

Spotlight.

ON COTTON R&D

Winter 2017

Rotation rewards

Weeds research:
giving growers options

CRDC's investments 2017-18



Australian Government
Cotton Research and
Development Corporation



Bruce Finney

In the Spotlight

In this edition, we are pleased to highlight examples of our investments in people and the impact they are making.

Whether it is a Nuffield scholarship, Young Farming Champion or a Science and Innovation Awardee, we are constantly impressed with the calibre of the participants and their ideas for advancing the industry. The opportunity to make more of this talent and ideas led CRDC to develop a new initiative called Rural.XO for growers, researchers and agribusiness participants – the goal being to provide a short course in the science of taking an innovative idea and successfully turning it into a reality. It has been tremendous to see the response to this initiative and we look forward to seeing the impact as we grow this activity within the industry as well as with a new diverse external group of people with different skills and experiences.

CRDC proactively seeks to understand and invest in RD&E to address the cotton industry's challenges and future opportunities. This commitment is embedded in our five-year strategic plans and the culture of our day to day operations. With our current strategic plan ending in June 2018 CRDC has commenced the process of formulating the 2018-2023 Strategic R&D Plan. This process is one we hope to see many growers involved in, as this Plan is about your needs and the broader industry direction for likely investment of more than \$100 million over the next five years.

Despite our best efforts in planning there is always the likelihood of the unexpected. It's hard to recall a more challenging cotton production season in recent years. In this vein, the industry did not foresee the resurgence (albeit a different strain) of Verticillium. Our ability to respond quickly by allocating funding to targeted research projects to understand and manage this threat is, needless to say, an integral part of our role. We are pleased to include a report on long-term trials and the efforts of researchers and growers working together to solve this challenge.

This edition also features research in weeds management and the development of tools to help growers manage herbicide resistance. The cotton industry is making a concerted effort to avoid the worrying scenarios experienced overseas, where weeds are becoming resistant to many modes of herbicide action. Predictive modelling can help determine both the resistance and economic outcomes of their weed control programs, and we encourage growers and consultants to use this free tool.

Of further note are two new projects, addressing the farming systems research needs of dryland cotton growers and cotton production management in Southern NSW. The projects are well underway, and the researchers look forward to working with growers to ensure some excellent outcomes.

Finally, our list of projects is included in this edition, for your information purposes. The list highlights the scope and direction of research investments in the last year of the 2013-18 Strategic R&D Plan.

Bruce Finney
CRDC Executive Director



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Cotton Research and Development Corporation

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ON THE COVER: Narrabri grower Tony Dampney and NSW DPI pathologist Karen Kirkby.

Want to see more of Spotlight?

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

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Winter 2017



PAUL GRUNDY

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Fast Facts



MELANIE JENSON

176

Kilograms of nitrogen per hectare (average) was being applied to cotton fields in 1996-97. In 2015-16 the figure was 275kg per hectare. (page 7).



JEFF WERTH

74

Percent of cotton growers believe they have glyphosate resistance (page 13).

\$200

Per hectare is the predicted value of increased yield by incorporating one cover crop every second summer fallow over the course of a whole rotation (page 20).

20

Percent establishment improvement using moisture-attracting additives at planting (page 24).



SHANNA K WHAN

Nellie Evans and Jess Lehmann are on a journey to promote the cotton industry.

Young champions

JESS LEHMANN and Nellie Evans have been selected as CRDC's inaugural Young Farming Champions (YFC).

Run by Art4Agriculture, the YFC program identifies youth ambassadors and future influencers working in the agriculture sector. The YFC promote positive images and perceptions of farming and engage in activities such as The Archibull Prize.

CRDC has partnered with Art4Agriculture for the first time in 2017 through its support of the YFC program. Cotton Australia also has a relationship with Art4Agriculture, supporting the Archibull Prize. These programs form part of Cotton Australia's focus on education, and the combined CRDC and Cotton Australia focus on workforce development.

Jess Lehmann is the daughter of well-known consultant, the late Chris Lehmann, hails from the family cotton farm at Narrabri, and works in cotton research.

"I am always amazed by the various people and bodies who contribute to our agricultural sector," she says.

"Whether it's farmers, contractors, researchers, scientists, policy developers, or agronomists; everyone is a part of the overall equation and everyone will benefit from future agricultural research."

After studying landscape architecture Nellie Evans discovered cotton on the plains of Warren, Bourke and Gunnedah and changed her career direction. Currently a fourth year agricultural science student at The University of Sydney she believes passionately in the industry.

"The cotton industry is really at the forefront of research and development as it faces a future of climate, social and market based challenges," she says.

CRDC's General Manager of R&D, Ian Taylor, oversees CRDC's investments in the 'People' program and says the partnership with Art4Agriculture further broadens CRDC's support of people in the industry.

"We support a wide range of programs – from Art4Agriculture through to the Australian Rural Leadership Foundation – all focused on providing development opportunities for people in cotton.

"It's an acknowledgement that people are our most important resource."

For more: www.art4agriculture.com.au

Turning ideas into action

Participants at a unique series of start-up science workshops have been given the potential to take an idea and turn it into a reality.

CRDC partnered with start-up science company Pollenizer and the Fisheries RDC to run two workshops titled the Rural.XO microhacks, held in March and May this year.

CRDC sponsored 20 cotton industry participants to attend, from growers to researchers, with the best ideas emerging from the events now with the opportunity to be incubated into real start-up businesses. The hands-on, two-day workshops in Sydney utilised Pollenizer's 'Startup Science' methodology.

"XO stands for exponential opportunities; exponential opportunities for new ideas to help transform the future cotton industry," CRDC Executive Director Bruce Finney said.

"The cotton industry was built on innovation and wouldn't be where it is today without the people who challenged the status quo, who took their big ideas and turned them into reality.

"It's in the spirit of this history we see our future, albeit in a vastly different approach with new technology and start-ups."

Young innovators Anastasia Volkova and Malcolm Ramsay took their existing decision-support tool FluroSat to the workshop to further their journey to commercialisation. FluroSat is a predictive crop health monitoring tool for early stress identification. Data is collected through satellites and drones and FluroSat allows tracking of poor crop development, to trace its cause to factors like nutrition, stress, weeds, insects and disease. Anastasia told *Spotlight* that the biggest benefit of the microhack was breaking down barriers by bringing a range of stakeholders, including farmers, agronomists, developers and CRDC representatives into the same room.

"It was a really unique experience. It is easier and a lot quicker to realise the full benefit of an innovation when we can have these discussions together.

"The farmers made it clear they don't



Participants at the first Pollenizer Rural.XO microhack in Sydney with CRDC's Bruce Finney (front left), and Cotton Australia's Nicola Cottee (back left) and Adam Kay (front right).

a start."

The idea Andrew took to the microhack was the development of a review system for farmers of new technology, apps and platforms.

"There is so much technology coming onto the market

want more information, they want the analytic tools."

Anastasia praised the cotton industry for its cohesion and attitude to innovation.

"We needed support from agriculture and got that from the cotton industry," she said.

"We chose to work with the cotton industry because it is very consolidated, values innovation, and understands how technology can assist the industry.

"It would be great to have more events like this in the cotton industry."

Andrew Gill grows cotton south-west of Narromine. He said the event showed how a glimpse of an idea could be teased out into something worthwhile. Meeting people from the fisheries industry, discussing and comparing issues was also a highlight.

"It was really interesting to see how far apart we are as industries but how common our goals and needs are," Andrew said.

And while the workshop delved into possibilities around remote management through mobile technology, Andrew says it also highlighted the need for better connectivity in regional areas.

"Often we cannot benefit from new web-based technology and innovation due to poor connectivity," he said.

"Even if the technology is available, our substandard internet out here is a barrier to adoption.

"We heard at the workshop that 'If it (the idea) doesn't work on a phone don't develop it' – which negates a lot of ideas when you don't have adequate mobile connectivity for

now, but no real information about them, independent testing or reviews we can access to see if the product is useful or fits our needs."

Grassroots innovation

Cotton Grower Service's business development manager Reinder Prins said the microhack provided a stimulating environment that encouraged participants "to come up with solutions to problems we didn't even know we had before we started".

"The main value I see in the microhack is fostering innovation at a grassroots level," Reinder said.

"There are many people in cotton with valuable ideas that could benefit many: they just don't know how to get them out there, so microhacks can ensure everyone gets a chance to work on their idea and see how they might make it grow into a business venture.

"Transforming an idea into a business venture is not easy in the best of circumstances, but with a geographically widespread industry that is located in predominantly sparsely populated areas where certain resources might be far away, it is even harder.

"To get this kind of knowledge into our industry will benefit everyone, especially once the participants start sharing the methodology with others with good ideas as well."

For more

www.pollenizer.com/rural-xo

Unlocking the hidden value of gin trash

AGRICULTURALLY-based industries including cotton production can generate several million tonnes of waste each year, which typically represent a burden to the industry through expensive waste management. There is however potential to convert this trash into treasure.

Cotton gin trash is one such promising renewable biomass feedstock that could support regional biorefineries producing a range of value-added bio-based products such as fuels, chemicals, feeds, fibre and energy.

In a CRDC-funded project, NSW DPI scientists in collaboration with a multidisciplinary team of phytochemists and pharmacologist from Southern Cross University and Western Sydney University are aiming to develop scalable, innovative and integrated processes to fractionate, refine and convert gin trash into multiple novel biochemicals and biofuels.

"Gin trash is an ideal low cost feedstock because unlike other biomass, it is concentrated at processing sites," says NSW DPI's Dr Shane McIntosh.

"The study has been designed to evaluate and develop processing methods



The stages in processing cotton gin trash to ethanol: raw trash; 'pretreated' or cooked trash; extracted sugars; and the fermentation beer (sugars to ethanol).

to exploit the high levels of carbohydrates found in gin trash specifically for the production of bioethanol.

"Moreover, the cotton plant is known to contain many important chemical compounds some of which are highly valued particularly in pharmaceuticals, nutraceuticals, pesticides and fragrances industries.

"The project will explore the full spectrum and potential product application of compounds which can be extracted.

"By developing a consolidated processing configuration, combining a number of different processes into one or maybe a few sequential steps that simplifies the overall processing, significant reductions in production costs can be realised."

As mentioned in the Autumn 2017 edition of *Spotlight*, CRDC will also be investigating the techno-economic feasibility of establishing bio-refineries, and the business model options, as a key component of *A profitable future for Australian agriculture: Biorefineries for higher-value animal feeds, chemicals, and fuels* project. This is a major collaborative project under the Department of Agriculture and Water Resources Rural R&D for Profit programme.

For more

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New era: new plan

CRDC's RD&E investments are governed by a five-year Strategic R&D Plan, which is developed in conjunction with the Australian cotton industry. With the current Strategic Plan due to conclude in June 2018, the development of the new plan is now underway.

The first step in the formulation of the 2018-2023 Strategic Plan is a scan of the environment in which the Australian cotton industry currently operates, with a particular focus on the threats and opportunities facing the industry now and in the future.

Two forums have been held – the first with CRDC and Cotton Australia's management teams, the second with the joint Boards – to conduct this environmental scan and to identify the key trends, determine progress against the industry vision, and to discuss the industry's preferred future and goals.

These key trends were then presented to the Cotton Australia grower advisory

panels at the CRDC Strategic Forum in Brisbane in late May, in order to gain critical grower input.

Using the feedback from this Forum, CRDC will now start developing the key themes of the new Strategic Plan – ensuring it addresses the key trends and issues identified by the Boards, management and growers – before circulating to industry partners for their feedback. This will involve consultation with representative bodies, like Cotton Australia, the Cotton Innovation Network and the Australian Cotton Industry forum; with the grower panels and individual growers; and with the Government, through the Department of Agriculture and Water Resources.

CRDC invites all growers to take part in the strategic R&D planning for the industry.

"CRDC exists to invest in RD&E for the Australian cotton industry, and our Strategic Plan guides all of our

investments for the coming five years – so it's essential that growers have the opportunity to their say," CRDC Executive Director Bruce Finney said.

"We'll be keeping growers informed as the Plan develops, and in conjunction with Cotton Australia provide more information on how you can contribute to the plan as we progress."

The development of the Strategic Plan, incorporating the feedback, advice and input of all stakeholders, will be finished in March 2018, with the commencement of the new Strategic Plan period in July 2018.

For more information, including the consultation plan for the Strategic Plan's development, visit our website: www.crdc.com.au.

For more:

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Survey tracks grower trends

THIS YEAR marks 20 years since the first surveys of Australian cotton growers' management practices and attitudes was undertaken.

In all, 10 surveys have been undertaken with the most recent covering the 2015-16 growing season. Over the years, surveys have focused questions on a range of different areas. CRDC has commissioned annual surveys since 2013 in an effort to build an ongoing picture of the industry to assess the success of R&D and better focus future investment.

Taking a step back

In 1997, 47 percent of growers had been growing cotton for more than 10 years and 32 percent for between five and 10 years. Pull rake and burn were still three words used consecutively in the cotton grower vocabulary. This method of crop destruction was being used by 10 percent of the 247 respondents. The use of solar as a serious energy source doesn't rate a mention, yet by 2016, 37 percent of respondents had solar energy installations.

In the disease arena, the first survey showed *Verticillium* wilt was a leading cause of yield reductions, albeit a different strain to those found in cotton fields today.

There have also been significant changes in terms of fertiliser use which, in irrigated cotton, has more than doubled from the average rate of 125 kg N/ha in 1995-96, to 275kgN/ha in 2015-16. A significant increase was between the first and second surveys, to 176 kgN/ha in 1999-2000. The 2016 survey showed 139 Kg N/ha solid and 193KgN/ha gas being applied.

Solid N and gas N were both used at higher rates in 2005-06 when

Grower surveys provide an insight to CRDC on how current research is meeting grower needs as well as what the future of R&D might look like.



compared to 2000-01.

In terms of irrigation management, irrigation scheduling was based on experience combined with crop stage and rate of growth for most irrigators with neutron probes used by 36 percent of respondents, water balance models and weather data by 32 percent and enviroscans by nine percent. Today growers have a much bigger toolbox to draw from, which includes Irrisat, canopy sensors, weather stations, C probes and modelling.

Residual herbicide use has also changed dramatically, largely due to the introduction of stacked Roundup Ready Bollgard varieties.

The survey of the 1999-2000 season revealed the main changes were an increased pre-plant use of diuron and a trend toward pendimethalin and away from trifluralin, but with an overall reduction in the use of grass herbicides. Conversely, post-plant use of diuron had reduced from 51 percent to four percent over the four years between the first and second surveys. Hard to control weeds were nutgrass, bladder ketmia, noogoora and bathurst burrs, bell vine and sesbania. While some of these weeds still pose threats, a new range

of problem weeds has emerged along with resistance to glyphosate-based products.

"There is no doubt cotton growing has changed significantly in the past 20 years," CRDC Executive Director Bruce Finney said.

"Showing how quickly management and attitudes change, in 2005-06, growers were asked if they felt they would be able to continue to farm productively using their current farming practices for the next 50 years.

"In the Namoi, 66 percent of growers said no, while 62 percent of southern growers, along with 29 percent in the Gwydir, felt it was possible to continue using current practices.

"History shows us that cotton growing since then has changed any many ways, with new technology, for example around irrigation, plant breeding and soil management.

"Much of this change has been supported by the new knowledge and practices generated through investment in industry RD&E."

For more

www.crdc.com.au/publications

Have your say! 2017 Cotton Grower Survey

The annual CRDC Cotton Grower Survey will open in June, and all cotton growers are invited to have their say.

Growers and farm managers will receive an invitation in early June to participate in the survey.

For all growers with an email address on file with CRDC, you'll receive an email invitation to participate – simply click on the link in the email to provide your feedback. For growers without an email

on file, we'll be sending you a hard copy of the survey via the post.

This year's survey looks at your 2016-17 crop, and seeks your thoughts on weeds, pests and disease control, pesticide management, irrigation technologies, NRM, on-farm training needs and cotton to market. The survey will take around 15 minutes to complete, and will provide valuable information to CRDC about the industry, on-farm practices, and priority

areas for future research.

The survey is conducted by a professional and experienced research team, Intuitive Solutions. Importantly, the information collected in the survey remains confidential, and only aggregated, anonymous information is passed on to CRDC.

For more

www.crdc.com.au/growersurvey

Support for vocational training in NSW

FUNDING has been made available for cotton and grains industry on-farm staff and industry professionals in NSW to undertake full and part qualifications.

A total of \$14.7 million in funding has been allocated for vocational training for the NSW cotton and grains industries over three years as part of the AgSkilled program, with NSW growers now invited to submit an early expression of interest.

This initiative builds on CRDC and Cotton Australia's Cotton Industry On-Farm Workforce Development Strategy. The strategy is focused on delivering workforce outcomes for growers on farm, and ultimately, will ensure that the cotton industry is able to attract, retain and develop people that will drive industry competitiveness. The strategy provides a shared and focused plan to ensure the cotton industry's investments in workforce target key priorities are well coordinated and deliver maximum outcomes.

AgSkilled will be administered under the NSW State Training Services Smart and Skilled program, and funding covers full qualifications (Certificate III – Diploma of Agriculture) and part qualifications (from one unit up to 50 percent of a full qualification).

NSW growers are now invited to submit an early expression of interest (EOI) to participate in AgSkilled. When submitting an EOI, please identify any current or future vocational training needs for your farm business.

For more:
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0427 107 234



Don't miss this opportunity

APPLICATIONS are open for 2018 Nuffield Australia Scholarships, with CRDC and Cotton Australia again supporting a cotton grower to participate.

Open to farm owners and managers aged between 28 and 45 (exceptional candidates outside this range will be considered), participants are given the opportunity to research a subject they believe will add value to the Australian agricultural industry. A willingness to share their findings with the cotton industry and wider agriculture is a major aspect of the scholarship.

The program includes a \$30,000 bursary to study global agriculture, with the Global Focus Programs offering a six-week, group travel experience in countries across three continents, where scholars investigate agricultural marketing, trade and environmental issues, while experiencing the social and cultural aspects. Individual study programs further enable scholars to travel to countries of choice to study their chosen topic.

CRDC and Cotton Australia are encouraging applications from growers keen to improve their knowledge and capacity, and share this with the industry.

"We support the Nuffield scholarship as we see the value in improving the capacity of our farmers," CRDC Executive Director Bruce Finney said.

"The knowledge and experience they bring back to the industry can be translated into on-farm improvements and the leadership aspect has also shone through."

Goondiwindi farmer Nigel Corish's Nuffield experience has led him to make changes on his farm in terms of nutrition and soil health, which he has shared with the cotton industry.

Nigel Corish embraced the Nuffield experience after he was selected three years ago. His focus was nitrogen use and soil health.

"It's been excellent to step outside the cotton industry and away from the farm – you can learn a great deal from other industries, it's been quite remarkable how the same challenges keep coming up and the issues they face are the things we face at home too," Nigel said.

"But it's not all about just travelling, it's about improving your business and improving leadership, so the benefits are amazing."

Importantly, Nigel says with planning and organisation, farmers can make time to step outside their business and family to do a Nuffield Scholarship.

"I thought no way would I be able to get organised enough, obviously having a young family and family commitments at home, it's a huge personal commitment, but put your hand up and give it a go – it's a life-changing experience and you'll never look back," he says. Applications close June 16.

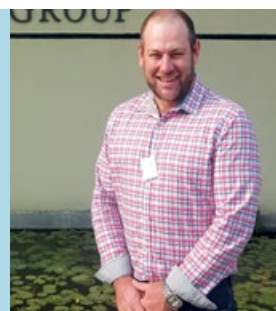
For more:
www.nuffield.com.au

Colour downgrades investigated

Nuffield Scholar Matt McVeigh has taken steps to curb the cost of colour downgrades in cotton, which each year strips the industry of millions of dollars in profits.

Supported by CRDC and Cotton Australia, Matt was awarded a Nuffield Scholarship in 2015, and travelled across 11 nations during his study, including India, Qatar, Turkey, Singapore, France, the United States, Mexico, Brazil, Argentina, Vietnam and China to research the problem of colour downgrades and find better ways colour downgrades can be managed.

To read Matt's full scholarship report go to www.nuffield.com.au/matt-mcveigh-3/



2017 Science and Innovation Awards

POSTDOCTORAL fellow Priscilla Johnston of CSIRO Manufacturing aims to research the use of polymers to improve water use efficiency and lower water requirements for cotton establishment.

Priscilla is the CRDC-supported awardee of the 2017 Science and Innovation Awards for Young People in Agriculture, Fisheries and Forestry.

"I'll be researching the use of a new polymer that can be sprayed onto soil to form a barrier that slows down soil-water evaporation and keeps more water in the soil for the plant to use," Priscilla said.

"The great thing about this barrier is that water can pass through it and into the soil which means there is also potential to capture and save water from rain or surface irrigation."

As the polymer degrades in soil, it also means there will be no removal and disposal costs for farmers.

"I'm really interested in making new polymers that can be used to help solve real world problems.

"Applying polymer technology in agriculture is leading to some really interesting material-based solutions that could help meet the future environmental and economic demands of the industry.

"Growers have already made huge steps toward reducing their water usage, but there are a lot more improvements that could be made by adopting emerging technologies."

This award will be used to run a



Receiving her Science and Innovation Award, Priscilla Johnston with CRDC Executive Director Bruce Finney and Chairman Richard Haire.

glasshouse trial, with the next step being in-field trials.

Priscilla has a PhD in polymer chemistry and some experience in soil chemistry and ecology and is part of a broader team at CSIRO developing material-based agriculture technologies, including a sprayable, biodegradable polymer membrane. This will be her first foray into the cotton industry.

"I am really looking forward to working with an industry that so clearly values research and the positive contributions it can make," Priscilla told *Spotlight*.

"I hope that my research project will help lead to a new solution for growers

to reduce their water use and increase water use efficiencies.

"I feel very fortunate to have won this award and I am excited to start the glasshouse experiment at Narrabri where I will get to see the polymer in action.

"My previous research focused on making new polymers for recyclable packaging and solar cell applications, and while relatively new to the ag sector, I have already learned a lot about the different ways polymers could be used by farmers to improve productivity and save water.

"I have thoroughly enjoyed my time in ag so far, and I hope that this will be just the beginning."

Cotton research goes SciFi at conference

THIS year's Association of Australian Cotton Scientists' conference will explore how digital technologies are impacting cotton breeding, research and production.

The third Association of Australian Cotton Scientists' research conference will be held from September 5 to 7, 2017 at the CSIRO Discovery Centre, Black Mountain, Canberra.

The conference *SciCott2017: Cotton Science Delivering Impact* will provide an opportunity for all Australian cotton researchers to present their research to their peers and to make and strengthen connections across the cotton research community. All aspects of cotton science

will be covered, with an emphasis on how digital technologies are beginning to impact on the breeding and management of cotton.

The invited international speaker is Prof Juan Landivar Bowles, the Director for Texas A&M AgriLife Research and Extension Centres at Corpus Christi and Weslaco Texas, who is at the forefront of using imaging technologies and drones in high throughput phenotyping systems to accelerate selection of superior genotypes and for precision crop management.

"We also hope to hold a 'data hackathon' where teams will develop novel digital tools (analysis, app or web

service) to extract meaningful information from historical cotton farm data," Conference chair Danny Llewellyn said.

"Entrants will be in the running for a prize sponsored by CRDC, with data being made available a couple of months before the conference so attendees can get a good head start."

The conference is being sponsored by foundation sponsor CRDC, along with CSD, CSIRO and Monsanto. Registrations will be open shortly at the conference website.

For more
www.cottonresearch.org

River and riparian zone research in focus

IT WAS all down river at Warren recently to learn about the value of riparian areas on cotton farms and what research is telling us about their value to growers.

In February, CottonInfo and Central West Local Land Services (CWLLS) in partnership with the Australian Government ran a riparian management field day at Warren in the Macquarie Valley in NSW.

CottonInfo Natural Resource Management Technical Specialist Stacey Vogel said the event was to extend the latest CRDC riparian vegetation research, increase participants' awareness of its value and share the latest BMP guidelines. In all, 45 people representing 10 cotton farms joined in.

"The seats in the kayaks were snapped up by the cotton growers and their families," CottonInfo Macquarie Regional Extension Officer Amanda Thomas said.

"Given the grower participation and the great feedback, we would like to run another day in the Narromine or Trangie end of the valley.

"The river provided the perfect backdrop for Stacey to share CRDC research, including really interesting information about which tree species can be beneficial for river bank stability such as river red gums and how these trees, which can live for up to 1000 years, store large amounts of carbon."

This research, undertaken by Dr Rhiannon Smith, who joined the day, has outlined ecosystem services provided by river red gums such as carbon storage and



Fred and Mabel Ceeney with dad Matt on the Macquarie River at Warren.

sequestration. Vertosols under river red gums have a higher total organic carbon percentage and provide a sustained input of carbon, through litter, for soil biology, providing better aggregate stability and erosion control. Rhiannon found river red gum sites stored significantly more carbon than other types of native vegetation, which is on average 200t C/ha, and as high as 400t C/ha.

CSIRO's Nancy Schellhorn's research found that on-farm native vegetation fills a critical temporal gap to support the life-cycle of many beneficials that provide pest control services.

"We also discussed Andrew Biggs' (QLD Department of Natural Resources) CRDC-funded research and the role river red gums and myalls play in mitigating excess recharge," Stacey said.

"Leaf litter from native vegetation has

an important role in suppressing weed establishment in riparian areas and assists germination of woody riparian vegetation, as found by Dr Sam Capon and Dr Stephen Balcombe's research."

Cameron Downing from CWLLS provided commentary during the kayaking, while ecologist Phil Spark (who camped out for two nights prior to collect an array of local wildlife) introduced eight species of microbats as well as many frog, lizard, fish, weeds and native plant species.

"The adults and children heard about their importance, their habitat and how useful they are on cotton farms," Stacey said.

For more

Stacey Vogel

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Success for burr funding

A COTTON industry project into noogoora burr control is one of 23 projects to secure funding under a \$10.5 million Federal Government funding program.

Deputy Prime Minister and Minister for Agriculture and Water Resources, Barnaby Joyce, announced the funding in early May and said the projects under the *Control Tools and Technologies for Established Pest Animals and Weeds* programme would strengthen the management of some of Australia's most significant agricultural pest animals and weeds.

"The funding will be used to develop

technologies such as herbicide spraying devices, automated traps and aerial thermal imaging for pest monitoring and to optimise the use of chemicals, biological control agents," the Minister said.

The successful project, supported by CRDC, NSW DPI, University of Queensland and Murrumbidgee Irrigation Association seeks to develop a bio-herbicide for species and/or hybrids within the noogoora burr species complex from an existing, naturally occurring fungal pathogen agent (*Alternaria zinniae*). Sampling and testing will also determine if all noogoora burr

complexes are hosts of *Verticillium dahlia* – currently a pathogen of great concern to the cotton industry.

Species within the noogoora burr complex are major weeds of irrigated and dryland cropping, pasture and rangeland systems, waterways and riparian zones. Bio-herbicide development is currently constrained by taxonomic confusion within the complex. DNA sequencing will help clarify the current recognised distinctions between the complex and hybrids found in the field to ensure the efficacy of the agent against the species.

Breaking the *Verticillium* cycle

THE PARTNERSHIP between farmers and cotton pathologists is making a breakthrough in the management of *Verticillium* wilt, to the benefit of the entire industry.

A cotton field with extremely high inoculum levels of the non-defoliating strain of *Verticillium dahliae* (VCG2A) has shown a dramatic reduction at Peter, Janet, Tony and Kylie Dampney's Narrabri farm. Severe patches of *V. dahliae* were heavily impacting cotton yields for several years, when in 2011 the Dampneys approached (former) CSD pathologist Dr Stephen Allen and NSW DPI's Dr Karen Kirkby for help.

The pathologists suggested trialling sorghum and durum wheat rotations and began assessing and monitoring inoculum levels in one of the worst affected fields to assess the trial's impact.

"Before the trial started we were seeing yield reductions of 20 to 30 percent," Tony said.

"To see that the inoculum levels are now zero is fantastic and we look like planting cotton next season, for the first time in five years.

"We learned a lot from being involved with the researchers and if not for this trial we would be battling an even bigger problem."

Initially, in 2012 researchers recorded six GPS points: three within severe patches of *V. dahliae* and three outside these patches. In June 2012 the rotation program began with durum wheat.

Soil from the GPS points was collected in May 2013 and isolated to quantify the inoculum level expressed as propagules per gram (ppg). The results showed that within



NSW DPI's technical assistants Sharlene Roser and Peter Lonergan with pathologist Dr Karen Kirkby on one of their regular soil sampling missions.

the severe patches inoculum ranged from 736-936 ppg and 608-736 ppg outside the patches. Further isolations in 2014 after successive sorghum and durum crops showed a reduction within the severe patches ranging from 110-206 ppg and 88-106 ppg outside the patches. Following further rotations, soil was collected again in December 2016 with inoculum levels dropping to zero at each of the six GPS points.

"It was a leap of faith from the Dampneys to be part of these long-term experimental management strategies to drive down soil inoculum levels, as this approach has not been quantified in cotton in Australia," Karen said.

"It is so pleasing to see these results and we thank the Dampneys for allowing us to undertake this trial work. It shows real results can be gained when we work together."

CRDC is funding the development of a fee-for-service *V. Dahliae* molecular diagnostic and quantification tool. This is being undertaken as part of the *Digital Technologies for Dynamic Management of Disease, Stress and Yield Program*, a project under the Australian Government Department of Agriculture and Water Resources Rural R&D for Profit programme.

Quantifying inoculum levels in cotton soil is a very involved and time-consuming process, taking four to six weeks from soil collection to gaining results.

"We will develop key components of a decision matrix which will allow growers and managers to quickly assess the risk of where and when to plant cotton," Karen said.

"Based on what we have seen at the Dampney's, this tool has the potential to significantly help researchers and growers assess the effect of management strategies on inoculum levels as well as assess the risk of disease in fields prior to planting.

"When this tool is released, growers and agronomists will be able to send in soil samples to be tested, much like they do for nutrient analysis."

Verticillium wilt is caused by the soil-borne fungal pathogen *Verticillium dahliae*. Recent research has found three strains in Australian cotton: two non-defoliating (VCGs 2A and 4B) and a defoliating strain (VCG 1A). It is unclear why only now the disease is causing such significant damage in some fields. Previous to Dampney's trials, once introduced to a field or farm, *V. dahliae* was almost impossible to eradicate, with growers reporting estimate yield losses from 10 – 62 percent.

CRDC is involved in several *Verticillium* research projects. The QDAF pathology group headed by Dr Linda Smith is investigating the effect of nitrogen rate on disease incidence, along with soil solarisation to reduce inoculum population. Grower trials are also underway across six sites in North-West NSW, in conjunction with CottonInfo.

NSW DPI researchers are also testing potential innovative solutions to cotton diseases to identify the best time and approach to introducing potential control products such as fungicides.

Innovation and sustainability on show

After just five years growing cotton, Ian, Marilyn and Harry Carter were awarded the Monsanto Cotton Grower of the Year in 2016, and hosted the National Field Day in March 2017.

THE CARTERS run a 2500 hectare cattle and dryland cropping operation on the Liverpool Plains of NSW, south west of Quirindi. The national kudos came after a string of local awards including Dryland Grower of the Year, Innovator of the Year and most recently, 2016 Farmer of the Year for the Upper Namoi CGA /Agvance Farming Group.

CRDC Executive Director Bruce Finney attended the field day at "Connamarra" and said the Carter's innovation, attention to detail and support for young people in agriculture was inspiring.

"These farmers have such a long-term view in terms of sustainability and have been so proactive and innovative in their approach to land management and farming," Bruce said.

"They have innovated methods to improve yield and quality while always

Ian Carter, Deputy Prime Minister Barnaby Joyce, Marilyn and Harry Carter at the Monsanto Grower of the Year field day.



VIRGINIA TAPP

keeping the health of soil and sustainability at the fore."

As dryland cotton farmers, preserving soil moisture is a major key to success. Ian identified that the greatest impact he could have on success was at planting, leading him to use water injection during seeding. Designing his own water injection trailer and through trial and error to identify the ideal water/seed ratio he has been able to improve his emergence rate by 25 percent, as well as vastly increasing his flexibility in planting time. Their 1.5-metre bed configuration has minimised compaction, while maximising the crop's access to moisture and even in the testing season's like 2015-16, the Carters' met their aim of

five bales/ha across their 451ha of cotton.

Ian is continually working to identify and fine tune techniques to reduce (or completely remove) tillage, reduce chemical inputs, reduce compaction and prevent salination, including planting of over 15,000 trees.

The Carters demonstrated several of their innovative on-farm techniques including no-till farming to conserve soil moisture and water injection at planting to get better establishment to the 150 people gathered at the field day. Deputy Prime Minister and Minister for Agriculture and Water Resources, Barnaby Joyce, was the keynote speaker. The day also included presentations and research updates from experts on climate, moisture attractants, seed soaking and microwave weed control, along with precision machinery displays.

The 2017 Cotton Industry Award recipients will be announced at a dinner on July 26 at Griffith, NSW, to recognise the rise of the cotton industry in southern areas of the state. The dinner will be held in conjunction with the Australian Cotton Collective and Cotton Trade Show on July 26 and 27. To book your seat, go to www.australiancottonawards.com

2017 Cotton Industry Award Finalists

Monsanto Grower of the Year and AgriRisk High Achiever of the Year

Andrew Dickson 'Marebone', Warren NSW
Mark Cathcart CSD Farms, Wee Waa NSW
Simon Corish 'Yattlewondi', Mungindi NSW
Rod Smith 'Archerfield', Gunnedah NSW
Ross Uebergang 'Tinobah', Miles QLD
Toscan Family Partnership, Darlington Point NSW

ADAMA Chris Lehmann Trust Young Cotton Achiever of the Year

Fiona Norrie, Narrabri NSW
Liz Lobsey, Toowoomba QLD
Cameron Derbidge, Goondiwindi QLD

Cotton Seed Distributors Researcher of the Year

Sharon Downes, CSIRO, Narrabri NSW
Paul Grundy (Toowoomba) and Steve Yeates (Ayr), QDAF & CSIRO, QLD
Graham Charles, NSW DPI, Narrabri NSW

For more
Lynda George

admin@australiancottonawards.com

Integrated Weed Management:

Time to take a stand against survivors

Weeds are a significant threat in all cotton farming systems both in terms of their ability to develop resistance and to harbour pests and disease.

GLYPHOSATE-TOLERANT cotton has been rapidly adopted by the Australian cotton industry since its introduction 13 years ago and currently accounts for nearly all of the crop. This has led to a change in weed management practices with growers moving from applying residual herbicides in anticipation of a weed problem to dealing with weed issues using glyphosate in combination with other chemical or cultural methods to control surviving weeds.

Tech panel concerns

CRDC-supported weeds researcher and CottonInfo Weed Management Technical Specialist, Eric Koetz of NSW DPI is a member of the TIMS Herbicide Tolerant Crops Technical Panel which met in Toowoomba in February, where they heard about emerging threats and the changes in the glyphosate-resistance landscape. Presenters discussed the current and future threat of herbicide-resistant weeds to cotton farming systems.

“A number of surveys supported by industry and CRDC have identified significant threats to the ongoing sustainability of glyphosate-tolerant cotton as glyphosate resistance levels increase,” Eric said.

“Most, if not all farms have some level of resistance weeds, and 74 percent of growers believe they have glyphosate-resistant weeds. Resistance testing however shows lower levels of 30 percent of farms with resistance.

“This is supported through industry surveys, with 36 percent of consultants believing that their

clients have glyphosate-resistant weeds.”

The technical panel is clearly aware of widespread herbicide resistance in cotton farming systems, not only to glyphosate but also to Group A and I chemistry and more than 90 percent of consultants are concerned about Group A resistance.

Emerging resistance

Recent surveys of sowthistle resistance have revealed widespread occurrence throughout all cotton growing valleys and increasing levels of glyphosate resistance of more than 20 percent.

Eric says an added concern is the recording of Group I resistance in two sowthistle populations in grain farming systems in South Australia and Victoria. While there has been no record of resistance in cotton systems, the extensive use of Group I herbicides in fallows is placing increasing pressure on this mode of action.

“Emerging weeds the herbicide tech panel is aware of and concerned about include annual ryegrass, bladder ketmia, *Amaranthus spp* and red pigweed,” Eric said.

“They all have the potential to damage crop yields and increase the cost of weed control.”

These weeds were identified in targeted weed surveys funded by CRDC across the industry and from information fed back to the panel from industry bodies. The emergence of annual ryegrass as a potential weed in summer cropping systems highlights the incredible adaptability of this plant. Already the number one weed in cereal production, this is not a weed that cotton farming systems need. High levels of group A resistance among annual ryegrass populations in farming systems highlights

the need for diversity in management and attention to control and remove survivors from fields.

Paraquat possibility

On the horizon is the possibility of paraquat resistance occurring in cotton farming systems.

“At present only 10 weed species have reported resistance in Australia and in all cases resistance arose from repeated use patterns over 15 years,” Eric said.

“Of particular concern is resistance in flaxleaf fleabane.

“Paraquat is an extremely important herbicide in maintaining the long-term effectiveness of glyphosate in farming systems: regularly used as a double-knock partner with glyphosate it plays a crucial role in controlling resistant plants.”

The technical panel believes it is critical that in any strategy for weed control the focus is on ensuring that there are no surviving plants to prevent topping up the weed seed bank. This reinforces the Herbicide Resistance Management Strategy of 2+2+0: using two non-glyphosate tactics targeting both grasses and broadleaf weeds during the cotton crop, plus two non-glyphosate tactics in summer fallow targeting both grasses and broadleaf weeds and ensuring zero survivors.

“While the Roundup Ready cotton system is standing up at the moment, the lack of different tactics being used to control weeds in cotton farming systems is an area of concern,” Eric said.

“Overseas evidence suggests that resistant weeds can become a major issue in a very short period of time.”

Pupae busting and weed control

DIVERSITY in controlling weeds using integrated weed management (IWM) is essential and Eric says the potential reduction in pupae busting with Bollgard 3 varieties removes a crucial late element in weed control.

“This late cultivation is an important tool in weed control and a move to a low disturbance system could lead to increased weed control costs, especially volunteers and ratoon cotton,” he said.

CRDC has been supporting a pupae busting trial to investigate the response of weeds in non-pupae busted plots. Initial results from two years of the experiment are showing differences in weed numbers from different timing and depth of cultivation, and intensity of weed management practices. A renewed focus of the experiment at the Australian Cotton Research Institute (ACRI) will be on the differences between glyphosate-only treatments; pre and post-emergent herbicides plus glyphosate; and the addition or exclusion of cultivation. This will allow comparisons between a minimal weed control system compared to a fully integrated system with multiple weed control tactics.

“Looking to the near future, the introduction of triple stacked cotton varieties within the next five years will require a robust management package during adoption,” Eric said.

“An extra group I herbicide in a farming system could potentially lead to more rapid occurrence of resistance in hard to control weeds such as sowthistle, which, as I’ve discussed, has already shown Group I resistance in grain systems in Victoria and South Australia.”



Eric Koetz surveying a channel harbouring some of the 'big five' – fleabane, feathertop, Rhodes grass and volunteer cotton.

ERIC KOETZ

What the weed surveys show

As part of the CRDC annual weeds survey in 2015 undertaken by Eric Koetz, a total of 144 fields were surveyed across seven growing regions.

Sowthistle is a particular weed of concern, as of the sample collected for the survey, just over 20 percent were assessed as resistant or developing resistance to glyphosate. The weed was only found to be glyphosate resistant in testing by Tony Cook in 2014.

“The TIMS Herbicide Tolerant Crops Technical Panel is worried that this figure could rise rapidly, especially in Northern cotton farming systems where fallow weed control is important for moisture conservation, especially in dryland systems,” Eric said.

“Furthermore, barnyard grass had more than 70 percent of samples recorded as either developing or having resistance to glyphosate (see Table 1).”

Very high levels of glyphosate resistance were also recorded in fleabane and windmill grass. While feathertop Rhodes grass only showed 20 percent of plants as resistant or developing resistance, the remaining 80 percent of ‘susceptible’ plants did experience significant ‘brown out’ and reduced seed production, however they were still able to produce viable seed. The poor control of these species is not surprising as none of these weeds appear on the glyphosate label as being controlled.



Eric Koetz has taken on the role of CottonInfo Weed Management Technical Specialist.

Valley variations and similarities

There is also a case of differing problem weeds within each cotton valley.

All valleys reported widespread fleabane, and sowthistle has also emerged as a common weed. A breakdown of other results shows that windmill grass is a major issue in the Namoi and Macquarie valleys and feathertop Rhodes grass is common in Central and Southern Queensland. Barnyard grass appears as a low level threat across all valleys.

Targeted weed surveys were conducted earlier this year to collect seeds from surviving weeds for future biology and ecology work. This work will provide researchers with detailed information of the phenology of these emerging weeds

and identify opportunities during their life cycle for control. Although not in the table, bladder ketmia and red pigweed were identified in a number of fields and have been identified as potential threats.

The encouraging sign from the 2017 weed survey was that 95 percent of cotton fields surveyed were weed free. Non-crop areas such as head and tail ditches and channel banks are the areas of greatest concern, many of these non-field areas had large populations of surviving weeds.

As part of the 2017 weeds survey, growers and consultants were asked about weed management and control tactics.

“Most growers are confident in the glyphosate-only system however, they realise that practice change is inevitable.

“The Herbicide Tolerant Crops Technical Panel is concerned that this practice change to date has been quite slow and only a rapid rise in glyphosate resistant weeds will encourage/force adoption of alternate tactics.”

Weed species	Collected samples	Viable samples %	Potentially resistant%	Developing resistance%	Susceptible%
Sowthistle	37	100	16	5	78
Fleabane	37	100	92	5	3
Feathertop Rhodes grass	19	50	10	10	80*
Windmill grass	24	37	45	45	10
Barnyard grass	24	75	22	50	28

Table 1. Glyphosate resistance level of five weed species collected from weed survey across seven cotton growing regions in 2015. *significant reduction in plant biomass and death occurred, however survivors produced viable seed. Resistance Score is the percentage of plant material greater than the growth of susceptible plant (control) 28 days after glyphosate. Score: > 50% = Potentially glyphosate resistance; 20%-50% = Developing glyphosate tolerance; 0-20% = glyphosate susceptible

For more

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On the front foot with Amaranthus

New CRDC supported research is preparing the Australian cotton industry for the possible incursion of the US's greatest weed threat.

While Palmer amaranth has not yet made its way to Australia, in the US, its rapid development of resistance to six classes of herbicide has led to devastation in some cropping regions, including cotton fields. It is costing the industry millions, and necessitated a move back to hand chipping for control, yet has ultimately rendering some fields unusable. Furthermore, last year a group of US researchers from the University of Illinois discovered Palmer amaranth in populations from Arkansas had mutated to develop resistance to the herbicide class known as PPO-inhibitors.

The focus of a CRDC PhD project being undertaken by Asad Khan is largely biosecurity preparation, as Palmer amaranth has been identified as a biosecurity threat for the Australian cotton industry. Asad's research at the University of Queensland is on the biology of *Amaranthus* species currently found in Australian cotton regions.

Amaranthus species are already a particular problem for Australian farmers, where they out-compete cotton for moisture, light and soil nutrients and can quickly take over fields, yet little is known of their biology. Amaranth may also harbour pests and diseases.

"The problem of these species in

Researchers are on the lookout for Powell's amaranth.



TONY COOK

Can you help?

The researchers are looking for help from growers and consultants to identify *Amaranthus* on cotton farms. The researchers wish to collect *Amaranthus* specimens as part of their study. If you see any suspect plants in fields, fallows or fence lines, please contact:

Asad Khan
0411 048 263
asad.khan@uq.net.au

Dr Bhagirath Chauhan
0427 923 272
b.chauhan@uq.edu.au

Queensland and NSW is increasing; however, knowledge of their biology is very limited," Asad told *Spotlight*.

"This project will develop understanding about the common *Amaranthus* species in Australia, in order to understand their risks as well as ensure that they can be quickly differentiated from an exotic species."

Staying ahead of evolution in

Weeds researcher Jeff Werth of QDAF is a part of a large scale project to prepare the industry for an evolving weeds landscape.

As a part of CRDC's *Staying ahead of weed evolution in cotton systems*, which covers a broad range of research, Jeff is investigating the effect of cover crops on weed suppression in dryland cotton systems on the Darling Downs.

"While we know that our non-chemical options at the moment are not as effective as herbicides (used in an integrated weed management system), the value of cover crops has never been quantified in terms of the effect they have on weeds," Jeff said.

Jeff says while the research still has another two years to run, coming to the end of two seasons' worth of trials, he's seeing around 50 percent weed suppression in cover cropped plot.

"What we are seeing so far is that the cover crop (in this case millet) can provide competition once it is established and large enough to shade out weeds, however early season competition does not occur when the cover crop is establishing."

"An issue in trying to establish cover crops in that planting can stimulate weed germination, through soil disturbance and the general practice to plant after rain. This coincides with weed emergence, so complementing the cover crop with a residual early season where possible is likely to be needed."



Head of weeds in cotton systems

JEFF WERTH

ABOVE: Cotton emerging through barley sprayed out prior to head emergence in dryland cotton cover crop trials on the Darling Downs.

“So our next step is to continue the experiment for another two years in order to gather more information over time, and in the future examine the effects of combining residual herbicides for early season control.”

An unexpected and interesting outcome of the trials this year was around yield difference. With this season’s yields affected by the hot, dry summer on the Darling Downs, Jeff said the control plot which had been sown to a barley cover crop then sprayed out around five weeks before planting yielded well above surrounding fields at about eight bales to the hectare.

“This is an unexpected result given the season, with the yields of the other plots averaging around four to five bales, indicating that the barley cover crop stubble reduced moisture lost by evaporation and possibly helped with soil water holding capacity and infiltration of the rainfall that did occur”

For more

Jeff Werth

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The big five

Under the same project, five problem weeds – barnyard grass, fleabane, sowthistle, feathertop Rhodes grass and windmill grass are under the microscope. Jeff Werth and private consultant David Thornby in conjunction with Bhagirath Chauhan from QAAFI and James Hereward from UQ Biological Sciences are examining the ecology of these species in an effort to give growers the information to manage them.

Research is underway into these plants’ such as how long it takes each species to reach key developmental stages, seed production, and timing of emergence.

“From this research we have a lot of data we are pulling together, to convert into a decision making resource for managing weeds in a similar way to how the Cottassist day-degree reports work,” Jeff said.

“It would help crop managers by providing information on how long from when a weed emerges to when it is ideal to spray, and how long until the weed starts producing viable seed and can return to the seed bank.”

Implications for triple stacked varieties

Research is also underway in readiness for the release of Monsanto’s new ‘triple-stacked’ technology which will produce varieties with tolerance to glyphosate, dicamba (Group I) and glufosinate (Group N).

Given the rapid adoption of glyphosate in grain and then cotton

systems and the equally as rapid evolution of resistance, the industry needs to be vigilant in ensuring it doesn’t happen with these new use products.

The five problem weeds are being tested in pot trials to gauge which are susceptible or resistant and how the glyphosate-resistant populations respond to the other two herbicide groups, dicamba and glufosinate.

“While a triple-stacked variety will offer weed control options, caution is needed not to start solely relying on the three usable products as we did glyphosate,” Jeff said.

“We also need to know how best pull those three herbicides together to minimise resistance forming

“Due to increasing glyphosate resistance there has been a move back to the use of residuals at planting, which as a researcher I think is a good move.

“However if we drop out other controls including residuals and rely on the dicamba and glufosinate we will see resistance to these products.

“If those three herbicides are used exclusively we will certainly see resistance.

“In terms of managing resistant populations, the guidelines of 2+2+0 in the Herbicide Resistance Management Strategy will get you through most times, but boots and eyes in the field are still vital to monitor after a pass to avoid seed set in survivors thus promoting resistance.”

This research will also be used to update guidelines in the HRMS when the new varieties are released. David Thornby is undertaking modelling to inform the new HRMS and the development of the decision support tool BYGUM (See articles following pages) will also be useful to inform these new guidelines and make sure the industry is on the front foot on the herbicide-resistance front.

The formula to manage/delay glyphosate resistance:

- 2 non-glyphosate tactics targeting both grasses and broadleaf weeds during the cotton crop
- +
- 2 non-glyphosate tactics in summer fallow targeting both grasses and broadleaf weeds
- +
- 0 survivors, control survivors of glyphosate applications and do not allow them to set seed.

A new look at the economics of weed control

The cotton industry has a new decision support tool for the management of glyphosate resistant barn yard grass.

BYGUM (BarnYard Grass Understanding and Management) gives growers and consultants new ways to look at the economics of summer weed control in Australian cotton/grains systems. Developed by CRDC and David Thornby from Innokas Intellectual Services, this weed management scenario testing tool combines biological, agronomic and economic factors to examine the economics of farm managers' current summer grass management strategies, and compare them to new tactics – which could be what your neighbours are doing, what your agronomist recommends, or new ideas from elsewhere.

“BYGUM can let you test changes in crop prices, rotations, weed management costs, herbicide availability or efficacy, and more,” David says.

It is free to download, use, and share, only needing a copy of Microsoft Excel, preferably on a Windows computer (BYGUM does run on many Mac systems but won't run on an iPad or android device at present). BYGUM is designed to be simple to use but with powerful possibilities for planning and learning about summer weed management.

“BYGUM lets you test changes in crop prices, rotations, weed management costs, herbicide availability or efficacy, and more.”



Weeds researcher David Thornby.

BYGUM is based on RIM (Ryegrass Integrated Management), a long-established tool for testing ryegrass management strategies in winter-cropping systems in western and southern Australia. RIM was developed by Australian Herbicide Resistance Initiative in conjunction with the University of Western Australia, with support from GRDC.

“BYGUM takes the well-tested framework of RIM and extends it to northern subtropical Australian farming systems, where summer and winter crops are both used, and fallows are an important part of the system,” David says.

“Running a simulation in BYGUM is a two-step process: first, set up the parameters of the system. Second, design a rotation and specify your summer grass management practices.

“BYGUM's five-year rotation results update with every change – there is no need to 'run' the model or collect output files.

“At any time, BYGUM can give a comparison between the current setup and one other scenario, meaning users can always see how the current strategy compares to their benchmark.”

The user-definable parameters for the system include:

- weed control products, prices, and efficacies including knockdowns and pre-emergents, used in different crops, in fallows, and in different phases of the crop;
- weed-free crop average yields and prices for several different crops;
- seeding rates (standard and 'high'); and
- non weed-control costs per crop per hectare.

“BYGUM isn't designed to tell you exactly how much you'll make every year,” David said.

“What it does do is allow comparisons of the likely bottom line, for your given set of inputs, between different possible weed management and cropping scenarios.”

BYGUM allows growers to save several scenarios and to compare two at a time, side by side. With it you can compare:

- crop yields with weed competition factored in;
- gross margins;
- weed seedbank densities and adult plant numbers; and
- the effects of different rotations and weed management strategies.

For more

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BYGUM is free to growers and consultants and is available now on the CottonInfo website at www.cottoninfo.com.au/barnyard-grass-understanding-and-management-bygum

SCENARIO #1:

Ask BYGUM: the value of glyphosate

What's the remaining value of glyphosate in rotations with glyphosate-resistant awnless barnyard grass?

BYGUM developer David Thornby has developed a series of scenarios to demonstrate this new decision support tool.

Since the first confirmation of glyphosate resistance in awnless barnyard grass, many other resistant populations have been found, and these populations don't all display the same level of resistance.

While glyphosate is no longer effective as a stand-alone control measure against any of them, some populations are less strongly resistant than others. In the case of the first-confirmed population, field rates still had around a 40 percent efficacy on small seedlings. For other more recently confirmed populations, efficacy even on small seedlings is much lower.

Given that glyphosate is going to be applied to these populations anyway, it's important not to overstate the usefulness

of glyphosate by hoping to be able to rely on it for some level of control. BYGUM can test the difference for us, between populations with strong resistance and those with moderately strong resistance.

David said he used a simple irrigated rotation, with modest use of non-glyphosate options in an otherwise glyphosate dominated system. He varied the effectiveness of glyphosate from around 40 percent ('moderate' resistance) to around five percent ('strong' resistance).

Key outcomes

The results show two key things. First, both systems are still making money after five years. High levels of crop competition keep seed production per escaping weed low, and the addition of a few effective tactics reduces the number of surviving plants to moderate/know levels of between six and 14 plants per square metre at the end of the fifth season.

Secondly, however, both systems are heading towards failure. Weed and seedbank numbers are increasing, however slowly. And while gross margins are the same at the end of season one, there is a predicted difference of around \$500/ha

between the gross returns in season five.

David says there are three lessons here.

"First, strong crop competitive effects might mask the seriousness of resistance issues in irrigated cotton, should they be present.

"Second, there are good reasons to determine just how strongly resistant your resistant awnless barnyard grass population is, if you're going to be sticking with a system that is predominately about the use of glyphosate.

"And third, allowing a slow decline with somewhat-inadequate weed management looks likely to have a substantial cost as the years pass by.

"We've made many assumptions in this example – in particular, that irrigated cotton is planted and provided with resources to allow for strong competitiveness against the weed.

"We've also made assumptions about crop and herbicide costs, average yields and prices.

"You could run BYGUM with a different set of assumptions that fit your experiences, and see if the results change."



Since the first confirmation of glyphosate resistance in awnless barnyard grass, many other resistant populations have been found.

SCENARIO #2:



LEFT: Cover crops allow growers to maintain some competition even in non-crop seasons.

than the summer fallow, and actual plant numbers per square metre are not reduced all that much (1.1 to 0.8 per square metre),” David says.

“But there is a substantial difference in seeds returned to the seed bank.”

The comparison scenario shows a substantial increase in the yield from the final cotton crop, due to the strong reduction in seed bank numbers at the end of the cover crop season.

“The benefits of the cover crop come due, as expected, in the following crop, where the seed bank has been driven down and emerging weed numbers are low,” David said.

“Over the course of the whole rotation, incorporating one cover crop every second summer fallow is predicted to be worth almost \$200/ha in increased yield.

“There is more than one way to protect future yields in a dryland rotation, but using cover crop competition certainly seems to bear looking at.

“We’ve made many assumptions in this example – in particular, that planting time and summer rainfall are conducive to good cover crop growth, resulting in high competition, that the barnyard grass population is strongly resistant to glyphosate, and that the cover crop doesn’t reduce moisture availability to the following cotton crop.

“We’ve also made assumptions about crop and herbicide costs, average yields and prices.

“Once again, users could run BYGUM with a different set of assumptions that fit their experiences, and see if the results change.”

Testing the value of a cover crop

In a one-in-one-out rotation of dryland cotton, summer fallows offer a chance to get on top of weed populations through vigorous use of non-crop herbicides.

However, with no crop competition present, they can also offer weed escapes an opportunity to set a lot of seed, especially when the key herbicide in both crop and fallow, glyphosate, is no longer effective.

“Cover crops allow growers to maintain some competition even in non-crop seasons,” David Thornby says.

“A good stand of millet (as simulated in BYGUM), sprayed out before seed set, allows for a combination of late season herbicide use to clean up survivors and

mid-season competition with glyphosate-resistant barnyard grass, reducing seed set per plant.”

The first scenario is a basic one-in-one-out rotation. This contains the assumption that the barnyard grass population is resistant to glyphosate, and that an early season residual and mid-season inter-row cultivation are used to provide some control in crop: summer fallows use two cultivations and a double knock.

In scenario 2 David replaced the second summer fallow with a cover crop. The cover crop includes cultivation, a double knock, spray out (assuming this is with a non-glyphosate product effective on glyphosate, such as paraquat), and a late application of paraquat over the now-dead millet.

“The cover crop is more expensive

There is more than one way to protect future yields in a dryland rotation.

SCENARIO #3:

Residual answers to resistance

Can you control a glyphosate-resistant grass by adding a residual in irrigated cotton?

In situations where a glyphosate-resistant summer grass starts to cause yield losses in cotton, growers obviously need to add some non-glyphosate options to their system to protect yields and prevent further weed blowouts. The questions then become where to add non-glyphosate tactics, to get most benefit, and how many are needed?

David Thornby used BYGUM to investigate this question. First he compared a system with glyphosate-resistant barnyard grass where only glyphosate is used with the same system with an early-season (pre- or at-planting) residual added.

Residuals tripled gross margins

The yield results of adding a single residual are striking.

The glyphosate-only system is still producing some yields (Figure 2 – primarily due to the competitiveness of irrigated cotton), but end-of-season weed numbers are very high and the potential of the system is being seriously under-utilised.

“Adding a single residual can reduce early-season weed numbers dramatically, and because this is when most of the competition effects occur, this has a huge benefit for the bottom line,” David said.

“Gross margins are almost tripled compared to glyphosate alone when the weed population is strongly glyphosate resistant.

“However, end-of-season weed numbers (and seedbank density, see bottom line Figure 1) are still unacceptably high, so a single residual doesn’t appear to be enough of an addition, despite the dramatic effect.

“A single year of poor control from the residual (rather than the average of around 85 percent efficacy) would certainly result in a blowout.”

Adding a mid- or late-season tactic provides some insurance against weed blowouts and seed production. Because late weed germinants in vigorous cotton stands don’t produce a lot of seed per plant, the

Choose enterprise and control options:	Sum 1	Wint 1	Sum 2	Wint 2	Sum 3	Wint 3	Sum 4	Wint 4	Sum 5	Wint 5
	Irrig Cotton	Winter fallow	Irrig Cotton	Winter fallow	Irrig Cotton	Winter fallow	Irrig Cotton	Winter fallow	Irrig Cotton	Winter fallow
Time of sowing	Average		Average		Average		Average		Average	
Soil preparation	Average		Average		Average		Average		Average	
Knock-down / Double-knock	Glyphosate	Paraquat	Glyphosate	Glyphosate	Glyphosate		Glyphosate	Paraquat	Glyphosate	Tillage
Early season residual	[A residual]		[A residual]		[A residual]		[A residual]		[A residual]	
Sowing method	No-till		No-till		No-till		No-till		No-till	
Crop seeding rate	Standard		Standard		Standard		Standard		Standard	
Weed control 1	Glyphosate		Glyphosate		Glyphosate		Glyphosate	Group A	Glyphosate	Glyphosate
Weed control 2										
Weed control 3										
Layby weed control 4										
Weed control 5	Glyphosate									
Weed control 6	Glyphosate		Glyphosate		Glyphosate		Glyphosate		Glyphosate	
Harvest options - Grains										
Harvest options - Other crops	Defol Drop		Defol Drop		Defol Drop		Defol Drop		Defol Drop	
Mature BYG setting seed:	96,543		86,688		87,658		87,741		87,748	
Seeds in soil next spring (m ²):	8808		8907		8915		8916		8916	

Figure 1: Irrigated cotton rotation with an early-season residual. While using ‘a residual’ in the notation here, a rotation of suitable products from different modes of action should be used in the field. The glyphosate-alone system is the same as this one, without the early season residual.

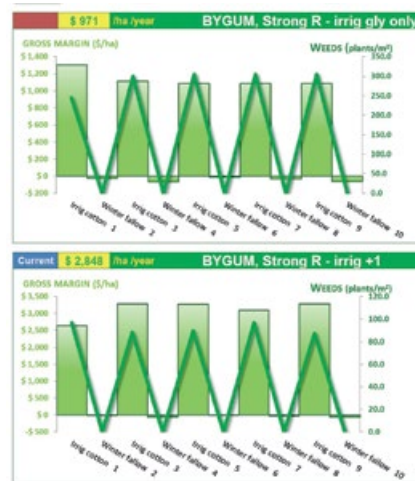


Figure 2: A comparison of gross margin and barnyard grass numbers at end-of-season between glyphosate alone (top) and glyphosate plus a single, early-season residual.

effects on yield aren’t so dramatic. However reducing surviving plants and especially reducing the seed bank size are critically important insurance against future blowouts and selection of resistance for other modes of action.

David tried two different tactics in BYGUM, adding either a layby residual to each crop or a mid-season knockdown.

Adding a layby reduces the seed bank somewhat, and cuts surviving plants at end-season down to around 25 per square metre. This still appears to be too many survivors for comfort, but it does represent a substantial improvement over an early-season residual alone, and offers insurance against future blowouts.

BYGUM predicts that it can be sustained at least for the five-year rotation. This comes at a cost, however: the reductions

in late-season weed numbers are offset by the price of the extra residual and BYGUM includes a penalty due to phytotoxicity.

In comparison with the layby system, a system with a mid-season knockdown, rotating between options including Group A herbicides, shielded paraquat and inter-row tillage improves the gross margin (due to a combination of taking out some weed competition and having some options with lower phytotoxicity-related yield penalties), but leaves more end-of-season survivors.

“So this is not an ideal system either – but is certainly an improvement in all ways over a single-residual system,” David said.

“These analyses show that while a single early-season residual can do a lot of heavy lifting in terms of reducing weed competitiveness, it’s not enough on its own for long-term sustainability.

“Late or mid-season tactics provide some insurance.

“BYGUM predicts that while good returns can be sustained at least for five years with this ‘plus two’ strategy, more non-glyphosate tactics would be needed to drive the seed bank to very low levels.

“We’ve made many assumptions in this example—in particular, that irrigated cotton is planted and provided with resources to allow for strong competitiveness against the weed, that resistance to glyphosate is quite strong, and that good efficacy is generally the case for residual applications.

“Pre-simulation weed numbers are assumed to be moderate and we’ve also made assumptions about crop and herbicide costs, average yields and prices.”

Workshops return

Last winter more than 300 cotton growers and consultants were able to formulate specific integrated weed management plans in a series of CottonInfo workshops on weed management.

Delivered by CottonInfo in conjunction with ICAN and technical input from weed specialists – notably QLD DAF's Jeff Werth and NSW DPI's Graham Charles, the objective of the workshops was to assist growers to develop plans for sustainable and practical integrated weed management strategies, tailored to their farm to better deal with increasing levels of herbicide resistance. To continue the momentum created in 2016, a further seven, one-day workshops are planned for winter 2017.

Workshops are tailored to each cotton growing region and cover the key themes of:

- Local issues of concern
- The ecology of problem weeds.
- Herbicide resistance and how it occurs.
- The cotton industry Herbicide Resistance Management Strategy.
- What non-glyphosate options can we incorporate into the cotton system?
- Managing volunteers and ratoon cotton.

Workshops finish with participants formulating their own weed control plan to address their specific weed management challenges.

Locations and dates for the 2017 workshops:

Dalby – July 11, O'Shea's Windsor Hotel
Chinchilla – July 12, Club Hotel
Talwood – July 13, Talwood Hotel
Rowena – August 1, Rowena Village Inn
Pallamallawa – August 2, Pallamallawa Hall
Bellata – August 3, Bellata Golf Club
Gunnedah – August 4, Gunnedah Services and Bowling Club

Participant numbers are limited to ensure ample opportunity to discuss and share experiences.

To find out more and to book:
www.icanrural.com.au/cotton.html



Management strategies

ICAN's Mark Congreve and John Cameron facilitated a series of weed management workshops in 2016 which were able to identify key issues and planned changes to weed management and how these varied between cotton growing regions.

There remains a very high level of reliance on glyphosate across all cotton valleys, both within the crop but also in the areas around the cotton paddocks and in the fallows.

"Almost everyone at these workshops was highly concerned about the rapidly increasing levels of glyphosate resistance and how we are going to manage this into the future," Mark Congreve said.

"One of the interesting outcomes of the workshops was discussion about what growers are planning to do differently on their farms to delay the onset of glyphosate resistance.

"There was a wide range of approaches; highlighting that no one solution will fit every farming system.

"However there were some common strategies to increase diversity in weed management."

Incorporating more residuals

Pre-emergent herbicides disappeared out of most cotton growing systems with the

advent of Roundup Ready varieties. Prior to that, pre-emergent herbicides were widely used throughout the cotton industry. With generally low incidence of resistance, pre-emergent herbicides offer a significant source of diversity; however they do need more management than post-emergent herbicides, so the choice of pre-emergent herbicide and when they are best applied varied across geographies, farming systems and irrigation set up.

The recent registration of Bouncer 960S (s-metolachlor) for application over-the-top of emerged cotton, potentially in a tank-mix with an early glyphosate application, was seen by many as something that was relatively simple to implement and likely to be highly beneficial to the overall integrated weed management plan.

"Use of pre-emergent herbicides will increase, but this will need to be managed to ensure that crop impacts are minimised," Mark said.

Control strategies should look at weed management across the farming system as well as in non-crop areas.

Strategies vary widely



Byron Birch of Moree gave the workshop a 'five out of five' rating.

"The content was relevant and practical and I left with a better understanding of herbicide modes of action; how resistance develops; target vs metabolic resistance and half-life of residuals and phenoxies. The discussion of scenarios and how to apply it in the farming system really brought it all home at a practical level."

– Byron Birch

MELANIE JENSON

"Better/firmer bed preparation and a watchful eye on likely rainfall in the weeks immediately after sowing were seen as critical to help mitigate risk of any adverse crop effects.

"Valleys with very cold conditions and slow starts in Southern NSW are more likely to seek diversity via in-crop options, rather than at or pre-sowing pre-emergent herbicides."

Alternate in-crop herbicides

The use of additional layby applications of a range of different herbicides is likely to receive more attention.

"Increased use of group A herbicides is likely, however Group A mode of action herbicides are prone to developing resistance," John Cameron said.

"There was interest in tank mixing Group A herbicides with glyphosate, yet this does not come without some issues, as the adjuvant packages used to optimise performance of group A herbicides is quite different from that used with glyphosate.

"This leaves a management decision whether the adjuvant package is optimised for glyphosate or the group A herbicide, or whether the herbicides are applied separately, leaving the decision as to which herbicide is best applied first."

More in-crop tillage

Most growers using flood irrigation are making at least one in-crop cultivation, primarily for water management and/or fertiliser application. There was general consensus that it would be relatively simple to also achieve better weed management objectives from this in-crop cultivation – by removing weed escapes and/or improving the incorporation of residual herbicides. Cultivation can make an ideal 'double knock' to control survivors after a post-emergent herbicide application.

Several participants mentioned that the time had come to pull out the shielded sprayer or lillistons from behind the shed and start including these operations in their weed management plan.

The introduction of Bollgard 3 may eliminate the compliance need for pupae busting in certain situations, however most growers indicated that an aggressive mechanical operation to remove the cotton plant is still likely to be required in most situations, and this potentially can be part of the weed management plan.

Chipping to stop weed set by survivors

The willingness to use chippers varied between growers. Some growers, often those with already very low weed seedbanks, have continued to regularly use

chippers as a core part of their program to 'keep their low weed seedbanks low'. Others said that they saw the need to re-introduce chipping primarily to help stop seed set from weeds that have survived herbicide sprays (and are thus deemed more likely to be herbicide resistant), or survived in-crop tillage.

"However, some participants saw the re-introduction of chipping as a 'last resort' and felt that if they had to start chipping again, this would be signalling that their farm weed management system was completely broken," John said.

Whole of farm and rotational strategies

Different weeds tend to blow out in different crops and different phases in the farming system rotation, so the whole farming system needs to be considered in an integrated weed management strategy.

Weeds such as fleabane often blowout in winter cereals and in non-crop areas and then encroach into cotton. As such, strategies should look at weed management across the farming system as well as in non-crop areas. Strategies for weed management in and around irrigation channels was an area identified that is requiring further research to develop more chemical and non-chemical solutions.



PAUL GRUNDY

Novel management in dryland investigated

Work is well underway in CRDC's new five-year dryland cotton systems research project.

Led by QDAF's Paul Grundy and Kaara Klepper, the project kicked off last season by working with growers to identify issues and strengths in their farming systems and specifically for dryland cotton research.

The project began with a series of dryland grower focus group workshops facilitated by CottonInfo's Sally Dickinson at Quirindi, Goondiwindi, Boggabri, Dalby and Moree to seek a better understanding of growers' production constraints and opportunities for dryland cotton in the context of the broader farming system.

A number of key issues that were common to all regions were identified. These centred around: effective crop establishment and end of season crop destruction; challenges associated with

"Preliminary trials have begun with moisture attracting additives"

Destructive power of water investigated

Preliminary work is underway with Greg Butler from Conservation Agriculture Australia Inc. in South Australia and Sundown Pastoral Company's Darren Hart from "Keytah" at Moree, investigating the efficacy of ultra-high water pressure (50,000psi) for root cutting post-harvest as an alternative crop destruction tactic. A preliminary trial with this technology showed some promise for root cutting with high pressure water, although engineering refinement is still required.

"It is early days but, but this technology may work for us in a number of ways," Paul said.

the lead out/transition to grain crops after dryland cotton; and weeds in the system (with summer grasses being of particular concern with different species being prevalent in different areas).

These topics along with a number of regionally specific issues are being reviewed in the context of previous research to develop priorities for both short and long term research questions.

Getting established

To improve planting success and promote better establishment, preliminary trials have begun with moisture attracting additives that may assist with cotton establishment under marginal surface moisture conditions. Trials at the farm of 2016 Cotton Growers of the Year Ian, Marilyn and Harry Carter at Quirindi have showed some promise with improvements of around 20 percent in

establishment success, Paul said.

"Another trial at Moree was rained out the night after we planted which negated the result, but these products will be investigated again at several sites at the start of next season," Paul said.

Rogues revisited

Rogue (volunteer and ratoon) cotton can pose serious management issues for dryland growers, and there are no products currently registered for the control of large volunteer or ratoon cotton plants.

Paul and CottonInfo's Sharna Holman have been testing herbicide strategies for the control of large volunteer and ratoon cotton plants in collaboration with Nufarm's Frank Taylor utilising WeedIT/optical boom spray rigs and a selection of herbicides as yet unregistered for use on cotton.

"We have three options that have

shown excellent potential – 100 percent control – against large volunteers and ratoons in stubble field scenarios, which will be ideal for all growers who experience escapes in subsequent grain crops or bare fallows,” Sharna, QDAF, said.

“Volunteers in particular have been a regular problem in ensuing grain crops such as sorghum, with the problem often becoming apparent post-harvest.

“At this point management options have been very limited or simply not effective, creating the risk of pest and disease carryover between seasons.

“The objective of this research has been to add large volunteer and ratoon cotton to the target species listing of several product labels. In the interim we will be seeking a permit for these options.”

To till – or not?

The pros and cons of whether or not to pupae bust dryland cotton and the implications of tillage versus no tillage on subsequent grain crops is a focus of several experiments being implemented in fields after this season.

Kaara said basic lead out/transition to grains experiments will begin this season, with one trial site near Goondiwindi and a second at Mungindi.

The focus of these experiments will be to determine the impact of pupae busting versus no tillage on subsequent grain crops (cereal and chickpea). Measurements will be made to determine tillage impacts on grain crop establishment, productivity and resulting stubble cover together with how each option affects soil related factors such as moisture changes, nitrogen cycling, weeds and diseases. Activity will increase in the second year of the project as resourcing increases and longer-term research questions are refined.

For more

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Research ramping up in the south

An initial aim of newly appointed Southern NSW cotton researcher Steve Buster was to form an overall picture of cotton growing practices in the region.

Steve’s role with NSW DPI at the Yanco Agricultural Institute is supported by CRDC and was created to address issues faced by southern growers, particularly around germination and emergence. This involves potential cool starts at both pre and post emergence, creating associated issues for crop health.

Since starting in February, Steve has been meeting with growers and consultants and has come up with a number of potential experiments to meet the needs of both current and emerging cotton growers in the areas around Hillston, Condobolin, Griffith, Coleambally and Berrigan.

“There are a series of experiments we are going to undertake around sowing date and how to increase and/or preserve temperature in the hill for optimal planting,” Steve said.

“I believe it would be really useful to also explore bed/hill formation and field geometry to help increase temperature in the bed, while row spacing looks like another avenue where some clarity would be useful around the best match to suit the climate.

“I’d like to see a long-term rotation trial to research many issues from disease, yield, trash management and water use efficiency, both in a commercial setting and at the Yanco research station.”

In an effort to rapidly assess the effect of planting dates, Steve has put forward a ground-breaking proposal to growers that would allow him access to ginning data. A ‘Southern Grower Cotton Field Data Base’ would allow Steve to quickly identify trends and make correlations between sowing dates and other growth parameters and yield for growers’ individual fields.

“This offers a fast and broad scale way to quantify the effect planting date has on yield, quality and timing of harvest.

“Season length drives everything: it has implications for planting date, early season



There is a series of experiments planned to explore sowing dates and how to get and/or preserve temperature in the hill in South-West NSW.

insect control, fertiliser management and end of season management so we need to get a handle on how long the season can be and how to drive ‘earliness’,” Steve says.

“We need to look at ways to reduce chilling of the seed bed at planting. Watering up and its effect on germination is of particular concern, particularly if growers are planting at temperatures below optimal and then watering up, which drops the soil temperature by up to four degrees.”

“CRDC is excited that someone with Steve’s experience and farming background will be working with southern growers to identify research gaps for the region, as well as testing and modifying current research findings,” said CRDC’s Allan Williams, who oversees the project.

“Steve has hit the ground running, and after only a few months has already approached CRDC, research providers and other industry groups to formulate and undertake experiments, trials and initiatives to drive the success and sustainability of these growers and burgeoning industry in the south-west.”

For more

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Keep moisture levels down this harvest

The use of round module builder pickers has grown very quickly in Australia and with it, uncertainty over the shelf life of the modules in the gin yard.

The advent of round bales required industry to revisit harvesting and module storage guidelines, which were developed for use with conventional modules. This brought CRDC to support research by Dr Menghe (Malcolm) Miao of CSIRO Manufacturing into the effect of plastic polyethylene film on module moisture and heat retention and cotton fibre quality.

The research found that, on the whole, round module storage has a small but detectable influence on the yellowness and elongation of the cotton fibre and that the industry guidelines for traditional modules in regard to moisture content at picking and module storage conditions were applicable to round modules.

“Growers have expressed concerns about the consequences of the situation where modules may be kept in the sun and through wet weather conditions for extended periods prior to ginning,” Malcom said.

“Cotton quality attributes (length uniformity, strength, elongation, and colour) displayed

statistically significant changes between modules ginned at the beginning of the storage period and at the end of the storage period (some up to 10 months), however not all these changes could be assigned to the effect of storage time.

“Two consistent trends emerged from these monitored ginning trials, which were increases in yellowness and decreases in elongation with module storage time.

“Interestingly, the increased yellowness (+b) lead to a positive impact on colour grade as Australian cottons are ‘super-white’, while the reduction in elongation may be caused by UV exposure of the cotton at the top and ends of the round module.

“This hypothesis needs be confirmed by further investigation.”

Another aspect of the research included analysis of a large industrial database that contained the picking and ginning dates and HVI test results of 222,793 bales of cotton from the 2015 season and 222,337 bales from the 2016 season. The cottons were grown in five regions including Moree, Warren, Narrabri, Trangie and Hay, and processed by six gins.

Trends between cotton quality indicators and module storage time were identified from each of the two seasons. However, the trends identified from 2015 were not repeated in the 2016 season.

“This inconsistency is attributable to the complex nature of weather conditions, cotton growth and ginning, any of which can have a more significant effect on cotton quality than module storage time,” Malcom said.

“The effect of a significant rain event in the Macquarie Valley was investigated showing cotton harvested after the rain showed lower yellowness, higher short fibre index and trash content.

“Essentially, cotton industry research shows fibre quality damage in this context is almost exclusively due to storage of extremely wet cotton harvested above the recommended moisture content of 12 percent.

“The current recommendation is to harvest and store seed-cotton at moisture levels below 12 percent.”

CSIRO's Dr Malcolm Menghe has measured the effect of storage on round modules.



For more

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Compaction impact

MICHAEL BRAUNACK

CRDC is calling on growers to be a part of a soil compaction survey to assess the impact of round bale pickers.

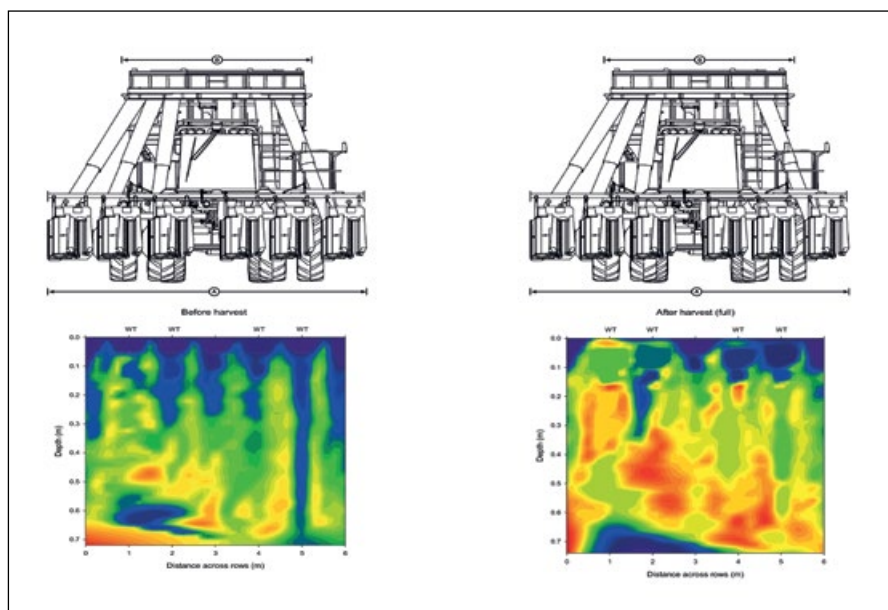
CSIRO's Michael Braunack, Dr John McLean-Bennett of University of Southern Queensland and CottonInfo Regional Extension Officers are looking to engage with growers and contractors over coming months on the issue of soil compaction due, in the main, to cotton picker traffic.

"We want to know whether it is an issue or not, and if so, what, if anything, are individuals doing to manage it?" Michael said.

"If it is an issue, we'd like to know what strategies being used to manage the problem, what has worked and what has not."

The responses and information will be used to gain a picture of the issue right across the industry and inform further research priorities. Michael and John with the network of CottonInfo REOs will collate the survey information from growers in their specific regions, through workshops and one-on-one engagement with individual growers.

This survey follows research undertaken



MICHAEL BRAUNACK

Figure 1: Soil strength profiles researchers measured before and after traffic by a JD7760 as part of their initial survey of changes due to picker traffic. The increased red areas indicate a higher soil strength, which will restrict root growth. The green area indicate where roots can grow without too much trouble. The measurements were taken at the same soil moisture content so the comparison between the two is valid.

Main image: Cotton roots growing at right angles instead of a single tap root, due to encountering a compacted zone beneath the plant line.

by Michael and others into the effect on compaction with the advent of round bale pickers, which are significantly heavier than their conventional predecessors, weighing in at around 36 tonnes.

"In our research we measured soil

strength profiles, which are an indicator of compaction, before and after traffic by a JD7760 as part of our initial survey of changes due to picker traffic," Michael said.

"The results can be seen (figure 1) in the increased red areas, indicating a

higher soil strength, which will restrict root growth. The less-compacted green area indicates where roots can grow without too much trouble."

CTF: the way forward

Research undertaken by John has found the best method to deal with heavy machines is to avoid unnecessary traffic by implementing a controlled traffic farming (CTF) approach.

"Modifying to true CTF in Australia should be considered the best management practice; indeed a number of growers have demonstrated the benefits of this approach," John said.

Further to affecting root growth and general soil health, compaction has significant effect on moisture infiltration and nutrient uptake.

"A true CTF system was shown to better protect soil water infiltration in our experiments undertaken at Warren in NSW.

"A wheat crop was able to access moisture to 80cm after two seasons of cotton in the CTF system using a JD7760 modified for CTF, but in the unmodified JD7760 system, the crop could not access water below 40cm due to compaction.

"The JD7760 has dual wheels on the front for increased machine stability, yet poses issues in the field in terms of compaction due to high axle loads."

True CTF is where all wheel tracks are the same width and equipment working widths are multiples of each other; so either 1:2 or 1:3 and so on. To modify a JD7760 to CTF one set of duals at the front are removed, and the front axle is modified to the same width as the rear axle.

"Finally, to manage compaction, incorporation of rotation crops that improve structure with a true-CTF system should see growers realise the full potential of their soil resource."

John has recently published two papers on the impact of compaction and CTF, which are available from the Inside Cotton website www.insidecotton.com

For more

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Become a better moisture manager



The low-down with
Jon Welsh

Every fortnight, CottonInfo publishes 'Moisture Manager': a summary of weather and climatic information tailored specifically for the cotton industry as part of the CottonInfo 'e-news' service.

This publication is designed to provide a broad overview of current conditions and report on seasonal forecasting commentary from the Australian Bureau of Meteorology and the International Research Institute (USA) and other leading domestic and international climate research agencies. The objective of this service is to raise awareness and increase growers and advisors' understanding of climatic and seasonal factors influencing on-farm strategic decision making, with the view to improving farm input efficiency.

The publication tables key measurements of the Pacific Ocean and Indian Sea Surface Temperatures as well as three different atmospheric drivers of eastern Australian rainfall: the Southern Oscillation Index, the Southern Annular Mode and Madden-Julian Oscillation.

Visual icons illustrate wet/neutral/dry phase indicators, creating a historical context of how these measurements have traditionally influenced climatic conditions. A range of information including Global Circulation Models (GCMs) are surveyed regularly to identify potential trends in seasonal (three-monthly) and multi-week (10-28 days) rainfall and temperature predictions. When aligned, results of seasonal GCM outputs can provide an early warning system for growers and advisors planning winter/summer crop rotations, fertiliser budgeting and water scheduling, and can assist in determining likely evaporation rates for the coming season.

All GCM sources contain hyperlinks for users looking to save in their browsers and track model outputs during critical operation and decision making periods. At the end of each season (winter/spring etc) a review of model performance versus actual



Get the low down on weather and climate information, which has never been easier to access, with the fortnightly Moisture Manager e-news, tailored for growers and consultants by CottonInfo's Jon Welsh.

rainfall and temperature helps understand accuracy in each reporting period.

Statistical models such as the SOI phase system and analogue or 'like' years also add to the suite of information used to assess climate risk.

CottonInfo has recently contracted the services of meteorologist Jim Roemer from US based Bestweather.inc, a climate and commodities risk management consultancy, whose tailor-made medium and long range predictions (published quarterly) are designed specifically for cotton growers to help manage risk at key decision points in the year.

Moisture Manager is an information-rich, user-friendly and up-to-date weather and climate service essential for farming businesses looking for an edge in climate risk management. Moisture Manager is supported by funding from the Australian Government, and delivered by CottonInfo: the Australian cotton industry's joint extension program, supported by CRDC, Cotton Australia and Cotton Seed Distributors.

To sign up for the fortnightly e-newsletter (and other CottonInfo communications) visit
www.cottoninfo.com.au/subscribe

 @CottonInfoAust



Recently contracted to the Moisture Manager team in 2017 is US meteorologist **Jim Roemer**, who publishes quarterly outlooks for cotton growing areas using his privately developed software 'Climatech'. Jim is a sports enthusiast and philanthropist, and also advises hedge funds exposed climatic variability such as energy and agricultural commodities.

Nick Gillingham manages the Sundown Pastoral Company's properties in the Gwydir Valley, and subscribes to the CottonInfo Moisture Manager fortnightly e-news.

"It is definitely useful, we take the seasonal forecasts into consideration when looking ahead," Nick said.

"It is user-friendly and saves time, as it analyses and brings together a lot of weather and climate information into one place.

"It saves me having to go to a lot of different websites to find out the same information."



Dr Tony Barnston is an International Research Institute Climate Scientist who's monthly ENSO commentary and collective assessment of all statistical and dynamical models features in the CottonInfo Moisture Manager. The IRI have close links with agencies such as the Food and Agriculture Organisation and the World Bank to monitor climate extremes in developing countries.



Getting back to basics

In recent years, the broadacre cropping industries have been hit by a wave of technology-based solutions aimed at assisting the decision-making processes of growers, managers and consultants.

The ultimate aim is of course, better, more informed and timely decisions based on historical data and research outcomes. This current generation of growers and consultants is now the regular consumer of readily available and affordable technologies, some of which may not have even been heard of 10 years ago. Today, products such as Agworld and IrriSat along with communication and financial packages, are the part of the average agro's toolkit.

Many of us who are just a 'few' years out of university may struggle a little with the adoption of new tools and rely on the skills of our younger counterparts to help us navigate the technology maze. We should never forget however, that the knowledge transfer goes the other way too, and at times, wisdom, experience and the 'know-how' that comes from having been up a few dry gullies, cannot be replaced by an app or a probe.

By no means are we belittling the value of our new set of tools. As an industry we are very fortunate to have so much being invested in our future. The observation is rather that sometimes, even the best of data can lead to bad decision making. If the implementation of these tools is not backed up by common sense and basic agronomic knowledge, the outcome may not be as planned.



MELANIE PEARSON

In the theme of 'Back to Basics' for this year's CCA seminars, the basics of integrated pest management will be on the agenda.

As a professional development organisation, Crop Consultants Australia (CCA) places a strong focus on reinforcement of the basics of science. A strong understanding of physiology, entomology and chemistry are the true vital tools in a consultant's toolkit. Like all tools however, they need sharpening and honing.

Our 2017 seminar agendas see the return of our popular 'Back to Basic' series of presentations – this year exploring physiology of differing varieties, and integrated pest management. These presentations are pitched at all of our attendees – those of us who are a 'few' years out of university, and those who are still learning the ropes. CCA understands that until we get those basics right, we can't apply the new research to achieve its best outcomes.

While CCA is a professional development association for independent

agronomists, we open our doors at seminars to all interested attendees. In particular we recognise that much of the upskilling that we offer to our members would be highly valuable to researchers and growers. Through the support of our partners, sponsors and other CCA projects, CCA continues to deliver tailored, high quality networking and training experiences at a very affordable price for the attendee.

For more information about our seminars or membership visit our website.

For more

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CRDC 2017-18 Projects List (as of May 2017)

In 2017-18, CRDC will invest \$22 million into approximately 200 research, development and extension projects across the five program areas of the CRDC Strategic R&D Plan (farmers, industry, customers, people and performance), in collaboration with 92 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 9 May, and is subject to change.

Program theme	Project title	Project code	Researcher	Organisation	Commenced in:	To be completed in:	
Program one: Farmers							
1. Successful crop protection	Biology of <i>Amarathus hybridus</i> , <i>A. mitchelli</i> , and <i>A. powellii</i> : emerging weeds of cotton systems	UQ1703	Asad Khan	UQ	Jan-17	Dec-19	
	Centre for Biopesticides & Semiochemicals: Development of new tools & strategies for IPM	DAN1404	Robert Mensah	NSW DPI	Jul-13	Jun-18	
	Centre for Biopesticides & Semiochemicals: Novel insecticides and synergists from endemic and exotic flora	UWS1401	Robert Spooner-Hart	UWS	Oct-13	Jun-18	
	Centre for Biopesticides & Semiochemicals: Semiochemical management for occasional pests of cotton and grains	UNE1404	Peter Gregg	UNE	Oct-13	Jun-18	
	Commercial development and evaluation of a machine vision-based weed spot sprayer	NEC1402	Stephen Rees	NCEA	Jul-13	Mar-18	
	Digital technology for dynamic management for disease, stress and yield	AGWA1701	Liz Waters	AGWA	Aug-16	Jun-19	
	Enhancing IPM in cotton systems	CSP1401	Lewis Wilson	CSIRO	Jul-13	Jun-18	
	Hard to control weeds in northern farming systems – understanding key processes to improve control methods (CottonInfo technical specialist)	DAN1402	Eric Koetz	NSW DPI	Jul-13	Jun-18	
	Improving the management of cotton diseases in Australian cotton farming systems	RRDP1724	Linda Smith	QDAF	Jul-16	Jun-19	
	Innovative solutions to cotton diseases	DAN1703		NSW DPI	Jul-16	Dec-19	
	Major capital item: Autoclave for the ACRI cotton pathology laboratory	DAN1704	Rod Jackson	NSW DPI	Mar-17	Sep-17	
	Managing verticillium risk for cotton	RRDP1723	Karen Kirkby	NSW DPI	Jul-16	Jun-19	
	NEW: The use of area wide management, IPM, detergents and oils for the suppression of whitefly population in cotton for the reduced reliance and use of chemical controls		Emma Ayliffe	Elders	Jul-17	Jun-19	
	NEW: Mirid and mealybug best practice management		Richard Sequeira	QDAF	Jul-17	Jun-20	
	NEW: Novel transgenic approaches to control silverleaf whitefly		Gimme Walter	UQ	Jul-17	Jun-20	
	Northern Australia cotton development & coordination leader	CSP1602	Steve Yeates	CSIRO	Oct-15	Jun-18	
	PhD: Developing the weed control threshold	DAN1601	Graham Charles	NSW DPI	Nov-15	Jun-18	
	PhD: Electrophysiological and molecular identification of novel biopesticides	UWS1601	Michelle Mak	UWS	Jul-15	Jun-18	
	PhD: Understanding the ecology of Reniform Nematodes in cotton			UNE	Jan-17	Dec-20	
	Regional weed management workshops for growers and advisors	CRDC1621	John Cameron	ICAN	Mar-16	Sep-17	
	Staying ahead of weed evolution in changing cotton systems	UQ1501	Jeff Werth and Bhagirath Chauhan	QAAFI	Jul-14	Jun-19	
	Viruses, vectors and endosymbionts: Exploring interactions for control	UQ1305	Jeff Werth	UQ	Apr-13	Aug-17	
	2. Productive resource efficiencies	Agronomy for resilient future cotton systems	CSP1601	Michael Bange	CSIRO	Jul-15	Jun-18
		Benchmarking water use efficiency and crop productivity in the Australian cotton industry (CottonInfo technical specialist)	DAN1505		NSW DPI	Jul-14	Jun-19
		BestWeather climate consultancy	CRDC1736	Matt Davey	BestWeather	Mar-17	Mar-18
		Increasing profitability through improved nitrogen use efficiency and reducing gaseous losses of nitrogen	AOTG1601	Peter Grace	QUT	Jul-15	Jun-18
More Profit from Nitrogen – Enhancing nutrient use efficiency in cotton		RRDP1712	Graeme Schwenke	NSW DPI	Jul-16	Jun-20	
More Profit from Nitrogen – Improved nitrogen use efficiency through accounting for deep soil and mineralisable nitrogen supply deployment of Enhanced Efficiency Fertilisers to better match crop N demand		RRDP1717	Lukas Van Zwieten	NSW DPI	Jul-16	Jun-19	
More Profit from Nitrogen – Improving dairy farm nitrogen efficiency using advanced technologies		RRDP1715	Helen Suter	UM	Jul-16	Jun-19	
More Profit from Nitrogen – Increasing nitrogen use efficiency in dairy pastures		RRDP1714	David Rowlings	QUT	Jul-16	Jun-19	
More Profit from Nitrogen – New technologies and managements: transforming nitrogen use efficiency in cane production		RRDP1719	Matt Redding	QDAF	Sep-16	Feb-21	
More Profit from Nitrogen – Optimising nitrogen and water interactions in cotton		RRDP1713	Alice Melland	NCEA	Jul-16	Jun-18	
More Profit from Nitrogen – Optimising nutrient management for improved productivity and fruit quality in cherries		RRDP1721	Nigel Swarts	UTAS	Aug-16	Apr-20	

Program theme	Project title	Project code	Researcher	Organisation	Commenced in:	To be completed in:
	More Profit from Nitrogen – Optimising nutrient management for improved productivity and fruit quality in mangoes	RRDP1720	Mila Bristow	NTDPIR	Aug-16	Jun-20
	More Profit from Nitrogen – PMA Meetings	RRDP1722	Allan Williams	CRDC	Jul-16	Jun-20
	More Profit from Nitrogen – Project Communications	RRDP1735	Allan Williams	CRDC	Jul-16	Apr-20
	More Profit from Nitrogen – Project Monitoring and Evaluation	RRDP1736		Jul-16	Apr-20	
	More Profit from Nitrogen – Quantifying the whole farm systems impact of nitrogen best practice on dairy farms	RRDP1716	Richard Eckard	UM	Jul-16	Jul-20
	More Profit from Nitrogen – Science Leadership and Project Coordination	RRDP1711	Marguerite White	ICD Project Services	Nov-16	Jun-20
	More Profit from Nitrogen – Smart blended use of enhanced efficiency fertilisers to maximise sugarcane profitability	RRDP1718	Weijin Wang	DSITI	Jul-16	Apr-20
	More Profit from Nitrogen – YourData platform	RRDP1727	Jeff Coutts	Coutts J&R	Feb-17	Jun-21
	New materials and options for reducing water losses from evaporation and seepage	NEO1701	Andrew Hamilton	NeoTop Water Systems	Jul-16	Jun-18
	NEW: Improving water use efficiency in a changing climate		Katie Broughton	CSIRO	Jul-17	Jun-20
	NEW: Minimising yield variability to maximise yield in a cotton farming system		Guna Nachimuthu	NSW DPI	Jul-17	Jun-20
	NEW: Precision management for improved cotton quality		Robert Long	CSIRO	Jul-17	Jun-20
	NEW: Where does the water go? Visualising irrigation efficiency by time-lapse water monitoring		John Triantafyllis	UNSW	Jul-17	Jun-20
	Opportunities for dryland cotton with Bollgard 3	DAQ1703	Paul Grundy	QDAF	Jul-16	Jun-19
	Optimising management of manure in southern NSW cotton production	DU1603	Wendy Quayle	CSIRO	Jul-15	Jun-18
	Optimising seedling emergence	DAN1701	Deb Slinger	NSW DPI	Jul-16	Jun-19
	PhD: Improving precision agriculture and environmental performance for the Australian cotton industry through fertiliser optimisation	ANU1602	James Latimer	ANU	Feb-16	Jun-19
	PhD: Next-generation fertilisers for nutrient stewardship in cotton production	UQ1702	Rhys Pirie	UQ	Jan-17	Jan-20
	PhD: The impact of irrigation methods and management strategies on nitrogen fertiliser recovery in cotton in southern NSW (CottonInfo technical specialist)	UQ1502	John Smith	UQ	Jul-14	Dec-20
	PhD: Utilising novel plant growth regulators to develop resilient future cotton systems	CSP1604	Claire Welsh	CSIRO	Jan-16	Mar-19
	Post doc: Cotton production in a future climate	CSP1501	Katie Broughton	CSIRO	Jul-14	Jan-18
	Post doc: Professor of soil biology	UNE1403	Oliver Knox	UNE	Jan-14	Dec-18
	Season benchmarking with canopy temperature sensors	CSD1701	Amanda Thomas	CottonInfo	Dec-16	Dec-17
	Smarter Irrigation for Profit: Develop precise and automated control systems for a range of irrigation systems	RRDP1603	Joseph Foley	NCEA	Jul-15	Apr-18
	Smarter Irrigation for Profit: Educating growers in innovative on-farm water management and scheduling practices	RRDP1734	Andres Jaramillo	SRA	Jun-17	Apr-18
	Smarter Irrigation for Profit: Evaluation of scheduling tools for the sugar industry	RRDP1609	Peter Samson	SRA	May-16	Apr-18
	Smarter Irrigation for Profit: Grower led irrigation system comparison in the Gwydir Valley	RRDP1606	Louise Gall	GVIA	Jul-15	Apr-18
	Smarter Irrigation for Profit: Grower-led cotton automation integration trial	RRDP1730	Louise Gall	GVIA	Jan-17	Nov-18
	Smarter Irrigation for Profit: Improved use of seasonal forecasting to increase farmer profitability	RIRDC1603		RIRDC	Jul-15	Jun-18
	Smarter Irrigation for Profit: Increasing farm profit through efficient use of irrigation for dairy farms	RRDP1604	James Hills	UTAS	Jul-15	Apr-18
	Smarter Irrigation for Profit: Integrated irrigation, dairy	RRDP1732	Monique White	Dairy Australia	Mar-17	Mar-18
	Smarter Irrigation for Profit: Irrigation agronomy for tailored and responsive management with limited water	RRDP1602	Hizbullah Jamali	CSIRO	Jul-15	Apr-18
	Smarter Irrigation for Profit: Maximising on-farm irrigation profitability – southern connected systems	RRDP1605	Peter Regan	NSW DPI	Jul-15	Apr-18
	Smarter Irrigation for Profit: NCEA technical support for technology integration & scheduling projects	RRDP1731	Joseph Foley	USQ	Mar-17	Apr-18
	Smarter Irrigation for Profit: Optimised dairy irrigation farms	RRDP1607	Monique White	Dairy Australia	Jul-15	Apr-18
	Smarter Irrigation for Profit: Project leadership and coordination	RRDP1501	Guy Roth	Roth Rural	Jul-15	May-18
	Smarter Irrigation for Profit: Scheduling technology matrix	RRDP1733	Monique White	ICD Projects	Mar-17	Dec-17
	Smarter Irrigation for Profit: When and how much	RRDP1601	Mike Morris	DEDJTR	Jul-15	Apr-18
	Soil System Research – physical, chemical and biological processes for plant growth and nutrient cycling down the whole soil profile	UNE1601	Oliver Knox	UNE	Jul-15	Jan-19

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3. Profitable futures	Agri-intelligence in cotton production systems – stage 1	QUT1701	Tristan Perez	QUT	Jan-17	Dec-18	
	PhD: A national regulatory framework governing big data in primary production	UNE1606	Gina Wood	UNE	Feb-16	Feb-19	
	PhD: Building climate change resilience in cotton through translational physiology	ANU1704	Demi Gamble	ANU	Feb-17	Mar-20	
	PhD: Characterisation of brassinosteroid effects and brassinosteroid-responsive genes in cotton for growth and stress tolerance enhancement	UNE1605	Anahid A Essa Al-Amery	UNE	May-14	Aug-18	
	Precision to Decision Agriculture: Agribusiness linkage	RRDP1702	Richard Heath	AFI	Jul-16	Feb-18	
	Precision to Decision Agriculture: Analysis of the economic benefit and strategies for delivery of decision agriculture	RRDP1726	Richard Heath	AFI	Dec-16	Aug-17	
	Precision to Decision Agriculture: Data Communications	RRDP1703	David Lamb	UNE	Jul-16	Dec-17	
	Precision to Decision Agriculture: Data rules	RRDP1704	Leanne Wiseman	Griffith University	Jul-16	Dec-17	
	Precision to Decision Agriculture: Data rules II	RRDP1706	Jay Sanderson	USC	Jul-16	Dec-17	
	Precision to Decision Agriculture: Data sources	RRDP1707	Simon Barry	CSIRO	Jul-16	Dec-17	
	Precision to Decision Agriculture: Data systems	RRDP1705	Brenton Cooper	D2D CRC	Jul-16	Dec-17	
	Precision to Decision Agriculture: PMA, PMC, Agribusiness forums & Regional workshops	RRDP1708	Rohan Rainbow	Rainbow & Associates P/L	Jul-16	Feb-18	
	Precision to Decision Agriculture: Project Leadership and Coordination	RRDP1701	Rohan Rainbow	Rainbow & Associates P/L	Jul-16	Feb-18	
Program two: Industry							
1. Respected stewardship	Biosecurity: 2016-17 scenario training	CRDA1711	Susan Maas	CRDC	Apr-17	Jul-17	
	Biosecurity: facilitate 2016-17 scenario training	PHA1702	Stephen Dibley	PHA	Apr-17	Jul-17	
	Conventional insecticide resistance in <i>Helicoverpa</i> – monitoring, management and novel mitigation strategies in Bollgard 3	DAN1506	Lisa Bird	NSW DPI	Jul-14	Jun-19	
	Cotton Map		Nicola Cottee	CA	Jul-17	Jun-18	
	Development of a spray drift hazard identification system	MRES1701	Graeme Tepper	MRES	Jul-16	Jun-19	
	Managing Bt resistance and induced tolerance in Bollgard 3 using refuge crops	CSE1601	Mary Whitehouse	CSIRO	Jul-15	Jun-18	
	Monitoring Silverleaf Whitefly (SLW) insecticide resistance	DAQ1701	Jamie Hopkinson	QDAF	Jul-16	Jun-19	
	NCEDD – Stewardship of biotechnologies and crop protection (CottonInfo technical specialist)	SC1601	Sally Ceeney	Ceeney Ag	Jul-15	Jun-18	
	NEW: Application of genomic tools to monitoring for resistance alleles in <i>Helicoverpa</i> spp.		Tom Walsh	CSIRO	Jul-17	Jun-19	
	NEW: Assess biosecurity risk for Bt alleles & RMP implication		Wee tek Tay	CSIRO	Jul-17	Jun-20	
	NEW: National biosecurity and disease extension and coordination and CQ regional extension (CottonInfo technical specialist)		Sharna Holman	QDAF	Jul-17	Jun-20	
	NEW: Preparation for exotic insect pests		Gimme Walter	UQ	Jul-17	Jun-20	
	Resistance research and monitoring to enhance stewardship of Bt cotton and management of <i>Helicoverpa</i> spp.	CSE1701	Sharon Downes	CSIRO	Jul-16	Jun-19	
	Sponsorship: Science Protecting Plant Health Conference, 2017	CRDC1738	Jenny Lawler	QAAFI	Apr-17	Sep-17	
	Surveillance and studies for endemic and exotic virus diseases of cotton	DAQ1601	Murray Sharman	QDAF	Jul-15	Jun-19	
	The sustainable chemical control and resistance management of aphids, mites and mirids in Australian cotton: 2014-2019	DAN1507	Grant Herron	NSW DPI	Jul-14	Jun-19	
	2. Responsible landscape management	Appropriate land-use methodology for Australian cotton life cycle assessments	UQ1701	Francois Visser	UQ	Jul-16	Jun-19
		Baselining Lower Namoi groundwater and evaluating Pilliga CSG developments	UNSW1601	Bryce Kelly	UNSW	Jul-15	Jun-18
		Cotton Rivercare Champion	CRDC1602	Mark Palfreyman	Capricorn North Pty Ltd	Sep-15	Jun-18
		Developing the groundwater health index (GHI) as an industry-wide monitoring tool	MQ1501	Grant Hose	Macquarie University	Jul-14	Dec-17
Improving the ability of the Australian cotton industry to report its sustainability performance		QUT1705	Erin Peterson	QUT	Oct-16	Sep-19	
Managing climate variability program – phase five		MLA1701	Tom Davsion	MLA	Jul-16	Jun-21	
Managing natural landscapes on Australian cotton farms to increase the provision of ecosystem services		GU1701	Samantha Capon	Griffith University	Jul-16	Jun-19	
Managing riparian corridors on cotton farms for multiple benefits		UNE1602	Rhiannon Smith	UNE	Jul-15	Jun-18	
NEW: Climate and energy for cotton farming businesses (CottonInfo technical specialist)			Jon Welsh	Ag Analytics	Jul-17	Jun-20	
NEW: NRM Technical specialist and extension campaigns (CottonInfo technical specialist)			Stacey Vogel	Vogel Consulting	Jul-17	Jun-20	
NEW: Quantifying the nutrients and pesticides cycle: from farm gate to catchments, groundwater and atmosphere			Dioni Cendon	ANSTO	Jul-17	Jun-20	

Program theme	Project title	Project code	Researcher	Organisation	Commenced in:	To be completed in:
	NEW: Quantifying the potential environmental impacts of pesticides used on cotton farms		Ashley Webb	NSW DPI	Jul-17	Jun-20
	NEW: Synthesis of natural resource assets in the cotton growing region of eastern Australia		Julian Wall	Eco Logical Australia Pty Ltd	Jul-17	Jun-20
	PhD: Effects of climatic fluctuation and landuse change on soil condition in the Lower Lachlan	US1403	Patrick Filippi	USYD	Mar-14	Sep-17
	PhD: Sustainable water extractions: Low flow refugia and critical flow thresholds	UNE1406	Marita Pearson	UNE	Jan-14	Dec-19
	Post doc: Keeping pest populations lower for longer: Connecting farms and natural systems	CSE1501	Vesna Gagic	CSIRO	Jul-14	Jun-18
3. Sustainable futures	Bio-degradation of dyed cotton fabrics	NCSU1701	Nelson Vinueza	NCSU	Jan-16	Dec-17
	Capital Item: GenesisERT Hydro Turbine	QUT1704	Stephen Hughes	QUT	Sep-16	Aug-17
	Capital Item: Redflow 8kWh Battery	QUT1703	Stephen Hughes	QUT	Sep-16	Aug-17
	Development of automatic siphons for cotton irrigation and use of hydro to recover energy from storage dams	QUT1702	Stephen Hughes	QUT	Sep-16	Aug-17
	Micro particles generated from laundering of cotton and other fabrics	NCSU1702	Richard Venditti	NCSU	Jan-17	Dec-17
	NEW: Innovative approaches to water security for Australian cotton irrigators		David Mitchell	NSW DPI	Jul-17	Jun-20
Program three: Customers						
1. Assured cotton	Investigating the relative contributions of weathering, insect honeydew and fungal agents to cotton colour grade changes and discounts	CSP1703	Simone Heimoana	CSIRO	Jul-16	Jun-18
	NEW: Managing cotton quality to maintain Australia's premium status (CottonInfo technical specialist)		Rene van der Sluijs	CSIRO	Jul-17	Jun-20
	Sustainable Apparel Coalition: membership	CRDC1608	Scott Miller	SAC	Aug-15	Jul-17
2. Differentiated products	An eco friendly treatment to improve the look and handle of cotton fabric	DU1701	Rangam Rajkhowa	DeakinU	Oct-16	Sep-18
	Application of aqueous glycine to improve quality and efficiency of cotton dyeing	DU1703	Rangam Rajkhowa	DeakinU	Jan-17	Dec-17
	Breathable cotton for compression athletic wear	DU1601	Maryam Naebe	DeakinU	Jul-15	Dec-17
	Improved thermal management performance of bedding systems	RMIT1701	Olga Troynikov	RMIT	Jan-17	Dec-17
	PhD: High value bio-extractives and bioethanol from cotton gin trash	DAN1504	Shane McIntosh	NSW DPI	Jul-14	Aug-17
	Smart cotton/carbon fabrics for electromagnetic interference shielding	DU1602	Jin Zhang	DeakinU	Jul-15	Jun-18
3. Competitive futures	Developing renewable fine chemicals from cotton biomass	SRA1601	William Doherty	QUT	Jul-15	Jun-18
	PhD: Exploring nanofibrous coating on cotton fabric with versatile protection and dynamic comfort	RMIT1702	Olga Gavrilenko	RMIT	Feb-17	Jan-20
Program four: People						
1. Workforce capacity	ABARES Science and Innovation Award sponsorship	ABA1701	Marie Finnegan	ABARES	Jul-16	Jun-18
	Aboriginal Employment Strategy student scholarships – Montana Jones	AES1601	Montana Jones	Merced Farming	Feb-16	Dec-17
	Australian Rural Leadership Program – Course 23	RIR1701	Matthew Bradd	ARLF	Aug-16	Oct-17
	Australian Rural Leadership Program – Course 23	RIR1702	Meagan Laidlaw	ARLF	Aug-16	Oct-17
	Co-investment in PIEF Membership for the cotton industry	CA1706	Adam Kay	CA/PIEF	Jul-16	Jun-18
	Cotton Young Farming Champions program	CRDC1728	Lynne Strong	PYIA	Dec-16	Jan-19
	CRDC Summer/Honours Scholarship: Developing versatile protective coating on cotton fabric	CRDC1724	Zhaowei Xu	RMIT	Feb-17	Nov-17
	CRDC Summer/Honours Scholarship: Effects of application uniformity change on energy requirement for Australian lateral move irrigation machines	USQ1701	Benton Munro	USQ	Nov-16	Oct-17
	CRDC Summer/Honours Scholarships		Various	CRDC	Jul-17	Jun-18
	Developing education capacity for the Australian cotton industry	CSE1602	Trudy Staines	CSIRO	Jul-15	Jun-18
	Horizon Scholarships 2014 – Felicity Taylor	RIRDC1401	Felicity Taylor	RIRDC	Mar-14	Dec-17
	Horizon Scholarships 2014 – Michael Wellington	RIRDC1405	Michael Wellington	RIRDC	Mar-14	Dec-17
	Horizon Scholarships 2014 – Sam Johnston	RIRDC1403	Sam Johnston	RIRDC	Mar-14	Dec-17
	Horizon Scholarships 2015 – Camilla a'Beckett	RIRDC1504	Camilla a'Beckett	RIRDC	Mar-15	Dec-17
	Horizon Scholarships 2015 – Scott Nevison	RIRDC1503	Scott Nevison	RIRDC	Mar-15	Dec-18
	Horizon Scholarships 2016 – Sam Knight	RIRDC1602	Sam Knight	RIRDC	Jul-15	Dec-19
	Horizon Scholarships 2017			RIRDC	Jul-17	Dec-20
	NEW: Post doc: Investigating the future skills required for cotton farms		Nicole McDonald	USQ	Jul-17	Jun-20
	Nuffield Australia Farming Scholarship	CRDC1711	Daniel Kahl	Nuffield	Jul-16	Sep-18
	People in Agriculture – employment starter kit website	DA1502	Shane Hellwege	Dairy Australia	Jul-14	Jun-18
	Peter Cullen Trust scholarship		Various	Peter Cullen Trust	Jul-17	Jun-18
	Skills profile and labour supply structure on cotton farms	UNE1402	Bernice Kotey	UNE	Jul-13	Aug-17
	UNE Cotton Production Course	UNE1604	Brendan Griffiths	UNE	Jul-15	Jun-18

Program theme	Project title	Project code	Researcher	Organisation	Commenced in:	To be completed in:
2. Networks	AgVet collaborative forum: plant industries, phase three	RIRDC1701		RIRDC	Jul-16	Dec-19
	Automation of recycling system: IREC field station	IREC1701	Rob Houghton	IREC	Mar-17	Oct-17
	BoardEffect governance platform hosting	CRDC1631		BoardEffect LLC	Jun-16	Jul-17
	Capital Item: Planter bar and trailer	CGA1703	Ian Gourley	DCRA	Sep-16	Oct-17
	CRDC Grassroots Grants		Various	CGAs	Jul-17	Jun-18
	CRDC Grassroots Grants: Strengthening CGA policy and procedures	CGA1608	Emma McCullagh	Central Highlands CGA	Oct-15	Sep-17
	CRDC Grassroots Grants: Upgrade to Darling Downs weather station network	CGA1708	Adam McVeigh	Darling Downs CGA	Dec-16	Sep-17
	Grower RD&E advisory panels – meeting travel, capacity building, Board Portal		Nicola Cottee	CA	Jul-17	Jun-18
	National RD&E water use in agriculture cross sector strategy	DA1701	Cathy Phelps	Dairy Australia	Nov-16	Jun-18
	NEW: Post doc: Improving grower decisions in complex systems		Geraldine Wunsch	USQ	Jul-17	Jun-20
	Plant Health Australia membership			PHA	Jul-17	Jun-18
	Plant Health Australia secretariat support			PHA	Jul-17	Jun-18
	Primary Industries Health and Safety Partnership	RIRDC1301	Simon Winter	Joint Partnership RIRDC	Jul-17	Jun-18
	RIRDC Rural Womens Award sponsorship			RIRDC	Jul-17	Jun-18
	Soils cross-sectoral strategy & National Soil RD&E Implementation Committee membership	DAFF1401	Mike Grundy	CSIRO	Jul-17	Jun-18
	Sponsorship: 18th Australian Cotton Conference foundation sponsorship	CA1601	Stuart Armitage	CA	Jul-17	Jun-18
	Sponsorship: Association of Australian Cotton Scientists cotton researcher conference 2017	CRDC1720	Danny Llewellyn	AACS	Sep-17	Sep-17
	Sponsorship: Australasia-Pacific Extension Network International Conference 2017	CRDC1707	Jeanette Long	APEN	Jul-16	Sep-17
	Sponsorship: Australian Cotton Fibre Expo	CRDC1713	Melanie Moloney	Aust Cotton Fibre Expo	Jul-16	Aug-17
	3. Communication	Documenting the production of best practice Australian cotton through videos	DAQ1702	Paul Grundy	QDAF	Jul-16
Stimulating private sector extension in Australian agriculture to increase returns from R&D		DA1601	Ruth Nettle	Dairy Australia	Jul-15	Jun-18
Travel: US Cotton Industry tour & precision Ag work experience		CRDC1740	Casey Onus	Landmark	May-17	Jul-17
Program five: Performance						
1. Best practice	'Science into best practice,' linking research with CottonInfo (CottonInfo technical specialist)	CSP1504	Sandra Williams	CSIRO	Jul-14	Jun-18
2. Monitoring and evaluation	Annual qualitative and quantitative surveys for the Australian cotton industry	CCA1601	Liz Todd	CCA	Jul-15	Jun-18
	Boyce Cotton Comparative Analysis	BCA	Phil Alchin	BCA	Jul-17	Jun-18
	CRDC Cotton Grower Survey	CRDC1733	Michael Sparks	Intuitive Solutions	Feb-17	Dec-19
	Longitudinal assessment of the cotton industry's People investments	CRDC1710	Jennifer Moffatt	Jennifer Moffatt consulting	Jul-16	Dec-18
	Measuring and reporting the value of capacity building on farms and in research	CRDC1701	Gordon Stone	QualData	Jul-16	Jun-19
3. Reviews	Impact assessment of selected clusters of projects – Stage 3: Sustainability cluster and myBMP cluster	CRDC1731	Peter Chudleigh	Agtrans Research and Consulting	Feb-17	Aug-17

Key:

AACS	Association of Australian Cotton Scientists	MRES	Micro Meteorology Research & Education Services
ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences	NCEA	National Centre for Engineering in Agriculture
AFI	Australian Farm Institute	NCSU	North Carolina State University
AGWA	Australian Grape and Wine Authority	NSW DPI	NSW Department of Primary Industries
ANSTO	Australian Nuclear Science & Technology Organisation	NTDPIR	Northern Territory Department of Primary Industries and Resources
ANU	Australian National University	PHA	Plant Health Australia
APEN	Australasia-Pacific Extension Network	PYIA	Picture You in Agriculture
ARLF	Australian Rural Leadership Foundation	QAAFI	Queensland Alliance for Agricultural and Food Innovation
BCA	Boyce Chartered Accountants	QDAF	Queensland Department of Agriculture and Fisheries
CA	Cotton Australia	QUT	Queensland University of Technology
CA/PIEF	Cotton Australia/Primary Industries Education Foundation	RIRDC	Rural Industries Research and Development Corporation
CCA	Crop Consultants Australia	RMIT	Royal Melbourne Institute of Technology
CGAs	Cotton Grower Associations	SAC	Sustainable Apparel Coalition
CRDC	Cotton Research and Development Corporation	SRA	Sugar Research Australia
CSIRO	Commonwealth Scientific and Industrial Research Organisation	UM	University of Melbourne
D2D CRC	Data to Decisions Cooperative Research Centre	UNE	University of New England
DCRA	Dryland Cotton Research Association	UNSW	University of New South Wales
DeakinU	Deakin University	UQ	University of Queensland
DEDJTR	Victorian Department of Economic Development, Jobs, Transport, and Resources	USC	University of the Sunshine Coast
DSITI	Queensland Department of Science, Information Technology and Innovation	USQ	University of Southern Queensland
GVIA	Gwydir Valley Irrigators Association	USYD	University of Sydney
ICAN	Independent Consultants Australia Network	UTAS	University of Tasmania
IREC	Irrigation Research and Extension Committee	UWS	University of Western Sydney
MLA	Meat and Livestock Australia		

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