Spotlight
ON COTTON R&D

WINTER 2021

THE INNOVATION EDITION

Australian cotton:
An industry with vision

Exploring new
scientific realms

Innovative by nature

CRDC

Dr Ian Taylor

In the Spotlight

Welcome to the 'innovation' edition of *Spotlight*.

As agriculture continues to navigate the brave new world created by the development of the internet of things, big data and technological advancements, CRDC is also creating new pathways to capitalise on it.

The role of the Australian cotton industry's world-class researchers and research projects are often the motor that drives innovation. Bringing this research together creates the brains for new technology for improved decision-making and crop management at the farm level. It also creates opportunities for cotton and its feedstocks to be transformed into new products for industries outside our traditional fibresphere, such as in the medical and bio-fuel industries. At the post-farm gate level, it gives the processors such as ginners the tools to turn out the fibre Australian cotton growers are so well known for.

CRDC will continue to support rigorous research, development and extension (RD&E) through traditional research pathways, albeit with a new focus on how to better bring knowledge and products to the field. We are also looking to the future, through our Vision 2029 commitment, to create and prepare the industry to increased sustainability and efficiency. Technology has a major role to play in this.

This has prompted CRDC and our fellow Research and Development Corporations (RDCs) to harness what is now a part of the R&D landscape. This includes the start-up community, major cross-sectoral collaborations, commercial partners and pathways to bring innovation to market, as outlined by the recently launched growAG initiative and the establishment of Agricultural Innovation Australia Pty Ltd.

The notion of putting a problem out there and asking innovators to solve it is not a new one. CRDC has, for some 30 years, worked with scientists to solve cotton's wicked problems. That has not changed, but the depth and width we cast our net is greater. There is a world of innovation waiting to be harnessed by Australian agriculture, and we as RDCs are ready to do just that.

In this edition we've provided some background on how RD&E is evolving and what it offers us. It is impossible to cover off every innovative project CRDC invests in, so in this edition you'll find a snapshot to illustrate how traditional research and development is backing innovation, along with the pathways CRDC is following to bring innovators to our industry.

You'll also find the full list of our investments for the coming year. If you'd like any further information about any of the RD&E that CRDC is investing in on your behalf, please give us a call.

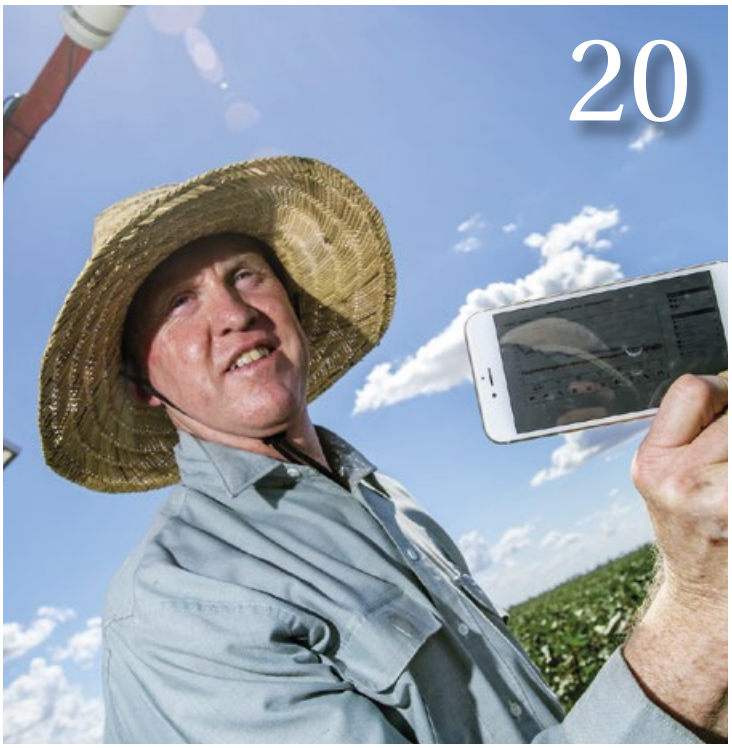
And, until next time, please enjoy this edition of *Spotlight*.

Dr Ian Taylor
CRDC Executive Director

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

MELANIE JENSON

Winter 2021



USQ

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

CRDC
COTTON RESEARCH AND DEVELOPMENT CORPORATION

Cotton Research and Development Corporation
ABN: 71 054 238 316
Our vision: A globally competitive and responsible cotton industry.
Our mission: To invest in RD&E for the world-leading Australian cotton industry.

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

IMAGE COURTESY JOHN DEERE

ON THE COVER: A new series of John Deere sprayers feature technology with its beginnings in industry-supported R&D.

Want to see more of Spotlight?

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

COTTON NEWS

FEATURES

ON THE COVER

Your chance to have your say

THE experiences and opinions of growers are integral to how CRDC prioritises research and development investment. A direct avenue for growers to influence these priorities is by being a part of the annual *CRDC Grower Survey* which opens via phone on June 1.

Gathering information about farming practices and growers' views on research, development and extension helps inform CRDC about the benefits of its investments. It informs future research and documents change in industry practice which can be quantified across the surveys which now span 20 years.

The reports from each annual survey give growers and crop managers the opportunity to compare their practices to others, gain a greater insight into all aspects of how others view the industry and manage their farms. It also allows for regional comparisons.

The surveys include core annual questions with focus areas to investigate specific aspects of the farming system. The grower responses are anonymously compiled to create the survey report which is available as a downloadable PDF or via an on-line interactive digital dashboard. Previous survey reports are at Inside Cotton, CRDC's electronic library with the latest report published on the CRDC website.

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

For more

www.crdc.com.au/growersurvey
www.insidecotton.com

UNE

Science plumbs new depths

INNOVATION can come in some of the most 'unlikely' of ways.

While burying cotton undies in paddocks around your farm might not have the high-tech hallmarks of 'innovation', this quirky experiment is creating conversations and focus around soil biology and health beyond the cotton industry.

'Soil Your Undies' is a joint CottonInfo and University of New England Cotton Hub campaign that began three years ago, and is so innovative, it's become a Citizen Science project!

CottonInfo has been supplying 100 per cent cotton undies for the experiment, which are buried for eight weeks in cotton fields and other areas on-farm. The level of degradation correlates to soil health and microbial activity. While there are high-tech methods to measure soil health, Soil Your Undies is proving that innovation can also be simple. CottonInfo is also tracking where the jocks are buried, and what state they're in.

The campaign has been led by cotton industry soil scientist and CottonInfo Soil Health Technical Specialist Dr Oliver Knox who has a knack for bringing quirky to science. As a result, now it's not just farmers involved – people across Australia are now soiling their undies in backyards and vegie gardens!

"Taking the experiment from farm to the classroom has been a great way to introduce children to the importance of soil and its incredible biology, whilst also talking cotton," Oliver said.

"With 2021 being the year of Soil Biodiversity, if you were ever going to soil your undies, then this is the year to do it!"

For more

www.cottoninfo.com.au/soil-your-undies

What's new in management?

THE 2021 Australian Cotton Production Manual is a critical reference tool for growers, outlining all the decisions to be made on-farm for cotton production. It's also a handy resource for farm staff, researchers and students. The manual provides an understanding of cotton physiology and important considerations for productivity and profitability. Published by CRDC and CottonInfo, it's updated each year to incorporate the latest research and consistent improvements in industry best practice. For subscribers, the hard copy is included with this edition of *Spotlight*, while the publication is also available for download at www.crdc.com.au/publications/australian-cotton-production-manual

IMAGE: MELANIE JENSON

Innovative new era in R&D has begun

In a sign of things to come, following a review of the Australian cotton industry's Vision 2029 in 2019, 'innovative' was added as a seventh objective to reflect its fundamental and increasing strategic importance.

The review was undertaken by the Australian Cotton Industry Forum, who were integral in creating Vision 2029 back in 2009. Vision 2029 outlined Australian cotton's shared 20-year aspirations. With the aim to take the 'long view', Vision 2029 aligned the industry's strategic focus and continues to inspire and unify Australian cotton to look beyond the immediate, to recognise future challenges and opportunities and be well positioned and prepared to tackle them.

In a collaboration between CRDC, Cotton Australia and the then Australian Cotton Industry Council (now Australian Cotton Industry Forum), the shared vision for the future of Australian cotton was developed to improve the industry's long-term performance, organisational cooperation, capacity, profile and prosperity. Every link in the Australian cotton industry chain was addressed including seed and chemical distributors, growers, consultants, researchers, pickers, truckers, ginners, classers, merchants, spinners and brand owners. In partnership, the industry identified trends and driving forces influencing cotton's future and developed scenarios to explore the possible futures Australian cotton might face: Boom, Bust, Food Replaces Fibre, and Present-Day Projection.

Vision 2029 initially outlined six key objectives for Australian cotton's preferred future – that by 2029 the Australian cotton industry will be:

Differentiated – world leading supplier of an elite quality cotton that is highly sought after in premium market segments.

Responsible – producer and supplier of the most environmentally and socially responsible cotton on the globe.

Tough – resilient and equipped for future challenges.

Successful – exciting new levels of performance that transform productivity and profitability of every sector of the industry.

Respected – an industry recognised and valued by the wider community for its contribution to fibre and food needs of the world.

Capable – an industry that retains, attracts and develops highly capable people.

Following 2019's 10-year review of the vision's currency, 'innovative' was added as a seventh objective to reflect its fundamental and increasing strategic importance: that we are 'an industry that continually adapts and progresses through new ideas, processes and impacts'.

The review explicitly recognised the impact of the digital revolution and that cotton, as an outward-looking industry, places great importance on understanding and responding to changing consumer and community expectations as the basis for trust and social license.

MELANIE JENSON

CRDC supported entrepreneur Anastasia Volkova is bringing crop management decision-making software to the market. Anastasia is pictured giving her 2018 Australian Cotton Conference Start-Up Alley presentation.

While the industry had already embraced and instigated new Research and Development (R&D) approaches to progress and instigate innovation prior this review, the inclusion of innovation as objective has tangible impacts on the way CRDC is undertaking the business of Research, Development and Extension (RD&E).

"The industry has built and continuously supports a culture of innovation across the industry," CRDC Executive Director Dr Ian Taylor says.

"To have input from all quarters on what innovation looks like and means to them is integral to the notion of shared vision that is also an achievable one.

"We have recognised the digital revolution and the importance of agtech and embraced the start-up community as a valuable contributor to advancing the industry.

"Through our recent involvement in programs such as the Australian Government's Business Research and Innovation Initiative (BRII), we are exploring and testing other methods and sources to address industry challenges – in this case spray drift."

BRII supports early-stage development of solutions to challenges put forward by government agencies including Research and Development Corporations (RDCs). CRDC submitted the challenge of eliminating spray drift.

"The program works by inviting start-ups and small businesses from across Australia to put forward potential solutions to the problem of spray drift, which continues as an issue, despite the focus and investment involved over many years," Ian said.

"Six successful applicants were announced in January, each receiving a grant of up to $100,000 to further develop their ideas and test feasibility.

"The most successful may be eligible for a grant of up to $1 million to develop a prototype or proof of concept."

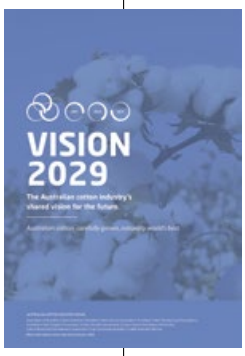
There is ever-increasing blue sky thinking to be harnessed. To this end, in 2017 CRDC supported innovators to attend science start-up workshops to support entrepreneurs, researchers and start-ups with ideas they wanted to bring into reality. Participants were then chosen to further their idea or innovation to the 'Cotton X-Lab' to further incubate and grow their projects.

CRDC partnered with a leader in start-up science, Pollenizer, and the Fisheries RDC to help take innovative ideas and turn them into a reality. Workshops enabled participants to develop their ideas with experts from across the industry and watch them come to life.

Anastasia Volkova and Malcolm Ramsey with their ag-analysis tool Flurosat were participants in the Cotton X-Lab program. Since then, the start-up has gone on to secure seed investment to

further develop the state-of-the-art remote sensing technology FluroSense, which allows farmers to measure crop health 'from the air'. The company has grown into a multi-million dollar venture offering novel technology for crops and natural resource management called Regrow.

CRDC is also supporting the development of a digital strategy for the cotton industry. This builds on the back of the *Precision Agriculture to Decision Agriculture,* and *Growing a Digital Future* projects, led by CRDC under the under the Australian Government's Rural R&D for Profit Program. These projects, delivered with fellow RDCs, addressed how digital agriculture could help producers harness its benefits to increase productivity and efficiency.



Further to this CRDC is creating additional avenues for innovation as partners in Agriculture Innovation Australia Pty Ltd, AgriFutures Australia's growAG, NSW DPI's The Gate, individual start-ups and by working with the commercial sector, all of whom play a role in bringing products to growers which will keep cotton, collectively, at the forefront of ag innovation.

"This activity moves in concert to our traditional R&D model and community, which continues to provide the scientific basis for new technology and improved management of cotton in Australia. It's the calibre and support of our RD&E community that has put Australia at the forefront of global production, prior to the digital revolution," says Ian.

"We have a long history of innovation and continue to see amazing products coming out of our R&D community.

"CRDC supported the development of early GM cotton varieties in partnership with CSIRO and our industry's world-leading insect resistance management strategies and best management practice program, which in itself was innovative for any Australian agricultural industry at the time.

"Coming out of CRDC-funded research and collaborations has been commercialisation of novel crop protection products Magnet and Sero-X, a new revolutionary insect monitoring system using smartphones, sensing technology and automation using the internet of things, and revolutionary new products using synthetic biology to allow plants to fight disease and pests, drought and climate change.

"We recognise the importance of innovation and transformative technologies in delivering impact where it matters most: on the ground and in our supply chains."

For more
Vision 2029
www.crdc.com.au/vision-2029

Engaging the start-up community

FLUROSAT and now Regrow CEO Anastasia Volkova founded FluroSat in 2016 while living in Australia. The now US-based agtech founder was a participant in a series of CRDC supported workshops including the Cotton X-Lab start-up program in 2017.

The Cotton X-Lab allowed the inventors to incubate and grow their project.

"We are extremely grateful to CRDC and X-Lab for connecting us with industry to get advice and run our ideas/questions about the prioritisation of the product features and the value to growers and agronomists," Anastasia said.

"It was invaluable in connecting us with government officials and other ag organisations which has led us to where we are today.

"This start-up coaching helped us with the formulation of business/product hypothesis and design of experiments to validate that in the quickest time possible.

"It helped us in keeping focused and defining our company strategy together with short/mid-term/long-term goals."

Initially, FluroSat utilised drone and satellite imagery to diagnose crop stress and produce nitrogen status maps that users calibrated using nutrient tissue sampling. This gave a full spatial representation of the nutrient availability across fields with just a few tests Today it is a fully automated solution to track, monitor, and manage crops from anywhere.

In 2018, FluroSat acquired ProductionWise, the digital agriculture platform of GrainGrowers. Anastasia and her team raised nearly $9 million with investors including Microsoft's venture arm M12.

The establishment of the new company Regrow earlier this year follows FluroSat's acquisition of soil health start-up Dagan. The flagship products of both FluroSat and Dagan and agronomic tools developed by FluroSat will be rolled into Regrow.

"Regrow is a single platform for systemizing and scaling sustainable agriculture practices, as well as measuring and verifying soil health and carbon outcomes," Anastasia said.

"With the use of computational agriculture, using machine learning and scientific modeling, the platform expands its capabilities into soil carbon accounting, bringing farmers and their agronomic decisions closer to benefitting from carbon markets."

Growing agriculture's pathways and opportunities

ACTING as a gateway to the world, growAG showcases Australia's world leading agricultural research, unique technologies and commercialisation opportunities on the one, new publicly-available platform.

growAG is a centralised platform that showcases Australia's agrifood innovation opportunities, success stories, and a comprehensive database of Australia's current agrifood research projects. It was launched in April by AgriFutures Australia in partnership with the Department of Agriculture, Water and the Environment and all 15 Research and Development Corporations (RDCs).

All the information on the platform is free to access and allows farmers, investors, corporates, startups, researchers, industry, government and universities from Australia and around the world to locate information and opportunities to deliver innovation back to the farm and the food and fibre supply-chain.

Minister for Agriculture, Drought and Emergency Management the Hon. David Littleproud MP said the platform would drive investment and commercialisation.

"I'm very excited about the opportunities this platform offers to help ensure farmers have access to the latest technologies," Minister Littleproud said.

"Innovation will drive productivity, meaning more dollars in the pockets of our farmers and stronger regional communities.

"A world class agricultural innovation system is an Australian Government priority and a key pillar in support of the industry's target for a $100 billion sector by 2030."

The platform aligns with CRDC's aim to share valuable research and connect with innovators, researchers and inventors and enhance commercialisation opportunities.

"Australian researchers are highly innovative and it is time to catapult them into a global market as many of their technologies are highly scalable."

The Hon Michael McCormack MP, Kay Hull AM, the Hon David Littleproud MP and AgriFutures Australia Managing Director John Harvey at the growAG launch in Wagga Wagga (Wiradjuri country) in March.

"With increased transparency, growAG highlights the key people and organisations working within the Australian rural innovation ecosystem and allows more strategic investment in research projects, opportunities to collaborate, and the ability to identify and decrease the risk of duplication in research investment," CRDC Executive Director Dr Ian Taylor said.

"For many years, the RDCs have been working collaboratively across many projects and on growAG all Australian RDCs come together again.

"growAG provides a transparent gateway to our innovation system – it's a very exciting step forward."

Regional and global agrifood tech businesses are looking for innovation partners, pathways and opportunities in Australia and growAG showcases the agrifood and fibre innovation and solutions Australia has on offer to the world.

AgriFutures Australia Managing Director John Harvey says it is an important step in Australia's bid to attract global investment and collaboration to deliver innovation to our farmers.

"Often the Australian market for agricultural innovation is too small to justify the costs of commercialisation," John said.

"This results in technology remaining 'on the shelf', available to no-one.

"Australian researchers are highly innovative and it is time to catapult them into a global market as many of their technologies are highly scalable.

"This way Australian farmers get the benefit of the technology they have paid for, being commercialised.

"growAG provides domestic and international audiences with an easy way to find and connect with the research partners they are after."

growAG works seamlessly alongside evokeAG. which is the Asia Pacific premier agrifood tech event with a network who are interested and keen to participate in collaborative thinking to change the future of Australian agriculture for the better. The evokeAG. website also acts as a resource tool, with news, case studies, videos, podcasts and a startup directory.

For more

www.growag.com

www.evokeag.com

MELANIE JENSON

CRDC Dr Ian Taylor speaking at the *Growing a Digital Future for Australian Agriculture* National Forum held in Canberra (Ngunnawal country) in 2019, which bought together RDCs and a range of stakeholders from education and training, telecommunications, producer groups, universities, data analysts and government.

Innovation and collaboration meet across industry lines

THE whole is greater than the sum of its parts as the Research and Development Corporations (RDCs), in conjunction with the Australian Government Department of Agriculture, Water and the Environment create a public company to drive innovation.

This unprecedented move is representative of the new thinking of RDCs with the not-for-profit Agricultural Innovation Australia Ltd (AIA) formed to drive cross-sectoral research, leverage private sector investment and target transformational innovation. These aims are in line with the Department's National Innovation Agenda.

AIA will drive cross-sectoral research, leverage private sector investment and target translation and uptake of innovation. Work is already underway across the RDCs to progress collaborative projects that tackle climate resilience. Working together through AIA to deliver a new nationally focused, whole-of-sector approach to agricultural innovation will increase impact on-farm and along the supply chain and deliver value for the Australian community.

RDCs are the cornerstone of the agricultural innovation system and have been instrumental in underpinning the productivity of Australia's agriculture, forestry and fisheries industries for four decades.

However, facing increasingly complex challenges requires new approaches for new ways of working and new strategic responses.

Minister for Agriculture, Drought and Emergency Management the Hon. David Littleproud MP said this is an unprecedented collaboration and coordination of investment in agricultural innovation.

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

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

Overall, RDCs are responsible for investing around $800 million each year, with almost $300 million of this from Australian Government funding and around $500 million from industry levies. In partnership with the RDCs, the government is continuing to drive improvements in the RDC system.

"Addressing complex and cross-sectoral challenges, accountability and transparency to industry and the broader community must remain key to RDC activities," CRDC's Executive Director Dr Ian Taylor says.

"As co-funders of the system, innovation investments must continue to demonstrate value and returns for levy payers and taxpayers."

AIA is a key element of the Australian Government's National Agricultural Innovation Agenda to modernise Australia's agricultural innovation system.

Australia is recognised for excellent agricultural research outcomes supported by multiple streams of industry and government-backed investments, according to a 2017 OECD report. However, agricultural innovation in Australia was not designed to operate as a cohesive system – it is made up of many institutions and bodies put in place over time across different jurisdictions and commodities. This is limiting the effectiveness of our innovation investments.

Accelerating productivity growth is essential to harness opportunities and

Key Points

- Agricultural Innovation Australia (AIA) is a not-for-profit, public company established to facilitate joint investment and collaboration in cross-industry agricultural issues of national importance.
- AIA attracts investment from public, private, not-for-profit and global commercial entities to deliver agricultural innovation initiatives.
- As a single point of contact for cross-industry strategies, AIA makes it easier for investors to navigate and partner with the Australian agricultural system.
- The scope of strategies covers the agriculture, fisheries and forestry value chains, including input supply, production, processing and export.

mitigate the risks confronting Australian agriculture. The National Farmers' Federation has set an ambitious target for a $100 billion agriculture sector by 2030 – world class innovation will be essential to drive the transformational productivity gains required to meet this target.

Given this, in September 2018, the Department of Agriculture, Water and the Environment developed a shared vision to best position the Australian agricultural innovation system for the future.

The report says that, in looking to the future, there is opportunity for Australian agricultural innovation to modernise and achieve greater and more diverse outcomes from investment in innovation, to adopt a more coordinated approach to respond to future opportunities, threats and trends and to better position Australia as a globally relevant agricultural innovation system.

Based on insights gathered from extensive stakeholder engagement, coupled with research into global agricultural innovation systems, there is a compelling case for change and opportunity to strengthen Australian agricultural innovation.

CRDC has been working with fellow RDCs to realise findings from the report. In particular, there are three avenues where significant work has been undertaken. The cotton industry's long-term aspirations, set out in Vision 2029 reflect this, and were updated in 2019 to reflect the growing focus on driving innovation. They are:

1. Future opportunities, threats and trends within the agriculture sector will occur in a larger, more complex and a faster manner than ever before, requiring leadership and cohesion across the ecosystem to set strategic priorities and drive a more coordinated and cross-domain approach.
2. Improving the mix of investment in innovation and growing the total funding pool including private sector investment would achieve better and more diverse outcomes.
3. An innovation culture that is more dynamic, encourages entrepreneurship and a more open approach to risk taking, would better position our future agricultural innovation system within the global innovation landscape.

A key example has been participation and successful funding applications through the Department's Rural R&D for Profit Program, which promotes cross-industry collaboration, information and innovation sharing. Major projects led by CRDC have been *Smarter Irrigation for Profit Phase 1* and *2*, *Accelerating Precision to Decision Agriculture 1* and *2* and *More Profit from Nitrogen*. CRDC has also been a stakeholder is many other projects led by fellow RDCs such as:

- Digital technologies for more dynamic management of disease, stress and yield;
- Increasing farm gate profits, the role of natural capital accounts;
- Developing renewable fine chemicals from cotton biomass; and
- Improving plant pest management through cross industry deployment of smart sensor, diagnostics and forecasting.

These projects have innovation and collaboration at their core.

As a result of *Smarter Irrigation for Profit Phase 2*, the cotton industry is looking to commercialise a number of innovations developed through support of the project, including Variwise, SISCOweb and sensor technology (see article next page) which can be utilised across many agricultural industries.

For more
Agricultural Innovation Australia Pty Ltd
www.aginnovationaustralia.com.au


MELANIE JENSON

VARIwise one step closer to the field

UNIVERSITY of Southern Queensland (USQ) researchers Associate Professor Joseph Foley and Dr Alison McCarthy (pictured) are working with CRDC to develop a commercialisation strategy for VARIwise, software that combines in-season imagery with crop production models to provide yield predictions throughout the season.

According to Alison, there is potential to improve yield prediction by using crop production models, calibrated using available field data, and infield imagery to provide more detailed crop features over satellite imagery. The UAV or infield camera imagery is collected for each management zone as identified from vegetation index surveys, yield maps or satellite images.

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

"The EOI period has now closed and we have identified some potential partners," Alison said.

"However we are still interested to hear from growers, potential users, and future commercialisation collaborators for the cotton yield predictor.

"VARIwise provides a unique yield-forecasting based approach for management and irrigation decisions and considers a range of factors including growth stage and water availability."

For more
Dr Alison McCarthy
alison.mccarthy@usq.edu.au

Seeing a new way to spray

New vision-based plant detection technology released by John Deere in March this year was developed through projects supported by CRDC with researchers from the University of Southern Queensland (USQ).

USQ

University of Southern Queensland Centre for Agricultural Engineering Director, Professor Craig Baillie, said Australian research and innovation will enable Australian farmers to be at the forefront of transformative agtech.

The See & Spray Select™ technology, integrated into John Deere's new 400 and 600 series sprayers is the only technology of its type available in Australia and the industry's first factory-installed, targeted spray solution.

See & Spray Select camera technology rapidly detects green plants within fallow ground and automatically triggers an application to those plants. In doing so, it achieves a similar hit rate to traditional broadcast spraying but uses, on average, 77 percent less herbicide*. Operators can apply complex tank mixes more efficiently and can switch from targeted to broadcast spraying, without the need to leave the cab.

The initial experimental work to develop the vision-based plant detection technology was funded through a combination of industry research projects with CRDC, Sugar Research Australia, Hort Innovation, and USQ. USQ's Dr Cheryl McCarthy led the project.

"It's really exciting that we have a played a part in bringing new tech to a farmer's toolbox for weed control," Cheryl said.

"We have helped define technology that is here and now, and industry can see R&D turning into an engineered commercial solution.

"We acknowledge our research partners CRDC, SRA and Hort Innovation as well as the collaboration with John Deere (USA) in achieving a successful outcome for industry."

CRDC R&D Manager Susan Maas said the technology is a good fit for managing rogue cotton in fallows and rotation crops.

"We worked with USQ on case studies that were cotton industry specific," she said.

"The partnership has let us bring those lessons together and work to find a solution that has broad application."

USQ Centre for Agricultural Engineering Director Professor Craig Baillie said the technology was an excellent example of Australian research and innovation having global application, enabling Australian farmers to be at the forefront of transformative ag tech.

"Industry collaborations such as this assist to sustain the development of future technologies and products which will transform agricultural industries over the years to come," he said.

USQ provided the experimental technology underlying See & Spray Select three years ago, which John Deere further developed and tested across farms in the United States, Canada, and Australia before its global release.

John Deere Australia/New Zealand Managing Director Luke Chandler said collaborations such as this are a powerful pathway to helping farmers around the world unlock the value of targeted and applied agricultural technology.

"We are delighted to have collaborated with USQ to develop industry-leading innovation here in Australia that has potential to deliver positive and impactful changes for farmers globally," he said.

"The path to greater efficiency, profitability and sustainability begins in the paddock.

"It is through these types of collaborations that we can create practical, simple-to-use tools and technologies that save time and input costs, and reduce impact on the natural environment, for a higher performing farm sector."

For more
Susan Maas
susan.maas@crdc.com.au

*Based on tank-level sensor values taken at a steady state on John Deere sprayers equipped with and without See & Spray™ Select, before and after covering 75,000 acres of fallow ground with a typical weed pressure of 3,000 weeds per acre, using small and medium spray-length settings starting at 2.3 to 3.2 ft. (0.7 to 1 m), and average growing conditions (seasonal precipitation and temperature) across the US and Canadian Plains and Australian farms. Spray-length settings varied based on ground speed, spray pressure, and boom height. Sprayers were equipped with current hardware and software at time of study. Individual results may vary based on field and growing conditions, weed pressure, spray-length settings, and software version.

Digital strategy calls for input from all sectors

The digital transformation of Australian primary production will be a step change for all sectors and a steady hand is needed to guide the change. The cotton industry has started work on its digital strategy to ensure the entire industry is harvesting the benefit of all that digital agriculture has to offer.

A steering committee has been established to oversee the development of the cotton industry digital strategy, to help decide collectively the best way of realising the potential of digital agriculture as an industry. Organisations and interests represented on the committee include cotton growers, CRDC, Cotton Australia, Cotton Seed Distributors, Bayer, CSIRO and NSW DPI.

The digital strategy will be focused on increasing the profitability of producers, providing clarity and trust in data ownership and access rights, and stimulating an innovation environment that facilitates the development and adoption of technology.

The current and future state of digital agriculture in Australia was first examined in detail via a cross-industry project led by CRDC through the Australian Government's Rural R&D for Profit project *Accelerating Precision to Decision Agriculture (P2D)*. Commencing in 2016, this research united all 15 Research & Development Corporations (RDCs).

The research estimated digital agriculture could lift the gross value production of Australian agriculture by $20.3 billion, a 25 per cent t increase on 2014-15 levels. However the study also found many Australian producers are finding it difficult to navigate the digital agricultural marketplace and worry about unwise investments without a guarantee of return.

Producers lack trust in data management systems and are unclear about the terms that govern their data including who owns their data, and who has access to it. How any value generated from

IMAGE: MELANIE JENSON

using the data is shared is also a key concern. Many producers and agricultural stakeholders require improved digital skills and knowledge and are frustrated by the unreliability of telecommunications connectivity and the inadequate services currently supporting the adoption of digital technology.

"This lack of producer control and under-utilisation of data to make decisions is putting Australian agriculture at a global disadvantage," CRDC's General Manager, R&D Investment Allan Williams says.

"While producers are becoming more skilled at deploying precision agriculture technologies, they are also trying to manage the constant stream of data gathered from farm machinery, sensors and digital technologies, and understand how to best integrate it all to inform management decisions.

"Increased information about the status of soil, water and crops is of little value unless it can be used to make improved decisions and act on them.

"How to use this data to improve on-farm profitability often remains the challenge."

CRDC R&D Manager Dr Meredith Conaty is overseeing the development of the strategy.

"The P2D projects highlighted that while digital technologies have the potential to fundamentally transform the way food and fibre is produced, traded and consumed, it is unlikely that the full economic potential of decision agriculture will be realised until several existing interconnected constraints are addressed," Meredith said.

"On the basis that realising the full value of digital agriculture ideally requires access to the large amounts of data produced and held across the supply-chain, there are two specific requirements that must be addressed.

"We need data governance arrangements that both 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."

Engaging all sectors of industry

Along with the formation of the steering committee, CRDC has contracted AgThentic Advisory and DataGene to focus on building the business case for potential investment in the development of a 'trusted, scalable, flexible data sharing solution' for the Australian cotton industry, specifically focused on the supply chain from farm to merchant.

"This focus on developing the business case for improved data sharing between value chain actors is anticipated to raise options or 'strategic choices' that need to be considered by the industry," Meredith said.

"In this way, the business case for data sharing will guide the development of the industry's digital strategy."

A core component of the project is engaging with the industry to gain the perspective of all participants in the supply chain for cotton, and especially those who produce and hold data. This includes growers and consultants, technology providers, ginners, merchants and logistics services.

Project lead, AgThentic's Komal Patel said the aim of their research is to understand how decisions are made and why, to determine what needs to be true for solutions to actually be impactful in practice.

"Our focus is to understand the existing tools, systems and processes by which data is generated, captured, stored, used, and shared along the supply chain," Komal said.

"Understanding the state of data systems and processes today will then enable an analysis of what the future state could be tomorrow, and from a technical and commercial perspective, what will be required to achieve that vision."

Unlocking the potential of digital agriculture isn't just about the development of technical solutions. As growers know, it's also about ensuring that technical solutions are practical, usable, desirable and scalable.

"This stream of research will focus on understanding the behaviours, motivations, and pain points around data-sharing across the cotton value chain to help illuminate what factors may enable or hinder the adoption of data-sharing practices or tools, and how to solve for them going forward," Komal said.

"That's why we are wanting to speak to people from right across the cotton production chain, and we are inviting anyone interested in sharing their perspective with us to get in touch."

Contact CRDC to have your say

To develop recommendations that will truly be impactful, the researchers will have direct engagement with stakeholders across the production chain through one-to-one consultations and interactive workshops. Workshops will be held in mid-to-late July in Narrabri (Kamilaroi country), Goondiwindi, Toowoomba (Bigambul country) and Griffith (Wiradjuri country). One-to-one consultations will take place in coming months depending on stakeholder availability.

For more

Dr Meredith Conaty
meredith.conaty@crdc.com.au

Revolution in crop protection begins

Research is creating ground-breaking new products that can entirely change the way we think about and manage pests and diseases of cotton.

BioClay™ is a novel biological crop protection approach that is non-genetically modified, safe and environmentally sensitive. CRDC is working with a range of partners to bring BioClay to growers. Early research targets include insects, viruses and fungal disease in several crops, including cotton.

BioClay is a biodegradable spray solution of clay particles that works like a vaccine, stimulating 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.

BioClay is world-leading technology invented by scientists from the Queensland Alliance for Agriculture and Food Innovation (QAAFI) and the Australian Institute for Bioengineering and Nanotechnology (AIBN) at the University of Queensland (UQ). Nufarm Limited is the commercialisation and development partner.

Crop-specific research and trials currently include partnerships with CRDC and fellow Research and Development Corporation (RDC), Hort Innovation. These projects are looking at a range of pests including viruses and fungal diseases such as Verticillium wilt and sucking insect pests.

CRDC R&D Manager Susan Maas says this is exciting research with potential to help sustainably address key industry threats.

"BioClay is an entirely new way to approach crop protection, acting like a type of vaccine for the plant, where we can choose what pests or diseases we want to protect the plant against," Susan said.

"BioClay works by stimulating the plant's immune system to fight disease."

What is RNA?

While DNA is a commonly used term, RNA is a less familiar term that is being used more and more. *Spotlight* asked CRDC's Susan Maas to explain.

"DNA is essentially a cookbook full of instructions on how to make all the proteins required for a particular organism. Messenger RNA (mRNA) is equivalent to photocopies of a recipe from that cookbook and is used by that particular organism to get the instructions from the DNA to where the proteins are made," Susan said.

"Double stranded (dsRNA) that is highly specific to a particular pest, disease or virus can be used to prime a plant so that those important messages are stopped and the pest, disease or virus can't make a specific protein."

"This product is so innovative in that it can be adapted for use on a wide range of pests including invertebrate pests as well as root infecting pathogens.

"CRDC is supporting multiple projects using the BioClay platform including to protect against fungal diseases."

And the research isn't limited to endemic pests and diseases, but exotics as well.

"In partnership with Hort Innovation we have been able to scope the potential to apply this type of technology to cotton leaf curl virus," Susan said.

"Leaf curl virus is a high priority pest to Australian cotton that could be devastating if an incursion were to occur.

"Creating capacity and readiness to quickly deal with exotic incursions are key aspects of our investments in biosecurity preparedness, as is working with other plant RDCs to protect our industries from shared threats."

Commercialisation of BioClay is anticipated for around 2026-2028. We'll be keeping you up to date via *Spotlight*.

For more
www.crophub.com.au

In a partnership which includes CRDC, scientists Dr Elizabeth Worrall, Professor Neena Mitter and Dr Karl Robinson are working on novel products to protect crops from pests and diseases.

UNIVERSITY OF QUEENSLAND

Building on BioClay

Building on the ground-breaking work of BioClay™, researchers have turned their attention to tackling disease issues where there is no effective control measures currently available or emerging fungicide resistance.

CRDC is a partner in the Australian Research Council (ARC) Industrial Transformational Research Hub for Sustainable Crop Protection, which is bringing to market a biological alternative to chemical fungicides for use in horticultural and broadacre crops including cotton.

Led by University of Queensland Professor Neena Mitter, the Hub is building on the revolutionary BioClay platform to develop and commercialise an innovative biological alternative to chemical fungicides, targeting economically significant diseases of cotton and other crops. It addresses industry challenges of fungicide resistance, use of fungicides and damage caused by diseases such as Verticillium wilt in cotton.

Professor Mitter, who has worked in molecular biology and biotechnology in Australia and India for over 20 years, said the Hub was already building on UQ's BioClay technology to create a "smart" form of biological crop protection.

"We will be bringing biological-based fungicides to Australian broadacre and horticultural crops, resulting in reduced chemical use, increased crop productivity, and improved sustainability across the supply chain," Neena said.

She said the fungal pathogens targeted by the Hub were selected in close consultation with RDCs, including CRDC and other industry partners.

The ARC Hub for Sustainable Crop Protection involves staff from five UQ departments and involves partner organisations including Griffith University, La Trobe University, University of Tasmania, Curtin University, University of California Riverside, CRDC, Grains Research and Development Corporation, Horticulture Innovation, Australian Wine Research Institute Ltd, QLD DAF, South Australian Research and Development Institute, Wine Australia, Bioplatforms Australia Ltd, AUSVEG Ltd and Nufarm Australia Limited.

For more

Neena Mitter
n.mitter@uq.edu.au

Demi Sargent at the Australian Cotton Research Institute with wild cotton varieties that are being used to investigate improving tolerance to drought and climate change effects in crops.

MELANIE JENSON

Can resilience be programmed into crops?

Crop management could be revolutionised as new areas of science are continually discovered and interrogated.

CRDC is looking at the potential opportunities in new areas of science and one area in particular is synthetic biology: can it be used to create a more resilient, efficient plant, capable of withstanding extreme climatic conditions?

There have been rapid developments in the relevant technologies, providing exciting potential such as crops that sense and respond to their environment, through biosensors and genes that switch on or off in response to certain conditions. Current CSIRO investigations into creating stretchy, non-creasing, and waterproof cotton to better compete with man-made fibres is predicated on using synthetic biology.

The benefits of synthetic biology could be revolutionary in the way cotton growers manage their crops and improved resilience of the plant.

Synthetic biology is a broad field of research that essentially involves modifying biological processes and systems to develop desired functions and capabilities, often through genetic engineering. The technology can be used to develop a range of agronomic solutions, from introducing pest and disease resilience traits into crops, to improving drought tolerance and water use efficiency.

With research in this area still relatively new, CRDC has commissioned a scoping study to identify potential priority focus areas including whether cotton plants can be programmed to respond more efficiently to light availability, water deficit, drought and extreme climate conditions.

There is opportunity to use molecular and synthetic biology techniques to elicit plant immune responses or provide immunity to pathogens and assess technologies for rapid rewiring of pathways in cotton. For example, genes conferring disease resistance, genes associated with photosynthesis and other possibilities that may include fruit retention, defoliation, steeper and deeper roots and interactions with the soil microbiome.

"We are continually scoping new areas of science for innovation," CRDC R&D Manager Susan Maas said.

"Synthetic biology is a rapidly changing area of science, which was identified back during CRDC's 2018-2023 strategic planning process as a potential area of exploration to support the industry to transform and address key industry issues.

CRDC is supporting 2021 Science and Innovation Awardee Demi Sargent to undertake the scoping study.

Demi recently completed her PhD with support from CRDC, which uncovered that multiple wild cotton species native to arid central Australia exhibit superior photosynthetic performance under high temperatures compared to commercial cultivar *Gossypium hirsutum*. These discoveries will inform future research and possibilities to manipulate cotton.

"The research I conduct alongside Dr Robert Sharwood (Western Sydney University) and Dr Warren Conaty (CSIRO) ultimately aims to 'future-proof' cotton production against climatic extremes such as heat stress and drought," Demi said.

"We tested photosynthetic modification scenarios which showed

radiation use efficiency (the efficiency of converting light energy into carbohydrates for plant growth) and thus biomass growth could be improved by up to five percent at temperatures above 33°C by using synthetic biology to introduce photosynthetic machinery from key wild species into cotton cultivars."

"Our ultimate goal is to develop cotton cultivars using synthetic biology that enables plants to be capable of withstanding heatwaves and droughts and improve their resource use efficiency and productivity under challenging climatic conditions," Demi said.

"We aim to achieve this through improving photosynthetic efficiency and resilience against heat stress and drought using synthetic biology.

"We target photosynthesis because this critical process underpins plant growth and crop yield. Heat stress hinders photosynthetic processes, contributing to yield reductions/loss in crops.

"Photosynthesis is also linked to water use efficiency.

"Therefore, photosynthetic enhancements using synthetic biology are likely to improve crop yield and water use."

For more

Susan Maas
susan.maas@crdc.com.au

Going wild for new discoveries

The importance of Demi's research has been highlighted recently through the 2021 Science and Innovation Awards for Young People in Agriculture, Fishing and Forestry.

CRDC supports the Awards to further the revolutionary thinking of scientists such as Demi, with her aim to boost photosynthetic efficiency in cotton that could help shield the cotton industry from the effects of climate change.

The Awards are coordinated by the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) on behalf of the Department of Agriculture, Water and the Environment.

Demi is an awardee based on her project examining mesophyll conductance, which is a process that limits a plant's capacity for photosynthesis.

"Mesophyll conductance is one of the major gateways for carbon dioxide to enter the plant," Demi said.

"Firstly, the CO_2 will pass into little pores called stomata, then once it's inside those pores, the CO_2 will diffuse through the cell walls: this process is mesophyll conductance.

"In standard cotton cultivars, mesophyll conductance doesn't change when the temperature rises, however my CRDC-supported PhD research revealed an opportunity to boost mesophyll conductance in hot weather using imported traits from wild cotton cultivars.

"We found that this conductance could be increased substantially with increasing temperature."

Demi will use the award to measure the rate of mesophyll conductance under hot, dry conditions, in a commercial cultivar and other species. The young scientist believes the results of these studies could potentially super-charge a plant's ability to process CO_2, greatly increasing its ability to maintain biomass production and tolerate drought and heat stress.

For more

www.agriculture.gov.au/scienceawards

Welcome to modernised insect monitoring

Engagement with potential commercial partners has begun to bring revolutionary technology to simplify insect monitoring to the field.

Silverleaf whitefly (SLW) numbers can be difficult to monitor, due to their small size and mobility. This pest has increased in prevalence in recent years and successful management is important to maintain our reputation for high lint quality, and maintain healthy populations of beneficial insects and integrated pest management strategies.

QLD DAF's Richard Sequeira has created a new monitoring protocol based on counting SLW nymphs instead of adults, and whether alive or dead (viable or non-viable). Richard also developed new thresholds with an integrated decision support tool to guide insecticide applications and best manage SLW.

To complete the new monitoring system, a prototype phone app has been developed to count pests simply by taking a photo of a leaf. SLW nymphs are automatically counted, interpreted, logged and used to generate information about changes in the SLW population.

The app has been developed with support from CRDC by Dr Derek Long and Dr Alison McCarthy from the University of Southern Queensland in partnership with QLD DAF's Dr Paul Grundy and Leisa Bradburn. It runs a scoring process that counts nymphs and integrates this information with crop development and pest density thresholds. A commercial partner to bring the app to a full release was engaged earlier this year. Derek says that the industry reception to new vision technologies has been very positive.

"We are very happy with the engagement researchers and consultants have given us this season," he said.

"We look forward to seeing this technology in the field after we add the ability to track the ratio of viable and non-viable SLW, and then broadening the scope of the app to include other insects."

For more

Derek Long
derek.long@usq.edu.au

Putting the pressure on after harvest

Ultra high-pressure waterjet technology has been developed as an alternative post-harvest crop destruction tool in cotton.

Darren Hart inspecting the cotton trial on 'Keytah' at Moree (Kamilaroi country).

MELANIE JENSON

Successful crop destruction has been found to be troublesome in dryland cotton scenarios. Grower and consultant surveys have highlighted the need for alternatives.

Using a liquid jet-stream generated by 50,000 psi and operating near Mach 3, AquaTill it can cut through plant matter and penetrate soil. Developed by Flow International, AquaTill was first tested (without herbicide) in 2017 on mulched cotton in a project supported by CRDC with Sundown Pastoral Company's Darren Hart, Greg Butler from South Australian No-Till Farmers Association and QLD DAF's Paul Grundy.

This initial research showed promising results, however further trials found that by adding fluroxypyr in the mix and 'nicking' the ratoon, rather than completely severing the stem, was most effective in terminating the plant. This technique of incorporating herbicide into the AquaTill jet-jetstream has been coined Jetacide.

CRDC supported further independent trial work in 2019 and 2020 by the Dryland Cotton Research Association (DCRA), that investigated post-picking ratoon control in standing and mulched cotton crops.

The presence of ratoon cotton over winter continues to pose a risk to the industry's stewardship of Bt resistance.

CRDC R&D Manager Susan Mass said it is important to ensure complete control of ratoons between seasons as cotton plants surviving through to the next summer is a huge risk for Bt resistance.

"The green bridge can also enable diseases such as cotton bunchy top and insects such as mealybugs and whitefly to thrive and build into the next season," Susan said.

"With increasing interest in low and no tillage cotton it is important that growers plan for complete crop destruction.

"CRDC is really pleased to have been able to support the collaboration between CRDC, the DCRA and SA No-Till Farmers Association which has seen this great innovation emerge as a potential solution to this important issue.

"Pending APVMA registration, this method of crop destruction has applications in dryland cotton and systems in Northern Australia, so it's exciting to see it nearing commercialisation."

Registration of AquaTill Jetacide for cotton termination is underway and currently Titan Ag are supporting the APVMA permit that allows for further testing. The aim is to expand the Fluroxypyr 400 product label to include Jetacide as a new method for controlling cotton ratoon regrowth.

"So far, trials have been very encouraging and the DCRA has found Jetacide to be at least as good, and in many cases better than traditional cotton ratoon termination methods," Greg Butler said.

"It is important that new technology works at the farm scale."

Taking the tech into the field will require the expertise of manufacturers like NDF, a privately owned disc seeder manufacturer in Narromine NSW (Wiradjuri country), along with Seabrook Seeders in Coalstoun Lakes in Queensland (Wakka Wakka country). Both manufacturing companies are exploring the opportunity to commercialise the technology in Australia. Flow International is also developing retrofit kits for existing machinery.

The National Landcare Program in conjunction with NDF is supporting a series of demonstrations on June 14 at Narromine (Wiradjuri country), Spring Ridge, Moree and Narrabri (all Kamilaroi country) on June 15, 16 and 17 respectively.

For more

Greg Butler
greg@santfa.com.au

Tech and trials the key to smarter irrigation

Innovation is at the heart of providing cost-effective strategies to improve water use efficiency. It's also led to the development of a range of technologies that are successfully improving efficiency and management strategies for optimum water use efficiency and yield.

Smarter Irrigation for Profit Phase 2 (SI2) is tackling the challenge of reduced water availability by focusing on practical, cost effective strategies to improve the water productivity of Australian cropping and pasture irrigators. The project, led by CRDC, is a partnership between the major irrigation industries of cotton, dairy, sugar, rice and grains, research organisations and farmer groups.

The project is funded by the Australian Government Department of Agriculture, Water and the Environment, as part of its Rural R&D for Profit Program, round four.

Over three years, 14 projects will run under the SI2 banner. They will cover three components:

- Development of new irrigation technologies including new sensors, advanced analytics to improve irrigation scheduling and strategies to reduce water storage evaporation.
- Cost effective, practical automated irrigation systems for cotton, rice, sugar and dairy.
- A network of 36 farmer-led optimised irrigation sites on commercial farms across Australia.

There are seven research and demonstration projects directly related to cotton growing funded through SI2. Of these three have created and/or refined technology that is progressing toward

IMAGE: MELANIE JENSON

commercialisation. A current project is also supporting the commercial development of irrigation automation technologies previously developed in Smarter Irrigation for Profit Phase 1.

CRDC's R&D Manager Susan Maas oversees the project and says innovation has come to the fore with moves to commercialise VARIwise and SISCOweb, while canopy temperature sensors were commercialised in 2019 through an industry partnership.

"This type of innovation doesn't happen overnight, and the technology is based in sound, well tested research, and collaboration," Susan said.

"CRDC supported the development of VARIwise with Dr Alison McCarthy at USQ and of canopy temperature sensors in collaboration with CSIRO, and currently, researcher Hiz Jimali.

"Commercialisation of the canopy temperature sensor technology in 2019 came about through a partnership with agtech entity Goanna Ag, CSIRO and CRDC."

SISCOweb, the furrow irrigation optimisation measurement and modelling software, was developed by Malcolm Gillies and Dr Joseph Foley also of USQ and is also at a stage where researchers are engaging with commercial partners.

"Smarter Irrigation Phase 2 has given researchers and developers of technology the opportunity to test, adapt and refine their innovations further in on-farm settings at a commercial scale," Susan said.

"What is so important for growers and consultants who may be considering using new technology is knowing it is going to work on their farm, it's not going to consume more of their time and there is a clear, tangible benefit.

"Irrigation technology or infrastructure may offer improved water use efficiency and uniformity, improved yield, or ease of management, or all of the above.

"For some people it alleviates labour requirements with traditional pipe over the bank systems.

"It's such good news for the industry to see these products making it to the field, so they can begin to harness the benefits that technology, automation and optimisation offer in terms of water use efficiency, improved yield and reduced inputs."

Covering major aspects of irrigation optimisation through SI2 projects

Evaporation mitigating for cotton water storages

Ultra-thin monolayer technology is a potentially cost-effective method of reducing evaporation. However, current commercial monolayer products have low performance, are readily disrupted by wind, and need to be frequently reapplied. Research being conducted as part of this project is identifying more effective mono-layer solutions that can be used in conjunction with physical barriers to mitigate wind impacts on monolayer films, reducing water storage evaporation losses.

Preliminary economic analysis of the prototype barrier being developed found that over a 10-year period the average cost of water saved can be as high as $236/ML in regions with arid climates (2275 mm evaporation/year)

Deakin University researcher Dr John Hornbuckle talking sensors.

MELANIE JENSON

Plant-based sensing for cotton irrigation

Plant-based sensing techniques including canopy temperature sensors (CTS) and UAV thermal imaging have been shown to increase cotton yields while reducing labour and water costs. These benefits are realised by matching the irrigations with crop water demand through continuous monitoring of plants. This project is testing and refining these technologies on commercial cotton farms to better understand how they can be most effectively used to improve water use efficiency and productivity for fully irrigated and partially irrigated cotton.

An assessment of the economic benefits of incorporating CTS technology into irrigation management found it has the potential to improve farm profitability. The next steps are to ensure the technology is both practical and reliable at a commercial scale. Researchers are working closely with commercial growers and technology providers to further refine the methodology.

CTS technology is available through Goanna Ag as part of its GoFieldPlus irrigation management system. The researchers involved in this project are working closely with Goanna Ag to streamline the process of providing growers the actionable data in real time and to resolve any technical issues that may occur in the first year of commercial roll out of this product.

Precise real-time automated cotton irrigation for improved water productivity

This project is developing fully autonomous broadacre irrigation control systems for cotton (furrow and pivot) and dairy pasture (pivot). Research is being conducted on large commercial-scale fields under real farming conditions to ensure the systems are robust, reliable, and practical. The aim is to maximise water productivity by using existing advanced bio-physical crop modelling in conjunction with the latest irrigation optimisation models under the VARIwise control system.

Activities include further development of two minimal viable products (MVPs); VARIwise cotton yield and dairy pasture biomass prediction capability based on fixed tower and UAV camera vision analysis of key plant attributes; and SISCOweb synchronous furrow irrigation optimisation measurement and modelling techniques. The project is also supporting the commercial development of irrigation automation technologies previously developed in *Smarter Irrigation for Profit Phase 1*.

VARIwise-controlled cotton irrigation has led to a six per cent yield improvement and 14 per cent more efficient water use. The MVP VARIwise Yield Predictor has regularly predicted final cotton yield to within three per cent of actual yield six weeks prior to picking. Furrow irrigation optimisation leads to an average 10 to 15 per cent water saving per irrigation event. Commercial scale deployment of remote-controlled furrow irrigation is now common for less than $800/ha.

USQ researcher Dr Joseph Foley.

USQ

New tech-integrated smart sensing & automation for cotton

This project is developing and trialling low cost, integrated sensing and automation platforms to remove the requirement for manual irrigation checking and control. The project is also building the capacity of research and commercial partners to offer 'fit for purpose' automated irrigation platforms. R&D at the Irrigation Research and Extension Committee (IREC) demonstration farm at Whitton (Wiradjuri country), and on a commercial farm at Darling Point (Wiradjuri country) have shown positive early results and the owners of the 'Ringwood' commercial operation have expanded cotton irrigation automation across their multiple farms with approximately 800ha of irrigation layout converted across to automation technology systems for the 2020-21 irrigation season.

The two key learning sites provide an opportunity for irrigators to assess, understand and use integrated, smart sensing irrigation technologies and automation platforms. Commercial industry partners are now offering systems developed in the project across the Australian cotton growing areas and have established networks to provide service support.

Research activities have been able

Cross-sectoral integration and extension

Cross sectoral co-operation and collaboration around irrigation technology and information sharing is a major aspect of how RDCs are managing business. Researchers are working across the dairy, rice, cotton, sugar and grains industries to develop and extend technology and management strategies that have common usage across the sectors. There is significant potential for new technology to transition into new sectors.

The project is facilitating extension of the research results and technology to people across the five industries and beyond. The project supports peer-to-peer interaction and provides agricultural producers the opportunity to network and learn from people across a wide range of irrigation industries.

This includes farm visits and tours such as the cane growers and researchers from North Queensland who visited cotton farms in Moree (Kamilaroi country) in North West NSW (pictured) where they had the opportunity to talk to cotton growers and researchers. Most had never been on a cotton farm or seen the technology and irrigation systems used to make the industry one of the most efficient globally.

In addition, the support of and collaborations between commercial, industry and research organisation are helping to reduce the time to market for new and innovative technologies in the irrigation industry.

MELANIE JENSON/GVIA

to demonstrate that the linkage of smart sensing and automation through a cloud-based platform can be achieved within an irrigation farming system across a range of sensing and hardware platforms and protocols for IoT based approaches.

Key learning sites southern – making the most of water

This project aims to increase water productivity and profitability by expanding growers' knowledge of irrigation technology and best practice management. The project is grower driven with grower groups involved with the management and activities at each of the key learning sites located in the Lachlan, Murrumbidgee, and Murray valleys. A range of technologies are being used to demonstrate best practice management including soil moisture monitoring and automation. The aim being to optimise the limited availability of water resources to obtain maximum dollars per mega litre in a range of irrigated cropping systems. Project sites are located near Condobolin, Darlington Point and Finley in NSW (Wiradjuri country), and Kerang in northern Victoria (Wamba Wemba country).

The project aims to lift grower's knowledge so they can make more informed management decisions, optimising their return/ML water applied. Grower groups involved in the management of the sites are the Irrigation Research and Extension Committee (IREC), Central West Farming Systems, Irrigated Cropping Council and Southern Growers.

A feature of the project is the establishment of the Murray Valley soil moisture website, that provides real time data from soil moisture monitoring equipment installed at key learning sites as well as two case study farms. It allows growers to see how soil moisture data is used for scheduling irrigations, and how to monitor the effect and extent of rainfall events and plant growth on soil moisture.

"The project is grower driven with grower groups involved with the management and activities at each of the key learning sites..."

Gwydir Valley demonstration – application of latest digital technologies for precise automated irrigation

This project provides growers with commercially relevant information about how to best utilise irrigation monitoring tools and decision support systems to optimise irrigation. It also provides advice on the installation and management of automated and autonomous irrigation systems.

The project builds on the previous five years of irrigation system comparisons at 'Keytah', Moree (Kamilaroi country), where drip, lateral move, siphon and bankless channel were assessed for their water use efficiency and yield performance. This year an additional bankless channel field, a 500ha automated field with three sets of five bays linked by automated gates, has been included. The new bankless development has been fitted with 30 Padman Stops bankless channel bay outlets incorporating auto-winches enabling remote irrigation of the whole 500ha field. The field is being used by the Deakin University team in their smart sensing and automation project and by CSIRO in their plant-based sensing project.

SI2 field day at 'Keytah' showcasing the latest in irrigation technology and design.

MELANIE JENSON

Improving the science of water footprinting

This project will evaluate and potentially improve irrigation water foot printing measurement and reporting methods with the aim of making them more applicable for Australian agriculture. While water footprints have the potential to identify opportunities to improve industry efficiencies, they do have several shortfalls — most notably the potential for misapplication. This project will provide guidance for Australian extensive irrigation industries about the potential economic and environmental impacts of different water footprinting methods and will provide alternative options to water footprinting methods.

Several different schemes for water footprinting are currently in use and these schemes can give different ratings for the same agricultural production system. This lack of consistency means Australian farmers could find themselves penalised for having high water footprints depending on the scheme used with most schemes reporting high water footprints for farming systems located in the Murray Darling Basin.

For more

Murray Valley soil moisture website

www.murrayvalleysoilmoisture.site

Smarter Irrigation for Profit Phase 2 is led by CRDC in partnership with Dairy Australia, Sugar Research Australia, Grains Research and Development Corporation, AgriFutures Australia, CSIRO, University of Melbourne, University of Southern Queensland, Deakin University, Tasmanian Institute of Agriculture, NSW DPI, Agriculture Victoria and Gwydir Valley Irrigators Association. Supporting partners include farmer groups and commercial irrigation providers.

For more

www.crdc.com.au/smarter-irrigation-phase-2

Economic analyses defines benefits of irrigation innovation

As part of *Smarter Irrigation for Profit Phase 2 (SI2)*, economic analyses are being undertaken. Three studies completed by Ag Econ suggest that while the benefits stack up, growers should undertake individual farm analysis and consider specific farm and market dynamics when considering investments.

Evaporation mitigating for cotton water storages

TOP FINDINGS

- **The greatest water losses on farm are evaporation losses from on-farm storages, with an industry average loss of 25 per cent, and as high as 45 per cent.**
- **A combination of wind barriers and monolayers being developed and trialed by the University of Melbourne has shown the potential to reduce evaporation by up to 35 per cent.**
- **For an example irrigation system with a 1000 ML (30ha) storage and 1885 ML of irrigation water available, the combined barrier and monolayer could generate benefits equal to $712,978 ($23,405 per ha of the 30ha water storage).**
- **The actual benefits will be influenced by a range of factors including the dimensions of the farm storage, seasonal water availability, and seasonal water use patterns.**

OVERVIEW

As part of SI2 the University of Melbourne (UMelb) developed and demonstrated cost-effective and practical solutions to reduce evaporation from water storages. The research builds on previous large-scale field trials and subsequent lab trials to develop a unique solution to mitigate wind impacts on monolayer films, reducing water evaporation. Trials were undertaken at Yanko in southern NSW (Wiradjuri country) and St George in south-west Queensland (Bigambul country).

CONCLUSIONS

Drawing on the UMelb research and other industry data, this analysis quantified the potential value of water savings from the use of a combination of wind barriers and monolayers.

The present value of benefits equal to $712,978, or $23,405 per ha for the example 30ha water storage, represents the maximum cost (break-even cost) for the investment to be viable in this particular irrigation system. This will differ based on individual farm systems.

The UMelb research focused on early development and trials. As the technology progresses into further large-scale trials and development, producers will be able to draw on refined data to understand the economic implications, as well as the practical implications of installation and use.

MELANIE JENSON

Economist George Revell from Ag Econ is evaluating Smarter Irrigation for Profit projects.

Plant-based sensing for cotton irrigation

TOP FINDINGS

- **By supporting more accurate monitoring of a crop's stress levels and need for water, canopy temperature stress (CTS) technology can increase cotton yields while reducing labour and water costs.**
- **Incorporating CTS technology into irrigation management has the potential to generate an additional $152/ha/season.**
- **Due to long water supply lead times, some growers may find it harder to adapt irrigation management unless there is sufficient on-farm storage or bore water supply.**

OVERVIEW

As part of *Smarter Irrigation for Profit Phase 1* CSIRO conducted on-farm trials of canopy temperature stress (CTS) technology in NSW and Queensland. The overarching philosophy of the trials was to provide farmers the opportunity to use an irrigation scheduling tool that is based on real-time monitoring of a crop's stress levels and need for water.

CONCLUSIONS

Drawing on the Phase 1 research and other industry research and data, this case study evaluated the economic viability of CTS in cotton production, with the potential to generate an additional $152/ha/season. The costs of $25/ha/season may vary depending on field dynamics such as field size and differing soil types. The benefits of $177/ha/season were driven by the potential for improved irrigation management with regards to crop stress and water availability, generating yield savings one in two years and irrigation savings one in three years.

It has, however, been identified that where growers are faced with long water supply lead times they may find it harder to adapt irrigation management unless there is sufficient on-farm storage or bore water supply. As such, when considering incorporating CTS technology into irrigation management, producers should undertake individual investment analysis while considering specific farm and market dynamics.

Small pipe through bank irrigation system

TOP FINDINGS

- **Compared to manual siphon irrigation systems, automated small pipe through bank (sPTB) reduces labour inputs and costs.**
- **With an upfront cost of $604/ha and net benefits of $968/ha over 25 years, investment in automated sPTB with a blind head-ditch was found to generate a net present value (NPV) of $364/ha over conventional siphons.**
- **Up-front investment costs can be heavily influenced by individual farm characteristics, and could range from $500/ha to $1000/ha.**
- **The seasonal net benefits of $153/ha were driven by irrigation labour savings of up to 85 per cent.**
- **In years of low water allocation there may be insufficient irrigation water to fully use the sPTB area, leading to reduced return on investment.**

GVIA

Small pipes through the bank coupled with automation reduces labour inputs and costs, but up-front costs range widely.

OVERVIEW

As part of the Smarter Irrigation Phase 1 project the National Centre for Engineering in Agriculture at the University of Southern Queensland (USQ) completed successful trials of a blind head-ditch and small pipe through bank (sPTB) irrigation system at Moree, NSW, and supported early adoption of the technology at 'Waverley' near Wee Waa, NSW (both Kamilaroi country).

The trials highlighted the potential benefits related to commercially available sPTB systems, including:

- Reduced labour requirements in starting and stopping siphons and monitoring water levels.
- Remote control of furrow irrigations from an office computer, smartphone or tablet.
- Remote monitoring of water levels in channels and ditches, with alerts based on level.

CONCLUSIONS

While converting manual siphon irrigation to sPTB can represent a large upfront investment, this analysis has shown that the costs can be outweighed by operational savings particularly relating to irrigation labour. Drawing on the USQ research and other industry research and data, this analysis has identified an NPV of $364/ha over 25 years, equal to an internal rate of return of 10 per cent. When considering investment in sPTB, producers should undertake individual farm analysis and consider specific farm and market dynamics.

For more

George Revell
george@agecon.com.au
www.crdc.com.au/smarter-irrigation-phase-2

WENDY QUAYLE

There's money in manure: if you know how to use it

Thought about using organic amendments but not sure how to calculate this into synthetic fertiliser budgets? Think no more!

A national project, led by the Queensland University of Technology and working with researchers from La Trobe University, Centre for Regional and Rural Futures (CeRRF), Deakin University and the University of Queensland, is validating a cross-industry, manure management app for organo-mineral nutrient budgeting.

The first prototype has undergone some testing across different industries and has provided support in selecting the best site-specific synthetic-organic plant nutrient management practice that allows savings in synthetic fertiliser up to 30 per cent in cotton, 55 per cent in grain (sorghum and winter wheat) and 40 per cent in a vegetable crop rotation, without yield penalties.

The app builds on research projects supported by CRDC and partner organisations, quantifying the effect of organic amendments, and in particular chicken litter on cotton crops (see *Spotlight* Summer 2019-20).

According to one of the researchers, Dr Wendy Quayle from CeRRF, Deakin University in Griffith, NSW (Wiradjuri country), the integration of organic and mineral (from bagged fertilisers) nutrient sources remains a low-hanging opportunity that could boost Australian farming sustainability credentials.

"Incorporating plant nutrients released from organic soil amendments into cotton fertiliser budgets allows the reduction of synthetic fertiliser rate without compromising crop yield," Wendy says.

"This research is contributing to a series of experimental trials conducted across the Australian agricultural industries of cotton, horticulture, dairy and grain."

The app will help growers get the most out of manure by calculating not just the total amount of nutrients contained in these products and supplied at a given application rate, but also the timing of nutrient supply over time and the subsequent potential for making mineral fertiliser savings, nutrient use efficiency and economic benefit.

Data obtained from incubation experiments and compared against field results in different seasons, crops and manure types has allowed assessment of application rates and calculation of what is being provided in terms of available nutrients and fertiliser value. The data has enabled the development of this first prototype of the user-friendly organic amendments nutrient release calculator, involving an input-led calculator from a mobile phone user interface, which will be available from the Apple App Store or Google Play.

Users input information on manure spreading rates and the calculator determines the amount of crop available nitrogen and phosphorus. The app helps decide how much manure to spread to meet the crop requirement, and to assess the economic benefits with mineral fertiliser for different rates and ratios. For example, in cotton, 15m^3/ha autumn incorporated chicken litter provided 80 kg available N/ha, 35 kg available P/ha and reduced pre-plant fertiliser costs by $80-100/ha.

The information may also be retained for longer term farm records and potentially combined with precision agriculture digital platforms for variable rate fertiliser management.

For more

Wendy Quayle
w.quayle@deakin.edu.au

Listening in with artificial intelligence and machine learning

Key research in the *Cotton Landcare Tech-Innovations 2021* project is creating technology to keep an ear out for biodiversity in cotton country.

Led by Professor Stuart Parsons from Queensland University of Technology (QUT) the project has to date been focused on monitoring bat and bird diversity from Narrabri in NSW to Miles in Queensland to aid in the development of computer recognisers suitable for in-field detection work.

"We've come into the project with a good number of recordings for bats but sometimes the information isn't accurate," Stuart said.

"There's a lot of ground testing that's required to make sure we've got the right number of calls for the right types of species in each of the cotton growing areas we're focusing on.

"Birds are easier to catalogue as their calls give clues to their species however bats calls can be very similar, so it takes a lot of work to refine the library database."

Members of the QUT team have been collecting calls and ground testing them against what is ordinarily seen and heard on cotton farms.

Hear the call of the wild

QUT bioacoustics engineer Dr Roger Coles has been crucial to this.

"Throughout the end of 2020 and early 2021, the team has been able to place recorders in remnant vegetation and out in the cotton fields around Narrabri, Wee Waa, Moree (Kamilaroi country), St George (Bigambul country), Dalby and Miles (Barunggam country)," Roger said.

"We mostly record at night, and the recording device sits in the tree, picking up whatever bat calls it can from dusk to dawn, which helps us get a complete picture from the recorders.

"The range of detection varies depending on the species as some bats you can only pick up from 10 metres, and others can be heard over several hundred metres.

"The recordings are then compared to a set of reference calls. That's where the scientific analysis is coming in."

With recordings in place, the next phase of the project is creating digital recognisers that can be placed on farm to instantly recognise different bat and bird calls.

QUT

QUT bioacoustics engineer Dr Roger Coles has been crucial to collecting calls and ground testing them against what is ordinarily seen and heard on cotton farms.

Machine learning calls

"Currently, we're taking those calls and putting them into an analysis program," Roger said.

"When we see the structure of the echolocation signals given out by the bats on a screen as a sonogram, we can identify what bat that call signal belongs to, but that's manual and time-consuming.

"We're trying to train a machine to do it for us so the information can be used much more easily by the cotton industry to get a handle on the biodiversity on farm and the environment they are living in."

Team members Dr Philip Eichinski, Dr Lance De Vine and Professor Paul Roe are now using neural networks to teach and test computers to recognise the species of bat present, making the process of tracking bat biodiversity faster and more accurate. The team is working to create recognisers to identify a species based on a test set of recordings and are hopeful that eventually they will work as well as a human, if not better.

Project lead Professor Parsons said to date the results are very promising, however the recognisers need refining to ensure no mistakes are made and those next steps are very complex.

"Team member Tim Chant, an electrical engineer, is also developing a hardware device that can be put in the field with the model built into it to allow data to be transmitted directly on to a web platform," he said.

"Creating something that doesn't draw too

much power and can withstand the elements is proving to be challenging.

"We've got a really cost-effective option, but the grower needs to physically go out and remove the SD card and upload it to the cloud to do the processing.

"The other options we're looking at include coming up with something more integrated that has a GPS on it and does everything on board; or looking at something more 'next gen' with a small, fast, economical low power device that can process in real-time.

"The end goal to all of this is that each bit of biodiversity data for the subset of bird and microbat species will be easily accessible to any cotton grower interested in having the benefits and knowledge at their fingertips."

Regionally-specific data capture

The suite of species detected in the NSW farm locations is assisting QUT colleague and team member Associate Professor Susan Fuller in her recording work in northern NSW growing regions.

"We've identified that we need more data to help 'train' the computer recognisers to pick up a wider variety of not just insect-eating bats but bird species too," Susan says.

"Birds have slightly different calls depending on their location so it's critical that we develop the recognisers to work across all of the geographical ranges.

Since late 2020, Susan has been visiting key growing areas in South East Queensland where farmers are hosting sensors.

"This is such important foundation work to ensure we can build accurate recognisers to allow us to have the best collection of knowledge possible to then build low-cost sensors," she said.

"Something that's also imperative is that we also capture as many environmental sounds that might vary across different growing areas too, such as irrigation or farming apparatus or even coal seam gas systems, that the sensors can pick up.

"We've been very lucky to have some enthusiastic growers agree to have us place sensors on their property."

Grower sees value in outcomes

One such grower is Tamara Uebergang, based near Miles in south east Queensland (Barunggam country). Tamara's passion for understanding and communicating about agriculture saw her awarded a Nuffield Scholarship in 2019, with her research initially looking at alternative energy and carbon neutrality, then diving into the cotton supply chain. Her final study centred around waste created by 'fast fashion' and the role the Australian cotton industry can play in alleviating the issue.

Tamara Uebergang is supporting high-tech biodiversity monitoring on her farm near Miles (Barunggam country).

With her family, Tamara grows cotton on the same piece of land her grandfather started working in the 1950s on the Western Downs.

"We take stewardship and the role of being a custodian of our land seriously. When the opportunity came up to be part of the trial work with Susan, we were happy to say yes," Tamara said.

"Our place is suitable for this trial because we've got some shelter belts with remnant brigalow and mixed vegetation where we know birdlife reside and we were keen to know more.

"It's really non-invasive research with the potential to be very important to the industry into the future."

Tamara said she sees the value in the research outcomes as being two-fold.

"Obviously monitoring biodiversity on farm is good for both the environment and our business, but this also helps us to maintain our social license as sustainable cotton growers.

"More and more customers and consumers want to know about not just where their cotton comes from but how it's grown and under what conditions.

"This research really speaks to that growing interest."

Under the National Landcare Program's Smart Farming Partnership initiative, the Cotton Research and Development Corporation (CRDC) secured a $1.3 million grant to implement the three-year *Cotton Landcare Tech-Innovations 2021* project with a focus on four key research areas – innovation, technology, collaboration, and biodiversity.

For more

Cotton Landcare Tech-Innovations 2021

www.crdc.com.au/cotton-landcare-tech-innovations

An innovative industry, by nature

The latest tree planting technology was in the air at a revegetation demonstration day at Maules Creek near Narrabri (Kamilaroi country).

Cotton growers Andrew and Heike Watson 'Merriendi', along with Andrew's parents John and Robyn Watson, who began revegetation projects around 40 years ago, hosted the day which showcased innovations from the *Cotton Landcare Tech-Innovations 2021* project.

Through the National Landcare Program Smart Farming Partnerships initiative, CRDC secured a $1.3 million grant to bring Cotton *Landcare Tech-Innovations 2021* onto Australian cotton farms to enhance natural resources and biodiversity. The ambitious initiative builds on international best practice to implement and develop cutting-edge technologies, such as drone mapping and aerial seeding.

Planting trees from the sky

A feature of the field day was the demonstration by ecosystem restoration experts, UK-based Dendra Systems, with their AI-guided tree-planting drone technology. Rehabilitating mine sites with aerial seeding has been the core business of the company until their involvement in the Tech-Innovations project.

It's the first time riparian areas have been reseeded on a cotton farm using a drone. It took just minutes to disperse a mix of river red gum, river she-oak, river coobah and tea tree along the river in an area currently under rehabilitation by the Watsons.

Dr Rhiannon Smith from the University of New England spoke to outline her research comparing drones against tubestock and direct seeding for native revegetation in cotton landscapes.

She says that revegetation is generally not an area that immediately raises thoughts of innovation: generally, "you pop a tree in the ground, maybe put a guard around it, water it, and keep the weeds out".

"While it doesn't sound like a lot of effort when you put it like that, try scaling it up to hundreds or thousands of trees," Rhiannon said.

MELANIE JENSON

Usually seen working over mine rehabilitation sites, drones loaded with tree seeds are being trialled on cotton farms.

Direct seeders used in Australia for native revegetation are based on old technologies discarded decades ago by commercial agriculture. Many are small, single-row planters towed behind a utility.

Towable seeders are easily transported between sites, create less site disturbance, can deal with small seed quantities and are easily manoeuvred through the landscape. However, sowing capacity is about 10 ha/day, as opposed to the 10 ha/hour of large precision seeders sowing agricultural crops.

A matter of scaling up

"Drones, on the other hand, can broadcast seed over a hectare in approximately 10 minutes, avoiding obstacles, minimising soil disturbance and compaction," Rhiannon explained.

"As markets for biodiversity and carbon sequestration emerge, and landholders acknowledge the importance of native ecosystems in providing ecosystem services such as natural pest control, erosion mitigation and nutrient cycling, greater attention is being put into how native revegetation can be scaled up in a cost-effective way.

"Research and innovation must work side-by-side to improve technology and ensure that the solutions provided do the job they profess to do."

This was also highlighted in the 2019-20 Crop Consultants Australia Qualitative Report supported by CRDC.

"There's a lot of snake oil salesmen out there, and growers need assurance that they get what they pay for," Rhiannon said.

"Many revegetation technologies have been developed in high-rainfall, or temperate environments.

"In this particular instance, there are very few operators that understand the complexities of native revegetation in vertosol soils in water-limiting environments."

CRDC Natural Resource Management R&D Manager Stacey Vogel said the demonstration day was designed for local cotton growers and residents interested in native revegetation and improving biodiversity.

"Cotton growers are well-known for their willingness to explore new technology and are increasingly interested in getting involved in native revegetation and improving biodiversity on farms.

"We've had a really great response to the field day with people wanting to know more about revegetation, the drones and methods of restoration," Stacey said.

Host Andrew Watson acknowledges the role ecosystem services play in cotton growing and the benefits of investing in revegetation. He cites the ability to use natural predators of cotton pests which harbour in native vegetation as one of the reasons he has been able to grow cotton with little to no pesticides over many seasons. He also cited erosion control around river banks, gullies, paddocks and floodways as a major benefit.

For more

Stacey Vogel
stacey.vogel@crdc.com.au

Sentinel 6 in its first deployment trial at Eastbrook Farms at Nairne, South Australia (Peramangk country).

Smart surveillance on tour

Mobile units capable of detecting high-priority pests and pathogens in the air are one step closer to the paddock as the units are rolled out across growing regions for trials.

Six custom-designed mobile surveillance units, or 'sentinels', that feature sophisticated airborne trapping sit at the core of a cross-industry R&D program, *iMapPESTS: Sentinel Surveillance for Agriculture*. The program has brought together Australia's plant Research and Development Corporations, including CRDC, to research and develop a smart national surveillance system with the latest cutting-edge diagnostics to rapidly monitor and report the presence of airborne pests and diseases for agricultural sectors including viticulture, grains, horticulture, sugar, forestry and cotton.

The collaboration is now in the final stage of the proof-of-concept R&D program. A focus on in-field trials will enable the team to engage with growers and consultants at the coalface of the growing regions and deliver important pest and disease information that can contribute to on-farm pest management actions and biosecurity response efforts.

Units at CCA seminar

The units will also be on show at industry events including the Crop Consultants Australia seminar in Narrabri (Kamilaroi country) on June 23-24 this year. This will be one of the first opportunities for industry stakeholders in the region to get up close to see the newest trap and talk with the researchers behind its construction.

Each Sentinel is equipped with several airborne samplers, power supply, weather station, telemetry and an industrial computer for remote control and monitoring. They also include automated technology to configure samplers for different sampling requirements. And the technology is continually improving. The next generation optimised units are smarter, smaller, lighter, and more flexible compared with earlier models, an important feature in an ever-evolving industry, and especially important for responsiveness to biosecurity incursions.

Heading to IREC

In June this year a unit will be trialled at Tamworth Agricultural Institute before heading south to the Riverina to monitor pest and pathogens in association with the Irrigation Research and Extension Committee (IREC) in Griffith (Wiradjuri country). These trials aim to understand the pests and pathogens that can be detected in the regions and how this information may support on-farm pest management decisions. The iMapPESTS team are interested in understanding how data from airborne trapping relates to cotton crop monitoring and thresholds used to guide sprays regimes and integrated pest management.

Trial data is regularly shared through the iMapPESTS website as summaries and observations from project entomologists, pathologists and local service providers along with a data dashboard that features, weather, pest and pathogen counts. By the end of the project in 2022, the team hopes to have demonstrated a proof-of-concept surveillance system that is suitable to different regions and supported by the appropriate rapid diagnostic tests for key insect pests and pathogens across industry sectors.

The iMapPESTS team will work with growers and industry representatives to understand the best way to communicate and visualise the dynamic pest and pathogen information for end-users. Growers and those involved in plant pest management are encouraged to visit the iMapPESTS website for more information.

The program (2017-2023) is supported by Hort Innovation, through the Australia Government Department of Agriculture, Water and the Environment as part of its Rural R&D for Profit Program and CRDC, Grains Research & Development Corporation, Sugar Research Australia, Wine Australia, AgriFutures Australia, and Forest and Wood Products Australia.

For more

www.imappests.com.au/

Shakira Johnson

shakira.johnson@ausveg.com.au

Smart farming into the future

It's not so long ago that the term 'smart farming' had a very different meaning. The 'smart' farmer was one who understood his farm and had a knack for reading the weather patterns, with a dose of good luck thrown in.

Today's smart farmer however has a vastly different profile. They, as distinct from 'he', are an operator who gathers and deciphers relevant information from an almost endless source of data at their fingertips. Then, in conjunction with applied technology, they farm in a way that they, in turn, generate more data to contribute to the world supply. That data, if interpreted correctly, has the ability to create an unprecedented decision-making environment.

The smart farmer's own data has now also become another marketable output from their operation.

Just as many of the broader Australian public have concerns over their online footprint and its collection, storage, use and security, Australian farmers too are reticent when it comes to sharing their data, according to outcomes from the *Accelerating Precision Agriculture to Decision Agriculture (P2D)* project, which was led by CRDC as part of the Australian Government's Department of Agriculture, Water and the Environment's Rural R&D for Profit Program.

In a 2017 article *Big Data in Smart Farming – A Review* researchers observed a 'landscape of stakeholders exhibiting an interesting game between powerful tech companies, venture capitalists and often small start-ups and new entrants.' It seems that the value of agricultural data has caught the attention of the 'big' players and the optimistic short-term players alike.

As a result of their study, it was proposed that priority needed to be given to researching the issues of standards, ownership and governance, but more importantly, 'suitable business models for data sharing in different supply chain scenarios'.

It is worthy of note that until the 2020 drafting of the *Farm Data Code* by the National Farmers' Federation, there was no formal guide in Australia regulating how farming data could be collected, stored or shared. While comprehensive, the code is just that – a guide encouraging 'best practice.' The nuances of ownership and 'rights' continue to be played out in a series of court cases setting precedents, both here and internationally.

"Being tech savvy has become a core requirement rather than a point of difference for today's 'smart' farmer."

For most farmers the data market remains a complicated, relatively unnavigated and still uncertain space.

An uncertain space

So what then of the input data that provides the foundation of this decision-making process? While some of it may be comprised of an ever-growing databank of local on-farm history, how much faith should the grower have in 'off-farm' information sources being fed into their decision making?

Being 'tech savvy' has become a core requirement, rather than a point of difference for today's 'smart' farmer. The issue is that the 'tech' part often comes with a greater level of confidence than the 'savvy.' With so much of this data and information at our fingertips, and it would seem, so many companies out there ready to capitalise on this information hunger, where do we even start to identify reliable information sources?

This is a much more crucial decision than assessing the credibility of a website when trawling the net. What also does a grower do when their gut feeling and age-old farming intuition contradicts the information being recommended by the technology?

Just as the mode of operation of the farmer has evolved, so too has the role of their consultant. No longer is their advice limited to purely in-field agronomic advice.

Instead, growers are now turning to their consultants for guidance and information in the ag-technology sphere. Shared experiences, be they successes or failures, are a key to building trust and adoption of new approaches to decision making. Increasingly, this role is becoming an important part of the consultant's commercial offering.

This year, Crop Consultant's Australia (CCA) will be undertaking a project in collaboration with GRDC and the University of Melbourne to take an in depth look into the factors that impact decision making with regards to the adoption of, and trust in on-farm technology.

In a series of case studies, the project will examine the professional relationship between grower and consultant, and the internal and external factors that contribute to a successful decision-making dynamic, and confidence in its outcomes.

Through the project, CCA aims to provide its members, the broader industry and growers with a tangible insight into the assessment of the possible application, and adoption of technology on farm. It is evident from the outset however, that while the definitive data is all important, the 'understanding of the farm' still has an integral role to play. Maybe the definition of 'smart' hasn't changed after all.

For more

www.cropconsultants.com.au

CRDC Investments 2021-22

The 2021-22 year marks the fourth year under CRDC's five-year plan: the 2018-23 CRDC RD&E Strategic Plan. Under this Plan, during 2021-22, CRDC will invest $18.9 million into RD&E projects across five key areas, in collaboration with around 100 researcher partners, and on behalf of Australia's cotton growers and the Australian Government. This table outlines the projects that CRDC will invest in, along with the lead researcher, their research organisation, and the commencement and completion dates for the projects. *Please note that this table is current as of 5 May 2021, and may be subject to change.*

Key focus area	Outcome	Project title	Project code	Researcher	Organisation	Commenced in:	To be completed in:
Goal 1: Increased productivity and profitability on cotton farms							
1.1 Optimised farming systems	1.1.1 Improved yield and quality	Improving crop establishment, termination and weed control in dryland cotton farming systems	CRDC1937	Annabelle Guest	DCRA	Jan-19	Jun-22
		Increased yield through improved management of soil constraints in cotton farming systems	USQ1903	John Bennett	USQ	Jun-19	Jun-22
		PhD: Assessing yield and fibre quality variability in cotton systems through data science for improved management	US2104	Mikaela Tilse	USYD	Mar-21	Feb-24
	1.1.2 Improved input efficiencies	Combining targeted location and control of pests with prophylactic crop defence	COMM	Mary Whitehouse	CSIRO	Jul-21	Jun-24
		Determining the next steps for nitrogen research	COMM			Jul-21	Jun-23
		Identifying the trends and drivers of water productivity in Australian cotton through benchmarking (including CottonInfo technical lead Ben Crawley)	DAN2002	David Perovic	NSW DPI	Jul-19	Jul-22
		More Profit from Nitrogen – New technologies and managements: transforming nitrogen use efficiency in cane production.	RRDP1719	Matt Redding	QDAF	Sep-16	Sep-21
		More Profit from Nitrogen – Science leadership and project coordination	RRDP1711	Marguerite White	ICD Project Services	Nov-16	Sep-21
		Novel options and strategies for Integrated Pest Management (IPM) in Australian cotton	COMM	Doug McCollum	CCA	Jul-21	Jun-24
		PhD: Sub-paddock scale prediction of soil-water characteristic – need for localised calibration	COMM	Ned Skehan	USQ	Feb-21	Feb-23
		PhD: The impact of irrigation methods and management strategies on nitrogen fertiliser recovery in cotton in southern QLD	UQ1502	John Smith	UQ	Jul-14	Dec-21
		Professor of Soil Biology (includes CottonInfo technical lead and myBMP module lead)	UNE2001	Oliver Knox	UNE	Jul-19	Jun-24
	1.1.3 On-farm sustainable development is supported	Building profitable farming systems for the future through increasing Soil Organic Carbon (SOC) and optimising Water Use Efficiency (WUE) in a changing climate	2122FRP020	Annabelle Guest	DCRA	Jul-21	Jun-23
		Dryland & limited water systems research	2122FRP024	Sarah Dadd	NSW DPI	Jul-21	Jun-23
		Integrated Pest Management (IPM), biosecurity leadership & spodoptera, defoliation and climate adaption RD&E (including CottonInfo technical leads Paul Grundy and Sharna Holman)	DAQ2201	Paul Grundy	QDAF	Jul-21	Jun-24
		Leveraging limited water to maximise profit: 20+ years of cotton systems research	2122FRP014	Claire Welsh	CSIRO	Jul-21	Jun-23
		Optimising dryland cotton production in the Namoi Valley	US2102	Stephen Cattle	USYD	Oct-20	Sep-21
		Optimising dryland cotton production on the Liverpool Plains	US2103	Stephen Cattle	USYD	Oct-20	Sep-21
		PhD: Classifying the suitability of Murrumbidgee Valley soils for cotton production	US2002	Jonathon Moore	USYD	Mar-20	Mar-23
		Potential for broadacre cropping in the Northern Territory	CRCNA2001	Matt Hall	CRCNA	Jun-19	May-22
		Science leadership for cotton development in Northern Australia	CSP1903	Stephen Yeates	CSIRO	Oct-18	Sep-22
	1.1.4 Improved reliability of cotton production	Minimising yield variability to maximise yield in a cotton farming system	DAN1801	Guna Nachimuthu	NSW DPI	Jul-17	Jun-22
		Supporting southern cotton production systems: Cotton Research Officer (including CottonInfo technical lead Beth Shakeshaft)	DAN2001	Hayden Petty	NSW DPI	Jul-19	Jun-22

1.2 Transformative technologies	1.2.1 New technologies are adapted for use in cotton	Aggregating on-farm data sets: can we use old data to answer new questions?	COMM			Jul-21	Jun-22
		Defoliating cotton in an increasingly difficult environment	2122FRP015	Mark Congreve	ICAN	Jul-21	Jun-22
		Future Farm Phase 2: Improving farmer confidence in targeted nitrogen management through automated sensing and decision support	QUT1902	Peter Grace	QUT	Jul-18	Jun-22
		Identifying sensors for better Integrated Pest Management (IPM) in cotton	NEC1901	Alison McCarthy	USQ NCEA	Jul-18	Jun-21
		Smarter Irrigation for Profit 2: Beyond water smart – advancing dairy irrigation system performance	RRDP2012	James Hills	UTAS	Jul-19	May-22
		Smarter Irrigation for Profit 2: Cross sectoral integration and extension	RRDP2005	Louise Gall	GVIA	Jul-19	May-22
		Smarter Irrigation for Profit 2: Economic dairy case studies	RRDP2102	Daniel Armstrong	D-ARM Consulting	Aug-20	Feb-22
		Smarter Irrigation for Profit 2: Evaporation mitigating solution for Australian cotton water storages	RRDP2007	Greg Qiao	UMELB	Jul-19	May-22
		Smarter Irrigation for Profit 2: Gwydir Valley demonstration of latest digital technologies for precise automated irrigation	RRDP2004	Louise Gall	GVIA	Jul-19	May-22
		Smarter Irrigation for Profit 2: Improved irrigation system selection and operation for increased sugarcane productivity and profitability	RRDP2013	Michael Scobie	USQ	Jul-19	May-22
		Smarter Irrigation for Profit 2: Improving the science of water footprinting	RRDP2103	Guy Roth	USYD	Feb-20	Feb-22
		Smarter Irrigation for Profit 2: Key learning sites southern (making the most of water)	RRDP2014	Alex Schultze	NSW DPI	Jul-19	May-22
		Smarter Irrigation for Profit 2: Monitoring and Evaluation	RRDP2020	Adam McNeill	KG2	Jun-20	Mar-22
		Smarter Irrigation for Profit 2: Monitoring and Evaluation case studies and analysis	RRDP2101	George Revell	AgEcon	Jul-20	Mar-22
		Smarter Irrigation for Profit 2: New tech integrated smart sensing & automation for cotton	RRDP2003	John Hornbuckle	DU	Jul-19	May-22
		Smarter Irrigation for Profit 2: Plant-based sensing for cotton irrigation	RRDP2006	Hizbullah Jamali	CSIRO	Jul-19	May-22
		Smarter Irrigation for Profit 2: Project Management Committee meetings	RRDP2015	Cathy Phelps	C&J Phelps Consulting	Nov-19	May-22
		Smarter Irrigation for Profit 2: Precise real-time automated cotton and dairy irrigation for improved water productivity	RRDP2002	Joseph Foley	USQ NCEA	Jul-19	May-22
		Smarter Irrigation for Profit 2: Project communications	RRDP2104	Cathy Phelps	C&J Phelps Consulting	Jun-20	Jun-22
		Smarter Irrigation for Profit 2: Project leadership and coordination	RRDP2001	Cathy Phelps	C&J Phelps Consulting	Jul-19	Jun-22
		Smarter Irrigation for Profit 2: Scaling irrigation management to support whole farm operations	RRDP2011	Andy McAllister	DJPR	Jul-19	May-22
		Smarter Irrigation for Profit 2: Smart irrigation control for water and labour savings in rice growing systems	RRDP2008	John Hornbuckle	DU	Jul-19	May-22
		Smarter Irrigation for Profit 2: Video training sessions	RRDP2105	Steve Barratt	MRL Media	Nov-20	Jun-22
		Smarter Irrigation for Profit 2: What is my yield gap? Maximising water productivity	RRDP2010	Cath Lescun	Dairy Australia	Jul-19	May-22
		Smarter Irrigation for Profit 2: YourDATA Monitoring & Evaluation Database	RRDP2017	Jeff Coutts	Coutts J&R	Nov-19	May-22
	1.2.2 Cotton farms are digitally enabled	Informing a digital strategy for the Australian cotton industry (Business case)	CRDC2110	Sarah Nolet	AgThentic	Mar-21	Sep-21
		Informing a digital strategy for the Australian cotton industry (Data audit)	CRDC2111	Ian Posthumus	DataGene	Mar-21	Sep-21
1.3 Protection from biotic threats and environmental stresses	1.3.1 Increased understanding of the impact of pests, diseases and weeds, and environmental stresses	Climate proofing Australia's cotton industry through improving crop water use and photosynthetic carbon assimilation (Climate proof cotton)	2122FRP028	Robert Sharwood	UWS	Jul-21	Jun-24
		Evaluating and compiling cotton disease research findings for future direction	COMM			Jul-21	Jun-22
		Using DNA diagnostics to monitor disease suppressive cotton farming systems	CAS2101	Rob Long	Crown Analytical	Jul-20	Jun-23
	1.3.2 Improved identification, surveillance and management systems for pests, diseases and weeds and environmental stresses	Applying molecular tools to inform the Bt RPM for Helicoverpa and FAW	COMM	Sharon Downes	CSIRO	Jul-21	Jun-24

		ARC Research Hub for Sustainable Crop Protection	UQ2001	Neena Mitter	HIA/UQ	Jul-19	Jun-24
		Area Wide Management for cropping systems weeds, investigating the weed management, social and economic opportunity	GRDC2002	Rick Llewellyn	GRDC	Aug-19	Jun-22
		Biological based products for improved cotton production	UWS1901	Brajesh K Singh	UWS	Jul-18	Mar-22
		Characteristics of disease suppressive cotton farming systems and soils	DAQ2002	Linda Smith	QDAF	Jul-19	Jun-22
		Evaluate efficacy of novel chemistries, biocontrol agents and management practices to control Alternaria and Black Root Rot disease in cotton	DAN2101	Duy Le	NSW DPI	Jul-20	Jun-22
		Improved management of weeds in cotton and grains farming systems (including CottonInfo technical lead Eric Koetz)	DAN2004	Graham Charles	NSW DPI	Jul-19	Jun-22
		Modern systems agronomy for resilient cotton production	CSP2001	Claire Welsh	CSIRO	Jan-20	Jun-22
		Novel topical vegetable, cotton virus and whitefly protection – BIOCLAY	HIA1803	Neena Mitter	HIA/UQ	Feb-18	Jul-21
		Plant Biosecurity Research Initiative (PBRI) Phase 2	HIA2101	Jo Luck	HIA	Jul-20	Jun-23
		Plant Health Australia Membership 2020-2023	PHA2101	Stuart Kearns	Plant Health Aust	Jul-20	Jun-23
		R&D Manager, Disease	CRDC2105	Elle Storrier	Macpherson Agronomy Services	Oct-20	Oct-23
		Review of the Biosecurity Plan for the Cotton Industry	2122FRP029	Stuart Kearns	Plant Health Aust	Jul-21	Jun-24
		Sustainable insect management through improved insect resistance monitoring	DAN2003	Lisa Bird	NSW DPI	Jul-19	Jun-22
		Sustainable SLW management through improved insect resistance monitoring	DAQ2001	Jamie Hopkinson	QDAF	Jul-19	Jun-22
		Tools for assessing and achieving pesticide sustainability targets for the Australian cotton industry	2122FRP005	Mick Rose	NSW DPI	Jul-21	Jun-23
	1.3.3 Industry is prepared for a biosecurity incursion	Boosting Diagnostic Capacity for Plant Production Industries	GRDC2001	K'trie Coster	GRDC	Jul-19	Jun-22
		Plant Biosecurity Research Initiative (PBRI) – Phase 2	COMM	Jo Luck	HIA	Jul-21	Jun-22

Key focus area	Outcome	Project title	Project code	Researcher	Organisation	Commenced in:	To be completed in:
Goal 2: Improve cotton farming sustainability and value chain competitiveness							
2.1 Sustainability of cotton farming	2.1.1 Improved environmental footprint for cotton farms	Cotton Landcare Tech Innovations: Communications Support	NLP1903	Bernadette Pilling	HOC	Nov-18	Mar-22
		Cotton Landcare Tech Innovations: Florabank training	COMM			Jul-19	Jun-22
		Cotton Landcare Tech Innovations: Improved natural capital (biodiversity) on Australian cotton farms	NLP1901	Stuart Parsons	QUT	Jan-19	May-22
		Cotton Landcare Tech Innovations: Improved natural capital (biodiversity) on Australian cotton farms.	NLP1902	Rhiannon Smith	UNE	Jul-18	Jun-22
		Cotton Landcare Tech Innovations: One tree per bale business plan	COMM			Jul-18	Jun-22
		Cotton Landcare Tech Innovations: Spotlight evenings	COMM	Stacey Vogel	Stacey Vogel Consulting	Jul-18	Jun-22
		Feasibility study of managed aquifer recharge for improved water productivity	ANU1901	Anthony Jakeman	ANU	Aug-18	Aug-21
		Impacts and solutions: A scoping study on relative impacts of irrigation infrastructure on fish	DAQ2101	Michael Hutchison	QDAF	Jul-20	Jun-22
		Secretariat Support for Australian Screen Advisory Panel	CRDC2104	Craig Copeland	Ozfish Unlimited Ltd	Aug-20	Jun-22
		Supporting the revision of the industry's sustainable biodiversity indicators, metrics and target areas	COMM			Jul-21	Jun-22
		Towards carbon neutral cotton production	2122FRP027	Hizbullah Jamali	CSIRO	May-21	Mar-24
		Understanding the environmental co-benefits of irrigation water in the northern Murray-Darling Basin	2122FRP004	Peta Zivec	Griffith University	Jul-21	Jun-24
2.2 Create higher value uses for cotton	2.2.1 Increased value for Australian cotton	Developing renewable fine chemicals from cotton biomass (Biorefineries for higher-value animal feeds, chemicals and fuels phase 2)	SRA2001	William Doherty	QUT	Jul-19	Dec-20
	2.2.2 Increased understanding of market requirements and opportunities throughout the value chain	Joint RDC community trust project	RIRDC1903	Jennifer Medway	AgriFutures	Jul-21	Jun-22
		Strategies for improving labour conditions within the Australian cotton value chain	QUT1903	Alice Payne	QUT	Jun-19	Jun-22

2.3 Measurement and reporting throughout the value chain	2.3.1 CRDC collaborates in global leadership for sustainability initiatives	Australian participation in the European Union Product Environmental Footprint Technical Advisory Board	CRDC2008	Angus Ireland	AWI	Oct-19	Dec-22
		Cotton industry social and wellbeing sustainability indicators	UC1901	Jacki Schirmer	University of Canberra	Jun-19	Jun-22
		Membership of the Sustainable Agriculture Initiative (SAI) – Australian chapter	CRDC1902	Selwyn Heilbron	SAI Platform (Aust) Inc	Jul-18	Jun-23
		PhD: Textile supply chain transparency and accountability	UL1901	Mark Sumner	UL	Oct-18	Sep-21
		Sustainability metrics for the cotton industry	CRDC1944	Chris Cosgrove	Sustenance Asia	Jun-19	Jun-22
		Sustainable Apparel Coalition membership	CRDC1817	Glenn Robinson	SAC	Jul-21	Jun-22
	2.3.2 The value chain is transparent and understood by participants	Australian Cotton Industry Fourth Environmental Audit	COMM			Apr-21	Dec-22
		PhD: Sustainable value chain analysis of the Australian cotton industry	QUT1901	Zoe Mellick	QUT	Jul-18	Nov-21

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Goal 3: Build adaptive capacity of the cotton industry							
3.1 Science and innovation capability, and new knowledge	3.1.1 Science and innovation capacity is strengthened and strategically fit for a digital future	2021 and 2022 Science and Innovation Awards for young people in Agriculture, Fisheries and Forestry	ABA2101	Maree Finnegan	ABARES	Jul-20	Jun-22
		Australian Rural Leadership Program Course 26, Course 27, Course 28, Trail 2020, Trail 2021	RIR1903	Matt Linnegar	ARLF	May-19	Dec-22
		Building digital capability in the Australian cotton industry	COMM			Jul-21	Jun-23
		Cotton Production Course	UNE2002	Oliver Knox	UNE	Jan-20	Jun-23
		CRDC R&D Manager, People and Capacity	CRDC2106	Rachel Holloway	Rachel Holloway Consulting	Jul-20	Jun-23
		CRDC summer & honours scholarships	COMM		CRDC	Jul-21	Jun-22
		CSIRO student vacation scholarship program	COMM		CSIRO	Jul-21	Jun-22
		Digital strategy for the Australian cotton industry – phase 2	COMM			Jul-21	Jun-23
		Graduate tour – Careers in cotton industry	COMM		CRDC	Jul-20	Jun-22
		Honours scholarship: Nutrient stratification in the soil under irrigated and dryland cotton systems in contrasting soil types	US2101	Sarah MacKay	USYD	Feb-21	Dec-21
		Improving grower decision in complex systems: A targeted tool to assist cotton growers in appropriate technology adoption	QUT2001	Geraldine Wunsch	QUT	Jul-19	Mar-22
		Nuffield Australia Farming Scholarships	COMM	Jodie Dean	Nuffield	Jul-21	Jun-23
		Supporting adaptive research capacity for careers in the cotton industry	2122FRP010	Trudy Staines	CSIRO	Jul-21	Jun-24
	3.1.2 Increased understanding of the diverse human capital in regional communities	AACS Australian Cotton Research Conference	COMM		AACS	Jul-21	Jun-23
		Delivering best practice to manage future workforce skills	COMM	Nicole McDonald	CQU	Oct-21	Sep-24
		People in Agriculture	COMM	Sally Roberts	Dairy Australia	Jul-21	Jun-24
3.2 Futures thinking	3.2.1 Australian cotton growers are able to adapt to change	2022-2024 Joint-RDC Health and Safety Farming Alliance	COMM	Jennifer Medway	AgriFutures	Jul-21	Jun-24
		CRDC Grassroots Grants 2021-22	COMM		CGAs	Jul-21	Jun-22
		Grassroots Grant: Digitally enabled cotton farms	CGA2102	Amanda Thomas	Macquarie CGA	Sep-20	Oct-21
		Grassroots Grant: Increasing cotton grower skills, and awareness through projects across the Darling Downs cotton growing communities	CGA2106	Georgie Krieg	Darling Downs CGA	Nov-20	Sep-21
		Grassroots Grant: On-farm evaluation of pumping telemetry	CGA2002	Amanda Thomas	Macquarie CGA	Sep-17	Aug-21
		Nuffield Australia Farming Scholarship 2020: Richard Quigley	CRDC2009	Richard Quigley	Nuffield	Apr-19	Sep-21
	3.2.2 Increased opportunities for strategic foresighting	Strategic scoping studies	COMM			Jul-21	Jun-22
		Grower RD&E advisory panels and industry committees	CA2002	Sally Ceeney	Cotton Australia	Jul-21	Jun-22

Key focus area	Outcome	Project title	Project code	Researcher	Organisation	Commenced in:	To be completed in:
Goal 4 (Enabling Strategy 1): Strengthening partnerships and adoption							
4.1. Partnerships and collaboration	4.1.1 Growers/ consultants value CRDC farming systems research outcomes	20th Australian Cotton Conference Foundation Sponsorship	CA2004	Tracey Byrne-Morrison	Cotton Australia	Dec-19	Nov-22

	4.1.2 CottonInfo partnership is maintained and practice change improved	Climate, energy and business analysis for cotton growers (including CottonInfo technical lead)	AE2101	Jon Welsh	AgEcon	Jul-20	Jun-23
		Cotton industry database management	CRDC2101	Lee Armson	Lee Armson Consulting	Jul-21	Jun-23
		CottonInfo field demonstration trial	COMM		CottonInfo	Jul-21	Jun-22
		CottonInfo multimedia content development	2122FRP017	Tonia Grundy	QDAF	Jul-21	Jun-24
		CottonInfo NRM Technical Lead (including myBMP module lead) and CRDC NRM R&D Manager	CRDC2102	Stacey Vogel	Stacey Vogel Consulting	Jul-20	Jun-23
		CottonInfo Technical Lead – Nutrition (including myBMP module lead)		Jon Baird	NSW DPI	Jul-21	Jun-24
		Identifying key issues to maintain and improve Australian cotton fibre quality (including CottonInfo Technical Lead and myBMP module lead)	CRDC2103	Rene van der Sluijs	Textile Technical Services	Jul-20	Jun-23
		Proofreading 2021 Australian Cotton Production Manual and Cotton Pest Management Guide	CRDC2108	Helen Dugdale	Helen Dugdale Consulting	Apr-21	Jul-21
	4.1.3 Partnerships are strengthened to engage multi-disciplinary and multi-institutional resources	Agriculture Innovation Australia membership	COMM		AIA Ltd	Jul-21	Jun-23
4.2 Best practice (myBMP)	4.2.1 Best practice is based on science and measured impact	Cotton industry injury and safety statistics	COMM			Jul-21	Jun-22
		CRDC monitoring and evaluation data collection	COMM			Jul-21	Jun-22
		Economic data collection	COMM			Jul-21	Jun-22
		Ensuring best practice is based on science	CRDC2113	Chris Cosgrove	Sustenance Asia	Apr-21	Mar-24
4.3 Innovation and commercial-isation	4.3.1 Improved R&D innovation and commercial-isation	Commercialisation Management Tasks	COMM	Jarrod Ward	Ahurei Pty Ltd	Jul-21	Jun-22
		Spray Hazard Tower Network	COMM		GRDC	Jul-19	Jun-22

Key focus area	Outcome	Project title	Project code	Researcher	Organisation	Commenced in:	To be completed in:
Goal 5 (Enabling Strategy 2): Driving RD&E impact							
5.1 Impact and effectiveness	5.1.1 CRDC's RD&E investments meet grower, industry and government needs	CRDC Strategic Plan 2023-28 Project Management	CRDC2112	Bernadette Pilling	HOC	Mar-21	Jun-23
	5.1.2 CRDC monitors and evaluates RD&E impact	Annual consultant qualitative and quantitative surveys	CCA1901	Laura Causer	CCA	Mar-18	Sep-21
		Collaboration: Evaluation and Measuring impact	SRA2002	Leigh Clement	SRA	Oct-20	Sep-21
		CRDC Cotton Grower Survey 2020-22	CRDC2014	Michael Sparks	Intuitive Solutions	Jul-20	Mar-23
		Communications support project	COMM	Bernadette Pilling	HOC	Jul-21	Jun-23
	5.1.3 CRDC funded projects demonstrate value and return on investment	Impact assessment of projects	COMM			Jul-21	Jun-23

Key

AACS	Association of Australian Cotton Scientists
AIA Ltd	Agriculture Innovation Australia Ltd
ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
AgriFutures	AgriFutures Australia (formerly the Rural Industries Research & Development Corporation)
ANU	Australian National University
ARLF	Australian Rural Leadership Foundation
AWI	Australian Wool Innovation
CCA	Crop Consultants Australia
CRCNA	Cooperative Research Centre for Developing Northern Australia
CGA	Cotton Grower Association
CQU	Central Queensland University
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DCRA	Dryland Cotton Research Association
DJPR	Victorian Department of Jobs, Precincts and Regions
DU	Deakin University
GRDC	Grains Research and Development Corporation
GVIA	Gwydir Valley Irrigators Association
HIA	Hort Innovation
HOC	House of Communication
ICAN	Independent Consultants Australia Network
MLA	Meat and Livestock Australia
NSW DPI	NSW Department of Primary Industries
NTDPIR	Northern Territory Department of Primary Industries and Resources
QDAF	Queensland Department of Agriculture and Fisheries
QUT	Queensland University of Technology
SAC	Sustainable Apparel Coalition
SAI	Sustainable Agriculture Initiative
SRA	Sugar Research Australia
UL	University of Leeds
UMELB	University of Melbourne
UNE	University of New England
UQ	University of Queensland
USQ	University of Southern Queensland
USQ NCEA	University of Southern Queensland National Centre for Engineering in Agriculture
USYD	University of Sydney
UTAS	University of Tasmania
UTS	University of Technology, Sydney
UWS	University of Western Sydney

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