production in Brazil in the early 2000s, and it now requires continued use of resistant varieties and aphid management for ongoing control see image over page.

"The cotton aphid is common and widespread in all Australian cotton regions and CLRDV is also a

threat to grain legume crop. In collaboration with Dr Safaa Kumari, we have detected this virus causing disease in chickpea crops in other countries," Murray said.

"In recent years, cotton production has increased significantly in new regions in far northern Australia such as Kununurra, WA (Miriwoong country); Douglas-Daly (Malak Malak country) and Katherine (Jawoyn country) in the NT; Georgetown, Mount Garnet (Agwamin country), and Mareeba (Djabuganjdji country) in Qld.

"These regions are closer to potential northern incursion pathways from near neighbours such as Timor-Leste and Papua New Guinea: as such there is a risk of new viruses arriving and establishing in cotton crops in these regions."

Natural virus pathways

Further evidence of pathways between Timor-Leste and Northern Australia have been recently found for aphid-transmitted virus species which are in common between both locations. Recent GRDC and CRDC projects have found several new poleroviruses (same genus as CLRDV) in far northern Australia and Timor-Leste.

"These findings of other poleroviruses in common between Timor-Leste and northern Australia indicates that perhaps a natural pathway does exist for these aphid-transmitted viruses, such as aphids coming in on the wind or a cyclone, for example."

In June 2021, on behalf of Murray's team, QLD DAF's Dr Fiona Filardo in collaboration with the NAQS survey team undertook a survey for potential exotic polerovirus and begomovirus in alternative hosts to cotton in in the Bamaga region (Yadhaigana country) of far north Queensland. This is a high-priority pathway as it's in close proximity to the Torres Strait Islands which is a known pathway for pests and diseases moving south from Papua New Guinea.

Severely dwarfed cotton plant (centre) infected with blue disease (cotton leafroll dwarf virus – in Brazil. There are some similarities to the endemic cotton bunchy top, both are transmitted by cotton aphids. Control in Brazil is via use of insecticides and resistant varieties.

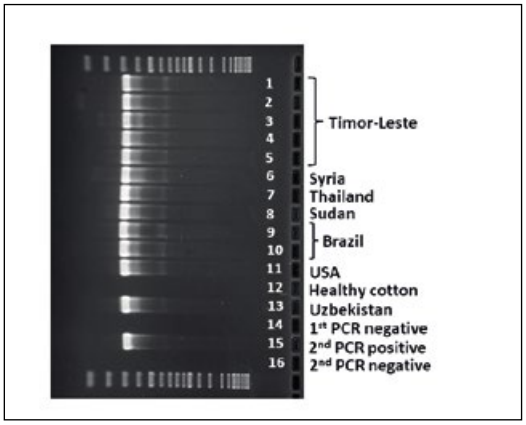


Figure 1. The nested PCR for the exotic CLRDV developed in this project is very effective to detect a wide range of diversity in CLRDV strains from seven countries.

More than 200 samples from about 24 plant species were collected. More than 150 of these were tested for polerovirus. One sample of ornamental hibiscus was positive and further testing is being done to determine the polerovirus species.

"It is most likely a commonly found, unpublished species found in this plant species in multiple locations across Northern Australia but it will be important to confirm this," Murray said.

"This movement of polerovirus demonstrates a potential pathway for CLRDV to move from Timor-Leste into Northern Australia and the recent expansion of cotton production in these regions may increase the risk of establishment and spread."

Coding disease around the globe

As part of the research project, Murray has characterised complete coding regions of several isolates of CLRDV from countries such as Timor-Leste, Thailand, Uzbekistan and Syria in order to determine genetic diversity.

Isolates they characterised from Timor-Leste, Syria, Uzbekistan and Thailand are not closely related to the known resistance-breaking strains from South America. However, research into resistance breaking strains of CLRDV from Brazil and Argentina have important implications.

The complete genomes of two CLRDV isolates known to overcome CLRDV-resistance have been characterised. These CLRDV strains cause 'atypical' cotton blue disease in resistant cotton lines. When compared to the complete genomes of typical CLRDV, these atypical-CLRDV isolates had a high degree of similarity across most of the genome, except for one specific coding region known as open reading frame 0. This region of the virus genome is thought to be vital to how the virus interacts with plant resistance genes and determines if the virus can overcome or 'break' resistance.

This knowledge will also be used to validate

rapid diagnostic tools being developed under this project as it will be important to have confidence that any diagnostic assay can detect all known diversity of CLRDV.

Rapid diagnostics for rapid responses

In the event of a suspected or actual incursion, correct identification is key. However identifying viruses isn't as simple as a visual inspection. Sophisticated process and equipment are usually involved, however that is changing.

Optimal diagnostics is a balance between speed, accuracy, and portability. The other complicating factor for detection of CLRDV is that the results of this study have shown very high diversity in CLRDV strains from several countries, so it's important to be sure any diagnostic will detect all known diversity and hopefully be robust enough to detect further unknown diversity.

Development and testing of transferable, rapid diagnostic technology to detect CLRDV is progressing, with researchers aiming to be able to move the technology to the site of an incursion and correctly identify infected plants in quick time. This is a significant breakthrough for biosecurity.

The gold standard diagnostic at the moment for CLRDV is a nested PCR which easily detects strains from seven countries (Figure 1). The aim is to have a real-time PCR that also detects all known diversity but in a more rapid format that can be transferred to other labs and does not require running electrophoresis gels (Figure 2).

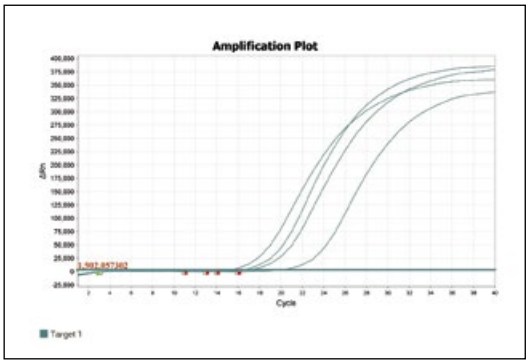


Figure 2. The preliminary testing of real time PCR was very promising for detection of CLRDV strains from Timor-Leste, Thailand and the US. Further validation of this and other PCR options are being done to confirm they work well with all known CLRDV strains. It is hoped this may provide a more mobile diagnostic option that could be rolled out in regional labs (close to possibly incursion pathways) in northern Australia if required.

"Preparedness is getting an accurate answer quickly – and if that means moving to another production area it would nice to be able to rapidly set up capacity in a local lab to undertake screening and diagnosis," Murray said.

"Our diagnostics are able to identify both endemic (cotton bunchy top – CBTV) and the exotic CLRDV.

"The thing we need to be mindful of is that blue disease can look a lot like bunchy top – in the field it may be hard to be confident which virus is present.

"That's also why I'd like to appeal to growers and consultants in those far northern regions to bag up any suspect plants and contact me directly.

"From three seasons of surveys in far northern production regions, we have not yet found the endemic cotton bunchy top (this is interesting in itself), so if any suspect plants appear in crops, we don't want anyone thinking they've just got bunchy top turned up when it could be an exotic disease."

Further work includes validating the real time PCR diagnostics against the known diversity of CLRDV. Thankfully, the CRDC-funded projects and other collaborations have enabled QLD DAF researchers to have perhaps the most extensive collection of CLRDV isolates from around the world so we can be confident in the robustness of diagnostics.

"The hope is to never have an incursion of CLRDV and these diagnostics will remain on the shelf, but preparedness is critical to success of any response to an incursion," Murray said.

Northern virus surveys

In mid-2021, virus disease surveys were done in the Kununurra cotton production region, Douglas-Daly cotton production region in the NT and Mareeba, Forty Mile Scrub and Gunnawarra (Agwamin country) in far north Queensland. A total of 27 cotton blocks across 13 farms were inspected. No virus-like plants were seen. Surveillance in WA, NT and far north Queensland was done in collaboration with QLD DAF's Dr Paul Grundy and CottonInfo Biosecurity Lead Sharna Holman with assistance from CSIRO's Dr Stephen Yeates.

While no virus-like cotton plants were observed during the surveys, the leafspot *Cercospora sp.* was found in two crops in the Douglas-Daly region. Diagnosis was confirmed by QLD DAF Pathologist Dr Linda Smith and this was a new record for cotton in the NT and was reported to the appropriate biosecurity agency.

"This confirmation may reflect the different diseases that may affect cotton in these new tropical production regions and demonstrates the importance of monitoring in these emerging production regions so early detections can be made and the best management practices can be established," Murray said.

For more
Dr Murray Sharman
murray.sharman@daf.qld.gov.au

Please send suspect plant samples to:
Dr Murray Sharman
Department of Agriculture and Fisheries, Queensland, Ecosciences Precinct
GPO Box 267, Brisbane 4001

The very good, the good and the… well we've seen far worse

Dr Oliver Knox heads the Cotton Hub at the University of New England (UNE). He's one of the industry's leading soil scientists, co-ordinates the UNE Cotton Production Course on behalf of CRDC, and is the CottonInfo technical lead for soil health. Oliver recently led a contingent of the industry's leading scientists to the Northern Territory with support from CRDC.

One of the scientists' hosts, Olivia Borden, with cotton scientists Paul Grundy, Graham Charles, Murray Sharman, Brendan Griffiths, Linda Smith and Oliver Knox.

Like a Charlie's Angels mission, it started with a phone call and a question: "can the knowledge from a cotton production course designed for the south be applied in the north?"

And like the show, but without the hair, Australian cotton industry scientists love a challenge so a plan was hatched, crack team assembled and contact made with local agents, aka agronomists, in Northern Australia to go there to find out. In what could be described as somewhere between the *Fantastic 4* and the *Magnificent 7* of cotton scientists, we put together a team specialising in weeds, virology, entomology, physiology and soil science.

The actual team consisted of myself (soil scientist), fellow UNE cotton course coordinator and soil scientist Dr Brendan Griffiths, QLD DAF entomologist Dr Paul Grundy, pathologist Dr Linda Smith and virologist Dr Murray Sharman and NSW DPI weed scientist Graham Charles.

Despite the tv show references, the aims of the CRDC-supported NT trip were serious and twofold. It was to expand current industry researchers understanding of NT farming systems, improve networks between the north and south, and support the NT industry through better understanding of issues.

Our team were met by the NT government scientists and staff of the Northern Australia Quarantine Strategy (NAQS) and NT Farmers. Suffice is to say they have their hands full, but also seemed to be excited about the opportunities that cotton could bring to the NT.

We were then educated about how so little of the NT has been cleared for farming and that only four per cent is freehold, with the majority of farms in a pastoral leasehold, which limits what they can produce that is not for livestock consumption.

In return, we emphasised the importance of Come Clean Go Clean, with a focus on the machinery and human aspect of clean cotton production, in order to limit some of the diseases they were concerned about. A visit with the NT plant industries staff showed off their amazing facilities, which left many of us envious until we stepped into the heat outside.

We crammed back into the car, turned up the aircon and headed for the Adelaide River, home of jumping crocodiles. Over the next few days, we visited several farms, talked to the growers and got a feel for what they are doing and what's got them concerned.

The crop

Planting for this season started with the onset of the wet season in early December in the NT. Some replant was required where profiles dried out too quickly, hot soil temperatures cooked seed before it emerged and also some areas of localised flooding where heavy rainfall in a short space of time caused stands to fail. This year's rainfall has been sporadic resulting in a range of dryland cropping experiences.

The crops in the first few fields were remarkably good. It was impressive to see a dryland cotton crop with over 25 bolls per plant and six plants per metre. However, in fields where the rain stopped in February, the same could not be said. While these crops have definitely been limited by a lack of water, they are still in better condition than seen in the south in drought.

That said, there were patches in some fields where the stand was dominated by unexplained runs of short undeveloped

plants. The team had a number of suggestions.

Water was one possible idea, as areas where ponding had occurred or where the topology suggested preferential flow made this issue worse, but flat fields had similar symptoms following old field layouts. Could it be an issue of nutrition and compaction? Perhaps. We discussed soil temperatures and what's known or not known about planting cotton seed into soils exceeding 50°C.

Could texture and colour have a role in this? Possibly, then your weed scientist reminds you that patchy development is seen with sub-lethal doses of residual herbicides. At these comments we are informed of broad leaf weed control in the area with metsulfuron (methyl). Perhaps we have a winner? We saw less of this issue in the more recently developed fields (without a history of residual herbicides) and the cotton was quite spectacular.

Crop destruction was discussed as a key challenge, noting the risk of disturbing these soils, and the lack of water for chemical control. This takes our thoughts to the roots, which are shallow everywhere we go. While we were told of cotton roots below two meters and shown capacitance probes with water draw down obvious at 80cm, the fields observed had nothing in the 20cm or so we could dig, although it was unclear if this shallow rooting was specific to fields or the timing and volume of rainfall in this season.

Some of the pivot irrigated crops have a lot of lower growth that will not result in yield. The opportunity to alter the Pix management strategy to even earlier, say four to five nodes instead of 12, to help manage this was discussed.

Disease

The promise of assessing disease based on images sent to pathologists in Qld just a few weeks prior has those in the team with a penchant for pox and pestilence excited, however the havoc these fungi caused at planting was no longer evident. Replants have produced good establishment and so we content ourselves with conversations and ideas that might help get better first time strike next season.

High humidity in tropical crops with dense canopies, particularly the irrigated crops, provides an oasis for lower canopy disease. Several crops had plants with what looked like powdery mildew, but other culprits are also being considered. Samples were taken with molecular sequencing outcomes now eagerly awaited, while potential control and yield impacts are pondered via email.

The soils

The soils were sandy and hard. We could dig little further than the roots appeared to go, but we will be better prepared next time.

Nutritionally the soils were deficient or low in almost everything except manganese, iron and sulphur. With the pH of several fields we visited below five and the amount of rain that can fall, could manganese toxicity be an issue?

Signs of premature senescence brought a potassium issue into the conversation. Potassium is considered immobile in most soils, but could a lack of clay and organic matter to bind it be causing some leaching or is it simply a placement issue that caused the lack of response?

The crops in fields where the rain stopped early this season brought the conversation back to which soils are best suited for cotton in the NT. The answer is those that it rains on, but the issues this year had growers tell us of a field or parts of that have struggled with hay production in the past. Perhaps less of a soil type issue with some cut-off point in hay production being easier to consider when thinking of planting cotton.

Rills were obvious on some of the more sloped fields and conversations about pulling field margins back, putting in contour banks or permanent plantings took place. Deep ripping was brought up to address the shallow rooting issues, but care and caution are prescribed as there were large crops on similarly small root systems and the risk of soil movement in this environment would have to be addressed.

The system

Through the CRC for Northern Australia, CRDC and GRDC-supported project *Potential for broadacre cropping in the NT*, led by the NT Department of Industry, Tourism and Trade, the research station at Douglas-Daly has been exploring the benefits of mulch and they appear obvious, whilst planter configuration trials showed no difference in establishment.

The choice of refuge is mixed at present, but weed issues encountered with pigeon pea may make it the less likely future choice.

Optimal planting windows appeared to be in mid-December. Planting or replants in January were prone to having been affected by this year's lack of regular rain in the wet season. Only time will settle on what consistently works best for the dryland crops up there, but the irrigated crops may yet benefit from being given the same planting considerations undertaken for the Ord and northern Queensland areas and copies of the northern cotton production guide, *NORpak*, are now in the post.

The future

Cotton is certainly an exciting prospect for the NT, especially with the gin near Katherine becoming operational in December. However, as with any new farming system, there are challenges, particularly dominated by climate.

Supporting the staff and farmers who are establishing cotton in the region is definitely worthy of our time and assistance. There is a hunger to see cotton succeed in the NT, a promise to undertake trials and to become more open in sharing their learnings. All of this is likely to result in a great future for cotton in the NT.

On a final note, the team would like to express thanks to everyone who met with us, shared their experiences and made us feel welcome. We promised to return and we will.

"Optimal planting windows appeared to be in mid-December. Planting or replants in January were prone to having been affected by this year's lack of regular rain in the wet season".

For more
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Central Queensland grower Aaron Kiely has fulfilled an ambition to be a part of the ARLP.

ALI KUCHEL

Creating stronger foundations with farmers

Cotton growers Aaron Kiely from Emerald (Gayiri country) in central Queensland and Jack Brennan from Warren (Wailwan country) in western NSW are about to embark on a journey that 'changes lives'.

They've been chosen to participate in the Australian Rural Leadership Program (ARLP) with support from CRDC, Cotton Australia, Australian Food and Fibre and Paraway Pastoral. The ARLP is run by the Australian Rural Leadership Foundation (ARLF). It's the longest-running and most in-depth experiential leadership development program in the country, giving participants a valuable opportunity to grow their leadership and create a network of change-makers to positively influence their organisations, industries, and communities across rural, regional and remote Australia.

Participants engage in a range of experiential learning opportunities in varying contexts during their four sessions over 15-months.

Aaron Kiely has had his sights set on the ARLP since experiencing other industry leadership programs, starting with Future Cotton Leaders, which he credits for setting him on a path to share his passion for agriculture and understanding what being a leader can offer others. Aaron was a part of Cotton Australia's Cotton 20 initiative and is now a course mentor, while most recently he attended the ARLF TRAIL program with support from CRDC and described the experience as 'life changing'.

"I am most grateful for the opportunities that have come my way made possible by the generous support from my sponsors. It is humbling to know that they have confidence in me to represent our industry," Aaron said.

Aaron is extremely passionate about agriculture and has a real love for sharing his experiences with others.

"I've really got to thank my family, business, friends and community for the support they give while I embark on these programs, it just wouldn't be possible without that support," he said.

"Participation in leadership programs allows me to give back to our industry – applying what I learn

about myself and helping others grow," Aaron said.

"The program's I've done to date have given me the confidence to tell my story and the industry's story – to stand up and say what I believe in.

"I look forward to learning more and challenging myself through ARLP, while connecting with other industry leaders from different sectors."

Jack Brennan manages Paraway Pastoral's aggregation at Warren in the Macquarie Valley, a mixed farming operation with cotton, grain and pulse crops plus sheep and cattle across four properties totalling roughly 45,000 hectares.

Jack says the ARLP course had intrigued him when he first heard about it through past participants. Paraway Pastoral's CEO Harvey Gaynor, formerly of Auscott, is an alumni of Course 9, and fully supported Jack's application to Course 29.

"Farming has always been my focus – I've been obsessed with it since I was a kid. I've done a lot of practical courses in production, but this will be the first in leadership," Jack said.

"I was encouraged by a few people across the industry to apply, and Harvey recommended doing it while my four children are younger.

"As my job transitions to managing people, now with up to 12 permanent staff and 40 to 60 others at peak times, leadership and people management becomes the required skill.

"Combining people and farming is the ultimate mix for me, and to make it work you need good leadership.

"We all want money, satisfaction, health and enjoyment in our workplaces. We know there is a shortage of people in agriculture, an issue which has become even more obvious in the last couple of years. So, we need to inspire people to want to be part of the industry through good management."

With his wife and four children, Jack is also involved in a sheep stud west of Warren. He's a fifth-generation grazier and a first-generation cotton grower, which is satisfying his love of farming and thirst for knowledge.

"I'm relatively new to the cotton industry – I knew about it through cotton growers out here and did a bit of chipping as a teenager back in the day. When I started growing cotton, I was really taken by it. It's not so much the cotton fibre part – it's the people.

"The industry is so professional and focussed and everyone agrees where the benefits are.

"It seems that by nature everyone is marching in the same direction and when you are doing that you attract good people. I'm so impressed by growers who are willing to share their experiences, knowledge and advice.

"It's a progressive industry in terms of technology and uptake and in a relatively short time has worked out how to grow cotton from the northern tropics to the Victorian border.

"I'm very grateful to the cotton industry for being willing to support a newcomer through this leadership program."

Aaron and Jack are two of 28 cohort members who will participate in Course 29 of the ARLP, thanks to the generous support of sponsors. Each ARLP scholarship is valued at $50,000 and participants are selected via a rigorous and highly competitive process.

Jack Brennan says for him, combining people and farming is the ultimate mix, and to make it work you need good leadership.

For more

Australian Rural Leadership Program

https://rural-leaders.org.au/programs/australian-rural-leadership-program/

Time for a shift in thinking about workforce

As agricultural industries across Australia seek to sure-up sustainable on-farm workforces, cotton is looking to tailor a new approach, titled SHIFT.

Creating a shift in workforce thinking and management requires the best in the business – Chantal Corish, Jo Eady and Dr Nicole McDonald are working on a ground-breaking project to attract and keep people in the cotton industry.

SHIFT will deliver a suite of resources and tools to support cotton's workforce attraction, retention and development through the CRDC-supported project *Delivering Best Practice for Management of Future Skills*.

It is aimed at aiding the development, coaching, training and leadership required to ensure a future-ready workforce and to embed these within cotton businesses. It is being led by long-term cotton industry workforce researcher, Dr Nicole McDonald, with leadership specialist, Ruralscope's Jo Eady, new CRDC-supported PhD student Chantal Corish, and Dr Amy Cosby who leads the Agriculture Education and Extension research team at the Central Qld University (CQU) Institute for Future Farming Systems.

Each member of this team brings specialist knowledge and skills to the table.

Nicole has recently completed a CRDC project focused on cotton's future workforce: the catalyst for SHIFT. Jo leads the Australian Future Cotton Leaders Program for CRDC and Cotton Australia, and Chantal is a cotton grower and psychologist based at Goondiwindi (Bigambul country). Her PhD study is investigating the role of psychological safety on farms and will be directly integrated into the SHIFT project.

"SHIFT refers to a shift in mindset, behaviours and culture to create a sustainable on-farm workforce," Nicole said.

"It is called SHIFT after the five pillars that this project is built around."

What is SHIFT?

When it comes to workforce development that encourages attraction and retention, it helps to think about skills, structures and activities organised around the SHIFT pillars.

Social sustainability focuses on maintaining and improving social quality beyond the farm gate. Central to this is the importance of building cohesive, reciprocal, and trusting relationships. This influences the attractiveness of an industry and retention of workers to cotton communities.

Human sustainability encompasses the development of skills and abilities to support the functions and sustainability of the farming organisation. This means developing the work structures and skills to enable work engagement, reduce burnout, and ensure individuals and teams thrive at work.

Innovative workplaces focuses on the skills and processes that help people generate, explore and collaborate on new ideas and solutions and set up a learning culture on farm. PhD student Chantal Corish will be specifically exploring the concept of psychological safety in on-farm work environments and the impact of this on team learning and performance.

Future focus is all about purposeful direction and working towards a desirable future. Whether this is at the individual employee level of identifying and setting career goals or at the business level of workforce planning, this is all about strategic thinking and management of the future.

Transformational leadership is about leading yourself and others through change. Setting a vision, inspiring people to adapt, considering individual's strengths and interests, and getting a team open and curious to change.

For more

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These pillars are: Social sustainability, Human sustainability, Innovative workplaces, Future focus and Transformational leadership.

"Each of these pillars were recurrent themes in my earlier research for how people were taking action to adapt to the future of work," Nicole said.

"It is a workforce development framework that is truly from the cotton industry, for the cotton industry and is centred on the mechanisms by which we achieve the positive workforce outcomes we're striving for: high performance, engagement and satisfaction, all which lead to better production outcomes."

Nicole likened the attitude to that of a sports team that wants to win – they direct their focus to executing their game to the best of their ability.

"If we consider attraction and retention as the way we know we have a 'winning' employer of choice status, ensuring we have the skills, structures and are taking actions focused on effectively addressing each of the pillars of SHIFT is how we master our game," Nicole says.

"The future of work is volatile, uncertain, complex and ambiguous, and requires a capable workforce to embrace the changes required to adapt to new developments on farm.

"Best practice people management relies on the successful ability of growers to lead their teams through change processes and is important for worker motivation to learn and accept/use new technology, worker engagement, job satisfaction and retention."

So far the project has been evaluating and identifying pathways and methods of delivery for people development and management resources. The next phase, starting in August, will see the educational design and development of pilot program/extension resources.

"We will be doing this as a co-design process with cotton growers and cotton farm employees, ensuring any tools for SHIFT are fit for purpose, ensuring adoptable extension resources/training and *my*BMP integration that support the standards of best practice."

For more
Dr Nicole McDonald
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Dr Simon Kelderman (who recently completed his PhD with Joe at CAE, and is now a CRDC-supported post-doctoral fellow) with Dr Malcom Gillies, Associate Professor Joe Foley and 'Waverley' farm manager Andrew Greste.

The dream team: partnering to deliver new irrigation tech

The dream of being able to operate broadacre cotton irrigation systems remotely and autonomously is now a reality. Autonomous irrigation technology is now being used to optimise water use with systems shown to average 10 to 15 per cent water saving per irrigation.

The cotton industry is seeing the benefits of being involved in the development of two systems, SISCOweb and VARIwise, with the help of growers Steve Carolan and Andrew Greste at Wee Waa (Kamilaroi country) in north-west NSW.

SISCOweb is an optimisation system for furrow irrigation that determines the infiltration characteristic of the field during each irrigation to generate an appropriate and optimised inflow cut-off time appropriate. In this way the furrow irrigation is automatically optimised for the grower's requirements every time.

VARIwise is a system that determines the site-specific irrigation requirements using control strategies and field data and also provides forward predictions of cotton yield.

Developed by Associate Professor Joseph Foley, Dr Malcolm Gillies, Dr Alison McCarthy and the team at the University of Southern Queensland's (USQ) Centre for Agricultural Engineering (CAE), these technologies would not have been possible without working with cotton growers who embrace on-farm research and development.

"Research conducted on large commercial-scale fields under real farming conditions is needed to ensure that these systems are robust, reliable and practical," Joe said.

"The CAE team have been lucky to work with Steve and his farm manager Andrew at 'Waverley' for many years.

"They're no strangers to R&D on the farm and in particular autonomous

irrigation systems, being intricately involved in trial work during the first Smarter Irrigation for Profit program."

The SISCOweb and VARIwise trials have continued under the Smarter Irrigation for Profit Phase 2 program (SI2) to develop fully autonomous broadacre irrigation control systems for furrow and pivots in cotton, and pivots in dairy pasture.

Further refinement of the technology was due to start at Waverley when COVID struck, and researchers were unable to travel from Queensland to set up or monitor the trials.

Joe says there was initial concern the trials would have to be abandoned during a crucial stage for the development of SISCOweb, with the technology nearing commercialisation.

"Thankfully Andrew and Steve were there to support us through this and take on the task of setting up, maintaining gear and collecting data," Joe said.

"They set up our trials up across six blocks in a 125ha field which allowed thorough testing of the SISCOweb system in a commercial context."

Malcolm said setting up complex experiments can be tricky, even for engineers, however the Waverley team handled it like pros. This included laying the equipment out across the field, including advance sensors for SISCOweb, and installing in-field cameras and UAV imagery for cotton crop yield prediction using VARIwise.

"The team was also maintaining a number of pieces of equipment in the field, including rain gauges, irrigation control structures and soil probes," Malcolm said.

Andrew says the decision to run the experiments was an easy one, due to the value of the work.

"I can see real commercial benefits to the irrigation sector from this work and I didn't want to lose a year of development," he said.

"We've been collaborating with Joe and his team for a number of years so we were familiar with their work and the equipment they have been trialling. It wasn't too difficult, we just had to commit the time to it.

"I did most of the work myself as I was most familiar with the research," Andrew said.

SISCOweb, once initiated, waits for signals from automatic advance sensors and uses continuously measured furrow inflow data to optimise for the best time to cut off water, so that uniformity is maximised, or a minimum depth is applied at all positions down the field.

"The involvement of growers in all aspects of the Smarter Irrigation for Profit program has been critical to its success.

Irrigation by text message

SISCOweb was initially configured for use with manual siphon irrigation to send a text message to the grower for the best time to cut off. Now that remote-control furrow irrigation gate actuation can be installed, those systems are rescheduled by SISCOweb to close the gate at the optimum cut off time after the grower 'accepts' a hyperlink recommendation in a SISCOweb text message.

"Andrew Greste worked tirelessly with us around these trials, interacting with us early in the morning, and very late some nights, including New Year's Eve, so that he was comfortable with the way irrigations were autonomously controlled," Joe said.

"Thanks to his involvement, a better understanding of each irrigation's performance was developed, and differences in the various optimisation targets could be tested," he said.

Andrew said the team had done some performance testing the previous season, but this year was the first season where it was run remotely by the SISCOweb system.

"Uniformity in our system is pretty good – the real benefit is being able to match the run times to the varying infiltration rates we see during a season, improving our overall efficiency both in tailwater and also applying the optimum amount of water that the crop requires," Andrew said.

Managing in-season variation

Previous research by Malcolm and the CAE team has shown that the infiltration characteristic can change significantly during the season, with some irrigations drastically under-replenishing the soil-water deficit, and others over supplying the deficit. SISCOweb solves this problem, by optimising cut off times for each irrigation to hit the target application depth. Commercial scale installation of an autonomous furrow irrigation system is possible for less than $800/ha, making it an attractive proposition in terms of payback.

"The broader aim is to maximise water productivity by using a combination of the advanced bio-physical crop modelling of VARIwise to schedule irrigation events in conjunction with SISCOweb for optimisation of each furrow irrigation event," Malcolm said.

"While research is ongoing to ensure that these systems are robust, some of the automation products representing interim steps toward fully autonomous optimised irrigation control systems are now under commercial development.

"The SISCOweb system is fully operational and running on commercial servers using various providers' interfaces.

"At additional farms in NSW and Qld, USQ has been testing the integration of advance sensors from other manufacturers with the SISCOweb system leading to commercially available solutions for furrow irrigation optimisation in real time."

The Smarter Irrigation for Profit Phase 2 project will conclude in June 2022. The two phases of the project have been led by CRDC with support from the Department of Agriculture, Water and the Environment as part of its Rural R&D for Profit program.

Cathy Phelps, the phase 2 project manager, thanked Steve, Andrew and all of the participating cotton growers.

"The involvement of growers in all aspects of the Smarter Irrigation for Profit program has been critical to its success. Without their support and input the program would have struggled to achieve its outcomes."

For more

Smarter Irrigation for Profit Phase 2

www.smarterirrigation.com.au

Taking controlled traffic to the next level

Dalby cotton grower Dan Hayllor with their CP690 in the shed earlier this year, gearing up for a big season.

BRAD PFEFFER

About six years ago, the Hayllor family faced a major challenge with soil compaction at their irrigated and dryland farming operation near Dalby (Barunggam country).

That season, they had about 250mm of rain just before picking, which presented the opportunity to follow their cotton with a winter crop.

However, it also presented a logistical challenge for managing multiple machinery passes with different row spacings in a relatively short period and with wet conditions. In that situation, avoiding serious soil compaction was almost impossible.

"We had our pickers on duals, and tractors on two metres and three metres so when we picked the cotton, we'd driven just about everywhere," Dan Hayllor explained.

"Then we mulched it and when we went to plant winter crop it was a huge battle. It took three times longer than it should have and we broke the planter several times."

It was a lesson in the challenges of compaction and became a catalyst for the family going down the path of putting all machinery on four metre wheel centres, including their picker.

Now every piece of machinery drives on four metre tramlines, which has drastically reduced the compacted area in their paddocks and created a system that works seamlessly between their irrigated and dryland.

Irrigated cotton is grown on solid one-metre rows and dryland grown in double-skip configuration. As well as modifying the axles on the CP690, the Hayllors have created a 12-metre front for the picker.

They aren't aware of any other cotton pickers that have had their wheel spacing modified in this way, but Dan Hayllor said making the change was a matter of making the decision and then doing it.

"Five or six years later, in 2021, we had a similar rain event of 180-200mm at defoliation," Dan said.

"The pickers handled those wheel tracks very well. We followed it with our 12-metre mulcher, then left it and went in with wheat that winter and pulled off nearly threes tonnes per hectare.

"That stubble cover is there now and the ground has a full profile again for cotton in 2022-23."

The Hayllors also saw the benefits of the system when planting their faba beans for the first time in a paddock that had been using the four-metre tramlines.

"Normally, even 18 months after the picker had been through after cotton, we would see the difference in soil structure when using a tine or planting deep.

"Planting those faba beans was the first time we went across the lot and did not see a difference in soil structure: it's a system that is working well for us."

Dan said that the principles of four-metre tramlines built on the huge amount of work that had already occurred in three-metre systems by many

others in the industry, especially for dryland farming systems.

For them, opting for four-metre was the next step in controlled traffic that linked dryland with irrigated.

"One of the biggest areas of effort was getting the front bar of the picker to 12 metres," Dan said.

"Yes, it is an expensive process with axles, spacers, rear axles and rims, but most other machinery can fit to four metres now."

He believes water infiltration has improved and there is also less work in ground preparation.

"In comparison, if you are compacting over two metres, it can just destroy the structure of the hill and getting that back can be incredibly difficult."

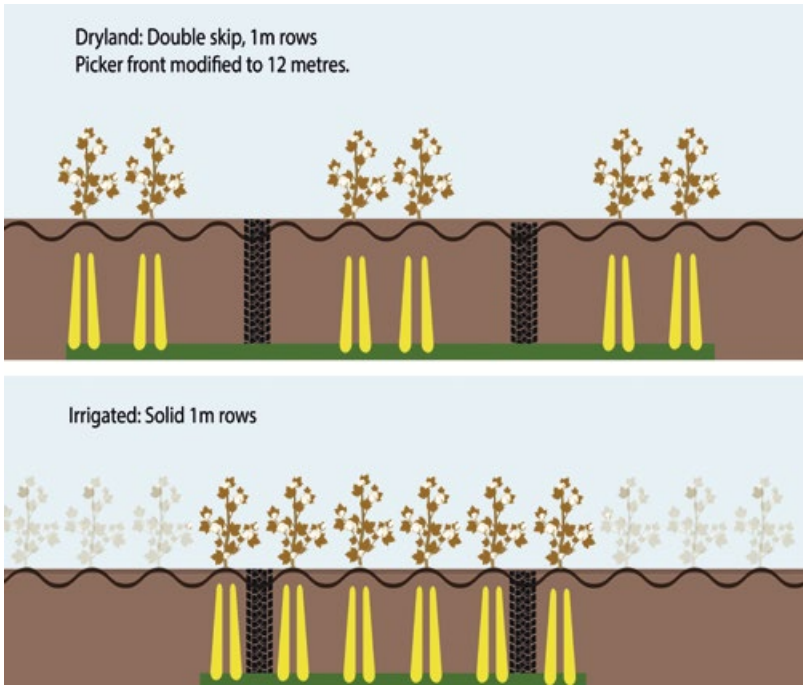
The last piece in the puzzle is a chaser bin that fits the system and can be reached by the header, which arrived earlier this year in time for sorghum harvest.

"We had rain ahead of harvest, so it's exciting to be able to harvest without stepping off the tramline," Dan said.

"It has taken us four or five years and we had to do a lot of planning and modifications, but we are excited to be there and looking forward to seeing the results."

In recent years, CRDC funded a research project conducted by Professor John Bennett at the University of Southern Queensland (USQ) to examine the issue of compaction with modern cotton pickers.

The 2016 research found that for the six cotton fields studied, there were significant occurrences of soil compaction beneath all wheels. All sites had some change in subsoil porosity down to 0.8 metres, with significant compaction observed to this depth on more than 50 per cent of soils.



The tramlines for the picker in dryland and irrigated scenarios.

For more

Listen to a CottonInfo podcast featuring Dan Hayllor by scanning the QR code.

Be a part of CRDC's grower survey

In the 2021 CRDC Grower Survey, it was found that more than 50 per cent of growers believe regional climate patterns will result in a change to their production systems over the next 10 years. What will the 2022 Grower Survey tell us about the industry?

The experiences and opinions of growers are integral to how CRDC prioritises R&D investment. A direct avenue for growers to influence these priorities is by being a part of the annual survey which opens via phone on June 1.

"Gathering information about farming practices and growers' views on RD&E helps inform future research, and helps document change in industry practices over time, which is critical for cotton's sustainability reporting," CRDC Executive Director Dr Ian Taylor said.

The reports from each survey give growers and crop managers the opportunity to compare their practices to others – be it across farms of a similar size or within their valley - and gain a greater insight into all how others manage their farms.

The surveys include core annual questions with focus areas to investigate specific aspects of the farming system. This year's survey looks at water, nutrition and soil, IPM and crop protection, staff development and digital technologies. The grower responses are anonymously compiled to create the survey report which is available as a downloadable PDF or via an online interactive digital dashboard. All previous survey reports are at Inside Cotton, CRDC's electronic library. With the latest report and dashboard published on the CRDC site.

The survey is short and conducted via phone by professional research team, Intuitive Solutions. All cotton growers who have a number on file with CRDC will be contacted from June 1.

For more

CRDC Grower Survey

www.crdc.com.au/growersurvey

CRDC Investments 2022-23

The 2022-23 year marks the fifth and final year under CRDC's five-year plan: the 2018-23 CRDC RD&E Strategic Plan. Under this Plan, during 2022-23, CRDC will invest $18.6 million into RD&E projects across five key areas, in collaboration with around 100 researcher partners, and on behalf of Australia's cotton growers and the Australian Government. This table outlines the projects that CRDC will invest in, along with the lead researcher, their research organisation, and the commencement and completion dates for the projects. *Please note that this table is current as of 4 May 2022, and may be subject to change.*

Key focus area	Outcome	Project title	Project code	Researcher	Organisation	Commenced in:	To be completed in:
Goal 1: Increased productivity and profitability on cotton farms							
1.1 Optimised farming systems	1.1.1 Improved yield and quality	PhD: Assessing yield and fibre quality variability in cotton systems through data science for improved management	US2104	Mikaela Tilse	USYD	Mar-21	Feb-24
		Supporting a sustainable Northern Australia cotton, grain and cattle system	2223FRP	Debra Pearce	CRCNA	Jul-22	Jun-25
		Supporting southern cotton production systems: Southern cotton agronomy and fibre quality	2223FRP057	Beth Shakeshaft	NSW DPI	Jul-22	Jun-25
	1.1.2 Improved input efficiencies	Assessing the critical N and P values of cotton cultivars for improved yield and fertiliser efficiency	2223FRP026	Tim McLaren	UQ	Jul-22	Jun-25
		Optimising irrigation performance in bankless channel cotton layouts to improve water management and nitrogen use efficiency	2223FRP022	Wendy Quayle	DU	Jul-22	Jun-25
		PhD: Sub-paddock scale prediction of soil-water characteristic: Need for localised calibration	USQ2101	Ned Skehan	USQ	Feb-21	Feb-23
		Professor of Soil Biology (includes CottonInfo technical lead and myBMP module lead)	UNE2001	Oliver Knox	UNE	Jul-19	Jun-24
		Water productivity benchmarking in the Australian cotton industry	2223FRP042	David Perovic	NSW DPI	Jul-22	Jun-25
	1.1.3 On-farm sustainable development is supported	Limited water decision support	DAN2203	Sarah Dadd	NSW DPI	Jul-21	Jun-23
		Optimising dryland cotton production in the Namoi Valley : Cotton production and research at Nowley, Spring Ridge 2021-22	US2202	Stephen Cattle	USYD	Oct-21	Sep-22
		Optimising dryland cotton production in the Namoi Valley: Cotton production and research at L'Lara, Narrabri 2021-22	US2201	Stephen Cattle	USYD	Oct-21	Sep-22
		PhD: Classifying the suitability of Murrumbidgee valley soils for cotton production	US2002	Jonathon Moore	USYD	Mar-20	Jun-23
		Science leadership for cotton development in Northern Australia	CSP1903	Stephen Yeates	CSIRO	Oct-18	Sep-22
		Supporting farming system adaptation to climate and biological pest threats (including CottonInfo technical leads for Integrated Pest Management (IPM) and biosecurity)	DAQ2201	Paul Grundy	QLD DAF	Jul-21	Jun-24
	1.1.4 Improved reliability of cotton production	Benchmarking soil carbon, soil properties and management between long term experimental sites and on-farm cotton industry sites	2223FRP056	Guna Nachimuthu	NSW DPI	Jul-22	Jun-25
1.3 Protection from biotic threats and environmental stresses	1.3.1 Increased understanding of the impact of pests, diseases and weeds, and environmental stresses	Climate proofing Australia's cotton industry through improving crop water use and photosynthetic carbon assimilation (Climate proof cotton)	UWS2201	Demi Sargent	WSU	Jul-21	Jun-24
		Tactical management and surveillance of Verticillium, Fusarium and reoccurring wilts	2223FRP053-54	Linda Smith	QLD DAF	Jul-22	Jun-25
		Using DNA diagnostics to monitor disease suppressive cotton farming systems	CAS2101	Rob Long	Crown Analytical	Jul-20	Jun-23

	1.3.2 Improved identification, surveillance and management systems for pests, diseases and weeds and environmental stresses	Advanced field sensing for improved crop management	2223FRP013	Alison McCarthy	USQ	Jul-22	Jun-25
		ARC Research Hub for Sustainable Crop Protection	UQ2001	Neena Mitter	HIA/UQ	Jul-19	Jun-24
		Area wide management for cropping systems weeds, investigating the weed management, social and economic opportunity (Rural R&D for Profit program)	GRDC2002	Rick Llewellyn	GRDC	Aug-19	Jun-23
		Bioclay 2020 Australia-India Strategic Research Fund (AISRF) grant application	COMM			Nov-19	Jun-24
		Biological based products for improved cotton production	UWS1901	Brajesh Singh	WSU	Jul-18	Aug-22
		Developing proactive approaches to IPM in cotton production systems	CSP2203	Simone Heimoana	CSIRO	Sep-21	Aug-24
		Improved insecticide resistance monitoring for key pests to support sustainable insect management	2223FRP001	Lisa Bird	NSW DPI	Jul-22	Jun-25
		Improved insecticide resistance monitoring for silverleaf whitefly (SLW) to support sustainable insect management	2223FRP002	Jamie Hopkinson	QLD DAF	Jul-22	Jun-25
		Improved management of weeds in cotton and grains farming systems (including CottonInfo technical lead for weed management)	DAN2004	Graham Charles	NSW DPI	Nov-19	Jun-23
		Modern systems agronomy for resilient cotton production	CSP2001	Katie Broughton	CSIRO	Jan-20	Dec-22
		Novel options and strategies for IPM in Australian cotton	2122FRP009	Doug McCollum	CCA	Jul-21	Jun-24
		Plant Biosecurity Research Initiative (PBRI) Phase 2	HIA2101	Jo Luck	HIA	Jul-20	Jun-23
		Plant Health Australia membership 2020-23	PHA2101	Stuart Kearns	PHA	Jul-20	Jun-23
		R&D Manager for CRDC Disease portfolio	CRDC2105	Elle Storrier	Macpherson Agronomy Services	Oct-20	Oct-23
		Regional demonstration of integrated weed tactics across farming systems	2223FRP052	Eric Koetz	NSW DPI	Jul-22	Dec-24
		Review of the Biosecurity Plan for the Cotton Industry	PHA2201	Stuart Kearns	PHA	Jul-21	Jun-24
		Surveillance and management of cotton diseases in NSW	2223FRP048	Duy Le	NSW DPI	Jul-22	Jun-24
		Tools for assessing and achieving pesticide sustainability targets for the Australian cotton industry	DAN2201	Mick Rose	NSW DPI	Jul-21	Jun-23
		Validation and implementation of new molecular tools for Bt Resistance monitoring	CSP2204	Sharon Downes	CSIRO	Sep-21	Aug-24
	1.3.3 Industry is prepared for a biosecurity incursion	Boosting diagnostic capacity for plant production industries	GRDC2001	K'trie Coster	GRDC	Jul-19	Jun-23

Key focus area	Outcome	Project title	Project code	Researcher	Organisation	Commenced in:	To be completed in:
Goal 2: Improve cotton farming sustainability and value chain competitiveness							
2.1 Sustainability of cotton farming	2.1.1 Improved environmental footprint for cotton farms	Building profitable farming systems for the future through increasing soil organic carbon and optimising water use efficiency in a changing climate	CRDC2202	Annette McCaffery	DCRA	Jul-21	Jun-23
		Carbon and biodiversity benchmarking in native vegetation on cotton farms	2223FRP005	Rhiannon Smith	UNE	Jul-22	Jun-25
		Closing the loop: textile waste composting for improved carbon footprint and sustainability	2223FRP009	Thava Palanisami	UON	Jul-22	Jun-25
		Developing a common methodology for greenhouse gas (GHG) accounting	AIA2102	Alison Laing	CSIRO	Jun-21	Feb-23
		Evaluating the economic and environmental return on investment of modern fish screens	2223FRP004	Craig Boys	NSW DPI	Jul-22	Jun-25
		Greenhouse gas (GHG) baseline and mitigation for cotton	CSP2102	Hizbullah Jamali	CSIRO	May-21	Jun-25

		PhD: Integrating deep learning AI software with hardware for next generation acoustic biodiversity monitoring	2223FRP006	Stuart Parsons	QUT	Jun-22	Nov-25
		Seeking regionally specific guidelines for cover crops through farmer-led best-practice and soil security	2223FRP043	Alex McBratney & Thomas O'Donoghue	USYD	Jul-22	Jun-25
		Understanding the environmental co-benefits of irrigation water in the northern Murray-Darling Basin	GU2201	Peta Zivec	GU	Jul-21	Jun-24
2.2 Create higher value uses for cotton	2.2.2 Increased understanding of market requirements and opportunities throughout the value chain	Joint Reserch and Development Corporation (RDC) community trust project	RIRDC1903	Jennifer Medway	AgriFutures	Jul-21	Jun-24
		Strategies for improving labour conditions within the Australian cotton value chain	QUT1903	Alice Payne	QUT	Jun-19	Aug-22
2.3 Measurement and reporting throughout the value chain	2.3.1 CRDC collaborates in global leadership for sustainability initiatives	Australian participation in the European Union product environmental footprint technical advisory board	CRDC2008	Angus Ireland	AWI	Sep-19	Dec-22
		Cotton industry social and wellbeing sustainability indicators	UC1901	Jacki Schirmer	UC	Jun-19	Nov-22
		Membership of the sustainable agriculture initiative (SAI) Platform – Australian chapter 2018-24	CRDC1902	Selwyn Heilbron	SAI Platform (Aust) Inc	Jul-18	Jun-24
		Sustainable Apparel Coalition membership	CRDC2205	Glenn Robinson	SAC	Jul-21	Jun-24
	2.3.2 The value chain is transparent and understood by participants	Undertaking the fourth environmental assessment of the Australian cotton industry	CRDC2210	Susan Madden	GHD	Sep-21	Oct-22

Key focus area	Outcome	Project title	Project code	Researcher	Organisation	Commenced in:	To be completed in:
Goal 3: Build adaptive capacity of the cotton industry							
3.1 Science and innovation capability, and new knowledge	3.1.1 Science and innovation capacity is strengthened and strategically fit for a digital future	ABARES Science and Innovation Awards	ABA2101	Maree Finnegan	ABARES	Jul-20	Jun-23
		AgriFutures Horizon Scholarship program	COMM	AgriFutures	AgriFutures	Jul-21	Jun-23
		Australian Future Cotton Leaders program: 2022 and 2024	CA2201	Paul Sloman	Cotton Australia	Oct-21	Oct-24
		Australian Rural Leadership Program: Course 26, 27 & 28 and TRAIL 2020 & 2021	RIR1903	Tristan Richmond	ARLF	May-19	Dec-22
		Australian Rural Leadership Program: Course 29, 30 & 31 and TRAIL 2022, 2023 & 2024	RIR2201	Tristan Richmond	ARLF	Jul-21	Dec-25
		Cotton Production Course	UNE2002	Oliver Knox	UNE	Jan-20	Jun-23
		CRDC Summer and Honours Scholarships	COMM			Jul-21	Jun-23
		Developing people (research students, industry people)	COMM			Jul-21	Jun-24
		Digital strategy for the Australian cotton industry – phase 2	COMM	Matt Shaffer	DataGene	Jul-21	Jun-23
		Improving grower decision in complex systems: A targeted tool to assist cotton growers in appropriate technology adoption	QUT2001	Geraldine Wunsch	QUT	Jul-19	Nov-22
		Nuffield Australia farming scholarships	COMM	Jodie Redcliffe	Nuffield	Jul-21	Jun-25
		PhD: Drought resilient cotton: combining synthetic biology solutions to improve cotton productivity under future water limited and heatwave conditions	UWS2202	Garima Dubey	WSU	Mar-22	Mar-25
		R&D Manager for CRDC People and Capacity portfolio	CRDC2106	Rachel Holloway	Rachel Holloway Consulting	Jul-20	Jun-23

	3.1.2 Increased understanding of the diverse human capital in regional communities	Association of Australian Cotton Scientists (AACS) Australian cotton researchers conference	COMM		AACS	Jul-22	Jun-23
		Delivering best practice to manage future workforce skills	CQU2201	Nicole McDonald	CQU	Oct-21	Sep-24
		Exploring a cotton and grains agricultural traineeships model	2223FRP029	Amy Cosby	CQU	Jul-22	Mar-23
		How to attract and retain young people on cotton farms	2223FRP027	Amy Cosby	CQU	Oct-22	Oct-24
		Opportunities for greater diversity in the cotton workforce	2223FRP028	Nicole McDonald	CQU	Sep-22	Mar-23
		People in Agriculture website 2022-24	DA2201	Greg Jarman	DA	Jul-21	Jun-24
	3.1.3 Increased opportunities for innovation skills development	Designing the integration of extension into research projects	HIA2201	Jane Wightman	HIA	Jan-22	Jul-22
3.2 Futures thinking	3.2.1 Australian cotton growers are able to adapt to change	Grassroots Grant: Coleambally community demo farm soil improvement	CGA2204	James Kanaley	Southern Valley CGA	Dec-21	Dec-22
		Grassroots Grant: The connectivity challenge	CGA2203	Amanda Thomas	Macquarie CGA	Dec-21	Dec-22
		Rural Safety and Health Alliance 2021-24	RIRDC2201	Jennifer Medway	AgriFutures	Jul-21	Jun-24
	3.2.2 Increased opportunities for strategic foresighting	Strategic scoping studies	COMM			Jun-22	Jul-23
		Sponsorship: CSIRO AgCatalyst 2022	CSP2004	Michiel Van Lookeren Campagne	CSIRO	May-20	Nov-22

Key focus area	Outcome	Project title	Project code	Researcher	Organisation	Commenced in:	To be completed in:
Goal 4 (Enabling Strategy 1): Strengthening partnerships and adoption							
4.1. Partnerships and collaboration	4.1.1 Growers/ consultants value CRDC farming systems research outcomes	20th Australian Cotton Conference Foundation Sponsorship	CA2004	Tracey Byrne-Morrison	Cotton Australia	Dec-19	Nov-22
		21st Australian Cotton Conference Foundation Sponsorship	COMM	Tracey Byrne-Morrison	Cotton Australia	Jul-22	Jun-23
	4.1.2 CottonInfo partnership is maintained and practice change improved	Climate, energy and business analysis for cotton growers (including CottonInfo technical lead)	AE2101	Jon Welsh	AgEcon	Jul-20	Jun-23
		Cotton industry database management	CRDC2101	Lee Armson	Lee Armson	Jul-20	Jun-23
		CottonInfo field demonD2:D5stration trial: Optimisation of application in tailwater backup systems	CSD2201	Andrew McKay	CSD	Oct-21	Aug-22
		CottonInfo multimedia content development	DAQ2202	Tonia Grundy	QLD DAF	Jul-21	Jun-24
		CottonInfo technical lead for irrigation (includes myBMP module lead)	2223FRP039	Lou Gall	GVIA	Jul-22	Jun-25
		CottonInfo technical lead for nutrition (includes myBMP module lead)	DAN2202	Jon Baird	NSW DPI	Jul-21	Jun-24
		Identifying key issues to maintain and improve Australian cotton fibre quality (including CottonInfo technical lead)	CRDC2103	Rene van der Sluijs	TTS	Oct-20	Jun-23
		R&D Manager for CRDC Natural Resource Management (NRM) portfolio and CottonInfo technical lead for NRM	CRDC2102	Stacey Vogel	Stacey Vogel Consulting	Jul-20	Jun-23
		Scientific and CottonInfo technical lead for weeds (includes myBMP module lead)	2223FRP012	Graham Charles	NSW DPI	Jul-22	Jun-25
	4.1.3 Partnerships are strengthened to engage multi-disciplinary and multi-institutional resources	Agriculture Innovation Australia membership	AIA2101		AIA	Jul-20	Jun-24

4.2 Best practice (myBMP)	4.2.1 Best practice is based on science and measured impact	CRDC data collection for M&E	COMM			Jul-20	Jun-23
		Economic data collection	BCA2201	Jono Hart	Boyce	Jul-21	Jun-22
		Farm performance – rate of return data for cotton sustainability report	CRDC2208	Simon Fritsch	Agripath	Nov-21	Mar-24
		myBMP: Ensuring best practice is based on science	CRDC2113	Chris Cosgrove	Sustenance Asia	Apr-21	Mar-24
4.3 Innovation and commercialisation	4.3.1 Improved R&D innovation and commercialisation	Commercialisation management tasks	CRDC2203	Jarrod Ward	Ahurei Pty Ltd	Jul-21	Jun-24
		Commercialisation process coordination and support for WSU plant extract pesticides	CRDC2218	Doug McCollum	AGK Services	Apr-22	Sep-22
		Demonstrating and integrating irrigation technology for cotton	2223FRP034	Joseph Foley	USQ	Jul-22	Jun-25
		Post doc: Measuring evapotranspiration from canopy temperature	2223FRP016	Simon Kelderman	USQ	Jul-22	Jun-25
		Spray drift hazard alert and warning systems	DISA2201	Alicia Garden	Discovery Ag	Jan-22	Jun-28

Key focus area	Outcome	Project title	Project code	Researcher	Organisation	Commenced in:	To be completed in:
Goal 5 (Enabling Strategy 2): Driving RD&E impact							
5.1 Impact and effectiveness	5.1.1 CRDC's RD&E investments meet grower,industry and government needs	CRDC Strategic Plan 2023-28 project management	CRDC2112	Bernadette Pilling	HOC	Mar-21	Jun-23
	5.1.2 CRDC monitors and evaluates RD&E impact	CRDC Cotton Grower Survey 2020-22	CRDC2014	Michael Sparks	Intuitive Solutions	Jul-20	Mar-23
		CRDC Cotton Grower Survey 2023-2025	COMM			Jan-23	Nov-25
		CRDC Stakeholder Survey 2022	CRDC2215	Michael Sparks	Intuitive Solutions	Mar-22	Nov-22
		CCA Consultant Surveys 2022-24	CCA2202	Doug McCollum	CCA	Apr-22	Mar-25
		Communications support project	COMM			Jul-21	Jun-23
	5.1.3 CRDC funded projects demonstrate value and return on investment	Impact assessment of projects	COMM			Jul-21	Jun-23

Key

AACS	Association of Australian Cotton Scientists
ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
AgriFutures	AgriFutures Australia (formerly the Rural Industries Research & Development Corporation)
AIA	Agriculture Innovation Australia Ltd
ARLF	Australian Rural Leadership Foundation
AWI	Australian Wool Innovation
CCA	Crop Consultants Australia
CGA	Cotton Grower Association
CQU	Central Queensland University
CRCNA	Cooperative Research Centre for Developing Northern Australia
CSD	Cotton Seed Distributors
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DA	Dairy Australia
DCRA	Dryland Cotton Research Association
DU	Deakin University
GRDC	Grains Research and Development Corporation
GU	Griffith University
GVIA	Gwydir Valley Irrigators Association
HIA	Hort Innovation
HOC	House of Communication
NSW DPI	NSW Department of Primary Industries
PHA	Plant Health Australia
QLD DAF	Queensland Department of Agriculture and Fisheries
QUT	Queensland University of Technology
SAC	Sustainable Apparel Coalition
SAI	Sustainable Agriculture Initiative
TTS	Textile Technical Services
UC	University of Canberra
UNE	University of New England
UON	University of Newcastle
UQ	University of Queensland
USQ	University of Southern Queensland
USYD	University of Sydney
WSU	Western Sydney University

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