Spotlight
ON COTTON R&D

AUTUMN 2022

Growers embracing future leadership

Cultivating community trust

Keeping carbon on farm

CRDC

Dr Ian Taylor

In the Spotlight

In this edition of *Spotlight*, high on the agenda is the continuing theme of sustainability and environmental responsibility. Recent events in the carbon trading market have growers contemplating their carbon status and what they should potentially do with any credits. In this edition, we bring you the key things to consider before embarking on soil carbon farming.

In addition, to help growers continue to improve their carbon footprint, we've included salient research from leading scientists on how and why nitrogen fertiliser must be better managed for the industry to meet its commitments to sustainability.

Not only has trial work been undertaken to ascertain exactly the N requirements of cotton crops, and how and when they use it, but economic analyses of current versus best practice paints a clear picture: we have all the knowledge – we now need action.

CRDC is committed to providing growers with this knowledge, through our targeted R&D and the CottonInfo extension program, to prompt action through decisions around soil health and nutrition. The More Profit from Nitrogen (MPfN) project was a multi-million dollar, five-year investment that has created an in-depth current bank of knowledge, and we've included some further articles this edition discussing findings. I urge all growers and consultants to visit the MPfN webpage on the CRDC website to access the trial results and economic analyses.

Ensuring a sustainable workforce is also top of mind for growers right now: right across agriculture, attracting the right people for the job is proving problematic, with the pandemic highlighting the issue even further. CRDC continues to invest in programs about people in order to build our industry's capacity. We're profiling some of our Australian Future Cotton Leader Program participants in this edition, along with the cotton-supported CSIRO summer scholars.

It's great to see such diverse groups in both programs, with such enthusiasm about participating in our industry on different levels.

Ensuring workforce health, safety and wellbeing is also paramount, and we're supported a PhD to ensure we focusing on giving on-farm workers the best and safest experience. Former cotton-supported Australian Rural Leadership Program participant, cotton grower and psychologist Chantal Corish is the PhD student on this project, bringing together three of CRDC's people-focused investment areas: leadership, WH&S, and wellbeing.

Also in this issue, we share the results of a fantastic new partnership with the University of Sydney, which has extended our capacity in dryland cotton research. It's a new model of R&D investment for CRDC and has the potential to become a long-term co-investment.

We've also built new partnerships with the Australian Research Council and University of Queensland's new Research Hub for Sustainable Crop Protection, to further investigate the use of BioClay to manage Verticillium wilt. BioClay is a non-toxic, biodegradable product and a game changer for plant industries with its ground-breaking technology. We are watching the development of this product very closely, as may also have applications for other pests.

I've heard it said that we should always have something to look forward to. This year we have two – there's a feeling of buoyancy in the industry for this season and the next, and we will have the opportunity to regroup as an industry at the Australian Cotton Conference. We are looking forward to supporting this world-class event and catching up with you all. Until then, we wish you a safe and prosperous harvest.

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.

Autumn 2022

FEATURES

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
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Our mission: To invest in RD&E for the world-leading Australian cotton industry.

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ON THE COVER: Jenna Bell is a third-generation farmer based at Whitton in the Riverina (Wiradjuri country) with her husband Andrew and their children. Jenna is also a 2022 Australian Future Cotton Leadership Program participant.

Want to see more of Spotlight?

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

COTTON NEWS

Closing speakers are always a highlight of the event – who could forget 2018 and the lads from the Betoota Advocate?

Get ready, it's on again!

IT'S going to feel like Christmas in August when the Australian Cotton Conference returns.

After a couple of false starts in previous years due to COVID-19, the committee has made the call and set the date – August 16 to 18 at its traditional venue, the Gold Coast Convention and Exhibition Centre (Bundjalung country). Needless to say there is already a buzz in the industry, as people have missed catching up with everyone on everything at this most anticipated event on the ag calendar.

The Conference is run by Cotton Australia and the Australian Cotton Shippers Association (ACSA), with CRDC and Cotton Seed Distributors the Foundation Sponsors. The Conference team is led by Chair Hamish McIntyre of Cotton Australia and Vice Chair Roger Tomkins of ACSA with the support of a seasoned team, and a volunteer committee of people from across all sectors of the industry: growers to shippers, marketers to researchers including CRDC's Ruth Redfern.

The Conference theme "Here for Good" is a nod to the industry's resilience over the last few years, as well as an opportunity to explore the positive contributions the industry is making in sustainability, research, innovation, supply chains and to our cotton communities.

Registrations are now open for delegates, exhibitors and sponsors, with more information on the website.

CRDC has been a Foundation Sponsor of Conference from the very start. CRDC Executive Director Dr Ian Taylor says while the program of speakers and special events is being developed, attendees are assured of another conference packed with the latest research and development and practical advice for farmers.

"People are really looking forward to the networking opportunities, and feedback from committee members is that some attendees have also really missed the conference as a source of the latest research and product development," Ian said.

"Delegates love the opportunity to not only hear from, but also speak with researchers and discuss their own on-farm issues.

"It is always such a packed card, the biggest problem is usually deciding which sessions to attend.

"The industry is continuing its long-standing commitment to sustainability through the PLANET. PEOPLE. PADDOCK. Sustainability Framework," Ian said, "and the conference will feature a lot of the supporting research for our industry's plan for the future."

According to Cotton Australia CEO Adam Kay, alongside access to cutting edge research and the latest developments, delegates can also look forward to sessions covering farm management, leadership, traceability and the marketing of our product to the world.

"With the Conference attracting such a large diversity of delegates from across our supply chain, we need to tailor and stream sessions across a broad range of interesting topics and speakers...there's something for everyone," Adam said.

"It'll be four years between Conferences for our industry due to disruptions from the pandemic, and so we're expecting a huge turnout and an incredible event that re-unites our people and sets our direction for the future," he said.

For more

www.australiancottonconference.com.au

Australian scientists transforming crop protection tech

A new Australian Research Council (ARC) research hub – the Research Hub for Sustainable Crop Production – was launched in November 2021 to address challenges of fungicide resistance, chemical residues, off-target effects and environmental harm.

It is being led by the University of Queensland (UQ), in collaboration with 15 partners, including CRDC and fellow research and development corporations (RDCs) GRDC, Wine Australia and Hort Innovation.

The Hub research team are taking on the global challenge of transforming crop protection technology by developing and commercialising the innovative biological alternative to chemical fungicide: BioClay.

BioClay is a non-GM, non-toxic fungicide for specific fungal diseases of crops, including Verticillium wilt in cotton. It's a biodegradable spray solution of clay particles that stimulates the plant's immune system to fight disease. It uses gene silencing technology that is precise and specific in the way it helps plants defend against pathogens. It works by binding pathogen or pest specific dsRNA, which is slowly released after being applied to the plant, to fight pests with longer protection periods. dsRNA is a well understood, highly specific and targeted way to help plants protect themselves. The benign clay particles on the leaf surface degrade in the presence of natural carbon dioxide and moisture, leaving no residue.

This is not the cotton industry's first involvement with BioClay: CRDC has been involved in earlier crop-specific trials with

CRDC R&D Manager Susan Maas spoke at the launch of the new Research Hub for Sustainable Crop Production.

Hort Innovation and the research team, led by UQ's Professor Neena Mitter, who is the Research Hub's founding Director.

Through the new Hub, UQ Professor Linda Aitken and QLD DAF's Dr Linda Smith will focus on *Verticillium dahliae*, which causes Verticillium wilt, one of the most damaging diseases of cotton worldwide. On cotton, strains of *V. dahliae* have been classified into two pathotypes: defoliating strains, which are highly virulent and can completely defoliate the plant, and non-defoliating strains, which are mildly virulent and cause wilt and partial or no defoliation.

Verticillium wilt is a high priority issue for the Australian cotton industry. Last year almost a quarter of cotton consultants surveyed reported Verticillium impact greater than $50/ha.

CRDC R&D manager, Susan Maas says this project provides an exciting opportunity for the industry to get a deeper understanding about this pathogen, while also working towards a solution.

"For CRDC this project epitomises our ambition in delivering cutting edge innovation, building research capacity and developing sustainable solutions for key industry challenges," she said.

Engaging some of Australia's leading researchers, the Hub will also be training a future workforce, supporting collaborative research between ag industries and the Australian higher education sector. Researchers will collaborate with industries to translate research into breakthrough products, new businesses and ideas to grow the economy and strengthen Australian research.

"Collaboration is a real strength of this project," Susan said.

"The highly collaborative multidisciplinary nature of the hub is allowing us to learn with other industries and connect with research expertise from all over Australia.

"Importantly the hub remains focussed on delivering solutions for industry and Nufarm is the commercial partner.

"BioClay could transform crop protection and we are pleased to partner to bring this innovation to cotton."

For more
www.crophub.com.au

Warwick puts CottonInfo on world stage

COTTONINFO Program Manager Warwick Waters has received an international award for excellence in extension services.

Warwick was announced as the recipient at the Australasia-Pacific Extension Network's (APEN) Conference in February.

The APEN Awards acknowledge leadership in a major extension program or initiative and the use or development of extension principles in the work.

"This award is a great reflection on Warwick's enthusiasm and commitment to extension in the cotton industry" CRDC Executive Director Dr Ian Taylor said.

Warwick said the award was a real surprise and honour.

"It is a reflection of the cotton industry's commitment to a long-term, well-resourced extension program that has enabled us to learn and improve over time," Warwick said.

"CottonInfo has a very balanced approach, with permanent regional extension officers , *my*BMP capturing best practice, technical leads who network with researchers, our diverse communications program, and everincreasing resources like manuals, YouTube clips and podcasts."

The award identified the way extension is being integrated with cotton research projects earlier, with the CottonInfo team working to support these projects and develop adoption pathways to improve their impact.

"Testament to its success and Warwick's leadership, CottonInfo is now informing a new cross-RDC project looking to improve the integration of adoption into research projects," Ian said.

What's all the fuss about trust?

How much does the community really trust Australian agriculture, and what would inspire greater trust in our rural industries?

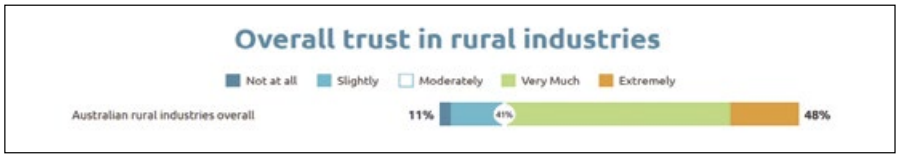
To answer these questions, CRDC is collaborating on the Community Trust in Rural Industries research program – a partnership involving CRDC and 10 of its fellow rural research and development corporations, the National Farmers' Federation and NSW DPI, to enable rural industries to proactively address community trust. The program is led by AgriFutures Australia, and its aim is to develop an aligned approach to long-term engagement with the community over the course of three years.

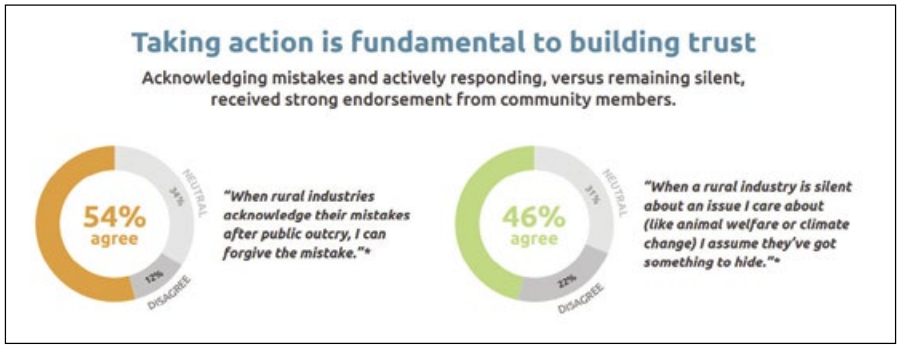
Two years of research data has been collected and analysed by lead researcher Dr Kieren Moffat, the founder and CEO of Voconiq, a company that has its foundations in CSIRO.

Dr Moffat and his team have found that trust in, and acceptance of, rural industries is strong and increasing, with the majority of Australian's seeing farmers as responsible stewards of the land. This trust brings with it great responsibility – the community expects farmers not to compromise environmental responsibility for economic sustainability.

The research shows that trust in rural industries is dependent on four key drivers: environmental responsibility, responsiveness to community concerns, the importance of products produced by rural industries, and distributional fairness (meaning that the benefits of rural industries are shared fairly especially with regional communities).

"Building trust isn't just giving consumers more science, more research or more information... research shows it's about demonstrating that you share their values when it comes to topics they care about most, like environmental stewardship," Dr Moffat said.





According to Dr Moffat, taking action based on community concerns is fundamental to building trust with Australians.

"Acknowledging when things go wrong and actively responding, rather than remaining silent on challenging issues, received strong endorsement from community members. Industry responsiveness via listening and responding to community concerns is a strong driver of trust in the research," said Dr Moffat.

CRDC's Executive Director Dr Ian Taylor said the research shows that the pathway to building and maintaining community trust is to be responsive to community attitudes, particularly around environmental sustainability and resource use.

"This is particularly relevant to the cotton industry right now, as we begin our fourth independent environment assessment and continue finalising our sustainability targets under the PLANET. PEOPLE. PADDOCK. Sustainability Framework," he said.

"These initiatives are clear demonstrations of 'responsiveness through action' and of providing proactive, transparent, long-term engagement on emerging issues and concerns. The setting of our sustainability targets, and our efforts of continuous improvement to reach them, are a clear indicator that we as an industry are taking our environmental responsibility seriously."

As the community trust project enters its third year, some of the partner industries are undertaking industry-specific studies – including cotton through a CRDC and Cotton Australia partnership. This cotton focal study is currently underway, with the findings to be reported in the next edition of *Spotlight.*

For more
www.agrifutures.com.au/national-rural-issues/community-trust/

Dryland cotton research finds a home

A new R&D partnership last season generated an extra $280,000 for dryland cotton research.

In a 2020 partnership with the University of Sydney, CRDC provided $75,000 toward growing 65 hectares of dryland cotton at two of the university's research farms. The crops were used to support dryland cotton research and when harvested, the initial investment and surplus returned to CRDC, to be reinvested with the university for further dryland cotton research.

The cotton was grown at the University's 'L'lara' (Narrabri, Kamilaroi country) and 'Nowley' (Spring Ridge, Kamilaroi country) farms, with a great first season success, averaging between five and six bales per hectare – and a total return of approximately $432,000. This enabled CRDC to reinvest an additional $280,000 in dryland farming research with the University of Sydney, and continue the $75,000 support at the farms for crops again this season.

The returns from the crop grown at 'L'lara' will be reinvested to support a new PhD project investigating the radiation use efficiency (RUE) of cotton and how this may be improved to increase yield in dryland cotton varieties.

The returns from 'Nowley' will support a new PhD project investigating the carbon accounts of dryland cotton production. It will measure and monitor soil carbon concentrations, soil water dynamics and dryland cotton crop yields to assess the effects of various management strategies.

CRDC Executive Director Dr Ian Taylor initially approached the University of Sydney to propose the partnership, with the aim of increasing investment in dryland cotton research and creating opportunities to expand the potential of dryland cotton.

"Being dictated to by the weather has meant setting up dryland cotton research in the field has always been tricky, and

commercial dryland trials generally require more land than irrigated trials due to the planting configurations used," Ian said.

"We have worked with growers in the past to run commercial trials, but generally it's a one in four or five-year rotation crop for them – so the opportunities for research can be scarce, particularly during drought years. In addition, current research facilities just don't have the area to run large scale experiments."

Organising continuous access to sites dedicated to dryland cotton research is difficult – especially at a commercial scale, but this partnership with the University of Sydney has resolved this issue.

"When we first considered this business model for 'participatory research', we were in drought. As dryland is an important component of the cotton system, we focussed on how we could provide greater investment in dryland cotton research," Ian said.

CRDC discussed the idea with the University of Sydney's Dean of Science Professor Iain Young and Sydney Institute of Agriculture Director, Professor Alex McBratney, who were very supportive of the idea and agreed to trial the model for one year. They agreed that if the trial was successful, there would be support to continue the new approach.

"To have sites dedicated to dryland cotton research is critical, so this is really positive news for the cotton industry, and to be partnering with one of the best research institutions in the country, this is a huge bonus for dryland growers," Ian said.

"Furthermore, the return on our investment in growing costs means we can fund more research.

"Fortuitously, as we were planning and setting up the trials (in 2019-20) the drought began to break – and were able to capitalise on a good first season and create an additional $280,000 for dryland research.

"The partnership allows us to better support dryland research by having dedicated sites and investing specifically in projects that increase dryland capacity and capability.

"Our aim is to continue to build expertise in dryland cotton growing and research."

It's exciting times for R&D in regional areas, with Dean Iain Young saying the university is expanding its research capacity at Narrabri.

"This partnership with CRDC and the imminent completion of a new building with the Wheat Research Foundation at our Narrabri Research Station has given the university the confidence to plan for the employment of more staff," Iain said.

"We plan to have four new early-career research staff in Narrabri working in areas such as crop physiology, weed science, native grains and digital regenerative farming."

University of Sydney soil scientist and farms director Associate Professor Stephen Cattle says the new research projects are timely.

"As limiting greenhouse gas emissions is now an urgent political and environmental challenge across the globe, estimating the carbon account of dryland cotton production and developing techniques to make that crop more carbon positive, seems a prudent use of the research funding drawn from last season's crop," he said.

"This crop investment strategy is a game-changer for the CRDC and university cotton research programs."

For more
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One phase closer to a digital strategy

A cross-sectoral group of growers, merchants and researchers have been meeting to develop a digital strategy for the Australian cotton industry – to set us up for a digital future and enable greater cooperation and use of industry data to create value across the supply chain.

The digital strategy will be tailored to give the Australian cotton industry a means to benefit from digital agriculture. A key focus of the strategy will be providing clarity and trust in the critical issues of:

- Who owns the data?
- Who can access the data?
- How are the benefits from data sharing shared?

Addressing these will help stimulate an innovation environment that facilitates the development and adoption of technology. At the farm level, this involves better collection, use and sharing of data to decrease inputs and increase yields and improve sustainability metrics. Post-farm gate, integration of data is a key aim, so that the industry can continue to meet market expectations.

"Realising the full value of digital agriculture ideally requires access to the large amounts of data produced and held across the supply-chain. As a result there are two specific requirements that must be addressed," CRDC R&D Manager Dr Meredith Conaty says.

"We need data governance arrangements that provide clarity on data ownership, control and access, and facilitate data sharing between multiple participants; and a clearly-defined value proposition for sharing data along the supply chain.

"Unless these requirements are met, on-farm innovation and the development of innovative business models will be constrained."

In December 2021 phase one of the steering committee's work was completed, which included a data and capacity audit of the industry as a whole and the development of three 'business cases' to establish how and what value could be created through data sharing in the cotton industry.

The data and capacity audit produced several recommendations, including establishing a digital strategy (including data integration, standardisation and automation), establishing a data governance and management group to lead this process, developing a proof-of-concept centralised industry data base of on-farm management data, investing in training and education and developing roles for digital agronomy support and services.

The three business cases investigated for data sharing value were:

1. Linking farm and classing data to improve quality outcomes.
2. Participating in premium supply chains based on sustainability credentials.
3. Supporting global marketing efforts for Australian cotton to ensure market access and demand.

Now that it is clearer where and what value could be created through data sharing, the next step is to support the development of the infrastructure and agreements and begin exploring how to better share data and realise this potential value.

Phase 2 of the project will consist of two parts: the establishment of a data governance and management group (as recommended by their first report) and the development of a more cohesive digital strategy focusing on the agreements, data ownership and integration or standardisation processes which are currently hindering this process.

"Alongside this work, a proof-of-concept centralised industry database will be developed," Meredith said.

"Knowing exactly who we are as an industry, describing what we do and how we do it is reliant on good on farm data.

"We will look at ways to collect, report and add value to this data, so that the whole industry can benefit from the sharing of their information, and the potential can be realised."

For more

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Is soil carbon farming an option for you?

As companies around the world increase their voluntary purchase of carbon credits to offset greenhouse gas emissions, the spot price of Australian Carbon Credit Units (ACCUs) has surged to over $50 (as at January 2022).

Sustainability expert Chris Cosgrove says as a result, the promise of creating a new revenue stream from soil carbon credits has captured the attention of farmers everywhere.

What's not to love: improve soil health, reduce net greenhouse gas emissions by storing carbon in the soil, and make more money at the same time! Unfortunately, it's not that simple. The cotton industry is taking a cautious approach to "soil carbon farming". Why? Let's look at the role of soil carbon in meeting key farm objectives.

Objective: Make money from soil carbon credits?

If farmers adopt new practices that store carbon or prevent the release of greenhouse gases, they may be able to sell carbon credits to regulatory or voluntary markets (see breakout box). The vast majority of farming carbon credits are related to managing vegetation (native vegetation regrowth, plantation forestry and avoiding clearing), but it is possible to sell carbon credits resulting from increased soil carbon – if the increase is a result of practice change.

Experts from the University of Melbourne have highlighted a number of issues farmers need to be aware of before taking this option in a cropping system. These include:

- Cost: any income from carbon credits needs to pay for the costs of soil sampling and analysis, record keeping and auditing. This calculation may change if Australian carbon credit units (ACCU) prices continue to rise, but the relatively low capacity for many cropping soils to significantly increase soil carbon content needs to then be considered.
- Opportunity cost: generating carbon credits requires a change in management practice to increase soil carbon (for example converting land from cropping to pasture). This change in practice may incur an opportunity cost (for example, fencing and pasture establishment) and farmers are locked into this practice for the period of the carbon contract, limiting their ability to take advantage of future opportunities or change practices.
- Risk: Soil carbon increase depends primarily on growing more vegetation, which depends on water availability through rainfall or irrigation. If there are several drought years, soil carbon may reduce – potentially leaving the farmer exposed to delivering more contracted soil carbon volumes than they have in their soil.
- Loss of carbon credits: When a farmer sells carbon credits on the voluntary market, those credits are lost to the farmer, the industry, and Australia (if the buyer is offshore). This limits the ability of the farmer, the industry, or the nation to claim 'carbon neutral' status.

Objective: Increase productivity with more soil carbon?

Soil carbon can be increased by following simple soil health principles: maximise soil cover, minimise soil disturbance, maximise living roots.

These principles increase the mass of vegetation matter above and in the soil, providing food and shelter for the soil organisms that are needed for healthy soil. This increase in soil carbon, in turn, increases the ability of soil to perform the functions needed for a productive cotton farm, including:

- Improved nutrient storage and cycling

How does carbon farming work?

Through photosynthesis, vegetation on farms draws in carbon dioxide from the atmosphere. That carbon is stored in plants while they are alive, and stored in soil as soil carbon when plants and animals die and decay.

Farmers can sell soil carbon in their soil to two markets:

- **Regulatory market**. The Australian government operates the Emissions Reduction Fund (ERF). Farmers can sell carbon credits (one tonne of carbon dioxide equivalent = one Australian Carbon Credit Unit, or ACCU) to the government in a reverse auction process. A farmer needs to adopt a new practice (called additionality – something done in addition to standard practice), commit to permanent storage (25 or 100 years), and meet other criteria to be eligible.
- **Voluntary market.** Farmers sell carbon credits to companies – usually via an intermediary, who typically takes care of the paperwork and auditing (for a fee). Credits offered on the voluntary market are only about 10 per cent of the total market in credits under the ERF2.

A number of vegetation management and agriculture (piggery, cattle, dairy, cotton, soil carbon and savannah burning) methods are eligible to participate in the ERF. As at July 2021, the soil carbon method accounted for only about 0.002% of agriculture and vegetation management ACCUs issued2, and no projects had been registered for cotton (which relates to fertiliser efficiency).

The PLANET. PEOPLE. PADDOCK. Sustainability Framework has a simple message: reduce net emissions by reducing N application, reducing fossil fuel use and storing more carbon in native vegetation.

- Improved water infiltration and holding
- Improved soil structure for root growth
- Co-benefits including erosion and runoff reduction.

For most farms and at current ACCU prices, the financial benefit from soil health productivity gains will be more than the financial benefit from carbon credits after costs, opportunity cost, risk and loss of carbon credits are factored in.

Objective: Increase soil carbon to reduce net emissions?

All cotton growers should be striving to contribute to a climate neutral world by reducing emissions from cotton production while sustaining carbon in the soil and vegetation on cotton farms. So keeping carbon in the soil has a role to play.

However most cropping systems are likely to be limited in their ability to significantly increase soil carbon, and their ability to keep carbon in the soil (carbon can be locked in soil for thousands of years if undisturbed, but tillage disturbs the top layers of soil and exposes carbon rich matter to oxygen, resulting in the release of carbon dioxide).

For most cotton growers, effective ways to reduce net emissions are:

1. Increase the efficiency of nitrogen fertilisers to reduce emissions of nitrous oxide, a potent greenhouse gas. Nitrogen accounts for about 60 per cent of cotton production emissions.
2. Limit fossil fuel use (diesel, petrol, non-renewable electricity).
3. Protect and restore native vegetation, especially in riparian zones (water availability dramatically increases carbon sequestration, in soil or vegetation).

Follow the framework

As with most things in farming, it's complex, and there is no 'right' answer for every farm business. The cotton industry is continuing to watch this closely, but for now, is cautious about promoting "soil carbon farming" to growers.

Instead, the industry's PLANET. PEOPLE. PADDOCK. Sustainability Framework has a simple message:

- Reduce net emissions by reducing N application, reducing fossil fuel use, and storing more carbon in native vegetation
- Increase soil health and productivity by adopting practices that increase soil carbon.

For more

www.crdc.com.au/growers/sustainability
www.farminstitute.org.au/publication/a-landholders-guide-to-participate-in-soil-carbon-farming-in-australia/

The science is in: check your N rate

Reducing the volume of emissions released in cotton production while sustaining carbon in the soil and vegetation on cotton farms is a focus for CRDC.

As an industry, reducing nitrogen (N) fertiliser application to within industry guidelines and improving N use efficiency (NUE) would decrease the risk of excess environmental losses of N, both saving money and reducing negative environmental impact. It's an important step in lowering the industry's carbon footprint and demonstrating commitment to sustainability.

Emissions are dominated by nitrous oxide, with fertilisers contributing about 60 per cent of the greenhouse gases to grow, gin and move a bale of irrigated cotton to port.

The 2019 Australian Cotton Industry Sustainability Report showed on-farm greenhouse gas emissions had increased by 12.6 per cent since the previous report five years earlier.

As a result, the Australian cotton industry as a whole, through the PLANET. PEOPLE. PADDOCK. Sustainability Framework, has committed to a reduction in greenhouse gas emissions.

Results are already positive, with the most recent data from the 2019-2020 season showing improved NUE. This led to an estimated 14 per cent decrease in emissions per bale from 2018-19, and a 24 per cent reduction from the peak emissions per bale in the 2016-17 season.

A substantial body of information from over 20 years of research is available to inform N management decisions and improve NUE. CRDC led fellow research and development corporations (RDCs) from the dairy, sugar and horticulture industries in the More Profit from Nitrogen (MPfN) project, a five-year partnership, which wound up in 2021. It was an initiative of the Australian Department of Agriculture, Water and the Environment's Rural R&D for Profit program.

The focus of the research was to support practice change among growers from these industries to improve NUE, increase profitability and decrease emissions.

Economists from AgEcon undertook an evaluation of the MPfN projects and the program as a whole. The study found adoption occurs in stages depending on the overlapping of a range of underlying factors including the strength of extension pathways and stakeholders' appetite for risk and change (social aspects), and underlying market conditions relating to the commodity and the innovation (economic aspects).

In undertaking an evaluation of the projects under the MPfN program, a wide range of social and economic barriers were identified by MPfN stakeholders, with the primary impediments being the perceived risk of missing out on lost productivity with reduced N application, combined with the low cost of traditional N sources such as urea.

"Together, these factors support a culture in many industries where N is applied as a form of cheap insurance to maximise productivity," according to economist George Revell who conducted the evaluation component.

"The identified social and economic factors present potential barriers to practice change, reducing the rate or level of overall adoption of new practices and technologies.

"Understanding and addressing these barriers to change where possible and reinforcing the key research messages through industry specific resources and extension becomes critical to achieving incremental practice change and industry impact.

"I think we will see adoption over time as MPfN recommendations are integrated into industry resources and extension programs.

"Promisingly, stakeholders commented that adoption was already evident in all industries involved in MPfN, with demonstrated potential for

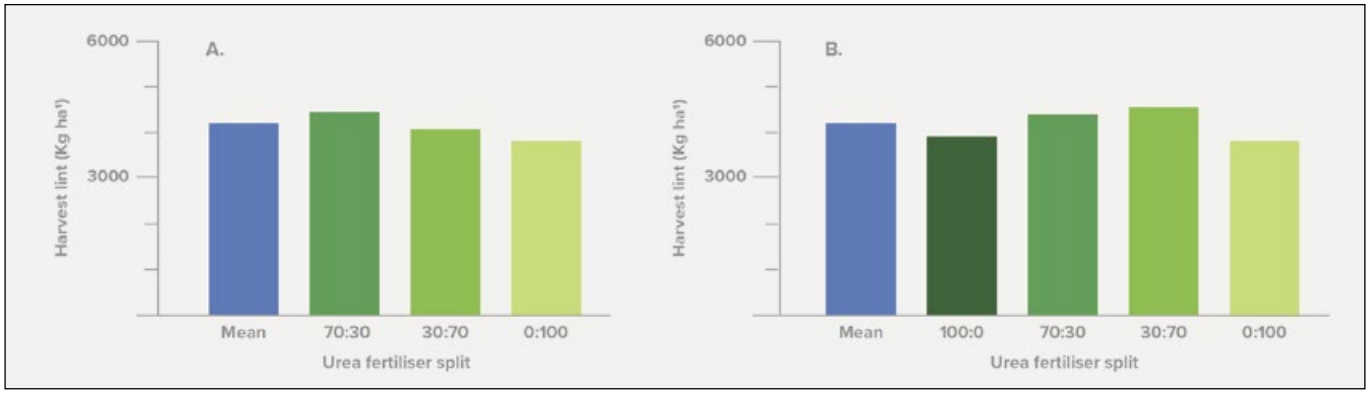

Figure 1. Cotton lint yield (kg/ha) measured by mechanical harvest (A – 2016-17) and season fertiliser application timing trial (B – 2017-18). Apparent treatment differences in graph A were not statistically significant. Bar on chart B = least significant difference.

economic and environmental benefits including yield or quality improvements, reduced N inputs, and reduced losses of N to the environment."

Applying knowledge makes economic sense

There are methods available to crop managers to improve NUE and environmental outcomes, which are already widely used. One of these is varying the timing and rate of N fertiliser applications. Research from a MPfN project scientifically assessed the implications of timing on irrigated cotton yields. The project was led by Graeme Schwenke of NSW DPI, with further economic analysis of the results undertaken by AgEcon's Jon Welsh.

Measured over two seasons, the research found no significant lint yield difference between different combinations of pre-plant and in-crop N applications. However, significant lint yield differences were found between the pre-plant and the 30:70 pre-plant / in-crop treatments in the 2017-18 season.

The split-application plots received three in-crop applications (broadcast urea) followed by irrigation within a day. There was no effect of the split fertiliser application on the measured yield at harvest during the 2016-17 season (Figure 1-A).

During the 2017-18 season, the all-applied pre-plant (100:0) yield was slightly less than the in-crop application (Fig 1-B), with significant differences between 100:0 and 30:70 treatments. The trial also showed there was no potential lint yield penalty for 70:30 or 30:70 in-crop application relative to all-in-crop treatment (0:100).

On an individual cotton crop gross margin basis, the irrigation N application line item (Table 1) puts these results into context. Using a partial budget approach, four separate practices are summarised.

Taking an average yield of various treatments from 2016-17 and 2017-18 years using a nominal $500/bale price, crop revenue was slightly less for the upfront treatments when compared with split N application (three spreading applications at $6/ha). A single banded application is valued at $40/ha pre-plant.

N lost in runoff from the field (Figure 2) was also factored into the variable cost at $1.50 kg/N. While the application costs and losses were lowest in the 0:100 treatment, the highest gross margins were with split applications in the 2017-18 experiments due to the higher yield.

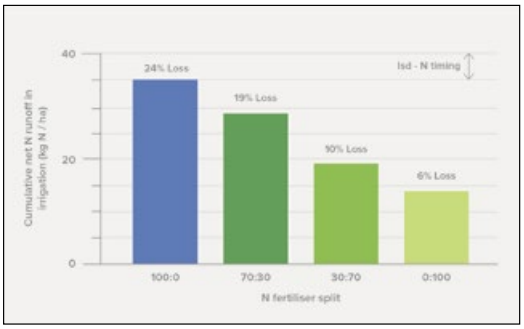

Figure 2. Irrigation field runoff comparison and effect of N application timing trial 2017-18

Factor in residual N

Jon said that leading into a new season, there can be significant leftover levels of N in the soil, so fertiliser input use and costs can be reduced by taking this into consideration. The trials saw a large difference in the post-harvest residual soil N between treatments, particularly in the first year, when the N rate used was the region average.

Leftover N from in-crop fertiliser strategies (0:100, 30:70) can be utilised by the following rotation or cotton crop, provided no post-harvest off-farm losses occur. In second-year trials, pre-trial soil N levels were used to reduce the N rate.

"Pre-season soil testing is important to calculate the required N fertiliser rather than following a fixed N recipe," Jon said.

"The aim is to match the N supply with plant demand for optimised efficiency, so it's worth considering this research, which showed the highest gross margin was with a 30:70 or 70:30 split N application.

"In terms of N losses, they were highest with the 100 per cent upfront option, while losses were minimised with all in-crop applications."

The results and data for all the More Profit from Nitrogen projects are available on line. The reports are presented as accessible and easy to interpret documents for growers and consultants, with supporting videos and case studies.

For more

www.crdc.com.au/more-profit-nitrogen

Treatment	Lint yield (bales/Ha)	Revenue ($/ha)	N Application cost1 ($/ha)	Lost N from field ($/ha)	Partial Budget GM ($/ha)
100% up-front	15.2	$7,600	$40	$53	$2,825
70:30	16.3	$8,150	$58	$42	$3,368
30:70	16.3	$8,150	$70	$29	$3,369
100% in-crop	15.7	$7,850	$18	$21	$3,123

Table 1. Partial Gross Margin budget showing four separate treatments: upfront and split in-crop N applications.

Tech solutions for improved nitrogen application

Satellites are being used to manage nitrogen use efficiency on the Future Farm.

The Future Farm is a collaboration between CRDC, Queensland University of Technology and CSIRO, designed to improve farmer confidence in targeted nitrogen (N) management through automated sensing and decision support systems. Future Farm will automate the processing of crop and soil N information from data acquisition and analysis, to the formulation and implementation of decision options.

N fertiliser typically represents 20 per cent of variable costs in irrigated cotton production, and is a major determinant of profitability and productivity. The large increase in N fertiliser pricing in 2021 has significantly eroded profitability. There is a wide range in N fertiliser being applied across the Australian cotton industry (eg. 180-519kg N/ha in irrigated systems) and these applications are not correlated with yield, which is concerning from an N use efficiency (NUE) perspective.

A study from 2015-18 on the Darling Downs (see next article) across 12 locations found that only 17 per cent of the N taken up by the crop was derived from applied fertiliser; that is 83 per cent was soil-derived N either from soil organic matter or residual from the previous season. N fertiliser losses were lower in the overhead irrigated sites (35 per cent) compared to the furrow irrigated sites (51 per cent).

To optimise NUE we can use the tools of precision agriculture to deliver on the 'Four Rs' – putting the right amount of the right product in the right place at the right time.

"The large increase in N fertiliser pricing in 2021 has significantly eroded profitability."

Future Farm will automate the processing of crop and soil N information from data acquisition and analysis, to the formulation and implementation of decision options.

For example, applying N fertiliser well before sowing is a common practice in the cotton industry when in fact applying too much too early can lead to extensive losses in the form of denitrification when the soil becomes saturated.

Traditional N management trials assess the yield response of cotton without considering the variability in soil chemical and physical properties across the entire field.

The use of management zones and optical sensors (satellite and ground based) offer an economically viable alternative. Reflectance data collected from these optical sensors can also be used to calculate Vegetation Indices (VIs), providing rapid and vital information on crop development at a fine scale and over a large area which informs N management.

The objectives of Future Farm include an evaluation of freely available 10-metre resolution satellite data an evaluation of freely available 10-metre resolution Sentinel-2 satellite data to to estimate petiole nitrate N, leaf N and lint yield across management zones using VIs.

Researchers also compared VIs derived from Sentinel-2 and a very high spatial resolution ground based optical sensor (Crop Circle). They found that VIs can estimate differences in crop N status within management zones, however, a multivariate approach that considers soil moisture, canopy structure and soil background reflectance is required to accurately predict leaf N, petiole NO_3^--N and lint yield across the entire field.

The sensor comparison has found that VIs derived from Sentinel-2 provide similar results and reflectance patterns to the Crop Circle. Sentinel-2 can therefore be used as a cost-effective source to estimate N status and inform N management decisions.

Future Farm will significantly improve the way in which soil and crop sensors are used to inform decisions about the amount and timing of N inputs to maximise productivity and profit.

For more
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Over application of nitrogen is a costly waste

Science continues to support the need for a close look at nitrogen (N) and soil management, with recent trials showing only 17 per cent of N taken up by the crop was derived from fertiliser and the remaining 83 per cent supplied by the soil.

A nearly 50 per cent loss of applied N fertiliser across 500,000 ha at the industry average N rate is equivalent to just over A$200 million in lost N fertiliser alone at current urea prices.

Queensland University of Technology's (QUT) Professor Peter Grace and a group of fellow scientists have analysed the N fertiliser use efficiency (NFUE).

In irrigated cotton production in Australia, N fertiliser is one of the key production drivers with an average application rate of 275kg N/ha across the industry, and some fields receiving as much as 500kg N/ha. With the cost of urea trebling in 2021, this represents a significant proportion of the farm budget. Ensuring the efficient use of an expensive input is critical for profitability.

The clay soils on which the majority of Australian cotton is grown are prone to waterlogging resulting in significant losses of N (including the greenhouse gas nitrous oxide) to the atmosphere via denitrification, or deep drainage and surface runoff.

Only a few (relatively dated) Australian studies have reported N fertiliser use efficiency (NFUE) in cotton based on fertiliser experiments using the stable isotope ^{15}N. This historical data has mainly been collected from research stations under relatively ideal, experimental and well managed growing conditions.

The team of Clemens Scheer, David Rowlings, Massimiliano De Antoni Migliorati and Dio Antille (then University of Southern Queensland, now CSIRO), have run one of the first studies using ^{15}N on commercial farms to provide a realistic assessment of NFUE in the cotton industry. The ^{15}N fertiliser provides a clear distinction between the uptake of N into the crop from applied N fertiliser and that from the soil itself (ie. mineralisation of soil organic matter, decaying crop residues and roots or residual fertiliser from previous years). The use of ^{15}N also enables calculation of how much of the applied N fertiliser was permanently lost during the season and how much is left in the soil at the end of the season.

Comparing rates

Over three years from 2015-18, replicated field trials were undertaken on five commercial farms located in the eastern Darling Downs (Barunggam country). Each year, the trials were conducted on a selection of both furrow and overhead irrigated fields. Fertiliser rates and application timings, and crop protection followed each farmer's standard practice. The farmer's N practice was compared with two alternative N management variations, firstly reducing the fertiliser rate by 30 per cent, then using a nitrification inhibitor, in this case DMPP (3,4-dimethylpyrazole phosphate), in combination with the reduced N rate. An unfertilised N treatment was also included.

	N applied (kg/ha)	Lint (bales/ha)	Crop N uptake (kg N/ha)	iNUE (kg/kg)
Urea-Farmer's Practice	161	10.6	225	10.3
Reduced Urea* + DMPP	115	11.0	228	11.3
Reduced Urea* only	115	10.6	223	11.9
ZERO N	0	8.8	192	10.8
*30% reduction of farmer's normal N fertiliser practice				

Table 1. Impact of nitrogen fertiliser management on yield, N uptake and iNUE on the Darling Downs (2015-18).

Results show significant losses

The average lint yield under the grower's practice was 10.6 bales/ha, with an average N application of 161kg N/ha (Table 1). Even without a N application, lint yield was nearly nine bales/ha, indicating a large surplus of mineral N available in the soil profile even before the season started.

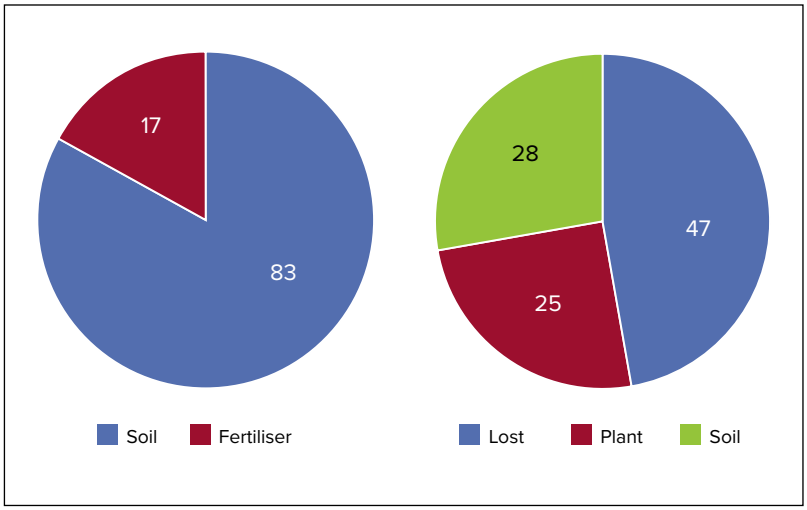
Reducing the N fertiliser rate (115 kg N/ha) and combining DMPP had no significant effect on yield and crop N uptake compared to the farmer's practice. Average internal crop N-use efficiency (iNUE) across all years and treatments was 10.9 kg lint/kg crop N uptake, with no significant effect of N fertiliser treatment. This was slightly lower than the optimum.

Only 25 per cent of the applied N fertiliser was directly taken up by the crop compared to 47 per cent of the N fertiliser being permanently lost during the cropping season (Figure 1). A 47 per cent loss of N at 161 kg N/ha is equivalent to a loss of at least A$230/ha at current urea prices. Reducing N fertiliser by nearly a third in combination in combination with DMPP increased fertiliser N recovery in the plant (32 per cent of applied N) and reduced N loss (38 per cent). At harvest, 28 per cent of the N fertiliser remained in the soil profile.

Overall, N fertiliser losses were lower in the overhead irrigated sites (35 per cent) compared to the furrow irrigated sites (51 per cent), but this effect was not significant due to the generally higher N rates used in the furrow irrigated systems. Only 17 per cent of the N taken up by the crop under farmer's practice was derived from fertiliser and the remaining 83 per cent was supplied by the soil (Figure 2).

Figure 1. (Below left) Source of applied N recovered in the plant at harvest on the Darling Downs (2015-18).

Figure 2. (Below right) Fate of applied N in cotton farming systems on the Darling Downs (2015-18).



High yields without N?

Fertiliser NUE in irrigated cotton production on clay soils of the Darling Downs is low under current N management strategies. This indicates that commercial farms have highly elevated levels of available N in the soil profile at sowing, most likely due to excessive N fertiliser applications in previous years.

This means that even without the application of N fertiliser, high yields can potentially be maintained in the short term, but definitely not sustained without adequate N inputs from either soil or fertiliser sources.

The average N application rate in the three-year study (137 kg N/ha) was only half the industry-wide average N application rate of 275 kg N/ha for irrigated cotton in Australia. This suggests that N losses (including nitrous oxide) across the industry may be significantly higher than the values reported in this study.

A nearly 50 per cent loss of applied N fertiliser across 500,000 ha at the industry average N rate is equivalent to just over A$200 million in lost N fertiliser alone at current urea prices.

There is considerable scope and urgency at current N fertiliser pricing to reduce N fertiliser rates in irrigated cotton production systems. This can be done without compromising productivity and profitability. The residual effect of N fertiliser applied in previous years must be considered when assessing these N fertiliser rates. It is also critical to synchronise crop N demand with N supply from all sources including soil and fertiliser. Management strategies that sustain or build soil organic matter and allow growers to reduce the amount of N fertiliser applied should be the norm.

For more

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What is biodiversity and what do we think about it?

The term 'biodiversity' is in danger of becoming a buzz word and its meaning in relation to cotton farms varies from grower to grower, according to a new industry study.

Attitudes and thoughts around how CRDC can help cotton growers maintain and even build on-farm biodiversity have been heard through a recent research project. The *Perceptions of strategies to strengthen biodiversity management on cotton farms* report is part of the Cotton Landcare Tech Innovations 2021 project (funded by CRDC and the National Landcare Program) to create a legacy of biodiversity action on cotton farms and throughout the cotton value chain.

Understanding the challenges growers face in adopting on-farm biodiversity management will help CRDC assist industry in developing a business strategy to create a legacy of biodiversity management throughout the cotton value chain. Clearly defining what biodiversity really means and providing an economic business case for growers to get on board have been highlighted as important first steps in the subsequent report.

QUT environmental and conservation social scientist Dr Angela Dean and Liz Otto from Cornerstone Sustainability led the study. Working alongside CRDC they heard from 54 growers and consultants through online surveys, group discussions and workshops.

Their investigations centred on four biodiversity practices:

- Targeted revegetation and regeneration
- Stock exclusion from rivers, streams, and wetlands
- Control of environmental weeds, and
- Control of feral animals

The aim was to uncover the factors that might motivate or constrain growers from taking up or strengthening these practices. Because many growers already have some experience in these practices, the emphasis was on improving outcomes rather than maintaining existing practices.

Overall, the research found that most participants believe that biodiversity loss is a serious issue that the cotton industry needs to address.

Participants saw opportunity for greater leadership on promoting biodiversity to growers, land managers and consultants to improve uptake or works to improve it. Growers also saw an opportunity to acknowledge and build on what many of them are already achieving.

Enhancing biodiversity on cotton farms is a focus for industry and growers.

The cotton industry also has the opportunity to better define what is meant by 'on-farm biodiversity', as it was shown to mean different things to different participants, and which areas of the farm it applied to, as they require different management strategies.

Some discussion was raised as to whether biodiversity also includes crops.

CRDC R&D Manager and CottonInfo Natural Resource Management Technical Lead Stacey Vogel said from a broad policy, political and social point of view, biodiversity refers to natural environment/capital/assets. The cotton industry's most recent (2019) sustainability report defines biodiversity as 'Along with soil and water, biodiversity – the variety of life forms found in an environment including

animals, plants, bacteria, fungi and micro-organisms – makes up the natural capital that cotton farms rely on to exist.'.

"While our sustainability reporting and CRDC R&D programs separate biodiversity into soils, water and natural areas (due to the complexity of management and reporting) CRDC considers and invests in biodiversity as a component of a whole farming system," Stacey said.

An overarching issue was maintaining a favourable cost-benefit and finding the capital to undertake work to enhance biodiversity, whether that was tree planting or fencing riverine areas.

This study follows earlier research under the Tech Innovations 2021 project that identified priority areas and practices for biodiversity conservation within broader cotton-growing regions.

"Through partnerships with Country Road and Landcare Australia, we've been using that research to engage cotton growers within the Namoi Valley in on-ground biodiversity restoration projects," Stacey said.

"What we hear is that while many growers supported the concept, the challenges and realities of implementing biodiversity management practices on their farms deterred many from participating.

"It was clear that to develop a compelling legacy of biodiversity action, the industry needed to understand more about these implementation challenges."

The findings show that growers and consultants

- **87% indicated that biodiversity management would support integrated pest management.**
- **83% said it would help support a 'clean, green' image for the industry.**
- **79% believed it would support a community licence to operate.**

see supporting biodiversity on farms as an opportunity to do the right thing and build social licence for the industry. However the meaning of 'biodiversity' as it applies to the farm has become somewhat hazy, and participants felt in many cases they lacked the tools to identify, measure and gauge the impact of management practices to improve or enhance biodiversity.

And while natural capital and ecosystem service are key aspects of biodiversity on cotton farms, work needs to continue to define what is meant by these terms and quantifying their value.

"CRDC and industry leaders now need to make sure growers and consultants understand the industry's definition of biodiversity: where and how it applies to a farm," Stacey said.

"The benefits of monitoring and improving it need to be clear and accessible, via economic studies, research and peer learning.

"It also showed that to accelerate this we need to communicate a clear definition of biodiversity along with clear and accessible methods or tools to measure goals, gauge success and value natural capital and ecosystem services."

CRDC intends to do further work in coming months to help the industry develop the business strategy for a legacy of biodiversity management. This new report provides invaluable background for that project.

"The biodiversity strategy will complement and build on other work currently happening, such as the industry's PLANET. PEOPLE. PADDOCK. Sustainability Framework, our work with NRM Regions Australia, the Country Road Landcare partnership and *my*BMP," Stacey said.

"We'd also encourage land managers to take part in our environmental studies, which can provide them with valuable information about their farm's health.

"And we will be looking for grower's feedback on the industry's environmental performance through an online survey in coming months as part of cotton's fourth independent environmental assessment. We invite all growers to participate."

For more

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Fashion and sustainability: everybody's business

From paddock to retailer, whose responsibility is it to be 'sustainable' and how much responsibility should each link in the supply chain bear?

Brands, retailers and growers all have a role in supplying a sustainable and environmentally responsible product. However, recent research commissioned by CRDC has shown that the concept of 'sustainability' means different things to different parts of the supply chain, and that there's a general lack of sufficient and appropriate data to determine the sustainability credentials of specific types of cotton.

CRDC-supported researchers Zoe Mellick and Alice Payne at Queensland University of Technology (QUT) and Jacqueline Vater and Mark Sumner from Leeds University in the UK have been studying sustainability and fashion through several CRDC-supported projects.

Their research has shown a disconnect between cotton growers and brands/retailers in defining sustainability, knowing how to achieve

it and communicating what sustainability looks like on farm. They have found the terms 'sustainability' and 'environmental sustainability' are not straightforward and mean different things to different people. Similar issues were also raised through a separate recent CRDC-supported study with growers looking at barriers to improving biodiversity on farms (see story page 17).

"Cotton farmers are focusing on growing environmentally sound cotton contributing to healthier environments whilst fulfilling the sector's demand for 'sustainable' cotton – even as the definitions of how 'sustainable' cotton is defined can seem ambiguous," Alice said.

Based on interviews conducted with cotton farmers and brands/retailers, the researchers found that there is no independent body to verify any sustainability measures taken. Further, the majority of sustainability initiatives are not focusing on the grower/supplier side but are heavily dominated by brands/retailers.

Mark Sumner says brands are being forced by their stakeholders to define sustainability for an industry which is very hugely diverse and globally complex.

"Their definition is driven by their many different agendas but is limited by their lack of knowledge about the extended supply chain – such as cotton farming," he said.

Who defines what is environmentally sustainable?

The study found that brands and retailers predominately get information about environmental impacts related to cotton and how to reduce these impacts from industry initiatives such as Textile Exchange, Textiles 2030, Sustainable Apparel Coalition, conferences, and trade fairs.

In order to address the climate crisis it is crucial for brands/retailers and cotton farmers to share risks and rewards, as well as build relationships to foster communication.

"Australian retailers are looking for quantifiable LCAs to understand impacts; and communicate impacts to the customer."

The majority of retailers that the team have been speaking with are using industry tools such as the Higg Index to determine what a sustainable material/more sustainable cotton alternative is as well as determine their sustainable raw material sourcing strategy based on this information. This is challenging as it presents an average of the world production and hence is not granular enough differentiating cotton grown in different regions let alone individual farms.

"It is crucial to highlight that these initiatives and certification schemes are currently key influencers for the apparel sector determining which fibres are considered to be 'sustainable' and also stipulating appropriateness of specific targets determined by brands/retailers," Jacqueline said.

"At the same time, our research showed that the apparel sector has an issue with unsubstantiated claims driven by the lack of sufficient appropriate data to determine impacts, for example life cycle assessment (LCA) data, which form the backbone of industry tools such as the Higg Index."

The use of LCAs has been criticised for a range of reasons, including being used to compare the impacts of cotton growing in different regions, or under different production systems.

"Most LCAs on cotton have not been undertaken in a way that allows for such comparisons, leading to misinterpretation and misuse of data, which suggests that it is important to have the grower's voice included in the conversation," Zoe said.

However Zoe notes that some of the Australian retailers interviewed were sceptical of information coming from industry bodies who had a clear vested interest in the results making them look good.

"Australian retailers are looking for quantifiable LCAs to understand impacts; and communicate impacts to the customer. So we need to find a way to bridge this gap between the limitations of LCAs, and the expectations and needs of brands/retailers," she said.

For growers, what sustainability means can be largely tied up with cotton identity programs such as *my*BMP and certifications are increasingly becoming a requirement for growers' market access. However, these measures come at cost for the cotton grower which are not always paid for by traders or the brand/retailer.

The sustainability tag in fashion is a everyone's responsibility, but one sector shares more risk than others – growers.

Who carries the risk?

The research found that the environmental and economical risk surrounding cotton tends to be allocated to the grower, not the brands/retailers.

"While brands/retailers also face environmental risks, this tends to be reputational and legislative risks, which are different to the farmer's risk," Alice said.

"The majority of the environmental and economic risk is currently allocated to the cotton farmer," Mark says.

"That's why it is essential to integrate the perspective of cotton farmers into the sustainability conversation, to understand challenges faced by the cotton growing industry and to work on solutions that are of mutual benefit to brands/retailers and farmers.

"We need to identify options and ways of more equally distributing these risks. Being 'environmentally responsible' must become a collective responsibility throughout the industry – from farm to retail shop floor."

How do we tell our sustainability story?

Communicating cotton's sustainability story from growers to end user consumers is challenging, as growers generally only communicate up to the merchant, limiting the ability to engage in a dialogue about sustainability impacts on farm.

This means others in the supply chain, such as merchants, need to be involved in the dialogue to bridge the gap between farm and brand.

"Whilst farmers are measuring impacts arising on the farm, translating these into a per garment figure is difficult because everything on farm is measured by bale, not by garment," Zoe said.

"This is where certifications become the key communication device for retailers and suppliers as they identify whether cotton is 'sustainably produced' without going into the complicated detail of on farm production.

"This highlights that there are challenges with how environmental sustainability is communicated."

The research demonstrates that brands and retailers are currently setting the environmental agenda without consulting with cotton farmers on the validity of strategies and targets. The dilemma for industry is that growers are creating and adding sustainable value to cotton, however this is only recognised if attached to a certification system.

"Essentially what we have here is a value gap whereby growers are creating sustainable value on farm that they want to sell to the retailers who can then pass onto to the consumers," Zoe said.

"However retailers said that consumers want sustainable products, but in the majority of cases they expect the sustainable value created by the farmers to be delivered at no cost to them, the customer," Mark added.

"This is an important reality of the market which is often under reported.

"We could observe that the majority of brands/retailers and cotton farmers are currently not truly working collaboratively, with the exception of initiatives such as brand partnerships through Cotton Australia's Cotton to Market program.

"The research suggests there needs to be an industry-wide conversation to bring growers closer to retailers to tell their stories and value-add their product."

For more

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Nitrogen use efficiency and weeds highlighted

Cotton industry consultants have once again shown they are the eyes and ears in the field, with the release of their annual survey.

The survey shows that just over 50 per cent apply N at rates above the industry's benchmark of 250kg/ha, and a small proportion nearly double that rate.

The survey also shows that cotton crop management is continually evolving as growers and consultants, particularly in Southern NSW and Central Queensland, continue to work with vastly different seasonal conditions and weather challenges.

The 2020-21 Qualitative Report from Crop Consultants Australia (CCA) and CRDC summed up the season as cool and wet, which created challenging conditions, especially for southern growers, faced with an already short season.

Increased nitrogen (N) use/falling N use efficiency (NUE) has been a contributor to increasing greenhouse gas emissions over the past five years in the industry. In this edition of *Spotlight* we have a focus on nitrogen use efficiency, the impact of over-application of N, and its effect on greenhouse gas emissions and the industry's sustainability credentials.

The survey shows that just over 50 per cent apply N at rates above the industry's benchmark of 250kg/ha, and a small proportion nearly double that rate. Split application is the timing method of choice, with 77 per cent of consultants recording that option. A small group (18 per cent) applied all N up front.

The majority of N application in dryland crops was in the up to 50kg/ha range (58 per cent).

There are a number of tools being used by consultants and their clients, with the most popular being soil tests and nutrient budgeting, followed by seasonal climate forecasts.

Scientists and researchers are urging crop managers to test N levels prior to a new season, as trials are showing significant levels left in the soil in irrigated crops, which must be taken into account when budgeting. However, while soil tests for a range of elements and nutrients are being used, annual testing is not widespread, with the bulk of tests 'in some fields every season' in irrigated crops. It's a similar scenario in dryland crops.

Weed control issues are shown to be similar to the 2019-20 survey. Again, managing herbicide resistant weeds and the emergence of resistance species across more regions is a key issue, in particular feathertop Rhodes grass (FTR), milk/sowthistle, fleabane and summer grasses.

This followed the 2017-18 report which rated weeds as having a bigger impact on profitability, either through budgeted or unbudgeted costs or through yield loss, over disease and insects.

The most recent report confirms glyphosate (Group M) resistance on 52 per cent of clients' farms, with 34 per cent of clients seeing Group I resistance, mainly in irrigated systems. Group A resistance levels were similar in both systems.

A large proportion of consultants are using the Herbicide Resistance Management Strategy advice of combining glyphosate with more than three non-glyphosate tactics, particularly in dryland crops. It's rare to see glyphosate as the only weed control tactic used.

Milk thistle is ranked as the greatest emerging challenge in both dryland and irrigated systems and FTR is the biggest current control challenge followed by fleabane and awnless barnyard grass.

In 2020-21, 44 per cent of consultants' clients are spending $50-$100/ha on weed control, while 24 per cent spend between $100 and $300/ha. Of those weeds, windmill grass had the largest impact of profitability, followed by annual ryegrass and rogue cotton.

The 2021-22 report is the latest in a long-standing series of consultant reports. CRDC commissions the CCA survey each year, as well as the annual Cotton Grower Survey. Together, they provide current and longitudinal knowledge of on-farm practices and attitudes, to aid the research, development and extension effort within the Australian cotton industry.

For more
www.crdc.com.au/publications/cotton-consultants-survey

Efficiency of bankless under the microscope at St George

St George district grower Craig Saunders has always been on the lookout for ways to improve water use efficiency.

Ever since the Saunders family started growing cotton about 40 years ago, siphons had been their mainstay method of irrigation. But in the search to improve water use efficiency they have also tried a range of techniques such as pipes through the bank, centre pivot and even cane fluming.

"Water is our biggest limiting factor, not land," Craig said.

"Water is hard to buy and it's expensive, so ever since we were able to measure our water use we have been looking for ways to use it more efficiently.

"With some of these systems, you can be convinced that the irrigation is efficient.

"Then you measure the water use efficiency and are a bit deflated when you see the results.

"That has happened to us a few times, but it has also spurred us on to a newer and better way."

At their property 'Thuraggi Overflow', at St George (Kooma country) they have recently introduced a bankless channel system with a tailwater backup, designed by local water engineer Glenn Lyons with structures and equipment from Padman Stops. They have also automated the system, which has helped bring further precision and labour-saving to their irrigation management.

So far, Craig believes it is ticking the right boxes. They have estimated a time saving of up to 20 hours for an irrigation event across the 270-hectare field. Yields have improved and they have been able to use sections of the field with marginal soil types that were previously dryland country.

"Before the automation, we already thought the system was good, but this has now taken it further," Craig said.

"Land valuers and the bank manager also see the value in the investment, so once the bank was on board, everything else was easy."

Craig is confident that the system has greatly improved water use efficiency, but he also wants to see it in hard data, like many in the industry.

For this reason, Craig is working with the CottonInfo team, the Gwydir Valley Irrigators' Association, Padman Stops, Glenn Lyons, NSW DPI and the University of Southern Queensland (USQ) to assess the efficiency of the bankless channel, tailwater and backup system.

The work is funded by CRDC under the Smarter Irrigation for Profit program, which is supported by the Australian Government's Rural R&D for Profit program.

CottonInfo Regional Extension Officer (REO) Andrew McKay said the industry had extensive data on the water use efficiency of siphon systems, but significantly less so when it came to bankless systems.

"With the collection of data on soil water use, water applied, rainfall and irrigation uniformity it will be possible to calculate the irrigation water use efficiency and – more importantly – the gross production water use index," Andrew said.

"The trial will also investigate the potential to apply surface irrigation technologies such as SISCO to the tailwater backup siphon-less design to improve irrigation optimisation.

"This information will help determine where there have been water savings and identify where further saving may be possible.

"The growers feel they are saving water with these systems, so through this trial we will gather the data to find out."

Craig Saunders and Lucas Wuersching say that automated bankless irrigation has delivered labour savings and improved water use efficiency.

What's the system?

The trial will consist of monitoring irrigations in three bays, each of roughly 30ha. The field is irrigated by a main supply channel fed directly from the farm's

storage, which will be measured with a storage meter. Released water will also pass through a Siemens ultrasonic water meter measuring flow rate and volume into the main supply channel.

As each bay is irrigated, a Padman inlet automatically opens to allow water into the distribution basin. Water that enters the basin will be measured with a Starflow ultrasonic doppler meter fitted to the Padman inlet for each bay.

As the distribution basin fills, water flows over the sill and down the bay. As water reaches the tail drain, it then backs up to finish off uncompleted rows. Water advance and depth sensors along with soil moisture probes will be placed along the furrows to gather data on infiltration characteristics and soil water dynamics.

Once all rows in a bay have been irrigated, a Padman outlet is opened at the tail drain end into the adjacent bay and the tail water used to irrigate the adjacent bay from the bottom upwards. Water depth sensors in the tail drain are used to automatically trigger the outlet opening. The inlet from the main channel to the distribution basin is also opened to irrigate from the main channel.

This allows the next bay to be irrigated from both ends to shorten run times and improve efficiency. Once all three bays are irrigated, water will drain off the field through a Padman outlet. Depth sensors at the outlet will measure water volumes off the fields.

By measuring the volume of water that leaves the storage, the volume of water that enters the bays and the volume of water that leaves the field, the total volume of water applied to each segment of the field can be determined. This volume of water, along with data from the soil moisture probes and the water advance and depth sensors can then be used to determine distribution uniformity, irrigation application efficiency and losses due to deep drainage.

The SISCO software developed by USQ will then be used optimise these parameters. Remote sensing and yield data will also be used to determine the irrigation water use efficiency and gross production water use index.

The benefit of this trial is that it will provide useful information that designers such as Glenn Lyon can use when developing systems. It will also benefit growers who want to make changes to improve water use efficiency, energy use and labour resourcing.

ABOVE: Grant Oswald with Padman Stops and CottonInfo St George REO Andrew McKay, installing sensors as part of the trial earlier this season.

LEFT: Taking water off the field.

Craig Saunders said they were very keen to see the results. “We might get a green tick or we might get a red cross, but we are going to know at the end of the season,” he said.

CottonInfo will be providing results from this trial later this year. Keep an eye on the CottonInfo email newsletter and future editions of *Spotlight* for the details.

Goodbye rotobucks

Lucas Wuersching gets excited when he talks about the benefits that come with automated bankless irrigation.

There are the immediate benefits of a life without siphons – not starting, stopping and moving them – and doing away with the headaches of rotobucks. There are also fewer late nights and early starts, checking water and changing shifts.

But there are other benefits, according to Lucas.

When CottonInfo visited Saunders Farming two weeks before Christmas and spoke to Lucas, they were about to start their first irrigation (which was significantly delayed compared to normal due to frequent storms early in the season).

“Normally at this time of year we’d be going through with our last cultivation, and it would be a big stress on the plant,” he said.

“It would be stressful on us as well because we’d be wanting the rotobucks in straight away to start watering.

“With the bankless system, we can get in much sooner.”

Through a LoraWAN network, the system at ‘Thuragi Overflow’ is connected via range of sensors that links back to an app that they can access via phone or tablet.

“Normally as we’d get through the season, the water would start going through in 12 hours, then eight hours and then down to six hours. We get tired as the season goes on.

“Now I can sleep at night, wake up and check my phone. It sends you a text message if there is an error with heights. I look at the height sensors for the ditches regularly.

“There’s a big labour saving as it is getting harder to find people to come and shift pipes and the water saving is allowing us to grow more and better cotton.”

For more

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Use the QR code to see a video of the trial.

Key weeds prove 'what doesn't kill you makes you stronger'

Low doses of herbicides can have unintended and reversed consequences on weeds, by stimulating the biomass production and reproductive features of two key species in Australian cotton cropping systems – flaxleaf fleabane (*Conyza bonariensis*) and awnless barnyard grass (*E. colona*).

This phenomenon, known as hormesis, can then indirectly contribute to resistance development.

Results from a recent NSW DPI research project supported by CRDC show a clear negative implication of low doses of glyphosate and paraquat in resistant populations of the two species. The study highlighted the importance of accurate herbicide application for suppressing weed growth and resistance evolution, as well as the importance of regular herbicide resistance testing.

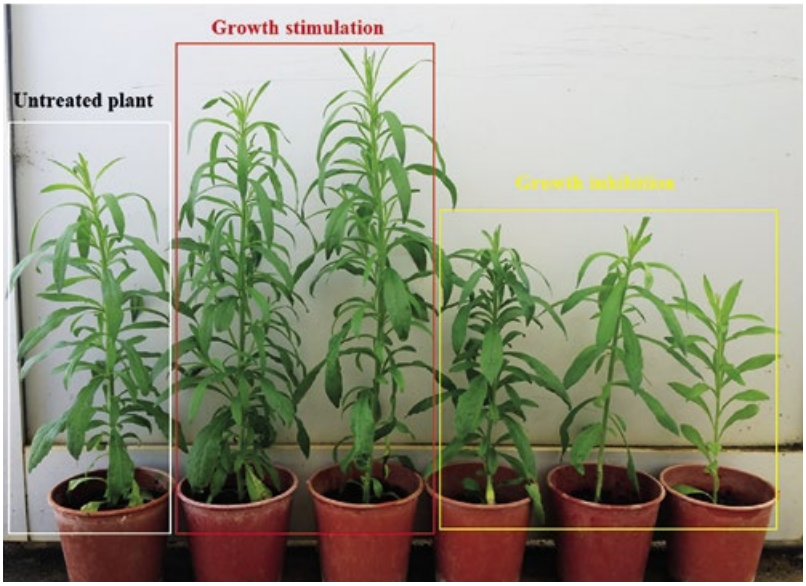
Random weed surveys and resistance testing over three seasons (2018-2020) shows awnless barnyard grass and tall fleabane are developing increased levels of resistance to glyphosate. Their resistance levels and dynamics are changing over time, despite concerted efforts to manage resistant weeds using current knowledge and best practice.

This project led by NSW DPI scientist Dr Md Asaduzzaman (Asad) looked into the additional factors that might be involved in either directly or indirectly influencing resistance development and the potential impact of herbicide hormesis on resistance development in awnless barnyard grass and tall fleabane.

Hormesis describes the stimulatory effect of low doses of toxic substances on plant growth. A high dose of herbicide could cause inhibition in a plant, while a low dose can cause stimulation.

"The adaptability of these two species directed us to hypothesise that herbicide hormesis can occur particularly in resistant populations and might be adding an extra advantage in resistant phenotypes of heterogenous natural populations," Asad said.

"Our studies in barnyard grass and tall fleabane have clearly indicated that a resistant plant can be stimulated by herbicides when the plant does not receive the intended dose.



Pot trials demonstrating the effect of hormesis on tall fleabane.

"For example, we found low doses of paraquat can induce more biomass in resistant tall fleabane plants.

"Consequently these plants can generate higher numbers of seed buds during the reproductive stage compared to plants treated with nil and high doses of paraquat."

Researchers confirmed both the vegetative and reproductive growth of resistant populations were stimulated by low doses of paraquat applied at the four to six leaf stage (Figure 1). Hormetically boosted resistant plants produced, on average, 30 to 60 per cent more buds/plant than untreated plants.

Boosting biomass in barnyard

Low doses of glyphosate generated more biomass in both susceptible and resistant phenotypes of awnless barnyard grass (Figure 2). The resistant phenotypes produced more biomass than susceptible phenotypes throughout their life cycle and they expressed their enhanced response mainly at the reproductive stage at doses 100-540 g active ingredient /ha. They generated 20 to 40 per cent more spikes/plant than non-enhanced plants (Figure 3).

On-farm considerations

Plants from resistant phenotypes can shift the hormetic dose zone to higher doses and this can intensify the hormetic effect causing the stimulated

weed to be more competitive with the associated crop.

NSW DPI's Eric Koetz is also the CottonInfo Integrated Weed Management Technical Lead. He says resistant populations that are stimulated by herbicide hormesis may achieve an overall fitness and over time developed a mechanism to hermetically adapt themselves to the high selection pressure environment.

"A relevant example is more vigorous, healthier, and taller weed growth at non-cotton crop sites such as fence lines, laneways and channels," Eric said.

"While these plants are not competing with crops for resources, they may be exposed to spray drift which can act as hormesis doses, through environmental (eg. dust on surface, high temperature) and management factors that convert full herbicide doses into different sub-lethal doses.

"Eventually these enhanced plants have the potential to contribute resistant phenotypes to susceptible populations leading to resistance development in cropping fields."

Errors in application, leaf contact of treated and untreated plants, protection by taller plants or mulch, soil degradation and spray drift or run-off can further lead to alterations of plant growth in resistant plants within a population. The latter effects may change the size distribution within a population (resistant vs susceptible) and these scenarios could stimulate the growth of treated plants in the short term and accelerate resistance development in the long term.

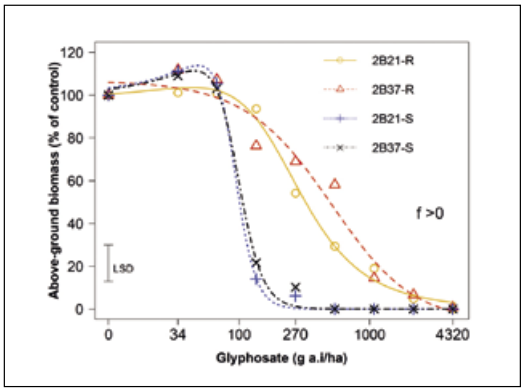


Figure 2. Above-ground biomass of glyphosate-susceptible (2B21-S and 2B37-S) and glyphosate-resistant (2B21-R and 2B37-R) phenotypes of awnless barnyard grass. Lines describe the predicted survival responses according to employed hormesis equation. The *f* >0 indicates there is a stimulation at low doses of glyphosate in susceptible phenotypes.

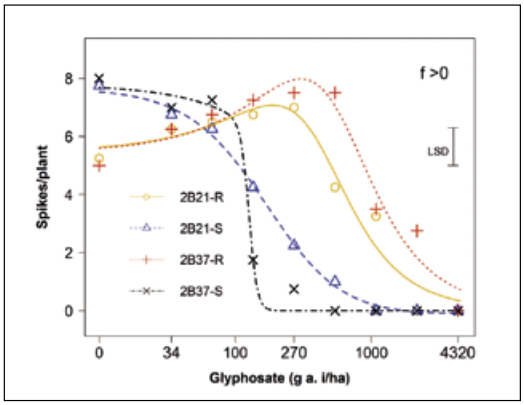


Figure 3. Spikes/plant of glyphosate-susceptible (2B21-S and 2B37-S) and glyphosate-resistant (2B21-R and 2B37-R) phenotypes of awnless barnyard grass. Lines describe the predicted survival responses according to employed hormesis equation. The *f* >0 indicates there is a stimulation at low doses of glyphosate in resistant phenotypes.

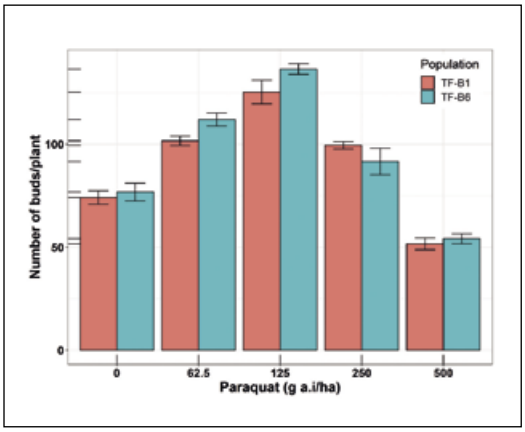


Figure 1. Paraquat hormesis in two resistant (TF-B1 and TF-B6) populations of tall fleabane. The application of low doses of paraquat act as sub-lethal doses and stimulated the vegetative and reproductive growth of resistant tall fleabane populations.

Eric says this latest research reinforces the current industry guidelines that residual herbicides be used in an integrated weed management (IWM) system to ensure the ongoing efficacy of key herbicides such as glyphosate.

"Glyphosate is an important herbicide in Australian agricultural production systems and new management practices are needed in cotton IWM systems," Eric said.

"The Australian cotton industry's Herbicide Resistance Management Strategy (HRMS) aims to prolong the life of glyphosate in Roundup Ready cotton production.

"The HRMS protects the life of glyphosate in combination with other tools to effectively disrupt targeted weeds by an IWM approach.

"From a management point of view, soil-applied herbicide is one of the chemical options which target seedlings before they germinate early in the season providing ongoing residual control and taking the pressure off glyphosate use.

"Regular resistance testing in both cropped and non-cropped sites is crucial to avoid additional factors like hormesis which indirectly contribute to resistance development."

For more

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Herbicide Resistance Management Strategy

www.cottoninfo.com.au/publications/herbicide-resistance-management-strategy

Creating leaders now for the future

The selection panel had their work cut out for them when choosing the latest cohort of the industry's premier entry-level leadership program – Australian Future Cotton Leaders.

Ultimately, diversity was the biggest winner, with eight women and seven men from across NSW, Queensland and the ACT participating in the 2022 program with support from Cotton Australia and CRDC.

CRDC Communications Manager and leadership program lead Ruth Redfern said the participants include cotton growers and farm managers, researchers, extension officers, marketers, and fashion designers.

"They're a talented mix of people who are already working to improve the future of the Australian cotton industry," she said.

"We're confident that we have selected 15 people who are dedicated to empowering themselves and who will empower others across our industry, across many sectors and in diverse ways.

"In their day-to-day roles, these emerging leaders are already tackling big issues like cotton's heat and drought tolerance, water use efficiency, ginning optimisation and showcasing cotton as a renewable resource for emerging designers.

"Previous graduates have been drivers of change in industry and we have confidence that the 2022 participants will continue that tradition."

The program will feature face-to-face forums, interactive online discussions, one-on-one coaching and integration with industry activities. Participants will also undertake an individual project related to their area of interest. In the past these projects have been launching pads for alumni to start or enhance the impact they have on the industry, and often represent the start of a leadership journey that, as is the aim, continues well beyond the program. The program winds up with the Australian Cotton Conference, on again this August.

Cotton Australia CEO Adam Kay said the calibre of applicants highlights the role Australia has in leading the world in improving cotton quality and environmental stewardship.

"I am excited about the 2022 Future Cotton Leaders Program because of the potential for real benefit to the participants and the industry as a whole," Adam said.

"They have some game-changing ideas and a passion for improving sustainability, quality and yield.

"The program is professionally delivered, empowering participants to give as much as they take, encouraging fresh thinking and innovation from our emerging cotton decision-makers.

"It aims to develop their leadership knowledge, skills and experience so that they, in turn, can play key roles in further developing the industry," he said.

This year will see a greater level of grower

Jenna Bell is from a third-generation farming family and has also started an off-farm business.

participation, along with women who are working in the value chain in innovative ways.

Skills for future roles

Jenna Bell is from a third-generation farming family, based at Whitton in the Riverina (Wiradjuri country) where she now grows cotton and winter cereals with her husband Andrew and their children. As well as farming, Jenna is the grower support coordinator for Southern Cotton and co-owner of an irrigation automation business.

Through the program, Jenna hopes to gain the skills to take greater leadership roles in the industry and enjoy higher-level management roles.

"I'd like to keep stepping up the leadership ladder," Jenna said, "and am really grateful to have the support of my current workplace.

"The current management at Southern Cotton, and in particular our Executive Director Kate O'Callaghan, have been very supportive of my application to Future Cotton Leaders and Kate is one of my role models.

"Her leadership qualities are inspirational to me and I hope through this course to build some of those skills and also give back to the cotton industry, as Kate has done."

Jenna says the encouragement of her local Cotton Australia Regional Manager Harriet Brickhill also gave her the confidence to apply.

With a strong interest in sustainable agriculture and economic profitability, Jenna is also involved in the family's irrigation automation business. The system was designed by her cotton-growing husband Andrew and a friend who is a mechatronic engineer, for use on their farm. However the system was so successful that other growers in the area wanted to use it, and so the business was born. They've since supplied the automation technology free of charge to the IREC field station at Whitton.

"It is such an innovative organisation and the site is really working hard to do the research and get the information out there that we can irrigate more efficiently and sustainably through automation.

"Supporting IREC was a way for us to support the industry that is supporting us through the innovative R&D happening there and elsewhere throughout the industry, with mutual benefit for businesses and the industry more broadly.

"I think this is an example of how I view the leadership course – an opportunity to leverage my strengths and build up any areas that need strengthening to provide leadership that benefits myself, my family and the industry."

Danni Ingram runs the family farm with her husband Robert and young family.

Self-development and giving back

Danni Ingram is no stranger to the cotton industry and has recently stepped into the president's role with the Central Highlands Cotton Growers' and Irrigators Association.

As a cotton grower with husband Robert they took over running the his family's farm around seven years ago.

Applying for Future Cotton Leaders is something Danni was wanting to do for a while.

"I have two children and one heading to school this year, so felt I had some extra time on my hands and so the time was right to do this," she said.

As an agronomist, Danni is also involved in agronomy work on farm, something she's been doing for a while now.

"I started checking for dad who was an agronomist when I was 15 at Murgon in the South Burnett (Waka Waka country)," she said.

At the ripe old age of 25, Danni took on a manager's role with CGS in Emerald (Gayiri country),

"It is an opportunity to leverage my strengths and build up any areas that need strengthening to provide leadership..."

where she remained for five years until the arrival of her second child, when the manager's role and running the farm became "a bit too much".

"In applying for the course, there is an aspect of self-development and giving back as well," Danni said.

"I think there are different ways of having or showing leadership – some people are good at being the 'front people' of leadership and some are more behind the scenes, guiding and helping.

"There are also different levels of leadership that people are comfortable with and I'm hoping to find mine.

"While I have been in leadership roles for years, I find some of the personality aspects of good leadership taught through the course are really interesting, and I can use this on the farm.

"It's also a good opportunity to connect with others – the cotton industry is fantastic for making connections, it's actually surprising how many people I already know in this intake!"

As a volunteer on the CGA and other community roles, of particular interest to Danni is the notion of volunteer burnout, which may yet form the subject of her project.

"So many organisations, inside and outside of cotton, rely on volunteers and it is generally a core group," she said.

"They're on the CGA, local show and school committees and so on – it is the same people turning up again and again.

"As a CGA we do a lot of things that require volunteers such as teach the teacher, putting up displays at the show, or running the awards night.

"I feel leadership is making sure everyone is willing to turn up.

"I also feel there is a lack of confidence in younger people which is barrier to them stepping into volunteering and leadership.

"I'd love to help guide people to build confidence to take the next steps.

"Sometimes it is adapting to change ourselves and changing our mindset of 'they won't listen to me' or 'I'm too young'.

"I took on a manager's role at 25, and while it was scary it led me realise what I can achieve and was a great lesson I've taken with me since, that we can achieve things we don't think or realise we are capable of."

Looking toward autonomy

Charlie Clark is a part of the family operated Clark Farming group along with his family, growing cotton and broadacre crops with his wife Jess on one of their operations north of Goondiwindi (Bigambul country).

He's looking at leadership and management from a perspective of building a sustainable, corporatised family business. He also has an interest in workforce issues and how this will play out in the future as farms are modernised and autonomous farming becomes more widespread.

"Future Cotton Leaders is a pathway to continue to upskill in management training and ensure the longevity of sustainable family outfits like ours," Charlie said.

"And we can't operate and grow without good people working with us, so need to focus on creating a workforce in a rapidly changing agricultural environment.

"We have a long-term outlook for our business – my aim is to move to autonomous machines and technology wherever and whenever we can."

A priority for Charlie is how to attract and upskill staff with qualifications in other trades into more managerial roles within their organisation.

"We have people with various skills and trades who have made their way to ag.

"I'd like to learn more about how we can create our future on-farm employees and managers."

"Agriculture as an industry laments our lack of qualified staff available, however perhaps we need to better value the people already in agriculture.

"A good start would be some way to recognise experience and the skills of people who've worked on farms which acknowledges their prior contributions to farming, to encourage them to stay in it," he said.

"And for those looking to get into the industry, I believe an agricultural trade could encourage more entrants into the cotton industry."

He feels agriculture could benefit from supporting agricultural accreditation beyond what is currently available at TAFE for example.

"It could solve some workforce issues if we could get an ag/farming trade off the ground, structured the same as traditional trades, giving apprentices on-the-ground training from *my*BMP-accredited growers."

Charlie's also hoping the course will further his leadership skills to develop a positive and enjoyable farm culture, and bring people into that internal culture to create good workplaces and successful, sustainable farms. Farms where people want to stay and work.

"As a grower, I believe we need leadership skills which can help create a great work culture and help us navigate the labour market in readiness for when we transition to and embed autonomy and robotics into our farming systems."

For more

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Support for workforce attraction

The Australian Department of Agriculture, Water and the Environment has provided a grant for new research to help attract and retain workers.

The Community Perceptions and Workers Experiences' Project, managed by CRDC's fellow research and development corporation (RDC), AgriFutures Australia, aims to deliver insights into community perceptions around working in the agriculture sectors, as well as exploring worker experiences and the impact they have on attraction and retention.

Ultimately the aim is for jobseekers to have a better understanding of modern agriculture, the workplace opportunities it offers and how to enter the workforce.

CRDC, Cotton Australia and key agricultural workforce researchers will represent the cotton industry on the steering committee over the 12-month project, which will include qualitative and quantitative research, industry roundtables, communication and extension.

CRDC R&D Manager Rachel Holloway said this is a novel project that will provide foundations to closing the gap on attracting people into the agricultural workforce.

"It will also support proposed CRDC projects in attracting and retaining young people in cotton career pathways, supporting school leavers and career changers, and providing opportunities for greater diversity," Rachel said.

"A group of RDCs, along with key state and federal representatives, have been meeting since last year to discuss agricultural workforce research, and this new project is timely for informing how to collectively address a complex problem."

Most recent CRDC-supported research into human capacity, conducted by Dr Nicole McDonald of Central Queensland University, has shown that the future of work is never certain and there are many pathways to attract and retain people in agriculture. Several trends are shaping changes in the way people work in the cotton industry. These include access to digital technology, environmental challenges and society's expectations.

Her research found that it is the 'human' aspect of the cotton industry and agriculture that will be a major factor in determining whether the industry is disrupted by changing economic, environmental or social landscapes and how the industry positions itself to plan, adapt, respond and capitalise on these trends.

"The future of work is never certain and there are many pathways to attract and retain people in agriculture."

For more
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PhD to improve wellbeing on farms

Goondiwindi (Bigambul country) cotton grower and practicing psychologist Chantal Corish is aiming to create safer working environments on cotton farms.

Chantal has recently received a scholarship to undertake a PhD with Central Queensland University (CQU) and CRDC. She will also have the opportunity to contribute to a broader industry-funded project being undertaken by the CQU Agri-tech Education and Extension team that aims to deliver best practice to manage future workforce skills in the Australian cotton sector. This PhD project is a vital part of ensuring resources and outcomes are evidence-based and lead to improved practical outcomes for the cotton industry workforce.

In her current role, Chantal works with organisations to develop workshops and programs tailored to their workplace mental health and wellbeing needs and regularly advocates for greater awareness of emotional intelligence (EQ) and psychological safety within workplaces to increase employee engagement, retention and general wellbeing. This will also be a focus of her PhD study.

Chantal (centre) graduated from the Australian Rural Leadership Program in 2021, with support from CRDC, Cotton Australia, Auscott and Prime Super. She is pictured here with ARLP Director Anna Carr and former Governor General, the Hon. Sir Peter Cosgrove.

"Prior CRDC-supported research identified psychological safety as a key factor that could prove essential for the future of work in the cotton industry," Chantal said.

"I want to explore the effect of psychological safety on team learning, performance and wellbeing among cotton farming employees to achieve optimal positive workforce culture and workplace sustainability.

"I believe there is a dearth of knowledge in relation to farmer and farm workforce wellbeing and optimal workplace culture on farms.

"I'm really keen to use my fairly unique position as a rural psychologist and cotton farmer to help further the knowledge and understanding of farm worker needs in the cotton industry and more broadly across agriculture."

Giving scholars a reason to return

Summer vacation scholars are relishing the experience of working with cotton industry researchers on research projects set to have a significant impact on the industry.

Ellie Bennett at work with Dr Tim Weaver and Research Technician Kellie Gordon during her studentship at ACRI Narrabri.

The students are a part of CSIRO's Agriculture and Food's Vacation Scholarship Program, which is aimed at students in second or third-year undergraduate studies.

This program is supported by researchers from CSIRO Agriculture and Food (led by Dr Hazel Parry) and agricultural industries through CRDC, Cotton Seed Distributors (CSD), Grains Research & Development Corporation, and Meat & Livestock Australia.

"Engagement with industry in our program is a win-win-win," Hazel said.

"Firstly, for the students to undertake exciting projects with real-world applications, secondly, for industry to gain insight to and benefit from the new ideas emerging at CSIRO, and thirdly for our scientists to have capacity to explore those ideas and gain visibility for them".

CRDC and CSD have supported four students who worked on research challenges set by CSIRO cotton researchers over the summer university holidays. The researchers Dr Katie Broughton, Dr Tim Weaver, Dr Xiaoqing Li and Dr Mark Farrell and Nina Welti. worked with students Corey Cutler, Ellie Bennett, Lara Horvat and Kaidy Morgan. None of the students had previously worked in cotton research, but all gave very positive reports of their experience, which has opened up options in cotton research that they had not considered.

The projects are designed by the researchers so the students could complete their component within the 10-week program.

>

CRDC support for summer program

CRDC and CSD came on board again this summer to support the industry in showcasing opportunities and innovations in the Australian cotton research community to ambitious student researchers.

CRDC Executive Director Dr Ian Taylor said the calibre of Australian cotton's scientists is evident in that we are regarded world leaders in R&D.

"We have been incredibly fortunate to have our researchers both past and present," Ian said.

"We've had so many passionate scientists and researchers who have given us the tools to grow the most sustainable cotton in the world.

"With most things, how and why these scientists come or don't come to the industry is changing.

"Previous studies CRDC has supported show that exposure to an industry and the ability to create contacts and networks greatly increases the likelihood of a graduate – or for that matter a farm-based employee – coming to the industry.

"From the responses of the students, it is clear that a summer scholarship opens up a whole new world of research, and in some cases, makes them seriously contemplate a career they hadn't even considered before.

"We've also had feedback from our 2021 PhD Tour participants that by visiting Narrabri, meeting CRDC R&D Managers, researchers at ACRI and touring a farm, they felt a greater link to the industry so it goes to show how important exposure to the industry is."

Once you get to know us, you won't leave!

The program is an avenue to give these students an experience that may encourage them back to the industry when they graduate.

Cotton researcher Dr Hiz Jamali leads the program's engagement with the cotton industry including coordinating cotton related projects.

"The program addresses difficulties in finding and hiring quality Australian graduates who are ready to begin their careers in science and innovation," he said.

"By exposing talented undergraduate students to the excitement of scientific research we hope to attract these students to careers in biological and agricultural sciences, while at the same time contributing to CSIRO's research effort in basic and strategic research in sustainable agriculture."

Dr Katie Broughton came to the cotton industry as a young scientist and said it is great to have opportunities that attract early-career researchers to the industry.

"I didn't participate in this particular program but did have the opportunity to undertake two Cotton CRC-funded scholarship programs while I was at uni – it was great exposure!"

Dr Xiaoqing Li said student Lara brought her passion in science and her fascination for textiles and materials to her summer scholarship.

"This program has reminded me of memories from when I was a student at that age."

Xiaoqing feels the experience gives the students a greater insight into working in ag research to help influence career paths.

"I think it gives a great opportunity for them to develop a deeper understanding of the research fields," she said.

"It also shows the day-to-day life of a researcher and connects them with various people related to a research life: all of those things will have some effect on their career paths."

For more
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Corey at work in Dr Katie Broughton's experimental greenhouse at ACRI Narrabri.

What did they do last summer?

The four students come from a range of academic backgrounds, but all agree the experience has been eye-opening and given them insight into research life and the cotton industry.

Corey Cutler

Student Corey Cutler has been exploring genotypic variability in transpiration of cotton in response to drought, with support from researcher Dr Katie Broughton.

Corey is studying a Bachelor of Rural Science at the University of New England and is interested in becoming an agronomist after "taking a liking to plants."

"This is my first taste of cotton research or any type of research for that matter and it's been great," Corey said.

"I applied as I'm in my final year of my degree and completing my honours so I thought the program would give me head start in understanding the foundations to research and what better way to get some experience than with great mentors based at CSIRO.

"Engagement with industry in our program is a win-win-win."

"The most surprising aspect has been the amount of responsibility I have been given in regard to the project. I came in thinking I would just be assisting in the project but it is rather the opposite and people are assisting me."

The students have relished the opportunity to step away from the computer and on-line learning, as a result of COVID-19.

"The best part has been doing the hands-on practical stuff that I have missed out on with uni being online for the last two years," Corey said.

"The people I have met and the connections I have made have also been a highlight of the program."

Ellie Bennett

Ellie Bennett has been researching with Dr Tim Weaver, scanning cotton leaf and petiole samples with new emerging handheld NIR technology to assist the cotton industry to monitor the nitrogen use efficiency through real-time analysis.

Like Corey, Ellie said the pandemic has completely restricted her ability to partake in any hands-on field and laboratory work through her university degree.

"The summer studentship seemed like a fantastic opportunity to finally get some experience in conducting meaningful research involving hands-on field and lab work," Ellie said.

Ellie is studying conservation biology (a form of environmental science focused specifically on conservation). A lot of this is based around ecology, however she has more of a personal interest in sustainable agriculture and improving conservation efforts within agricultural industries.

"The studentship was attractive as my university doesn't focus at all on agriculture so I thought it would be a good opportunity to learn more about agriculture, network with professionals and open myself up to opportunities in agriculture that may blend nicely with my other areas of interest including conservation," Ellie said.

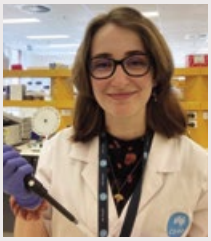
"This experience has given me an entire network of professionals to learn from and connect with, and broadened my perspective on the value of conducting research, in that it can have an industry focus, not just answer broad questions or solve scientific conundrums.

"This experience has definitely made me consider continuing work in the cotton industry and other agricultural industries as a future career path.

"It's exciting to know that there are still so many ways to improve the industry for growers and for the environment."

Use the QR code to see a short video Ellie created of the handheld NIR technology.

Lara Horvat



The diversity the students bring to the cotton industry is a win-win.

Lara Horvat has been working with Dr Xiaoqing Li on her research improving cotton quality for better dye uptake. Lara has definitely brought a new perspective to cotton, having completed a Bachelor of Medical Science just prior to this studentship.

"Throughout uni I jumped between different disciplines within medical science, eventually settling on cell and molecular biology," Lara said.

"Luckily, the broadness of this discipline allows me to apply my knowledge and skills to a variety of topics and explore a variety of ideas."

Beyond research experience itself, Lara said this program has pushed her to become more independent and confident in her work.

"At first I was very meek in the lab, but after a while the experience allowed me to trust myself and my work more, which I feel is very valuable not only in a career sense but in a personal sense as well," she said.

"Experiencing a proper office environment was difficult to get used to as I am not very social, but one of my favourite parts of coming into the lab is walking past people's desks and exchanging a greeting or having small chats with people in between busy schedules.

"I'd say the cotton industry is definitely a possible avenue for my future as a scientist! There is so much potential in further improving this vital crop."

Kaidy Morgan

Kaidy Morgan is interested in regenerative agriculture and ways in which the environmental impact of large-scale food and fibre production can be reduced. She's been working with Dr Mark Farrell and Nina Welti on the question 'Does diversity matter for cover crop selection?'.

Last year Kaidy completed a Bachelor of Agricultural Science at the University of Adelaide, studying subjects focused on soil health and function, with a plan to continue studying regenerative agricultural practices to improve the ease with which they can be incorporated into large scale systems.

"My summer project at CSIRO focussed on cover cropping and the effect of specific plant traits on soil chemistry and nutrient content," Kaidy says.

"Working as a summer student at CSIRO seemed like such an amazing opportunity for my career development.

"As a recently graduated student, it is rare to find a job that would allow me to have a lot of independence and responsibility, which made the studentship a great way to explore my options in the agricultural research field."

All the students remarked on the opportunity to work with the CSIRO scientists and embrace the culture of R&D.

"I really enjoyed being able to work with a great group of people that were all passionate about similar things to me," Kaidy said.

"I have never in my life been able to spend as much time with people that share the same interests, and I loved being able to have deep conversations about science and research in both a formal and informal manner."

CCA student member Olivia Bange.

CCA takes proactive approach to attract young agros

Australian agriculture did not need a pandemic to cause a skilled workforce shortage. It has been an increasing problem within most facets of the industry for years.

Recent domestic and international border restrictions have only highlighted the extent of the shortage that was being masked through the employment of backpackers and international skilled professionals.

In 2019 the Australian Government commissioned the National Agricultural Labour Advisory Committee to inform the development of policy strategies and programs for the sector. The committee reported many opportunities for development but highlighted a preexisting 'optimistic and proactive approach' by many in the industry and that a motivated, well-trained workforce does not emerge by itself.

"Industry leaders have to place workforce capability development planning at the core of their businesses and do so collaboratively across all parts of the sector," the report said.

Crop Consultants Australia (CCA) is one such industry organisation that has continued to lead the way in ensuring its members are connected, informed, engaged and ethical professionals in the cropping industry. Despite common belief, the definition of 'professional' is not limited to qualified practicing consultants. CCA places a high priority on the promotion of consultancy as a profession and mentoring and development of students and less experienced members of the industry.

To encourage student participation, CCA membership is free for undergraduates studying agriculture. Recently, CCA has developed a new membership level for recent graduates who will are now able to join for $99 for their first year of membership (a saving of $226 on full membership).

The benefits of belonging

Goondiwindi based (Bigambul country) CCA student member Matilda Paesler is heading into her third year studying rural science at the University of New England. Matilda has spent her summer

holidays bug checking and joined CCA on the recommendation of another member. She says her membership is enabling her to develop more extensive experience in the industry.

Matilda has always been destined for a career in agriculture and appreciates the problem solving and connectivity that are key parts of her future profession.

"CCA is a great way to connect and get a head start both before and after you've graduated," she says.

"I particularly get a lot out of the newsletters as they enable me to keep up to date with the real issues of the industry."

Likewise, University of Queensland third year student and CCA student member Olivia Bange says that the networking opportunities of CCA are presented in such a way that young members need not be overwhelmed. Like Matilda, Olivia spends her holidays working for a consultant and 'discovered' CCA upon their recommendation. For Olivia, who at the time was seeking clarity on her career direction, the CCA website provided great insight.

"I realised then that agronomy has so many different areas and specialities, study in the field doesn't limit you to a career in just one area, you can move in between," she said.

She said that study can often be very research based but "CCA enables me to dive deeper into current industry issues and understand the commercial implications".

Olivia calls Narrabri (Kamilaroi country) home and is the current President of the University of Queensland Agricultural Science Society and is keen to encourage other students to take advantage of free CCA membership.

"Free membership means that students have nothing to lose by joining and seeing if it is for them," she said.

Free and discounted membership is only the start for CCA in terms of what they would like to offer to the industry's future professionals.

CCA Young Member Director Liz Lobsey is seeking input from industry regarding other ways in which the Association can engage with, and mentor the new generation of consultants and researchers.

Liz is a consultant in Dalby (Barunggam country) and has observed that while COVID-19 has led to conversion to online delivery of study, it has also seen the decrease in practical placements that were previously integral to undergraduate curriculums. She believes that CCA is well positioned to help fill that learning gap and looks forward to working with students and universities alike to make this happen.

"CCA has never been an organisation that is all about gaining members," Liz said.

"We see our role as one of stewardship and mentoring and to do that we need to work across all sectors of the industry.

"Regardless of what sector a student chooses to pursue, we hope that they will see benefit in what CCA has to offer, in both the short and long term."

With domestic student enrolments in tertiary agricultural courses at an all-time high, CCA is playing its part in developing the professionals of the future. As borders reopen, and we welcome international an international workforce, the future of Australian grown agricultural talent also looks very bright.

"CCA is a great way to connect and get a head start both before and after you've graduated."

For more
CCA
info@cropconsultants.com.au

Goondiwindi based CCA student member Matilda Paesler.

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