Spotlight

ON COTTON R&D

SPRING 2021

Recycle, reuse: Cotton goes full circle

Water use efficiency continues to rise

Bringing people to a bright industry

CRDC

Dr Ian Taylor

In the Spotlight

Welcome to the Spring edition of *Spotlight*.

Any industry is purely a collection of people who inhabit all types of roles to create a functioning entity. People are naturally the Australian cotton industry's greatest asset: we're an industry with people at our heart.

That's why CRDC and our partners are working to ensure an ongoing range of new, enthusiastic people are coming to the industry. Recent studies have highlighted the gap that still exists in the perception and reality of the scope and desirability of careers in agriculture. Whether it be people on farms getting seed in the ground or tertiary students keen to be a part of a world-leading R&D environment, CRDC is working to establish better pathways for this to happen.

The capability of Australian cotton growers and those working with them on their farms sets them apart as the most efficient in the world. Executive Director of the International Cotton Advisory Committee (ICAC), Kai Hughes, has said that from a cotton point of view, Australia is one of the few countries in the world that is at the cutting edge of research. For this capability to continue, it is imperative the industry attracts the brightest and most enthusiastic researchers from the growing areas of science opening up and being focused on by CRDC and our research partners. The industry has seen particular value in leadership programs. Participants most often go on to take on roles within their farms, or within our research, grower, consultant, corporate and advocacy organisations which help the industry function sustainably to its highest level.

In this edition of *Spotlight* we take a look at these programs and what they bring to our people and industry. It's an industry that is always a hub of many exciting projects and developments.

In this vein, we also take a look at recent irrigation benchmarking figures, which show that the Australian cotton industry has almost halved the amount of water required to grow a bale of cotton over the past 25 years. This is an enormous achievement, and one that has primarily been driven by growers making improvements in irrigation infrastructure and driving efficiencies in their management practices, underpinned by CRDC-supported RD&E. The research also suggests that we are well on our way to continue this trend and reach the industry's ambitious sustainability water use efficiency target, outlined in the PLANET. PEOPLE. PADDOCK. Sustainability Framework.

On the cover of this edition is another fantastic sustainability story: a circular cotton project being led by Cotton Australia, with support from a range of partners including CRDC. This heralds the possible start of a truly circular industry.

Finally, as farmers, we always like to talk about the weather, which often includes lamentations around changing rainfall patterns. However, as an organisation committed to science, we can't just work on anecdotal evidence and short term trends. As such, we have collaborated on a project to investigate if our summer rainfall patterns are changing, and we bring you the lowdown here via our industry's own climate specialist, CottonInfo's Jon Welsh.

By the time this magazine lands with readers, our industry will be gearing up for another season, which is looking promising on the back of widespread rain over recent months. We wish you all a fantastic start to the season.

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.

MELANIE JENSON

Spring 2021

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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.

Postal Address:
PO Box 282, Narrabri NSW 2390
Offices: 2 Lloyd Street, Narrabri NSW 2390
Tel: 02 6792 4088
Fax: 02 6792 4400
Email: spotlight@crdc.com.au
Web: www.crdc.com.au
Communications Manager/Editor: Ruth Redfern
Editorial co-ordinator: Melanie Jenson
Editorial Contributors: Melanie Jenson.
Design: Deacon Design

COTTON AUSTRALIA

ON THE COVER: Returning end-of-life cotton garments to the cotton paddocks at Goondiwindi.

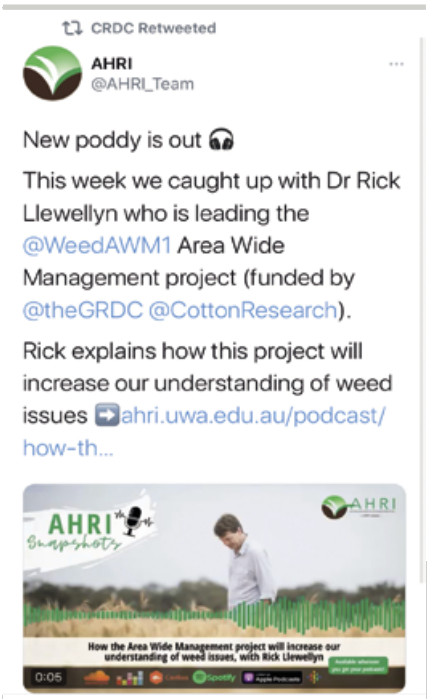
Want to see more of Spotlight?

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

COTTON NEWS

FEATURES

ON THE COVER



THE traditional approach to tackling weeds has been at a paddock or farm scale, however a cross-industry project aims to instead take an area-wide approach to weed management. In the cotton industry, area wide management has shown to be a useful tool in managing insect pests. It's also being used in the SOS (Stop off-target spray) groups in improving on-target spray application.

This collaborative project, *Area Wide Management for cropping systems weeds, investigating the weed management, social and economic opportunity* is led by the Grains Research and Development Corporation (GRDC) with support from CRDC, and is funded by the Australian Government's Rural R&D for Profit program. The project is developing an improved understanding of the bio-physical, geographic, economic and social drivers of area wide management success through studying key weed species across diverse landscapes. The project will also characterise and identify the social and economic costs and benefits of weed management.

To listen:
www.ahri.uwa.edu.au/podcast/how-the-area-wide-management-program-will-increase-our-understanding-of-weed-issues/

What does your CGA need?

UP to $10,000 is available for Cotton Grower Associations (CGAs) to help fund a project aimed at increasing the engagement of growers in the industry, solving specific regional issues and improving skills, knowledge and networks through the CRDC Grassroots Grants program.

This will be the tenth year of CRDC's Grassroots Grants, having provided support for 82 projects to the tune of more than $721,000 across cotton growing valleys since 2011.

The grants support on-farm trials, demonstrations and workshops while fostering collaboration, peer-to-peer learning and grower-led research. In the past year, supported projects through the Grassroots Grants program have included on-farm evaluation of pumping telemetry in the Macquarie; a study tour to investigate planting times, pests and spray drift management strategies for growers in Walgett; an on-farm demonstration of the internet of things (IoT) and low power, long range (LoRaWAN) networks in St George; a project to promote biosecurity management practice for emerging cotton regions and engaging growers in myBMP in the Northern Territory; projects to encourage the uptake of digital technology in southern NSW and the Macquarie; increasing skill development for growers in the Darling Downs; and tours for Central Highlights and Macintyre cotton growers to St George, the Ord and the Northern Territory.

Applications open annually in July and close November 30. All CGAs are invited to apply. Interested applicants should read the guidelines on CRDC's website and return a completed application form to CRDC.

For more
CRDC Grassroots Grants
www.crdc.com.au/for-growers/community-grower-support

Cotton champion is young farmer of the year

COTTON consultant, innovative farmer and agricultural advocate Emma Ayliffe from the Central West of NSW (Wiradjuri country) has been recognised as one of Australia's farmers of the year.

Emma made the trip from her home at Lake Cargelligo to Parliament House in Canberra in July to be named Young Farmer of the Year at the Kondinin Group and ABC Rural 2020-21 Australian Farmer of the Year Awards.

Emma is an active member of the cotton industry as a consultant and through running R&D trials in conjunction with her local Cotton Grower Association. She's a graduate of the Australian Future Cotton Leaders program and a former Young Farming Champion.

"Both these programs gave me a fabulous foundation," Emma said.

"The big part of Future Cotton Leaders was understanding myself, understanding where my strengths lie.

"It also helped understand my weaknesses and the need to have people around me to stregthen those areas, while working on improving myself.

"It was also a great tool for learning to understand personality types of the people around me."

The tools she learned for goal setting and planning were a highlight, as well as the contacts that she still uses today.

"That is probably the biggest win: the network," Emma said.

"There are plenty of opportunities for young people in cotton and agriculture – the key is to surround yourself with people who will advocate for you and help you open doors.

Emma Ayliffe is a champion of the cotton industry and advocate of agriculture in general.

"It is important to throw your hat in the ring and put yourself out there no matter how uncomfortable."

The Australian Farmer of the Year Awards event was opened by the Hon. David Littleproud, Minister for Agriculture and Northern Australia and recognised the outstanding winners.

"We got to participate in a leadership workshop with the other winners at Parliament in Canberra," Emma said.

"It was a great opportunity to meet with a number of politicians from various roles."

Preparing for the future: CRDC's strategic planning begins

PLANNING is underway for CRDC's new Strategic Research, Development and Extension (RD&E) Plan.

CRDC's research investments are governed by a five-year Strategic RD&E Plan, which is developed in conjunction with the Australian cotton industry. With the current Strategic Plan due to conclude in June 2023, the development of the new plan – which will cover the five years from 2023 to 2028 – is now underway.

The first step in the formulation of the plan was a horizon scan workshop: a focused look at the environment in which the Australian cotton industry operates, with a particular look at the threats and opportunities facing the industry into the future.

The horizon scan workshop was intended to be held in Canberra in August, but due to the ongoing challenges of COVID-19, was adapted to an online format with 50 attendees from across the cotton supply chain and further afield. The workshop looked at key considerations for the future cotton industry: the global trends and challenges shaping apparel and the influence of brands and retailers; the competitiveness of the Australian cotton supply chain and the growing need for cotton recycling; new tools and technologies like synthetic biology and genome editing, space-based technologies, and data and data exchanges; the critical role of biosecurity in safeguarding our Australian industry; the push towards carbon-neutrality; the impact of climate change and water availability; the future cotton farm and the growth of the industry into new locations; and commercialisation, including partnering with commercial partners and venture capitalists for success.

The workshop brought together key leaders from within the industry, but also

importantly heard from influential people outside the industry to provide new and diverse perspectives: like David Ball, Regional Director of Australia and New Zealand for Lockheed Martin's space division, about the role of space-based technologies in agriculture, and Barry Irvin, the Executive Chair of Bega Cheese, about how the Bega Valley is transitioning to carbon neutrality.

The next step following the horizon scanning workshop is a scenario planning exercise, which will bring together the boards of CRDC and Cotton Australia to map out the possible future scenarios for the Australian cotton industry. At the same time, CRDC will begin engaging directly with cotton growers and other stakeholders in the industry to understand key RD&E needs.

Early next year, CRDC will take the learnings from 2021 and start mapping out the proposed strategic direction, including key investment areas, through a series of strategic planning workshops. Growers and industry partners will be invited to participate.

"This plan is the roadmap by which the Australian cotton industry will achieve its preferred future," said CRDC Executive Director Dr Ian Taylor. "Therefore its essential that growers have the opportunity to have their say. We'll be keeping growers and the industry informed about how they can contribute as the plan develops."

The Strategic RD&E Plan, incorporating the feedback, advice and input of all stakeholders, will be finalised in March 2023, with the start of the new Strategic RD&E Plan period commencing July 2023.

For more
www.crdc.com.au/publications/crdc-strategic-plan

Support local when it comes to flora

BY learning how to propagate and harvest local native plants, members of the Namoi Valley (Kamilaroi) cotton community are creating an effective means to better tackle restoration or revegetation works.

CottonInfo and the Wee Waa Local Aboriginal Lands Council hosted a Florabank workshop in late May: a hands-on opportunity to learn about native plant propogation and harvesting. It also shared knowledge about native plants as food and medicine. The workshop, held at Wee Waa in North West NSW (Kamilaroi country) was led by Steve Field from Fields Environmental Solutions and David Carr from Stringybark Ecologica.

CRDC R&D Manager and CottonInfo Natural Resource Management Technical Lead Stacey Vogel said learning how to utilise seeds from plants endemic to a region is important as it creates more resilient seedlings.

"By learning to propagate and take seed from the vegetation around us, rather than bringing in seeds from another area, we are hoping for a higher success rate of survival," Stacey said.

"This is beneficial for farm gardens, community revegetation and conservation projects along with land restoration.

"There are also other advantages of using local seeds, like supporting biodiversity as local plants are likely to provide suitable shelter, food, and habitat for local fauna, like birds and insects."

The course taught participants how to collect and clean local seeds, construct a nursery, germinate and handle seedlings, as well as the steps to successfully plant out.

Another workshop focused on field identification and collection of native seeds is planned for mid-September, with spots still available, and Stacey has urged anyone interested to contact her.

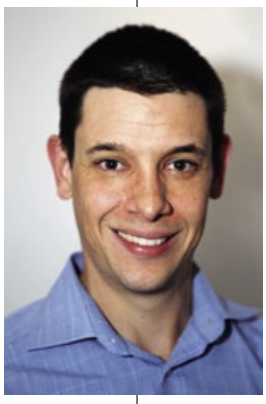
The Florabank workshop is the latest outcome of the Cotton Landcare Tech Innovations 2021 project funded by CRDC in partnership with the Australian Government's National Landcare Program Smart Farming Partnership Initiative. The project aims to provide cotton communities with practical and cost-effective technology solutions for restoring habitat connectivity and monitoring and managing biodiversity across the industry.

For more
Stacey Vogel
stacey.vogel@crdc.com.au
www.crdc.com.au/cotton-landcare-tech-innovations

Kerrie Saunders of Yinarr-Ma Bush Food Demonstration and Tours and Sydney University's Fran Abedi, learning how to manage native flora at Wee Waa.

Two familiar faces join CRDC

NEW CRDC Research and Development Manager, Elsie Hudson (pictured above), and CottonInfo Communications Lead, Brad Pfeffer (pictured right) have been welcomed to the CRDC team.



Elsie and Brad bring extensive cotton, agronomy and communications experience to CRDC.

"With Elsie's passion for science and practical knowledge we are really happy she has accepted the role, which will cover management of projects from the farming systems portfolio," CRDC Executive Director Dr Ian Taylor said.

Elsie may already be a familiar face to many, having moved out of the role of CottonInfo Regional Extension Officer, based in the Upper Namoi region (Kamilaroi country) of NSW.

CottonInfo is a partnership between CRDC, Cotton Australia and Cotton Seed Distributors, and the Regional Extension Officers are responsible for connecting cotton growers with industry research and researchers. As such, Elsie brings strong R&D knowledge and established relationships to the CRDC team. Elsie also has a love of crop science and has worked as a consultant across cotton farms in the Narrabri, Moree, Walgett and Bourke regions. She's looking forward to taking this next step in the industry with CRDC and will be based at Goondiwindi.

Brad is an experienced agricultural communications professional, specialising in research, development and extension.

For the past six years, Brad has been the Executive Manager of Communications and Adoption at CRDC's fellow research and development corporation (RDC), Sugar Research Australia. Brad brings a passion for extension and adoption communication and a strong understanding of the RDC system to the CottonInfo team.

Brad is coming back to cotton after growing up on a cotton farm on the Darling Downs.

Starting as a journalist for Rural Press, Brad has also worked as a media advisor in federal politics, a policy officer for Cotton Australia, and a communications manager for QLD Farmers' Federation.

"We really value Brad's experience in agricultural communication, his understanding of research and development, and his passion for keeping growers and consultants up to date with the latest science through CottonInfo," Ian said.

Brad will be based in Brisbane and will work closely with CottonInfo Program Manager Warwick Waters.

For more
Elsie Hudson
elsie.hudson@crdc.com.au
Brad Pfeffer
brad.pfeffer@crdc.com.au

Beth moves into technical lead role

EARLIER this year the cotton industry welcomed Beth Shakeshaft to her role as the CottonInfo Disease Technical Lead. Beth has brought a diverse range of skills and a southern perspective.

Beth has a Bachelor of Science in Agriculture with Honours, concentrating on cotton production in the Murrumbidgee Irrigation Area. She is now studying a Graduate Diploma of Mathematics majoring in statistics. Coupled with this, Beth was working as an agronomist in the Griffith area prior to taking on the CottonInfo role.

Beth is based at NSW DPI's Yanco Agricultural Institute, working on the Southern Cotton Crop Protection project, supported by NSW DPI and CRDC. This project is focused on managing insect pests and diseases, looking into management options for early season black root rot, late season Alternaria leaf spot, plant compensation after early season square loss as well as monitoring for key pests and diseases including black root rot, rhizoctonia, Fusarium wilt, reoccurring wilt, mirids and silverleaf whitefly.

"I have an interest in pest monitoring and management and am driven to produce meaningful results in this new position," Beth says.

"In my work I'll always ask the question, 'how will this work benefit the cotton industry?'"

CottonInfo Program Manager Warwick Waters said Beth is strengthening CottonInfo's presence and cotton's research capacity in the southern region.

"Beth brings valuable experience and a whole systems understanding from her previous role in agronomy, which is helpful for technical specialists.

"She will be networking with CRDC disease projects across the industry and coordinating disease extension through CottonInfo in partnership with our regional extension officers.

"This is supporting the focus of CottonInfo in connecting growers with research."

For more
Beth Shakeshaft
beth.shakeshaft@dpi.nsw.gov.au

growAG bringing cotton R&D to market

NSW DPI and CRDC-supported work which demonstrated effective biological control of insect pests in cotton is progressing to commercialisation.

An expression of interest period was recently facilitated through AgriFutures Australia's grow[AG] platform which is supported by CRDC and its fellow Research and Development Corporations. Through this expression of interest period, NSW DPI and CRDC were seeking partners to commercialise the related novel IP and deliver this to industry in Australia and internationally. This project is the outcome of years of research by NSW DPI Senior Principal Research Scientist, Dr Robert Mensah.

Since the early 1990s Robert has been developing non-chemical and natural chemical pest control tools for use in cotton and other broadacre crops in Australia, Africa and Asia. This includes the 18-year project in collaboration with CRDC. These years of research and trials have resulted in the development of DAT511 (*Metarhizium sp*.), an entomopathogenic fungal isolate demonstrating effective control of insect pests in cotton. It is effective against a range of insect pests including *Helicoverpa spp*., green mirids, silverleaf whitefly, green vegetable bugs, Rutherglen bugs, fruit fly and mealy bugs, while its efficacy against fall armyworm is subject to evaluation.

Three botanical products (plant extracts) code-named Plants W, Y and Z have also been identified, which have properties shown to modify the behaviours of insect pests including *Helicoverpa spp*. and sucking pests such as green mirids, green vegetable bugs and silverleaf whitefly.

SHANNA WHAN

Dr Robert Mensah has left the cotton industry with an incredible legacy that is leading to commercialisation through the new growAG platform. He is pictured here with Plant Health Australia's Jess Lehmann.

The current value of insecticides in Australia is more than $8 billion per annum, while the number of new biological products registered globally has increased each year, and over the past two decades the growth in biologicals and biopesticides has outpaced that of synthetic crop protection chemicals.

NSW DPI Director of Business Development, and former CRDC Executive Director Bruce Finney said Robert's research provides an ideal opportunity for companies to partner with NSW DPI and CRDC to help commercialise these novel products for crop protection and IPM.

This could include existing chemical businesses interested in diversified opportunities, or investors interested in alternate crop protectant products, with opportunities to either purchase or license the IP.

"NSW DPI and the CRDC are excited to see increasing global interest in the adoption of biological insect controls and are seeking opportunities arising to make the results of this unique research commercially available to farmers in Australia and internationally," Bruce said.

Showcasing commercial opportunities

GROW[AG] is the gateway to Australia's agrifood innovation system. It formalises a shared vision of the Department of Agriculture, Water and the Environment and Australia's 15 Research & Development Corporations (RDCs).

The program was designed to showcase world leading agricultural research, unique technologies and commercialisation opportunities in one, easy to use location. All the information on this platform is free to access and allows investors, corporates, startups, researchers, industry, government and universities from Australia and around the world to locate information and opportunities to deliver innovation back to the farm and the food supply-chain.

Other cotton-specific commercialisation opportunities previously listed on the website include the automated silverleaf whitefly counting algorithm developed by CRDC, QLD DAF and the University of Southern Queensland. Before listing, the prototype was extensively tested and was at an advanced stage of development. Commercialisation of the algorithm in a user-friendly phone-based app will enable more consistent sampling results, more efficient crop scouting and improvement in decision making. This in turn will enhance Integrated Pest Management (IPM) and deliver more sustainable outcomes in cotton pest management.

For more
www.growag.com

Growers cut water use by half

NSW DPI research combined with all other available water use data going back to 1992 confirms over the last 25 years, the Australian cotton industry has almost halved the amount of water required to grow a bale of cotton.

Water use has fallen from 1.43 ML/bale in 1995 to 0.74 ML/bale in 2020 driven primarily through improvements in irrigation infrastructure and management efficiencies underpinned by RD&E.

With support from CRDC, researchers from the NSW DPI Water Productivity Benchmarking Project, are tracking improvement in water productivity. CRDC has funded the monitoring of cotton water use for several decades, and the current benchmarking research project has been led by NSW DPI since 2006.

The involvement of the NSW DPI as an independent third-party research organisation helps validate industry's case that cotton growers are responsible and sustainable users of water. Benchmarking water productivity tracks industry's progress in the efficient use of water resources and demonstrates the cotton sector's commitment to responsible water stewardship. It also provides benchmarks for growers and a means to assess the impact of new technology and management strategies.

A key target of the cotton industry's current PLANET. PEOPLE. PADDOCK. Sustainability Framework is to achieve a 12.5 percent improvement in water productivity to reach the benchmark target of 0.71 megalitres per bale (1.41 bales per megalitre) by 2024, and on current trends this target is achievable.

Researchers conducted in depth water productivity benchmarking in 2007, 2009, 2013 and 2018. Their findings were combined with all other available water use data going back to 1992. This has found that industry has almost halved the amount of water required to grow a bale of cotton over the last 25 years.

The Water Productivity Benchmarking Project works with growers to assess their water productivity based on a gross production water use index (GPWUI) benchmarked against the industry standard. The aim is to extract maximum profitability and production out of valuable water supplies.

"GPWUI is the gold standard for determining water productivity in the cotton industry," explained NSW DPI Agriculture Research Officer and project lead Dr David Perović.

$$GPWUI = \frac{bales}{licensed + rain + runoff + soil\ moist. + storage\ used + evap.}$$

Figure 1. Gross Production Water Use (GPWUI) measures water productivity for every bit of water consumed across the season, and includes licensed water pumped from rivers and bores, effective rain, rainfall runoff captured and pumped into storage, soil moisture stored and consumed, all water from storage consumed and all evaporation and seepage from storage dams and channels. Each of these needs to be calculated per hectare of cotton area.

"It's the most reliable and meaningful method for measuring efficiency," David says.

The GPWUI is a measure of how productively water is used, expressed as the ratio of cotton yield (bales per hectare) to all water potentially available to the crop (megalitres per hectare). GPWUI accounts for all water from rivers and bores, all rain falling directly on the crop as well as harvested rainfall runoff, plus all soil moisture used by the growing crop.

The GPWUI also includes all water lost through evaporation and seepage during storage and delivery to the field. As GPWUI measures all sources of water available to the crop, it is the preferred metric for comparing water productivity across regions and seasons (Figure 1).

Implementing measurement of GPWUI across the industry through the consistent use of a standardised benchmarking calculation is critical for demonstrating progress towards ambitious water use efficiency targets.

"It has been very pleasing to see just how well the industry is performing," David said.

"Even after the significant improvements in water use efficiency that were achieved between the mid-1990s and the mid-2000s, growers keep getting better and better production out of finite water resources."

NSW DPI R&D Officer and CottonInfo Water Use Efficiency Technical Lead Ben Crawley said deeper analysis of 2018 data compared to 2007, 2009 and 2013 suggests that the biggest savings have come about through improvements in efficiencies in irrigation infrastructure and management.

"These improvements have allowed more water to be taken up by the crop and less water to be lost to evaporation and deep drainage," Ben said.

Dr David Perović and Ben Crawley from the NSW DPI Water Productivity Benchmarking Project.

Growers are encouraged to get involved in industry benchmarking research to benefit both their own profitability, and the reputation of the broader industry.

"In 2018, we had almost 60 farms involved in the Water Productivity Benchmarking Project, and we're looking to build industry participation," Ben said.

"Increasing the number of growers contributing their information will provide more comprehensive data to support the industry's reporting against sustainability targets."

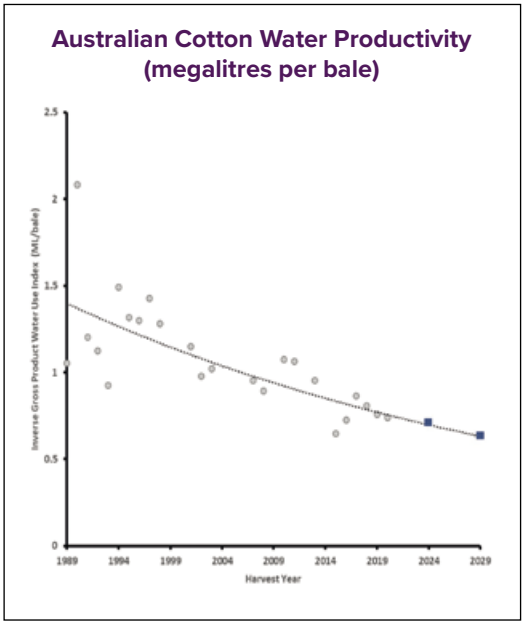


Figure 2. The grey circles from 1989 to 2019 represent actual averaged water productivity calculated from the Water Productivity Benchmarking Project and other CRDC research results. The blue squares represent CRDC's ambitious sustainability targets for water productivity from 2024 and 2029.
NB: The Water Productivity Benchmarking Sustainability Report expresses water use efficiency as a megalitres per bale unit to demonstrate the reduction in inputs per unit of yield, rather than the more familiar bales per megalitre, which indicates productivity per unit of input.

Register

Growers – register your interest or find out more by contacting the NSW DPI Water Productivity Benchmarking Project team.

- **Namoi, Gwydir, Border Rivers, Central QLD, Darling Downs**
  Ben Crawley – 0439 247 605
  ben.crawley@dpi.nsw.gov.au
- **Macquarie**
  Jasim Uddin – 0448 180 996
  jasim.uddin@dpi.nsw.gov.au
- **Southern NSW**
  Robert Hoogers – 0427 208 613
  robert.hoogers@dpi.nsw.gov.au

From field to fabric and back to the field

Cotton is looking to go ‘circular’ with an innovative idea to recycle cotton products at their end of life back into cotton fields.

Cotton grower Sam Coulton's property 'Alcheringa' at Goondiwindi in South-East Queensland (Kamilaroi country) is home to a game-changing trial to test if shredded cotton products could offer benefits to cotton soil health, and a scalable solution to textile waste.

The project is a partnership between the Queensland Government, Goondiwindi Cotton, Sheridan, Cotton Australia, Worn Up and CRDC-supported soil scientist Dr Oliver Knox of the University of New England (UNE), with guidance from circular economy specialists Coreo.

Around two tonnes of cotton textiles, garments and end-of-life State Emergency Service coveralls have been processed and spread onto a field at Sam's, combining cotton compost to help bulk and spread the material.

The trial will look at the breakdown process at different application rates, and assess effects on soil nutrition, respiration/CO_2 and microbial biomass. The project team hopes the results will provide evidence for a large-scale circular solution for 100 per cent cotton textile products in Australia, which are naturally biodegradable, renewable and recyclable.

Projections show that the breakdown of the processed garments in soil, rather than going to landfill, will mitigate 2250 kg of carbon dioxide equivalents (CO_2 e) from going into the atmosphere.

"Returning cotton garments to the farms on which they began would completely close the loop on a cotton product, providing a win for brands, retailers and consumers looking for circular solutions, and a possible benefit to our farmers, their soils and the planet: it's very exciting," said Brooke Summers from Cotton Australia.

"Textile waste is a major problem for communities and supply chains globally, with the latest Australian estimate showing approximately 85 per cent of apparel is sent to landfill at end of life."

Prior to spreading the cotton at 'Alcheringa' in July, lab-based testing of cotton fabrics by Oliver at UNE assessed the effect on soil during the biodegradation process in terms of potential benefits to soil health.

The experiment involved burying two-centimetre squares of cotton fabric in about 40 grams of moist soil (from Coulton's) and incubating it at 20°C for 24 weeks. The buried material equated to between 400 to 3000 kg of material applied to a hectare of

Science behind the scenes

Dr Oliver Knox says behind the application of the shredded material was a series of experiments to address some of concerns about applying shredded fabric to soil. One of the biggest concerns was whether the dyes in the material could have a negative effect on the field. Oliver has been analysing both Sam's clothing fragments as well as other dyed cotton material at UNE.

"To date I've not seen anything that would raise concerns over the process," Oliver said.

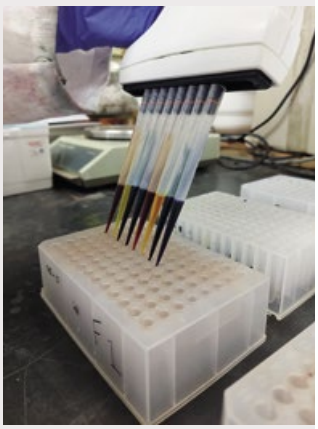
"We've been looking to see what effect the shredded dyed fabric has on soil biology as well as on cotton germination trials.

"While the naked dyes could inhibit germination when applied neat, the effect of presenting them at much lower concentrations and wrapped in cotton generally promoted both microbial activity and germination.

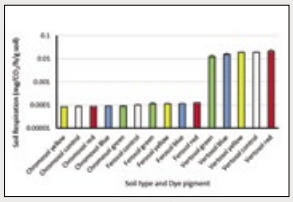
The dye trials at UNE were conducted with cotton applied at rates of two to four tonnes per hectare, which was used as a guide for the field trials.

"While dyes, finishes, buttons, zips, reflective tape and poly cotton thread all pose possible risks to our soils if we recycle clothing this way, there are many potential benefits," Oliver said.

"Natural fibres, like cotton and wool, can be broken down in most soils and in doing so both feed the soil biology and improve our soils, much like a compost or manure."



Testing dye to ascertain its effect on soil was undertaken at UNE with the help of science students Lilly McCook and Jazmin Madden, by adding high and low temperature dyes to different soils and a graph of the effect (or lack of) dyes on different soil types.



The effects of clothing dye on soil respiration.

Sam Coulton is keen to see the effect that returning cotton to the field will have on his farm, in a project that could create a win-win situation for farmers, consumers, soil health and the environment.

farmland, which is the equivalent of removing 2500 to 20,000 t-shirts from landfill (based on average T-shirt weight of 150g).

"We found that adding cotton fabric samples to soil increased levels of microbial (bacterial and fungal) activity in all but one sample," Oliver said.

"When added to soil, all but the tightest weave of cotton material broke down significantly in about 24 weeks.

"We also found that cotton seed germinated just as well in soil to which cotton fabric had been added as it did in soil to which no material had been added."

Further testing on the impact of dyes was also undertaken, with the assistance of UNE science students, with no adverse effects on the soils observed. However, fabric finishes and other challenges like the removal of components that don't break down such as buttons, zips and synthetic threads and tags are still being addressed.

The trial will be completed by harvest in early 2022, with initial results expected soon after, although it's expected the real benefits for cotton yield and long-term soil health may not be known for many years.

"We need to get smarter about how we reduce and manage waste," Oliver said.

"The potential to divert clothing from landfill, reduce greenhouse gas emissions and potentially feed our soils could help deliver more sustainable practices in multiple sectors."

Sam Coulton said being part of the solution to textile waste is very positive.

According to Oliver the idea to return clothing to soil to improve soil health has its roots in history, having been used around 240 years ago.

"At the onset of the industrial revolution (late 1700s), old rags as well as sewerage was collected by local farmers and applied to their land.

"Then the value of rags to make paper put pay to this until the 1930s when, 'to enable expansion should a threat arise', land fertility schemes resulted in clothing again being soiled as a means of disposal.

"As such the idea to redirect natural fibres, destined for landfill, to agricultural land is not a new process, and under this project is about to be revived."

"We grow it here and we should be able to bury it here with positive environmental and economic impact on the local community," he said.

For more

Brooke Summers
brooke@stepcommunication.com
Oliver Knox
oknox@une.edu.au

Bringing biosecurity and research focus to the North

Most growers and consultants in the Australian cotton industry would by now be familiar with fall armyworm (*Spodoptera frugiperda*) since its arrival into Australia in early 2020. However some would be less familiar with our own endemic species, the cluster caterpillar (*Spodoptera litura*) which is common in tropical regions.

Cluster caterpillar can cause damage to a wide variety of agricultural crops and has been a frequent pest of cotton in Northern Australia since the 1950s. Unlike *Helicoverpa* species, *Spodoptera spp.* have a naturally higher tolerance to Bt toxin proteins which has enabled larval survival in some Bollgard 3 crops in tropical regions.

The adoption of Bollgard 3 (which is only registered in Australia for control of *Helicoverpa*) has reduced the observed frequency of cluster caterpillar over the past few seasons compared to previous generation Bt technology, however there is still low but ongoing survival in some cotton crops. Why a small percentage of larvae are surviving in some crops but not others is unknown.

CRDC is supporting QLD DAF and CottonInfo Biosecurity Technical Lead, Sharna Holman, as part of her PhD studies, to conduct research that will inform a management framework for cluster caterpillar in tropical cotton systems.

Planned research will determine cluster caterpillar ecology within Bollgard 3 in tropical farming systems; pest adaptations that may advantage survival

The industry is building knowledge of pests endemic to the north of Australia through supporting Sharna Holman with her PhD study.

on Bollgard 3; and damage potential of cluster caterpillar to inform in-crop management.

This PhD research program brings together multiple stakeholders from QLD DAF, Western Australia Department of Primary Industries and Regional Development, University of Queensland and Bayer.

As part of the research program, Sharna will be based in Kununurra during the cotton season from 2022 conducting field studies and providing support to growers and local industry through CottonInfo. She will collaborate with the existing North Australian Crop Research Alliance (NACRA) and DPIRD RD&E staff in the North, and will help to link the region to CottonInfo and broader industry.

Sharna is looking forward to the opportunity to live in WA during their season, making a change from her base at Toowoomba.

"I'm really looking forward to being based in Kununurra each cotton season, immersing myself in the region and learning first-hand from growers and consultants the strengths and challenges of cotton production in tropical climates," Sharna said.

"Additionally, Northern Australia is of particular risk for the arrival of exotic pests and disease due to the humid climate and close proximity to Indonesia and Papua New Guinea. "

Sustainable crop protection has been raised by Northern growers as a high priority issue.

This project will build help build connections between Southern and Northern systems.

"Being based in the North is beneficial to my CottonInfo Biosecurity Technical Lead role, as it will assist with building relationships with biosecurity officers, crop protection researchers and industry across Northern Australia to be better positioned to face emerging exotic pest issues."

For more
Sharna Holman
sharna.holman@daf.qld.gov.au

AIA appoints inaugural CEO

Agricultural Innovation Australia Ltd (AIA) has announced the appointment of Sam Brown as its inaugural CEO.

AIA is a not-for-profit company established by the collective Research and Development Corporations (RDCs), including CRDC, to drive cross-sectoral research, leverage private sector investment and target transformational innovation.

Sam has been CEO of LiveCorp, one of the 15 Research and Development Corporations, for nine years. His appointment to AIA follows that of the Chair Bernie Brookes AM and the board in April 2021.

AIA Ltd is designed to prioritise and streamline co-investment to tackle hard to solve cross-sector problems and drive greater impact for industry and the broader community. CRDC has been actively involved in the establishment of AIA Ltd and its first investment project, the climate initiative, which aims to foster thriving agriculture, fisheries and forestry industries regardless of pressures from a variable and changing climate.

For more
www.aginnovationaustralia.com.au

Are our Summer rainfall patterns changing?

CottonInfo climate specialist and economist Jon Welsh says through many climate seminars, talks and on-farm economic evaluations he undertakes, farmers invariably want to discuss what they see as unreliability of summer rainfall in more recent times.

Managing Climate Variability, a partnership between CRDC, GRDC, MLA, AgriFutures and SRA, recently commissioned CSIRO to take a closer look at trends, observations and whether reduced summer rainfall is something dryland and irrigated farmers in the northern Murray Darling Basin need to adapt to. Jon has been working with CSIRO researcher Katharina Waha to deliver a report based on the research. He shares his take home messages with *Spotlight* readers.

Summer rainfall feeds a myriad of crops, including cotton, sorghum and corn and if irrigated, takes the pressure off allocated water use. After almost a decade of very few dryland summer cropping opportunities, many farmers in these regions began losing confidence in once reliable summer rainfall, but is this concern justified?

While south-eastern Australia has been the focus of many studies on soft-season rainfall trends, there is limited knowledge for other key agricultural production regions located in the mid-latitudes, between the tropical and temperate climate zones, and long-term rainfall changes in other seasons. In these parts of Australia's agricultural areas, which includes northern NSW, farmers have experienced reduced summer rainfall in recent years.

For example, in Narrabri (Kamilaroi country), seven out of 10 summers between 2012 and 2021 have been dry with rainfall below the long-term average of 216mm, except for the most recent summers 2019-20 and 2020-21. This number of consecutive dry summers has not been observed since 1926; the World War II drought (1935-1945) had six consecutive years of below average summer rainfall but the seventh year had above average summer rainfall.

Implications of continuous dry years in these areas include increased water and heat stress for crops and livestock, increased demand for irrigation water, high costs for replanting and decreased production efficiencies and profitability for producers in regional communities.

Identifying trends

The aim of the study was to understand whether observed declines in rainfall in the midlatitudes are part of a longer-term or regional trend requiring transformational changes to the farming systems or

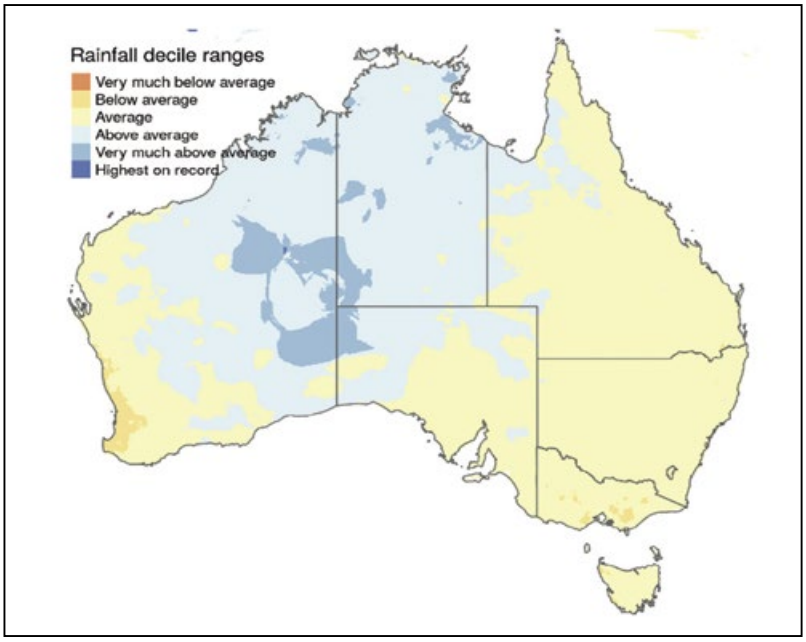


Figure 1. Summer rainfall deciles for the past 20 years (1999-2018). a) The map shows where rainfall is above average, average or below average, in comparison with the entire rainfall record from 1907.

are attributable to natural variability.

Rainfall is highly variable in Australia and rainfall variability is higher than could be expected for locations with similar mean rainfall with coefficients of variation (CoV) of 50 to 80 per cent. The CoV is a statistical measurement that represents the degree of scatter of observations from the mean. The CoV in summer rainfall for example in Narrabri was 50 per cent between 1926 and 2019 which indicates that, on average, every second summer has a 50 per cent rainfall deviation from the long-term mean. It is unclear to what extent observed rainfall declines are part of a long-term trend and to what extent underlying climatological drivers such as the El Niño–Southern Oscillation (ENSO) are already influenced by global climate change.

Teleconnections driving our rainfall

Teleconnection in atmospheric science refers to climate anomalies being related to each other at large distances (typically thousands of kilometres). The most emblematic teleconnection is that linking sea-level pressure at Tahiti and Darwin, which defines the Southern Oscillation.

The last 20 years' summer rainfall has also been average compared to the entire rainfall record in the northern Murray Darling Basin and the coastal Queensland and NSW region.

Annual rainfall at Bathurst, Nyngan (Wirajuri country) Coonabarabran (Wailwan country) and Bingara (Kamilaroi country) located in the northern Murray Darling Basin is dominated by El Niño–Southern Oscillation (ENSO), Southern Annular Mode (SAM) followed by the ENSO-IOD (Indian Ocean Dipole) interaction. (See *For more* box for link to explainers).

Overall, the rainfall pattern in the coastal areas is dominated by SAM and ENSO while further inland the influence of ENSO and ENSO-IOD interactions increase.

Others identified teleconnections in regional seasonal rainfall in eastern Australia and related them to large scale climatic drivers. The December, January, February (DJF) teleconnection describing rainfall variation in coastal southern Queensland was not correlated with any of the large-scale drivers considered ENSO, the Inter-decadal Pacific Oscillation index (IPO) and SAM, but with coastal cyclones and onshore winds that explain around eight per cent of the rainfall variability in the region.

The Queensland state-wide DJF teleconnection is related to ENSO but has smaller influence on the study areas in the northern Murray Darling Basin and coastal Queensland.

Trend analysis – an increase in summer rainfall and rainfall intensity in some locations

No linear trend in any of the climate indicators

Location	*Region*	*Cunnamulla*	*Curlewis*	*Pittsworth*	*Wallangra*
Indicator					
Annual (mm/year)	No	No	Yes (1.34-1.64)	No	No
Summer (mm)	No	No	No	No	Yes* (0.67-0.79)
Winter (mm)	No	No	No	Yes (-0.34--0.37)	No
Rx5day (mm/year)	No	No	No	No	No
R10mm (days)	Yes (0.03)	No	Yes (0.06-0.07)	No	No
CDD (days)	No	No	No	No	No
CWD (days)	No	No	Yes (0-0.01)	Yes (-0.008-0)	No
R95p (mm)	Yes (0.48-0.50)	Yes (0.63-0.81)	Yes (0.76-0.83)	No	No
* Mann Kendall test only, not t-test					

Table 1: For the Northern Murray Darling basin. There have been no trends detected in any of the rainfall indicators in Bingara, Miles, Narrabri and Peak Hill.

has been found in Bingara, Narrabri and Peak Hill (Wiradjuri country) in NSW and Miles (Barunggam country) in Queensland. The stations with changes in seasonal or annual rainfall are Curlewis NSW (Kamilaroi country), Pittsworth QLD (Barunggam country); and Wallangra QLD (Bundjalung country). Summer rainfall has increased by 19 per cent since 1990 in Wallangra (+) and winter rainfall has decreased by 31 per cent since 1990 in Pittsworth (-).

The total annual rainfall from heavy rainfall events has increased in Curlewis and in Cunnamulla which indicates a change towards more intense rainfall. The number of consecutive wet days has changed only slightly in Curlewis and Pittsworth.

We found four stations in a 200km radius from Narrabri that also experienced a long period of below average summer rainfall between 2012 and 2019. Curlewis, for example, located 120km south-east of Narrabri, where six consecutive summers have been dry with below average rainfall, which is however not unprecedented as the entire rainfall record indicates a similarly long dry period in early 20th Century.

The location of these five weather stations seems to indicate an area between 148 E and 150 E and 29.5 S to 31.5 S with below average decadal summer rain as the weather stations east of 150 E (Bingara, Barraba, Carroll Ranch, Wallangra) and north of 29.5 S (Mogil Mogil, Croppa Creek – Kamilaroi country) do not show the same trend.

We find no regional trend in annual and summer rainfall, but we find an increase for specific stations, Wallangra and Curlewis. Spatial correlation of rainfall is low which makes the identification of consistent, regional trends challenging. For example, while for the region overall we find a positive trend in the annual precipitation from heavy precipitation days in the northern Murray Darling basin overall but only in two of the eight weather stations in the region.

These results do not suggest a shift in the rainfall distribution or long-term trend in seasonal rainfall in the northern Murray Darling Basin and the coastal midlatitudes of NSW and Queensland that would justify the need for transformational changes yet. Some of the observed long periods of dry summers in northern NSW are rather unprecedented, for example for Narrabri but it is too soon to know if this is part of a longer-term trend and projected changes are equivocal.

The changes in rainfall distribution towards more intense rainfall and shorter consecutive wet periods are small and it is unclear how this trend will continue in the future. However, rainfall variability in these areas is high and strongly associated with variability in crop yields even in the absence of long-term trends which will continue to challenge farmers.

For more

Jon Welsh
jon@agecon.com.au
Katharina Waha
katharina.waha@csiro.au

For the full report
https://tinyurl.com/r527pb77

For the definitions
www.climatekelpie.com.au/index.php/climatedogs/

Developing cotton's leadership capability

Cotton industry researcher Nicole McDonald believes today's leader is 'someone who works to identify and realise the potential in people and processes'.

The next generation of workers who had been in the industry for five years or less are strongly motivated to seek challenging work with development opportunities to build their careers.

MELANIE JENSON

Nicole is passionate about people and understanding how the cotton industry can best manage and attract its people, especially in a rapidly changing world. Her CRDC-supported project – Understanding and Planning for the Future Cotton Industry Workforce – initially began with the focus on understanding the skills required to accept and adopt technology, knowing that digital agriculture holds the potential to improve the social, economic, and environmental sustainability of the industry.

But, Nicole says, as the project continued it became clear that this was not the only factor that could challenge and enable the future adaptation of cotton industry businesses.

"As case studies were developed, a common theme was identified for adaptive cotton industry businesses: leadership capability," she told *Spotlight*.

"The research found that the more that digital agriculture is embraced, people's leadership potential and capacity for leadership is going to become more sought out and valuable to the cotton industry in all jobs, from entry level positions through to management.

"In the research, a collection of adaptability orientations, skills and processes that can be developed from the early career stage to best practice people management/coaching and design of socially sustainable work cultures, and through to innovation and transformational leadership by growers were identified."

Identifying ways to support the engagement of all industry players, from new entrants to highly skilled and experienced business owners to unlock leadership capability and adaptability within themselves and their workplaces is the focus of the next project. This collection of adaptability orientations, skills, and processes are an important part of supporting the industry and individuals to thrive in the face of uncertain futures.

Nicole says the added benefit of the cotton industry's appetite to continue to invest in new and existing programs designed to give people the skills to lead is the reputation it upholds that attracts new talent.

"This is because the actions that are taken to develop workforce lead to workforce retention, and this kind of supportive culture of continuous improvement becomes an authentic, powerful attraction story.

"I found that the next generation of workers who had been in the industry for five years or less were strongly motivated to seek out work that was challenging and would present them with development opportunities to build their career.

"Many of the careers in agriculture are not necessarily linear with clear pathways and events outside of individual's control can disrupt career plans or trajectories.

"Initiatives such as the recent post-graduate symposium presented PhD students with a range of potential futures that increase their understanding of how their skills are valued and can be applied within the industry.

"Giving the next generation the leadership skills to navigate and create work opportunities, carving their own career paths and maintaining adaptability means they can adapt and stay engaged in the industry when volatile circumstances create potential career roadblocks.

"Experiencing this type of support early in their careers gives young people the confidence that they can achieve a rewarding career in the cotton industry."

Nicole herself is currently a part of the cotton industry's efforts to support new talent to develop their leadership capability, as a participant in the Australian Future Cotton Leaders program.

"Through this program I am developing the confidence and skills to take the research that growers have invested in and persist in finding practical ways that it can benefit the industry," Nicole said

"The cotton industry consistently demonstrates it is willing to walk the walk and not just talk the talk when it comes to developing people and that means it can clearly show the next generation why they should want to aspire to work in cotton.

"The proof is in the people."

For more

Nicole McDonald
n.mcdonald3@cqu.edu.au

Future of cotton is in its leaders

Planning for the future means giving people the skills to lead an industry.

Under the guidance of specialist Jo Eady from RuralScope, a group of 11 enthusiastic cotton industry participants met in Armidale earlier this year as a part of the Australian Future Cotton Leaders Program. The program, supported by CRDC and Cotton Australia, has been turning out industry leaders over more than a decade. The intake is biennial, and the program began in 2007, with the aim to give participants usable skills to take back to their communities, associations, boards and paddocks.

In the program Jo runs face-to-face forums, interactive online discussions, one-on-one coaching and integration with industry activities. Participants also undertake an individual project related to their area of interest, which will assist in developing their leadership skills in a real-life scenario.

Many graduates follow on to hold leadership positions at a whole-of-industry level, for example within Cotton Australia and CRDC, as well industry committees and projects. CRDC board director Ross Burnett is a graduate of the inaugural program, while CRDC R&D Manager Susan Maas graduated in 2009.

A number of Future Cotton Leaders graduates have gone on to the Australian Rural Leadership Program or become Nuffield Scholars, including growers Nigel Corish from Goondiwindi and Renee Anderson from Emerald, while consultant and farmer Emma Ayliffe was recently named the ABC and Kondinin Group's Young Farmer of the Year.

Some of the cotton industry's most well-known researchers Rose Broderick and Karen Kirkby were early career scientists when they signed up, and have gone on to be leaders in their respective research fields. Recent graduates include climate specialist Dr Katie Broughton, Dr Dean Brookes and CottonInfo Biosecurity Technical Lead Sharna Holman.

The course always includes an intake of people with various skills and industry experience and or knowledge and at different stages of their 'leadership journey'. Some may already be considered leaders.

This year's cohort includes cotton industry

Future ready: Future Cotton Leaders in Armidale recently with Cotton Australia's Paul Sloman, Chris Hutchinson (Moura), Rob Weinthal (Gunnedah), Kimberley Fawkes (Dalby), Joe Briggs (Coleambally), Will Jackman (Moree), Mel Swift (Macquarie Velley), Dr Ian Taylor, Richard Gray (Moree), Sally Ceeney (Warren), Nicole McDonald (Melbourne), Alexandria Galea (Emerald), Matt Anning (Springsure) and facilitator Jo Eady.

researcher Nicole McDonald, former CottonInfo Stewardship Technical Lead and now Cotton Australia Policy Manager Sally Ceeney, along with growers, consultants and agribusiness professionals. The course manages to remain relevant to these diverse groups.

"Each program always has diversity in it – this is a huge plus of this program," Jo says.

"Participants focus on their future visions and their projects and hence it has never mattered about where they are at as such.

"My role as a facilitator is to be able to read and assess and then to push and pull, encourage and challenge, support and hold a mirror up so that each can become more self-aware.

"Only when this is done can a participant see changes in the way they approach, operate and lead."

The model Jo created for the program is based on 'Inspiration + Education + Application + Integration = Transformation'.

"This program covers all four of those aspects but sits at the application and integration level," Jo said.

"Participants need to learn, apply and integrate their knowledge and skills in real life and real time with real people.

"This can be challenging and they are often accustomed to 'training' where they learn new information, finish the day and say that's great new info and then return to their work/business and industry and don't find time to apply it.

"This is where the project is so important and yes it needs self-drive and accountability to progress – this is all part of the learning."

Since the first program in 2007, the Australian cotton industry has changed, and so have attitudes around what constitutes leadership and what creates a successful leader. Jo says the program has changed and evolved over the years, which is aligned to the changes in society, how people interact and communicate.

"There has also been a shift because of community expectations of agriculture, from a strong focus on 'me and my farm/work' to 'me and the industry and what's my role in it?'," Jo said.

"Back in 2007 we saw a lot of technically-focused projects – today we see a lot more soft skill – people/communication/leadership/collaboration type projects."

Jo says changes are also reflective of where participants are feeling the need to improve.

"I think this is reflective of where their work/business and industry is too," Jo said.

"There is no room in the future for leaders that are only technically proficient – effective future leaders will be those who take responsibility for finding and bringing out the potential in others.

"There has also been a shift because of community expectations of agriculture, from a strong focus on 'me and my farm/work' to 'me and the industry and what's my role in it?'."

"We are entering a much more collaborative leadership stage as opposed to a positional leader stage which is what ag is built on.

"Leadership is about others, not just about yourself or the title or position you hold.

"It's necessary to get out of your own way as a leader and support others to come on board, together much more can be achieved than alone.

"This does require a set of skills that are new to many."

Jo says we are also seeing a shift from more transactional to transformational leadership where leadership is more about influence and impact than merely ticking off the jobs that have been done.

CRDC Executive Director Dr Ian Taylor met with the group in Armidale, sharing the story of his leadership journey that has taken him from a passion for planes and plants as a child to his current position. He also discussed the importance of establishing values and maintaining a positive culture in the workplace.

"We continue to support Future Cotton Leaders because we see the how it helps our people on the journey.

"A successful industry needs people to get it there, who can lift others to also play their part.

"Leadership is not an exclusive club: it's a set of skills and mindset that holds aspirations for everyone."

For more

Jo Eady
jo.eady@bigpond.com
www.cottonaustralia.com.au/leadership-programs

Future Cotton Leaders: finding her passion

Back in 2006 and one year out from her PhD, Rose Roche was "really looking for how I could make a difference and the opportunity came along".

MELANIE JENSON

Rose Roche has been a constant fixture in cotton fields for most of her successful career. Rose says finding direction early, with help from courses such as Future Cotton Leaders was a pivotal point in her life and career.

The opportunity was to be a part of a new industry leadership program – the Australian Future Cotton Leaders. Fast forward 15 years and Rose is one of the industry's most well-known career scientists, now leading CSIRO's Resilient Farming Systems Impact Area. She credits the course and the expertise of Jo Eady as a defining moment in her life and career.

Rose is particularly well known among the cotton growing community, which is not by chance.

As part of the Future Cotton Leaders program, participants undertake a project. Rose's project was 'how do we get better dialogue between growers and researchers to define research priorities?' She worked on it with fellow participant and grower Phil Firth. She says creating connections with growers has been a major factor in her research success.

"It was career-changing for me," Rose told *Spotlight*.

"To have a chance to stop and reflect early career on your career and goals while networking with this diverse and lively group was pretty amazing.

"It made me consider what role I wanted to play: it was career changing for a lot of us, some people completely changed their vocations.

"I was the only scientist there and that network of people became friends – we did projects together and the diversity of the group gave me different perspectives: we are still friends today."

Rose said being exposed to this network in her early-career stage was the most valuable – having time to build relationships and then work together over the ensuing years.

"Often our networks are who you went to school or uni with, but this course puts you in a diverse group you may not otherwise come across," Rose said.

"And building networks is not just about the individual benefit – the industry benefits from building those networks.

"It's so immense how important that is – it is a role of this program that we need to champion."

Rose is testament to this. Over the years she has worked closely with growers on research, which is a passion the program cemented, and encouraged young scientists to sign up. Some of these are now shining lights, such as Katie Broughton and Nicole McDonald.

"Making these connections with growers from the course, Phil, Brendan Warnock, Greg Hutchinson, Meg Kummerow and consultants like Dallas King allowed me to follow my passion to make R&D relevant to the users – farmers.

"I've continued to stay in contact with these people and used what I learned to further contact with growers across the industry.

"I went on to sit on the Lower Namoi Cotton Growers Association for a number of years, which I wouldn't have had the confidence to do without the program.

"Being part of this group helped grow those researcher-grower relationships and provide a conduit to the research community.

"It has always been critical to me that what we create it is human-centred design – knowing the needs of growers and how the research fits."

The mentorship aspect of the program also figures heavily in Rose's trajectory.

"It was great, and I've been able to hopefully emulate that by encouraging young scientists to do Future Cotton Leaders.

"Jo Eady was just fantastic – I would do another course with her tomorrow if I could."

We're well thanks, but a little stressed

A recent CRDC study has found that cotton growers have relatively high wellbeing compared to the Australian average, but also higher levels of 'psychological distress'.

Social and wellbeing measures are a useful indicator of how people working in the cotton industry as well as cotton communities are going. Measuring wellbeing over time can provide important information about what is going well in a community and what indicators of personal and community wellbeing need support. CRDC has used the results from the Regional Wellbeing Survey run by the University of Canberra (UC) to further investigate the health of the cotton industry.

The report by UC researchers Jacki Schirmer and Melinda Mylek has found that overall, cotton growers report relatively high wellbeing compared to the Australian average. This is not unusual as farmers generally report higher overall wellbeing compared to the general Australian adult population.

While cotton growers also reported similar wellbeing to most other agricultural sectors, they did report significantly higher psychological distress compared to the general community as well as any other agricultural sector including beef, sheep, grain, horticulture and mixed farming. Drought followed by COVID saw significant changes in cotton's workforce. Cotton growers also experienced particularly challenging conditions during 2019 and 2020, with a drop in both cotton production as well as value, likely providing at least one explanation.

Mixed emotions

"While a person can experience positive wellbeing and growing levels of distress simultaneously, after a period of increased distress, overall wellbeing may decrease," Jacki said.

"This finding suggests that while cotton growers have relatively high wellbeing, some pressures are increasing distress levels – something which has potential to lead in the longer term to overall decline in wellbeing if experience of farm-related challenges continues."

Cotton growers felt that their community was doing well, reporting high community wellbeing and liveability. However, they are also significantly more likely to report that they would shift to another community if they could, and to report high levels of loneliness.

"This may be reflecting difficult farming and business conditions rather than community wellbeing, as they were generally positive about the wellbeing and liveability of their communities compared to other farming sectors," Jacki says.

"Experiencing difficult conditions may also result in feelings of isolation; cotton growers might not feel able to talk freely about their challenges when conditions for other farmers might be getting better.

"Cotton growers show resilience through their overall positive general health and wellbeing, and high levels of community wellbeing and liveability, however high levels of loneliness, psychological distress, and a desire to shift, possibly due to difficult business conditions for the cotton industry in recent years, is also evident.

"The cause of this needs to be further explored and should be monitored in future sustainability reporting of the cotton industry."

CRDC R&D Manager Rachel Holloway oversees this project and says in Australia and internationally there is a growing recognition that sustainable, responsible industries need to monitor and report on their social outcomes, as well as environmental and economic ones. As a result, the cotton industry is investing in health and wellbeing targets and ensuring these targets are aligned with national averages.

"Understanding wellbeing can tell us not only about individual health and quality of life, but also the productivity of workforces and the sustainability of communities, giving an insight into the resilience of farmers and regional communities to adapt to change," she said.

Setting targets for wellbeing

The Australian cotton industry has been working towards developing social and wellbeing indicators to include in their sustainability reporting since 2018. The first set of indicators were published in 2020 as part of CRDC's five-year sustainability performance reporting through the *Australian Cotton Sustainability Report.* This report informs targets for PLANET. PEOPLE. PADDOCK. which is the framework to achieve the Australian cotton industry's vision of being a global leader in sustainable cotton production. The framework recognises sustainability is integral to the industry's future and provides a path for the entire industry to stay in business. The health and wellbeing of cotton industry people is a major component of a healthy industry.

Social and wellbeing targets are being finalised by the Sustainability Working Group. As a part of this, online workshops in cotton regions will be hosted by researchers to build understanding of indicators and to ask participants (growers and community members) to provide input to prioritise the relevance and appropriateness of these indicators for the cotton industry.

For more

Rachel Holloway
rachel.hollway@crdc.com.au

Developing pathways for a skilled workforce, enhancing our scientific research capabilities and acquiring new talent: building the capacity of the cotton industry to resolve current and future issues.

CRDC turns focus to tertiary

CRDC is continuing to ensure we have the people to do the job, through a project with CSIRO's Trudy Staines, a long-time advocate of the industry in her roles in education and careers.

For the past decade supported initially by the Cotton Research Co-operative (CRC) and CSIRO and since 2015 with additional support from CRDC, Trudy has been promoting careers in cotton science to school and university students and graduates. Her new project, supported by CRDC, will move the focus on university graduates and attracting them to the cotton industry.

CRDC's R&D Manager Rachel Holloway says the cotton industry is experiencing significant change with rapid advances in technology, drought, climate change and adapting to COVID-19 combining to potentially transform how we farm and undertake research. Building adaptive capacity in the cotton industry is a key focus area of the strategic plans of CRDC and Cotton Australia to capture the pipeline of opportunities, CRDC and Cotton Australia coordinate to target university, VET (vocational employment training), primary and high school students. CSIRO offers scientific training for university students and postdoctoral researchers, and supports student tours of the Australian Cotton Research Institute (ACRI). CRDC also supports a cotton industry tour for PhD and post-doctoral scientists.

However despite the best efforts of the agricultural sector, recent reports say there is still a lack of understanding about agriculture and the cotton industry as a place to work.

The Primary Industry Education Foundation Australia (PIEFA) and Cotton Australia's *The Food, Fibre and Our Future Report 2020* surveyed more than 1000 secondary school students from across Australia, which included examining a willingness for the next generation to take up a career in agriculture.

Trudy says it showed while many students found the subject interesting, there was only limited follow through in undertaking studies in agriculture with only one in five students considering an industry related career. Influenced by schoolteachers, media and family/friends, students are seeking jobs and careers that offer good working conditions, a safe working environment and job security.

"This data supports our work to increase awareness and ensure careers in the cotton industry reflect modern agricultural occupations," Trudy said.

Trudy Staines (foreground) with Rachel Holloway with a group of researchers at the Auscott Narrabi gin.

"Education and communicating are key to demonstrating the range of jobs and careers within cotton production, educating teachers, students and the mums and dads of Australia about these industries and the role they play in driving Australia forward commercially, environmentally and socially."

The project brings a new way to measure and monitor the pathways of careers in the cotton industry and starts to understand workforce data trends. A framework will help to monitor the project performance and outcomes.

An example of this is from the recent CRDC postgraduate Farm to Fibre Tour, where students were asked to be part of an ongoing data collection and monitoring initiative. Using a unique coding identifer, the participants will be asked about their career pathways at regular intervals, allowing CRDC to assess the impact of this initiative.

Rachel Holloway says research shows young people are not choosing careers in agriculture because the roles are assumed to be boring, low paid and in rural communities.

"Young people are unaware of the diverse

career opportunities offered by the cotton industry," she said.

"The workforce challenge is how to best promote multiple entry pathways to students and encourage them to take up employment in a rural agricultural sector.

"Research has showed a downward trend of high school students studying agriculture over the past 30 years, which creates a significant impact to the supply of students entering agricultural work or studying agriculture at universities.

"From 1991 to 2012, there has been a downward trend of students studying tertiary levels. In 2013 a gradual increase was observed but this slow increase in demand is well below the need to satisfy the agricultural employment market.

"There is a need for strategies to support non-farming youth into agriculture as this type of diversity is needed for Australian agriculture, with skills that are transferrable, challenge the norm, increase the pool of people in agriculture and bring diversity to regional towns.

"We need to ensure future skillsets are available to us – data scientists, engineers, robotics, artificial intelligence, biotechnology, genetics and electronics.

"At the same time we need to secure our on-farm workforce and CRDC has several related projects investigated opportunities to build and retain capacity using formalised social science frameworks.

"Of particular relevance is the project led by Dr Nicole McDonald from the University of Southern Queensland which identified 'employability skills' in farm workers.

"The cotton industry recognises that people and our workforce are critical to improve productivity, profitability and competitiveness in the industry."

CRDC R&D Manager Rachel Holloway looking at Demi Sargent's pot trials and learning about synthetic biology on the recent postgraduate Farm to Fibre tour around Narrabri.

Come study with us

CRDC scholarship students contribute extremely valuable and often breakthrough research to the Australian cotton industry. Many supported by CRDC go on to find a career in cotton, which is one of the aims of providing this type of support to early career scientists.

In recent years alone, CRDC-supported PhD candidate Rhys Pirie cracked the conundrum on what do to with waste glass, re-purposing it into many products including fertiliser. Dr Katie Broughton determined the effects of climate change on cotton growing through her postdoctoral studies, while current scholar Demi Sargent is using traits found in native cotton species to improve drought tolerance of commercial cultivars. Dr Dean Brookes was a CRDC-supported PhD candidate studying green vegetable bug (GVB) ecology and attended the World Cotton Research Conference in Brazil to present his PhD research, with support from CRDC. And CRDC's R&D Manager Dr Merry Conaty was a CRDC-supported summer scholar, before going on to do her PhD in cotton, with support from CRDC.

CRDC offers support for students through Postgraduate Scholarships, Summer and Honours Scholarships and by supporting the CSIRO Summer Scholarship Program and the ABARES Science and Innovation Awards. At present, CRDC is supporting 15 postgraduates. The PhD top-up scholarship is valued at up to $10,000 per year for cotton-relevant scholars who are receiving a Research Training Program (or equivalent) scholarship. The postgraduate scholarship is offered to masters or PhD students to assist with the completion of a cotton industry-specific project. These projects may relate to any field of cotton-research related to CRDC's Strategic RD&E Plan.

The Summer and Honours Scholarship program provides students with an opportunity to work on a real project in a working environment as part of their professional development. The scholarships enable university students to conduct short research, extension or industry projects under the direct supervision of a researcher or extension officer from either the public or private sector.

All CRDC research partners, researchers or extension officers may apply for CRDC Summer and Honours Scholarship funds, and the scholarships are open to all university students of a high standard who are completing their senior years of an undergraduate degree or enrolled in an honours program.

To apply, contact the CRDC research administration team.

For more
research@crdc.com.au

Farm to Fibre tour gets top report card from students

CRDC recently hosted a behind-the-scenes industry tour for its postgraduate-supported students.

Organised by CRDC R&D Manager Rachel Holloway and Education and Careers Officer Trudy Staines of CSIRO, the feedback from the immersive tour has been very positive. The visit included a farm and gin visit, meeting with CRDC managers and industry heads, and time at the Australian Cotton Research Institute (ACRI) to meet other researchers and tour the facility.

Rachel said a survey of participants after the tour saw knowledge of research careers in cotton jump from 19 to 75 per cent. More than 80 per cent found the tour very helpful. Of particular interest to CRDC from a careers perspective was that the most common barrier to applying for a job was not knowing how to decide which work opportunity was best for their career.

"This response forms much of the reason we run this tour," Rachel said.

"It gives students a close up look at the industry, the people and how it works, which is something some students don't otherwise have the opportunity to do.

"By showcasing our industry to postgraduate students, we are aiming to keep them with us."

Zoe Mellick is conducting a sustainable value chain analysis for her PhD study, to identify what sustainable value means to the Australian cotton industry and to its value chain.
The outcome of this project will be recommendations for the Australian cotton industry on how to create sustainable value.

She said the tour broadened her network with industry members and even 'planted the seeds' for future research collaborations. It was the on-farm visit that Zoe found most beneficial.

"Visiting the Kahl's farm was a big highlight for my research project

Mikaela Tilse found the peer-to-peer interaction a highlight on the Farm to Fibre Tour supported by CRDC.

- particularly hearing about how they make decisions on-farm based on the resources they have available for the season, as well as how sustainability is practiced on farm through crop rotation," Zoe said.

"It was also great to hear that they got through the cotton season without a single insecticide spray and maintained great yields, which was due to their biodiversity management."

Zoe said she learned communication skills from experts around how to talk about the value of research, including how her project fits in the overall cotton system, and what research will be needed in the future.

The tour also provided an opportunity to meet other postgraduate students to share research and experiences and create networks.

"Undertaking the tour with fellow post-graduate students made the experience all the richer.

"Through listening to questions that other students had we got to learn information that we never would have thought to ask about."

Fellow postgraduate Mikaela Tilse agrees. Mikaela's CRDC-supported PhD research looks at how we can use data science to better understand variability in yield, fibre and grain quality across the cotton and grain industries.

"My tour highlight was connecting with other postgraduate students at all stages of their research journey," she said.

"I appreciated the opportunity to hear from people nearing the end of their projects, learn from their experiences, and hear about other areas of research from right across the industry."

Demi Sargent lives in the Narrabri region and runs her experiments at ACRI. The tour for her still held learning opportunities.

"A highlight of the cotton tour was visiting a family-owned-and-run cotton farm.

"I particularly enjoyed their open-mindedness and hearing from the farmers themselves about their respect for and support of cotton R&D.

"It really showed me how progressive the Australian cotton community is, and the people that our research should be aiming to support."

Honours student Callan said his master's project is using automated species recognition to detect powerful owl *(Ninox strenua)*.

"My work with CRDC and the Queensland University of Technology project involves identification of avian species in passive recordings in order to aid in the development of acoustic recognisers for cotton biodiversity reporting," Callan said.

"I thought the tour was incredibly interesting.

"I had no idea how much research was undertaken in the cotton growing process, and it was encouraging to see how open the growers were to adapting new technologies."

For more
Rachel Holloway
rachel.holloway@crdc.com.au

Growing an industry requires growing its leaders

When it comes to inspiring people to become leaders, the Australian cotton industry has keenly felt the impact of the Australian Rural Leadership Foundation (ARLF) and its flagship Rural Leadership Program.

ABOVE: Celebrating the graduation of ARLP alumni Chantal Corish and Rod Gordon (second and third from left) with Simon Corish, current ARLP participant Ruth Redfern and ARLF Chief Executive Matt Linnegar.

The ARLF was formed in 1992 with the specific aim to develop leaders for rural, regional and remote Australia. The idea came out of the then newly formed Rural Industries Research and Development Corporation (RIRDC, now AgriFutures Australia), which was looking at how to encourage the development of new rural industries and thriving communities – based on the premise that the success of a community or industry lies in the capacity and willingness of individuals to become leaders.

RIRDC's Board identified that a key difference between successful rural communities and those perceived as failing was not due to inherent natural resources or strategic position, but to an individual or group of individuals. These individuals were standing up and taking on leadership roles.

They concluded that leaders were required, not only in state and national political roles, but within local schools, on hospital boards, within community and sporting groups, and local industries. With that, the ARLF was formed as an organisation that could influence change across Australian rural industries as a whole, and rural communities in general.

Today, as Australia's longest-running and most in-depth experiential leadership program for rural Australia, the cotton industry has supported a participant in nearly every one of the 28 courses. Current supporters are CRDC, Cotton Australia and Auscott Limited (now Australian Food and Fibre).

Participants attend 50 days of experiential learning and mentoring across four sessions over a 15-month period, under the ARLF remit to nurture and advance rural Australia; to take an ethical approach; challenge assumptions; and seek to respectfully influence change for the greater good

of Australia. Graduates' impact has been deeply felt across the depth and breadth of Australia.

Many graduates from the cotton industry have gone on to lead it – former CRDC chair and Cotton Australia board director Mike Logan was a part of the first cohort in 1993-94, who later said "When I would look around the board table, it was full of graduates. From the cotton perspective, the ARLP has been a wonderful investment."

Mike was a cotton grower based at Narrabri and attended the course with fellow grower Jack Warnock. Jack has played an active role in the industry throughout his life.

Many alumni of the ARLF programs are well known for their contributions to the industry: current CRDC Executive Director Dr Ian Taylor, former ED Bruce Finney, Dave Anthony, Adam Kay, Bruce Pyke, Harvey Gaynor, Bernie George, Paul McVeigh, John Hamparsum, Philip Armytage, Michael Murray, Dr Sharon Downes, Barb Grey, Arthur Spellson and Allan Williams, currently CRDC's General Manager, R&D Investment.

More recently, the industry is seeing graduates of the Australian Future Cotton Leaders Program move into courses like ARLP, such as Fleur Anderson, Jamie Iker and Sean Boland who are all industry leaders in unique ways. The most recent graduates are Rod Gordon and Chantal Corish, both currently based near Goondiwindi in the Border Rivers region of Queensland. Ruth Redfern, CRDC's Communications Manager and *Spotlight* editor, is half-way through Course 27, and Australian Food and Fibre's Justin McMillan was recently named as the recipient of support to attend Course 28 over 2021-22.

Highly recommended

Justin says he applied for the course because it came highly recommended by some of the previous participants.

"I am at a point in my career where I thought an opportunity like this would help me experience a higher level of professional development by mixing with a wide range of very experienced people with very different backgrounds in agriculture," Justin said.

"...a key difference between successful rural communities and those perceived as failing was not due to inherent natural resources or strategic position but to an individual or group of individuals who were standing up and taking on leadership roles."

Justin McMillan is the newest cotton-industry supported participant of the ARLP.

Having grown up on the family farm at Nevertire in the Central West of NSW, Justin has worked in cotton now for 25 years and spent the first 16 years of working life around Warren on cotton and grain farms. Now based near Narrabri, his role with Australian Food and Fibre is as General Manager – South, overseeing the farms in the Namoi, Darling, Macquarie and Murrumbidgee valleys.

"I have lived in the country all my life and have dealt with the ups and downs of droughts and floods and everything in between," Justin said.

"What I hope to achieve out of this course is an insight into different leadership styles, to broaden my network across rural Australia, to get more comfortable dealing with situations that would normally make me very uncomfortable – like meeting a group of total strangers from around Australia that all seem to have vastly more experience than myself.

"I'd also like to gain an understanding of the struggles and wins other industries are having in rural Australia.

"I am pleased to be involved in this program as I will be able to mix with a wide range of people from throughout rural Australia with different experiences and views on life and leadership."

ARLF Chief Executive Matt Linnegar said: "We are thrilled to announce the ARLP Course 28 cohort, at a time when courageous and influential leadership has never been more important to support recovery from drought, bushfires, floods and COVID-19, and build resilience to face future opportunities and challenges in rural, regional and remote Australia."

For more
www.rural-leaders.org.au

ARLP alumni give it the gold star

Course 26 of the ARLP are the most recent graduates, with the cotton industry supporting Chantal Corish and Rod Gordon.

Rod Gordon and Chantal Corish have both expressed how grateful they are for the cotton industry's investment in its people.

Rod lives and works near Goondiwindi in Queensland as the Central Regional Manager at Hancock Farmland Services' Australia, overseeing Brookland Farms. He's also a graduate of the first Australian Future Cotton Leaders program in 2007.

"For me the network that we become a part of in the ARLP is a stand-out: getting to know people from across industries and in various roles," Rod said.

"As far as skill development, we come to understand that leadership takes many forms – the course gives you the confidence to be who you are and to bring your own leadership style to the table.

"The course has given me more balance and flexibility in my leadership and I've learned to 'play what's in front of you' and help others to work to a common goal.

"It's learning balance and to empower others to be the best they can be."

Rod says on a broad level, he'll use what he's learned to help the industry face its many challenges, and on a day-to-day basis in his management role, he is now better equipped to deal with people of all personality types and skill levels. He said the cotton industry's support for leadership programs such as ARLP should be applauded. Rod was supported by CRDC, Cotton Australia and Auscott Limited.

"I'm really proud of the cotton industry's investment in people and their capacity and would highly recommend anyone considering to apply: do it!

Rod says he's lucky to have worked in all sectors of the cotton industry, from agronomy to cotton classing to ginning and marketing. He is also a graduate of the first cohort of the Future Cotton Leaders course.

Chantal is a psychologist and cotton farmer who also lives near Goondiwindi where she runs a coaching business that focuses on the wellness of people in rural Australia.

"This is something I really wanted to achieve as the foremost leadership program for rural and regional Australia," she said.

Chantal saw the program as an opportunity to bridge knowledge gaps between farmer mental health and her profession.

"The program is designed to promote self-discipline, provide pertinent networking opportunities, and enables the 'shoulders to stand on' that give a broader perspective of the industries and government structures in which I am working," she said.

"I will remain forever grateful to my sponsors for the incredible privilege and opportunity to complete this course."

Chantal was supported by CRDC, Auscott Limited, Cotton Australia and Prime Super.

Current ARLP participant Ruth Redfern is nearing completion of the program, having completed three sessions focused on personal, regional and national leadership. Her final session, focused on international leadership, will take place in early 2021.

COMMENT: WITH CROP CONSULTANTS AUSTRALIA

Our role in stewardship

It is easy to get overwhelmed by the negative 'noise' that has plagued the cotton industry on some media platforms and political forums of late. Upon critical analysis by those who have a little more insight, it is evident that many of these claims are nothing more than baseless, short term 'click bait'. Nevertheless, they have been highly damaging to the industry and those of us who work in it.

At our recent seminar in Narrabri, Cotton Australia Executive Officer Adam Kay shared with attendees the strategic and proactive campaign that Cotton Australia is taking in combating this misinformation head on. He highlighted the importance of each of us engaging in the sharing of the positive stories of the cotton industry.

We all have a stewardship role to play in communicating the Australian cotton story and preserving the elements and inputs that are integral to its sustainable future. But in an era when it is easy to default to online debate, we need to remember that 'stewardship' can be exercised in many ways.

Beyond the social media melee, there is a long established and potentially more direct way in which we all – growers, researchers, and consultants alike, can play an active role in shaping the future direction of our industry.

The Transgenic Insecticide Management Strategy (TIMS) Committee was established by the then Australian Cotton Growers Research Association (later to join into Cotton Australia) in the mid-1990s. One of its main purposes was to assist in the development of the initial 'industry approved' Resistance Management Plan (RMP) for Bt Cotton in Australia. In 1998, a relatively new organisation in cotton – Cotton Consultants Australia (to become Crop Consultants Australia) was offered a voice on the TIMS Committee. Members of CCA of the time recall this as a pivotal moment in the organisation when consultants were recognised for their role in the future of cotton in Australia.

The thinking behind the involvement of the TIMS Committee in the RMP process was that a plan that was developed by industry should have a much higher potential for adoption by growers than one written and enforced by regulators. This theory was not unfounded, and today, the current TIMS committee and its technical panels, are comprised of growers, researchers, consultants and members from the grain and pulse industries. It continues to operate with the ongoing brief to develop and review resistance management strategies within the cotton industry.

One of their key purposes in doing so is to ensure that the 'traits and products are stewarded in a sustainable manner that protects the right to farm for cotton growers, protects the social licence of the cotton industry and ensures commercial longevity for these technologies'.

CCA currently holds four of the 18 seats on the TIMS committee, representing consultants in all of the major cotton growing valleys. The fact that these positions are tightly held for extended periods by members, is testimony to the importance that our representative place on the role.

CCA director and long-term TIMS member Ben Dawson believes that involvement in the committee gives representatives a direct voice.

"We have the opportunity to make change and to have a say on the issues that are relevant to us," Ben says.

Likewise, these representatives are the voice of industry. To fulfill this however, they require input from the rest of 'us' to better inform their discussions. In doing so, we ensure that industry retains considered and evidence-based participation in protecting social licence and the future of our industry.

Our own role in stewardship however extends further than that of the TIMS committee. As industry professionals, it is our responsibility to ensure that the RMP and the principles and practices that underpin it, are adhered to and that compliance is respected. Growers and consultants alike, we are all accountable for promoting the cotton industry as a leader in best practice. It only takes one poor operator to bring the work of many into disrepute. Those who would happily see the contraction of our industry will then have a very valid reason to make 'noise' and be heard.

If you would like to make contact with a member of the TIMS Committee or find out more about its processes, visit www.cottonaustralia.com.au/stewardship. Alternatively, contact the CCA office for the contact details of the representative in your area. The CCA office is open Tuesday and Wednesday from 8am to 5pm, phone 0429 925 459.

"... we ensure that industry retains considered and evidence-based participation in protecting social licence and the future of our industry."

For more
www.cropconsultants.com.au

How and where do you put your P?

As cotton yield potentials continue to rise, so does the rate of removal of phosphorus (P) from cotton fields.

Rates of removal vary substantially with crop P status, ranging from 1.3 to 2.3kg per bale – emphasising the importance of a P replacement strategy to balance crop removal. However, for any strategies to be effective, the P must be placed in parts of the soil profile where uptake by the roots is likely to occur.

This requires an understanding of how cotton responds to different P distribution through the soil profile, and how effectively cotton root systems respond to fertiliser P placement strategies. Recent studies of crop uptake are starting to build this information, according to University of Queensland (UQ) Professor Mike Bell.

CRDC has supported research individually as well as under the More Profit from Nitrogen Program's *Enhancing nutrient use in cotton* project, supported by the Australian Government's Rural R&D for Profit program.

Data was gathered from an Incitec Pivot dryland cotton long-term fertiliser trial site on the central Darling Downs where, over 40 years, varying rates of applied fertiliser P had resulted in a wide range of soil Colwell P concentrations. These ranged from 8 to 64mg P/kg in the zero to 10cm layer but only 4 to 8mg P/kg in the 10 to 30cm layer.

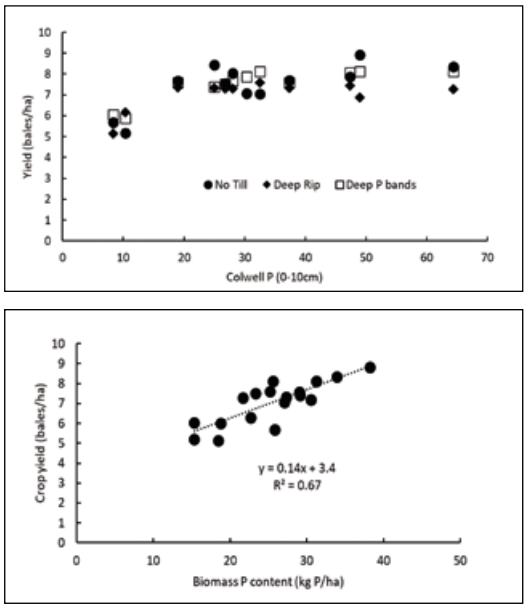


Figure 1. Relationship between (a) Colwell P in the 0-10cm soil layer or (b) P uptake in crop biomass and yield of a rainfed cotton crop at Colonsay on the central Darling Downs.

Subsections of each plot were either not tilled, were deep ripped to 20cm or were deep ripped with 20kg P/ha applied as MAP in bands 50cm apart. Cotton responded strongly (Figure 1a) to increasing amounts of P dispersed throughout the topsoil, with yields maximised once Colwell P exceeded 25mg P/kg. At low Colwell P concentrations, where yields were reduced, the crop was not able to respond to extra P applied in deep bands.

The soil test-yield relationship shown in Fig 1a suggests that the critical Colwell P concentration for this rainfed crop was much higher than the 6 mg P/kg found in studies of irrigated cotton near Narrabri.

However, even allowing for this higher critical soil test P concentration, biomass samples collected near cut-out showed a strong linear relationship between crop P content and cotton yield (Figure 1b). This suggests that the crop could have yielded more if it had been able to acquire more P, and that root access to P in the topsoil layer was probably restricted – either by topsoils drying out or a lack of surface root activity when the topsoil had been wet. This makes determination of the target soil P concentration for optimum yields challenging.

Limiting factors

The cotton root system response to P placement strategies, and to drying topsoils that limited crop P uptake were explored by UQ student Callum Bischof, using Sicot 746 BRF and Sicot 748 BRF. Varietal differences were negligible, but responses were consistent with the observations on the Darling Downs.

Cotton roots proliferated in a P-fertilised topsoil layer (Plate 1b), but not in response to a deep P band placed deeper in the soil profile (Plate 1d). Interestingly though, roots did show a small response to a shallow P band encountered immediately after germination (starter P), with increases in root growth in a zone around the shallow band (red dashed circle in Plate 1c). This differential response to P bands encountered at different growth stages was unexpected, though it suggests that starter P applications may provide useful responses during early growth.

Callum used a lysimeter study to explore the impact of water stress and the frequency of wetting and drying on P acquired from a fertilised topsoil layer, with plants grown until mid-boll filling. The top 15cm soil layer received either no P or 40mg P/

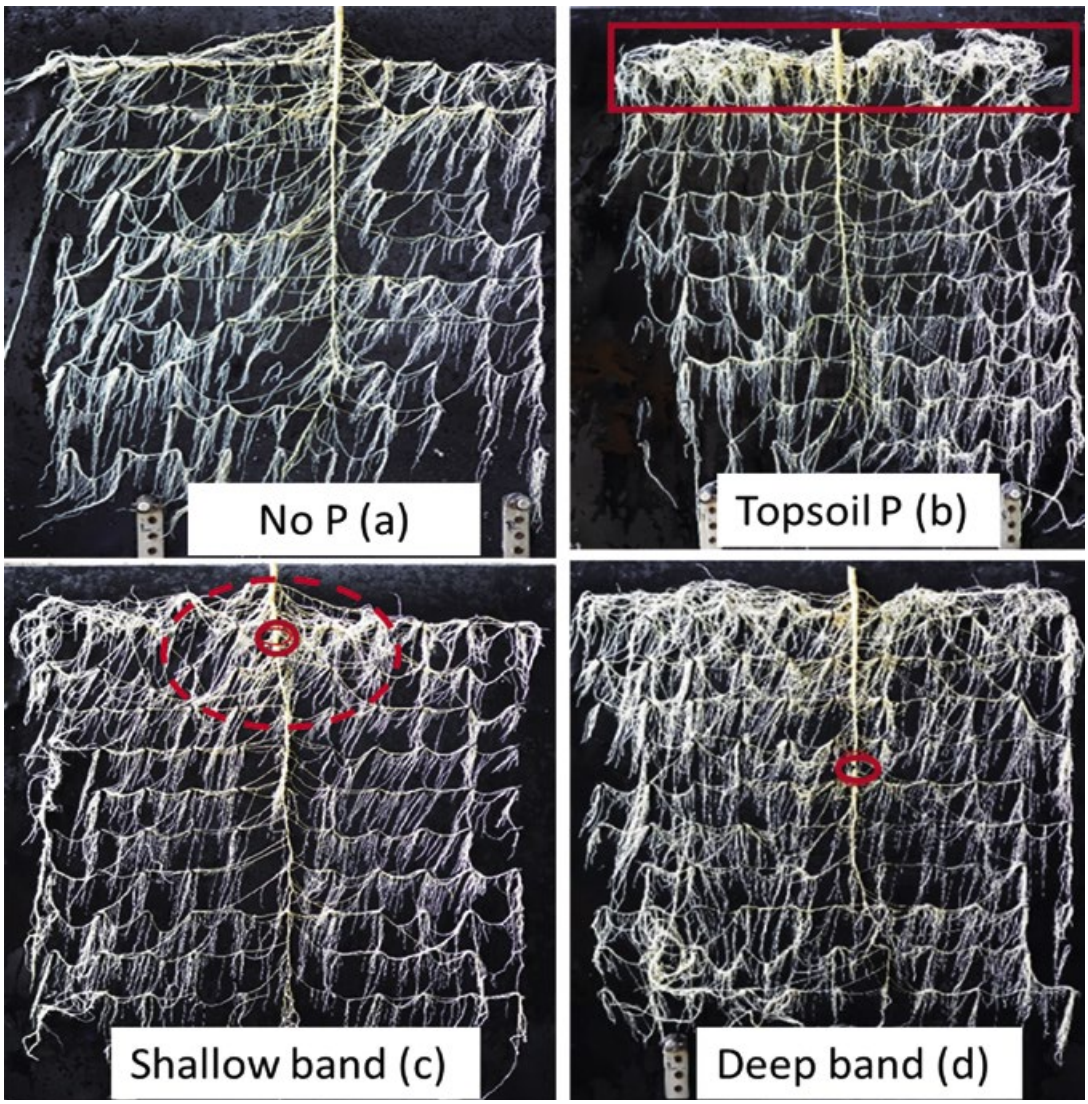


Plate 1. Root morphology of Sicot 748BRF supplied with (a) no P, (b) P dispersed through the top 10cm layer, (c) P applied in a shallow band immediately below the plant line, and (d) P applied in a band below the plant line at 25cm depth. Enriched zones are indicated by solid red circles or rectangles.

kg while the rest of the soil was low in P (6 mg P/kg). The large soil columns (60kg air dried soil) were irrigated from the top to maintain total soil water content at 80 to 85 per cent of field capacity, or rewet each time 20 per cent, 40 per cent and 60 per cent of the plant available water in the whole column was extracted.

Growth responses to water and P were significant but only effects of water regime were recorded in tissue P concentration (Figure 2a), with increased growth in response to more frequent irrigation causing decreased tissue P concentrations. This suggested that P uptake from a fertilised topsoil layer was not able to meet peak plant P demand, even when consistently moist, and this was supported by the linear relationship between plant growth and P uptake (Fig. 2b).

These studies highlight the limitations of existing fertiliser applications in satisfying the P demand of high yielding cotton crops. The cotton industry's challenge is to maintain high yields from irrigated fields as soil P reserves in deeper layers are depleted from prolonged cropping.

Further studies on the effectiveness of different P fertiliser placement strategies and the interactions between cotton root systems, water and P need to be conducted to develop practical solutions for producers.

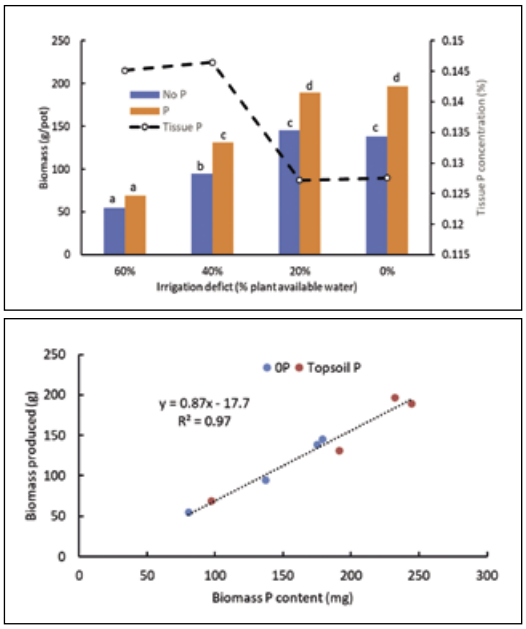


Figure 2. (a) Plant growth and tissue P concentration in response to P fertiliser applied in the top 15cm layer and different irrigation deficit irrigation treatments, and (b) the relationship between plant P uptake and biomass growth.

For more
Prof Mike Bell
m.bell4@uq.edu.au

Collaborating to ensure exotic pest diagnostic capacity

While dealing with bacterial blight is a thing of the past for Australian cotton growers due to resistant cultivars, the threat of an incursion from exotic, more harmful strains remains.

CRDC is supporting research to prepare the Australian industry for a possible incursion, as part of a cross industry partnership. A key focus is on the *Xanthomonas citri subsp. Malvacearum*, the bacteria which causes bacterial blight in cotton and diseases such as citrus canker in fruit trees. There are several described races and distribution varies between countries.

Bacterial blight of cotton was first reported in the US in Alabama in 1891 and is now widely distributed. Although strains of bacterial blight are already present in Australia, they are no longer a management problem due to the breeding of resistant traits into varieties here.

However concern remains over the possibility of incursions of hypervirulent races which could cause large yield losses if established in Australia. The term hypervirulent is used when a variant strain of a pathogen emerges that is more aggressive, causing a more severe infection and the rate of infection could be greater. Research aims to create preparedness by updating diagnostic protocol and developing rapid diagnostic tests.

In 2011, NSW DPI Cotton Pathologist Dr Karen Kirkby travelled to Texas to gain first-hand experience with bacterial blight to develop an Australian National Diagnostic Protocol for hypervirulent strains of *Xanthomonas*.

More recently, in 2016-17 US researchers found a *Pseudomonas species* that make some resistant cultivars susceptible to bacterial blight when there is dual infection. Typical symptoms of dual infection include a characteristic

Symptoms of bacterial blight start as small water-soaked lesions on the leaves. As the disease progresses the lesions turn black and papery with premature defoliation of the leaf occurring. If these symptoms are detected contact the Emergency Plant Pest hotline on 1800 084 881.

yellow halo surrounding the bacterial blight infected areas. Karen's ongoing engagement with her US counterparts has been integral in ensuring there is capacity to respond to an incursion and has highlighted the importance of ensuring diagnostics continue to be updated.

Boosting Australia's diagnostics capacity

It is critical as part of industry preparedness that there is the capacity to quickly identify a new threat. New bacterial diagnostic capacity will ensure that an incursion response can occur quickly and is built on sound science.

NSW DPI is partnering with New Zealand's Plant & Food Research as part of the Australian Government Department of Agriculture, Water and Environment's Rural R&D for Profit Program *Boosting Diagnostic Capacity for Plant Production Industries*, of which CRDC is a partner, with Grains Research and Development Corporation, Hort Innovation, Wine Australia, Sugar Research Australia and Forest & Wood Products Australia. The project began in December 2019 and concludes in 2023.

NSW DPI Senior Research Scientist, Dr Toni Chapman said this project aims to change the way bacterial pathogens are diagnosed and identified; how we develop diagnostic assays; and the development of National Diagnostic Protocols through the inclusion of new technologies for faster turnaround times.

The researchers will use genome sequences to develop diagnostic assays for the target pathogen *X. citri subsp. malvacearum*; using these new diagnostics to update the National Diagnostic Protocol for bacterial blight of cotton; and update the identities of the Australian reference collection of Xanthomonads.

"The benefit of this project is that *Xanthomonas* will be used as the model organism as we have readily available genome sequences," Toni said.

"All the methodologies developed and knowledge gained can be translated to other phytobacteria including, *Pseudomonas, Xylella, Agrobacterium* and *Dickeya.*"

CRDC R&D Manager Susan Maas says if a blight-like pathogen is detected in Australian cotton, it's imperative they can quickly determine what strain it is.

"This is all about creating better preparedness, to ensure we can quicky determine if a new strain is present and where it is," Susan said.

"It's important in an incursion that there are good diagnostics to inform decisions, especially any attempt to eradicate."

CRDC is working with fellow plant RDCs to keep those industries safe, through the Rural R&D for Profit project as well as the Plant Biosecurity Research Initiative, to improve biosecurity preparedness of both shared and unique threats from exotic incursions of pests. This work is highly relevant across multiple industries for other key exotic threats for example as citrus canker *Xanthomonas citri subsp. Citri.*

For more

Dr Toni Chapman
toni.chapman@dpi.nsw.gov.au

How will climate impact disease?

A warmer climate would not only suit cotton better, but one of its foes, Verticillium wilt.

As part of NSW DPI's Climate Change Vulnerability Assessment, researchers have assessed the impact of future climate on *Verticillium dahliae* and cotton production across NSW.

The Vulnerability Assessment is a project under NSW DPI's Climate Change Research Strategy. This large multi-industry project is looking at 42 commodities and related biosecurity risks to agriculture, forestry and fisheries in NSW. Cotton and *Verticillium dahliae* are being studied as part of this project.

The assessment draws on expertise from across the cotton industry to develop models of how climate affects cotton growth, cotton quality, and Verticillium. These models were then combined with future climate projections to look at how suitable our climate might be for cotton and Verticillium in the future.

Temperature was the first aspect of climate change considered. Initial results suggest that warmer temperatures will favour both cotton and Verticillium wilt caused by *Verticillium dahliae*. The trend is for southern districts of NSW to become more suitable to grow cotton when only temperature is considered.

The trend is not so clear cut for Verticillium wilt as there are two pathotypes: defoliating (D) and non-defoliating (ND), which are suited to different regions across NSW.

Warmer temperatures in the north of the state are more suitable for the defoliating pathotype while cooler temperatures in the south favour the non-defoliating pathotype. There will be little change in suitability for either pathotype in the cooler winter months compared to present day conditions.

The work considers not only the impact climate impact on yield, but also how cotton quality may be affected.

Early results show that higher temperatures are likely to result in a general increase in cotton's micronaire value. This may improve the quality of cotton in the southern cotton growing areas where micronaire can be low. However, in the north, quality may suffer as the micronaire is currently close to the upper limit of the highest quality grade.

Shifts in crop water demand and supply in the future may overrule changes in suitability due to changes in temperature. The researchers' next step is to use the cotton model to estimate water demand in the future. Future water demand will be compared with estimates of future water supply like that provided by long-term NSW Regional Water Strategies.

The final stage of the project is to consider climate change adaptation options. Researchers will look at options to improve cotton yield and quality and decrease risks of Verticillium, based on where there are opportunities shown in the impact assessments. This will provide an important pathway for increasing the resilience of cotton to future climate change, as well as highlighting where opportunities for increased production might lie.

For more

Michelle Miller
michelle.miller@dpi.nsw.gov.au
www.dpi.nsw.gov.au/climate

Research continues into new wilt

Reoccurring wilt is a newly described disease of cotton in Australia and has now been detected in Emerald, Theodore, St George, and the Border Rivers, Namoi, and Gwydir valleys. The disease has not been detected on the Darling Downs, Bourke, Macquarie, or Murrumbidgee valleys.

The incidence of the disease and pattern of plant death across cotton-growing regions was recorded during the 2020-21 disease surveys. Pathologist Dr Linda Smith leads QLD DAF's efforts in researching the pathogen causing reoccurring wilt and leads the Queensland disease surveys. NSW surveys are conducted by NSW DPI and led by pathologist Dr Duy Le.

"The greatest incidence has been seen in Central Queensland and we saw it for the first time in Emerald and St George in the 2020-21 season." Linda said.

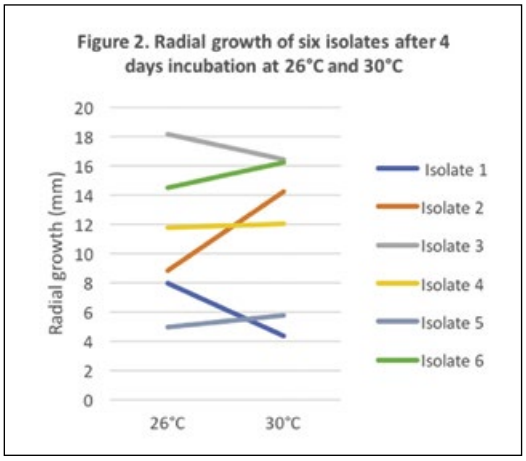
"It is difficult to say whether detection in new fields is due to the pathogen spreading from other fields or just being detected now that people are aware of it.

"However, there has been an increase in the size of the patches of diseased plants this season in some of the fields that have been monitored over several seasons, as well as spread within fields.

"Pathogens of other crops that belong in the same family as the reoccurring wilt pathogen are dispersed via aerial spores but it is not known at this time if this is a mechanism of spread for the cotton pathogen."

Confirmation of reoccurring wilt

If cotton is observed displaying symptoms of reoccurring wilt, please collect samples for testing by your state pathologist to confirm the pathogen.
It is also important for us to know where the disease is, so that we can continue to build our knowledge of the distribution, as well as the severity of the disease and collect information on the conditions associated with disease development. This information will assist to understand how to manage this disease.



The disease surveys found the following regional results:

Theodore

Detected in four of the eight fields surveyed, plus two fields that were not part of the disease survey. In two fields, the incidence was low at 0.33 per cent with diseased plants occurring singly. A third field had scattered single plants with an incidence of 2.3 per cent. A fourth field had patches of dead plants, with the largest patch approximately 10m x 20m. One field outside of the disease survey, which had reoccurring wilt confirmed the previous season, had dead patches of plants that had increased in size compared to the previous season. A second field outside of the surveys had a significant plant death in small patches throughout the field.

Emerald

Confirmed in one field outside of disease surveys. Dead plants were scattered throughout the field, mostly in pairs with a tipped-out plant that had died earlier in the season, next to a more mature dead plant.

St George

Detected in two fields, and on in a field at a third farm not included in the surveys. The incidence was low, observed in a small number of single plants among healthy plants.

Border Rivers

In three fields with an incidence of diseased plants from 0.5 to four per cent, occurring as single plants.

Namoi

Often occurred in small patches and was detected in three fields from two properties with an incidence of less than three per cent although up to six dead plants in a row were recorded. Of the two properties, one was newly detected and the other a targeted surveillance field due to its known history of reoccurring wilt.

Figure 1. Symptoms associated with reoccurring wilt (clockwise from top left) are sudden wilting with leaves and petioles having a bronze appearance; single dead plant with leaves attached among healthy plants; in cross-section stem has a wedge-shaped appearance which may be reddish grey in colour; blackening of the stem; (bottom left to right) reddish streaking of the vascular tissue can be seen when the bark is peeled away; root decay and wedge-shaped discolouration in tap root; small patch of dead plants.

Gwydir

In three fields from one new property, with a disease incidence of less than two per cent. Of the affected fields, dead plants occurred singly or in small patches.

Testing favourable environmental conditions

Linda and the team at QLD DAF are working to determine environmental conditions favourable to the pathogen, to better understand disease development. They've run glasshouse trials to observe symptom development under controlled environmental conditions. Linda said the plants remained healthy until water stress was imposed, resulting in sudden wilting and death.

"These results suggest that pathogenicity to cotton is triggered when plants are under stress," Linda says.

In a second experiment, the growth of the pathogen on artificial growth media at 26°C and 30°C was determined for six representative isolates (Figure 2). Temperature studies showed there is quite a variation in growth rate between the six isolates. Isolates also differed in preferred temperature for growth. Two of the isolates grew better at the lower temperature, one isolate grew at the same rate for both temperatures, and two isolates preferred a high temperature of 30°C.

"A second experiment is broadening the range of temperatures and increasing the number of representative isolates tested to include those collected this growing season," Linda said.

"Understanding the isolates' growth rates in different regions helps us identify the environmental conditions that will favour the pathogen in those locations."

For more

Dr Linda Smith – Queensland
linda.smith@daf.qld.gov.au
Dr Duy Le – NSW
duy.le@dpi.nsw.gov.au

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