

25 *Years*

CRDC: 25 YEARS OF
COTTON RESEARCH,
DEVELOPMENT
AND EXTENSION



Australian Government
**Cotton Research and
Development Corporation**



Australian Government

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Development Corporation**

COTTON RESEARCH AND DEVELOPMENT CORPORATION

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Our vision

A globally competitive and responsible
cotton industry.

Our mission

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

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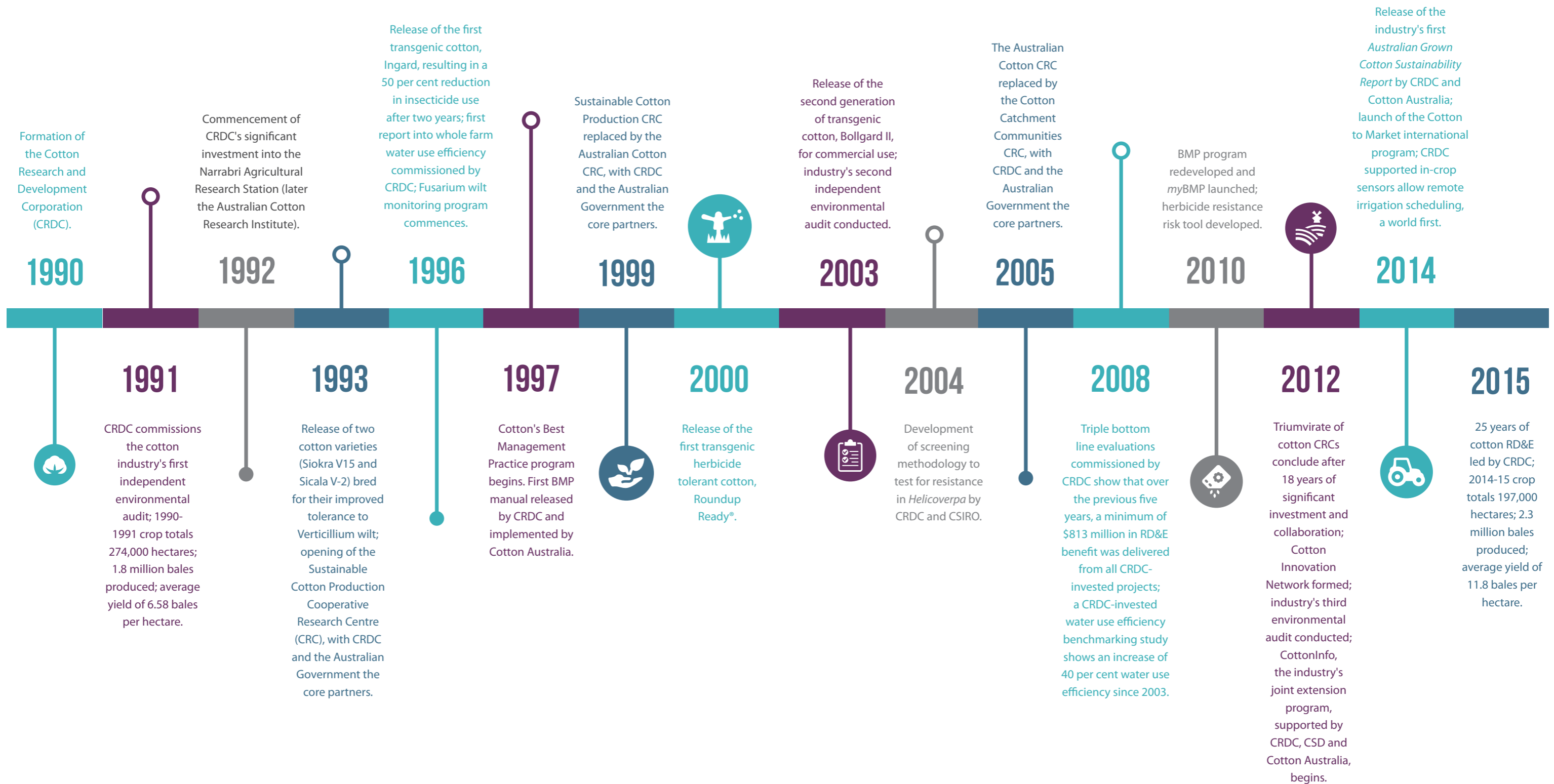


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25 YEARS OF RD+E



25 YEARS DELIVERING RD+E

The year 2015 marked 25 years of the Cotton Research and Development Corporation (CRDC). In this special publication, CRDC takes a look back at 25 years of delivering research, development and extension (RD&E) outcomes for the benefit of Australia's cotton growers, the cotton industry and the wider community.

Today, the Australian cotton industry is one of the success stories of Australian agriculture. Australian cotton is the highest yielding, finest, cleanest and greenest cotton in the world.

We are an industry taking responsibility for ourselves by changing our practices to meet our own expectations and those of contemporary society. Australia's best cotton producers now achieve more than two bales of cotton per megalitre of water – almost double the industry average of just a decade ago. Our industry is at the forefront of environmental management systems, climate change preparedness and climate change adaptation.

It's an extraordinary story of achievement, thanks primarily to the continued support of the industry and the Australian Government for RD&E.

It has been, and continues to be, a combined and collaborative effort. CRDC invests in RD&E on behalf of cotton growers and the Australian Government, with the oversight of industry bodies – originally the Australian Cotton Growers Research Association (ACGRA) and now Cotton Australia – and the research prowess of our many different research partners.

CRDC believes we should always give thanks to cotton industry pioneers for their vision and determination, not only to grow cotton, but to establish an industry supported by its own R&D. In this spirit, the ACGRA was established in 1972 with a voluntary R&D levy of \$0.25 per bale. This levy recognised the importance of collective funding for industry R&D. The pioneers were also strong advocates for the Australian Government matching grower financial contributions.

CRDC was established in 1990 under the *Primary Industries Research and Development Act 1989* (PIRD Act), replacing the Cotton Research Council. It was established by the Australian Government to work with industry to invest in RD&E for a more profitable, sustainable and dynamic cotton industry – at a time

“As you read through this document you will see words such as ‘proactive’, ‘cohesive’, ‘collaborative’, ‘comprehensive’ and ‘integrated’ appear throughout. In a sense, these words are the reason the CRDC was created.”

Ralph Schulze, *Spotlight on Cotton Research – 10 Years of the Cotton Research and Development Corporation, 1990.*

when the cotton industry was facing significant societal pressure around its environmental impacts.

In the 25 years since then, CRDC's strategic leadership and collaboration in RD&E investment has been a driving force behind the industry's continuous improvement and transformation.

Over this time, CRDC has invested more than \$280 million into RD&E on behalf of the industry, delivering billions of dollars in benefit back to Australian cotton growers on their farms. One project alone – CRDC's investment in plant breeding – is estimated to have contributed \$5 billion to the industry and the Australian agricultural economy.

In terms of the impact of R&D, our world-leading cotton yields and quality are easy to see and quantify. Efficiency gains in water use and reductions in pesticide use are also evident.

But arguably, cotton production would not have been possible for the last 20 years – during which time growers have collectively contributed to producing more than \$27 billion in exports – if it wasn't for R&D and the industry's commitment to improving its practices for controlling insects and managing diseases such as Fusarium.

CRDC has invested in some 2100 projects over the past 25 years – moving from a response-oriented approach of specifically

addressing the industry issues of the 1990s to a more proactive approach of collaboratively identifying potential future threats and opportunities and strategically investing in them to ensure the industry's continued success.

These are just some of cotton's RD&E achievements. In this special publication you will find our list: what we believe are the 25 major achievements in cotton RD&E over the past 25 years.

These are 25 key areas in which the co-investment into RD&E by cotton growers and the Australian Government has significantly benefited our industry – like our strong improvements in water use efficiency; our efforts to improve environmental performance; our contributions to building the capacity of the industry's most important resource, its people; and our contribution to the industry's best management practices program. These are all examples where investment in RD&E has helped to deliver highly valuable outcomes.

In celebrating the successes born from RD&E investment, we wish to acknowledge that they have been achieved due to the contributions of many people. We are proud to have worked with so many inspirational people – within our own team, and across the cotton research and cotton growing communities. We thank all who have been part of CRDC's journey to date.

25

The number of years CRDC has been operating

\$280m

CRDC's investment in cotton RD&E on behalf of Australia's cotton growers and the Government over the past 25 years.

2100

The number of research projects CRDC has invested in since 1990.

\$5b

The estimated return on investment at 2002 from CRDC's early investment in plant breeding.

\$27b

The value of cotton's exports over 25 years.



Overcoming THE INDUSTRY'S GREATEST THREAT

Cotton pest management in Australia is vastly different now from the early years of production, with industry-wide adoption of integrated pest management (IPM) contributing significantly to the industry's success story.

Throughout CRDC's 25-year history, investments that support the development and continuous improvement of IPM strategies have received a significant portion of research funds. Managing pests in a sustainable manner, without building resistance to control measures, has been the greatest challenge for Australian cotton growers and CRDC RD&E.

IPM is now standard practice and refers to the use of various sustainable methods to control pests. As a result of its broad adoption, the industry enjoys low levels of insecticide resistance, less dependence on insecticides, significantly improved environmental outcomes and sustainability, increasing average yields, and ever-widening areas of production.

However, the situation was vastly different when the CRDC entered the scene in 1990. At that time, the industry was under enormous pressure due to insect management challenges, and IPM RD&E projects received more of CRDC's research funds than any other area. The industry had witnessed the collapse of cotton production in the Ord River system of WA in the 1970s, and it appeared that the eastern states were headed in the same direction.

Dr Lewis Wilson is a CSIRO Senior Principal Research Scientist who began working in cotton entomology in 1985. He says that in the early days, pest control relied largely on broad spectrum organochlorines. These were effective until resistance began to develop in *Helicoverpa armigera*.

'Pyrethroids, which became available in the late 1970s, were hailed as a saviour for the industry due to their high efficacy and long residual control,' Lewis says.

'However, by the early 1980s overuse had rapidly selected for pyrethroid resistance in *H. armigera* and promoted the emergence of secondary pests such as spider mites and aphids due to inadvertent destruction of their natural enemies.'

High reliance on insecticides, organochlorine and pyrethroid resistance in *H. armigera*, and the emergence of secondary pests due to the inadvertent destruction of their natural enemies, catalysed the first intense efforts in IPM in Australia's cotton industry through the mid-1970s and the 1980s.

The pioneering researchers focused on identifying key pests, predators and parasites and developing pest sampling strategies and economic thresholds. As the industry grew through the early 1980s, pest research expanded to include resistance monitoring, improved pest sampling and thresholds, and ecological research.

When the CRDC started in 1990, resistance to conventional broad spectrum insecticides had crept higher, despite the industry having developed and utilised an Insecticide Resistance Management Strategy (IRMS) since 1983–84, making control of *H. armigera* increasingly difficult. This, and other environmental concerns arising from the use of pesticides in cotton, stimulated increasingly intense research into other IPM tools.

CRDC's investment into pest management during the 1990s was focused on finding alternatives to conventional insecticides. Research projects were undertaken to investigate the conservation and exploitation of natural enemies to reduce pest abundance, to better understand pest ecology, to research alternative support products for IPM (such as biological insecticides and beneficial insect attractant food sprays), and to study the ability of cotton plants to compensate for damage.

In CRDC's first year, RD&E directed to 'crop protection' and 'improved environmental outcomes' each received 33 per cent of total funding. With research into new cultivars and genetic modification at 17 per cent, this equated to 83 per cent of the first budget being committed to improving crop protection while improving associated environmental outcomes and creating cultivars to (among other characteristics) control pests, in particular *Helicoverpa*. Pest surveys and resistance monitoring also became part of the agenda.

Extension of IPM R&D outcomes was also given a high priority to ensure the dissemination of research results.

In 1992, Industry Development Officers (IDOs) were appointed in each of the major cotton-growing valleys, with funding from CRDC and state government departments, as well as investments in the publication of IPM technical documents, field days, seminars and workshops such as the IPM short course for growers. CRDC employed Bruce Pyke to ensure research results were communicated to growers and consultants. The release of the *LepTon* test kit with support from CRDC meant growers and consultants could differentiate between insecticide resistant *H. armigera* and susceptible *H. punctigera*. This improved efficiency and reduced the risk of spray failure. CRDC also began funding the monitoring of commercial crops across all regions.

Ingrid Roth was the National Cotton Extension Coordinator from 2001 to 2005. She says that evaluation work by the IDOs to communicate research outcomes to cotton growers, agronomists and consultants was a key factor in increasing interest in IPM strategies during the 1990s.

Unfortunately, high reliance on pyrethroids and other broad-spectrum insecticides that were detrimental to natural enemies, as well as socio-economic factors, meant that initially, IPM had limited effectiveness and uptake.

In CRDC's first year, RD&E directed to 'crop protection' and 'improved environmental outcomes' each received 33 per cent of total funding. With research into new cultivars and genetic modification at 17 per cent, this equated to 83 per cent of the first budget being committed to improving crop protection

In 1995, the first generation of Bt-cotton (Ingard) was introduced and lessons learnt with insecticide resistance strongly influenced the implementation of this technology with a pro-active, comprehensive Resistance Management Plan (RMP). In 1995–96 the development and field testing of the EntomoLOGIC program, supported by CRDC, was a breakthrough in IPM. It demonstrated that inputs could be reduced if effort was put into monitoring the crop for pests and beneficials, and if the recommended pest thresholds were applied rigorously. CRDC also produced the *Cotton Pest and Beneficial Guide* and *SPRAYpak* which focused on IPM and farmer responsibilities regarding pesticide use.

Lewis Wilson says that the effective control of *Helicoverpa* by Bt cotton and its low impact on natural enemies gave the first indication of how an IPM system could be developed that used natural enemies to reduce pest abundance and reduce the need to spray.

However, the 1998–99 cotton season was extremely difficult for growers. Heavy pest pressure caused control costs to escalate up to \$1000/ha, the emergence of cotton bunchy top (an aphid vectored viral disease) and escalating insecticide resistance threatened to once again decimate the industry.

'This was the tipping point for IPM adoption with the industry responding to the crisis with renewed interest in, and uptake of, IPM,' Lewis says.



'The Australian cotton industry's ongoing investment in research into pest ecology, management and resistance monitoring, has underpinned development of world-leading IPM and IRM/RMP strategies'

Interest from the industry was supported by articulation of the first IPM guidelines developed with input from growers, consultants, CRDC and researchers – particularly Dr Robert Mensah and Lewis – which incorporated resistance management.

Lewis says that around this time, the first effective 'selective' insecticides became available, enabling control of *H. armigera* with less negative effects on natural enemies and this enabled a practical IPM system to work. By the early 2000s IPM was gaining momentum.

Area Wide Management (AWM) groups, with the support of CRDC, were set up and run by either IDOs or local growers to coordinate pest management on a regional basis, share information and benchmark practices about managing pests. These groups provided a strong network for dissemination of information and for two-way communication between growers, consultants and researchers.

CRDC funded the economic analysis of different pest management approaches. It was conducted with members of the very first AWM group at Boggabilla, and showed that fields managed with selective insecticides actually returned greater profit than those managed with less selective insecticides. This finding was hugely influential in convincing economically shrewd cotton growers and consultants to move toward a more IPM-based system.

Ingrid Roth says that a number of researchers opened direct lines of communication with growers, consultants and AWM groups, and really worked to ensure R&D was in touch with industry.

'Another factor that I believe was critical to the increasing adoption of IPM at that time was the commitment to IPM by a number of key consultants and growers,' Ingrid says.

'By becoming advocates of IPM and proving its viability, they enabled others in the industry to gain the confidence to implement the strategies.'

Extension efforts proved highly successful, with studies commissioned by the CRDC in the early 2000s identifying an increase in growers' IPM knowledge as a significant factor in the change in attitudes and practices relating to IPM and the adoption of more environmentally friendly tactics.

By early 2000 pest management practices had begun to change and insecticide use had declined dramatically (see graph).

The release of Bollgard II in 2003 drastically reduced the number of sprays needed, and relieved pressure due to resistance to selective insecticides which had begun to develop. The rapid uptake of Bollgard II provided an ideal platform for IPM. Within five years, Bollgard II accounted for more than 90 per cent of cotton planted and insecticide use against *Helicoverpa* had reduced by 85 per cent providing an ideal platform for IPM.

And this platform is still critical, as ironically, the reduction in pesticide use on *Helicoverpa* allowed sucking pests to survive and new pests including silverleaf whitefly, mirids, green vegetable bugs, pale cotton stainers and solenopsis mealy bug have become more significant.

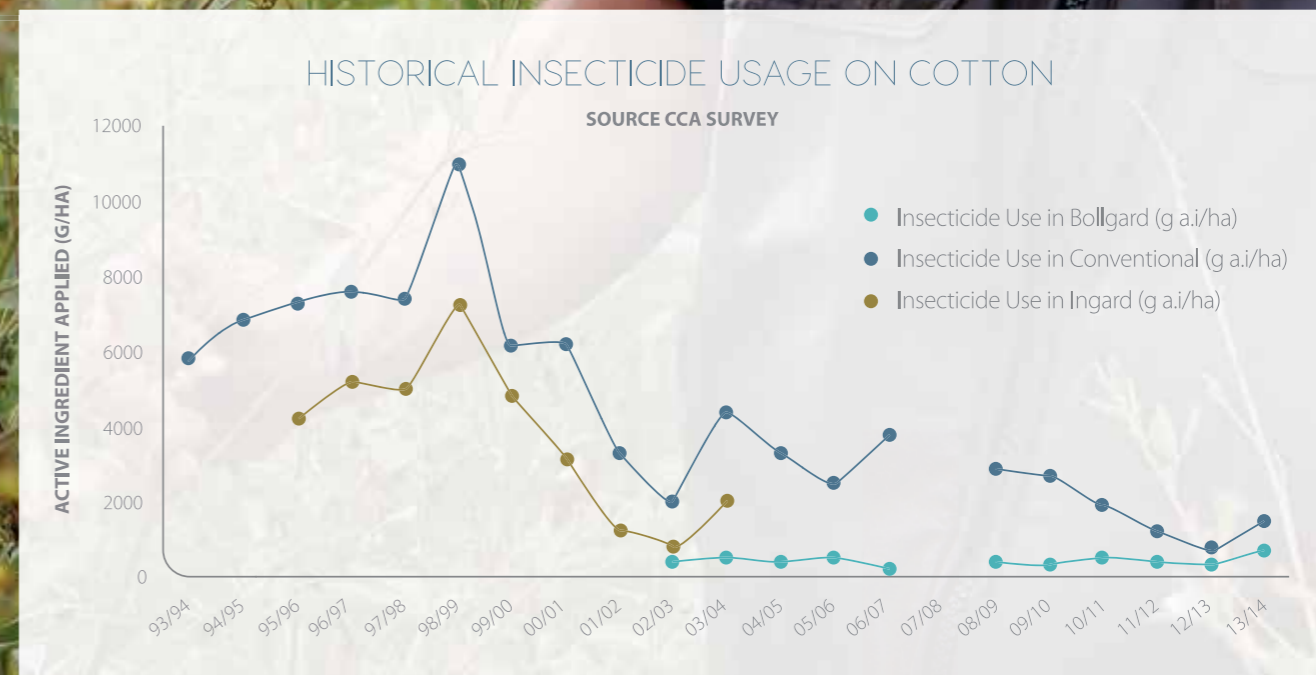
Lack of knowledge about these emerging pests created uncertainty for the industry. However, RD&E supported by CRDC enabled the industry to respond to these pest management challenges. CRDC has invested in projects to improve sampling strategies and thresholds, understand pest ecology and consider alternative control options without undermining existing IPM strategies for other pests.

This has resulted in no increase in pesticide use for sucking pests since the introduction of Bollgard II ten years ago, unlike many other countries around the world.

'The Australian cotton industry's ongoing investment in research into pest ecology, management and resistance monitoring, has underpinned development of world-leading IPM and IRM/RMP strategies,' Lewis says.

'It is one of the few industries that have successfully integrated IPM and IRM/RMP to ensure effective and sustainable pest management.'

As at 2015, the CRDC's investments in IPM are focusing on: research into enhancing IPM and establishing IPM in southern cotton regions; ongoing identification and understanding of pest and beneficial insect ecology; improved management of beneficials; various aspects of Bollgard 3 insect monitoring and management; development and commercialisation of biopesticides and semiochemicals; and sustainable chemical control and resistance management options for a number of insect pests.





BREEDING SUCCESS

Investment in plant breeding and biotechnology has positioned the Australian cotton industry as a world leader.

CRDC was the major investor in the CSIRO Plant Breeding Program from 1990 to 2007, investing \$46 million on behalf of growers. In 2006–07, CRDC reviewed the strategic direction of its investment in breeding and biotechnology R&D. Concurrently, Cotton Breeding Australia (CBA) was formed by CSD and CSIRO to support future breeding and research. CRDC continues to invest in plant breeding and biotechnology research to address issues such as tolerance to a changing climate, input efficiency, stewardship of Bt technology, resistance research and monitoring, and biosecurity outcomes.

The measure of the success of CRDC's investment lies in the fact that Australia's plant breeding research program delivered high performing, locally adapted varieties, which was an early aim of the Cotton Research Council and then CRDC. Due to investment by CRDC in partnership with CSIRO Plant Industry's cotton breeding team and the support of CSD, our growers have access to Australian-bred varieties that sit at the top end of market quality requirements, produce the world's highest yields, incorporate genes which resist the crop's number one insect enemy *Helicoverpa*, and which are now tolerant to the non-residual herbicide, glyphosate.

A 2002 study estimated that the industry's cotton breeding programs had produced an incredible return of more than \$5 billion to the Australian cotton industry and the nation since cotton breeding began in 1984. To put this in context, the \$5 billion return from the breeding program to the nation on its own significantly exceeded the cumulative investment by the Australian Government and rural industries through the 15 RDCs up to that time. In 2005 the CSIRO Cotton Breeding Team was awarded the prestigious Australian Government Prize for Rural Innovation.

By 2007, Bollgard II had been released and disease resistance vastly improved, with CSIRO-bred varieties representing 90 per cent of the Australian market and Australian-developed germplasm well represented in leading varieties of upland cotton grown around the world.

Developing cultivars to suit Australian conditions was a significant part of cotton research programs prior to the

establishment of CRDC, and even before 1990, Australian varieties already accounted for 70 per cent of the crop. CRDC continued to support breeding programs as a core R&D objective to 'develop new or improved cultivars', which also meshed with the objective of investigating non-chemical forms of pest control, in particular for *Helicoverpa armigera*. In these early years crop protection and environmental protection along with plant breeding were far and away CRDC's most important objectives.

By 1992–93, trials were showing promise and in 1993–94 the variety CS85 was released, bred specifically for marginal short-season areas, as well as Siokra V15 and Sicala V-2 which had improved tolerance to the widespread disease Verticillium wilt.

The \$5 billion return from the breeding program to the nation on its own significantly exceeded the cumulative investment by the Australian Government and rural industries through the 15 RDCs up to that time.

In 1996–97 the first of Australia's transgenic varieties was trialled with Ingard, which had positive but varied results. The industry quickly realised that reliance on one gene could lead to development of Bt resistance in *H. armigera*. Hence, CRDC supported research into other potential trans-genes and resistance mechanisms. Projects investigated the mechanisms of resistance, the management of Bt cotton and the monitoring of field populations for resistance. In the ensuing years, gene technology was used to breed insect and herbicide-resistant cotton varieties with Bollgard II (replacing Ingard) and Roundup Ready Flex traits from Monsanto. These traits now represent more than 95 per cent of Australia's cotton crop and have resulted in an 92 per cent reduction in insecticide use. Building on this work, the incorporation of a third gene to further delay the development of *Helicoverpa* resistance will see the commercial release of Bollgard 3 in 2016–17. As of 2015, CRDC continues its strategic investment in plant breeding-related research, with key areas including yield and quality improvements; drought, climate change and disease tolerance; and improving water use efficiency.





74,000ha

In CRDC's first year of operation the total crop was 274,000 hectares.

1.8 million

In the first year of CRDC's operation, the crop yielded 1.8 million bales, averaging 6.58 bales per hectare.

197,000ha

In CRDC's 25th year, 197,000 hectares were planted, producing 2.3 million bales and an average of 11.8 bales per hectare.

5.3 million

The record crop over CRDC's 25 years was the 2011-12 season when 5.3 million bales were produced from 600,000 hectares, the largest planting and yield ever. The average of 8.99 bales to the hectare was also a record. However, it didn't last long and was broken the following season with an average of 10.11 bales per hectare.



SUPPORTING RESEARCH INTO THE FIELD

Every day, somewhere in a cotton growing valley, extension – either directly or indirectly involving CRDC – is underway.

Whether it is a grower talking to a CottonInfo regional development officer or technical specialist; a researcher presenting to growers and consultants at an event; or an on-farm demonstration trial, information transfer and practice change is occurring as a result of a CRDC initiative.

With R&D comes a natural need for the ‘E’ – extension. CRDC’s first annual report said ‘The Corporation attaches high importance to the transference of technology and intends to build on the successful actions of the 1990–91 research’. Since this first report 25 years ago, CRDC has taken an increasingly proactive role in bringing research to Australian cotton farms and today, Australian cotton growers are the best in the world, producing higher quality cotton in a more sustainable way than any other country. CRDC’s most recent large-scale investment in this area is through the industry’s joint extension program, CottonInfo, with partners Cotton Australia and Cotton Seed Distributors.

‘The uptake of research and technology is a credit to our growers and has led them to be the most successful in the world,’ CRDC Executive Director Bruce Finney says.

‘Whether it’s knowledge from long-term projects or information needed quickly to respond to an emerging threat or issue, it’s uptake by growers that is CRDC’s ultimate goal: so they can be as successful and sustainable as possible - which they are - and they continue to improve.’

The link between CRDC and extension goes right back to 1991, through CRDCs support for extension people and programs to disseminate research knowledge to growers and consultants. Within its first year CRDC had instigated a number of workshops to disseminate and discuss the results of research with growers and consultants, such as soil management training.

The following year, this extension focus continued in earnest, with the appointment of Bruce Pyke as CRDC’s technology transfer coordinator. Bruce has been widely acknowledged for the impact he had on bringing research to growers over the following 20 years. His passion for research and innovation, coupled with his knowledge of entomology, made him the perfect fit.

During the 1992–93 season, in conjunction with its partners, CRDC supported the creation of cotton-specific regional extension roles and invested in placement of officers in the Darling Downs, Macquarie Valley and Emerald. Over the next two decades, these extension roles continued in different forms, and today form part of the CottonInfo extension team.

In addition to this one-on-one extension, information delivery and practice change has also been encouraged through many other mediums over the years.

One of the greatest vehicles for mass and broad extension of research to growers and consultants is the Australian Cotton Conference, which CRDC has always supported. In its initial days, the conference was the place to find research from every aspect of the cotton industry; today, it remains a prime industry event for research delivery and building relationships between growers and researchers, with CRDC as a foundation sponsor.

Another major avenue for providing information is the many, high quality industry information manuals and publications which CRDC has steadfastly supported. CRDC published the *Cotton Pest and Beneficials Guide* in 1995, along with the *CRDC Handbook*, a dryland cotton growing guide and a manual for new growers. For many years it published flagship publications such as the *Australian Cotton Production Manual* and the *Cotton Pest Management Guide*, in conjunction with research partners. While these are now published under the banner of the CottonInfo program, CRDC’s R&D investments underpin the latest research and best practices that these important publications contain. In addition, CRDC’s industry magazine *Spotlight on Cotton R&D* remains another major source of information for growers and consultants, as reinforced by survey results.

CRDC is also a great believer in the value of growers learning from growers and putting research into practice. The Big Day Out was initiated by CRDC in 2009, so growers could visit ‘Keytah’, managed by the recipient of the Cotton Industry Awards’ Innovator of the Year, to share knowledge with other growers. To this day, ‘Keytah’ remains an important CRDC-funded and grower-led trial site, with ongoing research and demonstration trials designed to help cotton growers see different cotton irrigation systems in action, and compare them.

The uptake of research and technology is a credit to our growers and has led them to be the most successful in the world

Initiatives that take researchers to the field to connect with growers are also a critical component of CRDC’s successful extension strategy. The recent and widely acclaimed irrigation technology and irrigation automation tours, for example, have resulted in growers implementing alternative irrigation technology and capital works, leading to improved infrastructure, water use efficiency and returns. Giving growers the chance to connect directly with researchers and to see research in action are major factors in the success of these types of initiatives. Additionally, the CRDC Grassroots Grants funding initiative for Cotton Grower Associations is also a valuable tool for extension and for enabling communities to put research into action, or undertake their own research.

CRDC Grower Surveys and reviews, such as the CRDC-commissioned *Third Environmental Assessment* in 2012, have shown that the research being applied in the field is helping to make our growers and consultants the most efficient and sustainable in the world.

1995

In 1995, the Co-operative Research Centre for Sustainable Cotton Production and CRDC conducted a review of extension within the industry. The feedback from industry was clear – growers wanted more extension people, particularly in areas away from major research centres. In the ensuing five years CRDC answered the call and by 2000 was funding, or partially funding, industry development officers for the Macquarie Valley, Bourke, Gunnedah, Hillston, Goondiwindi, St George/Dirranbandi and Emerald.





A COLLABORATIVE APPROACH FOR SUCCESS

To promote the best use of research resources and create a first-class environment for its researchers, CRDC has maintained its role as an ardent instigator, supporter and investor in collaborative programs, research, infrastructure and initiatives such as the Cotton Co-operative Research Centres.

Upon formation, CRDC allocated nearly \$1 million to upgrading the then Narrabri Agricultural Research Station, now the Australian Cotton Research Institute (ACRI). This may not sound like a large investment in today's terms, but it was a large investment at the time, as CRDC's entire budget was around \$3 million. During those early years CRDC sought to improve research facilities and ramp up capability, and funded the purchase of equipment and machinery for ACRI and field trials. Investment continued at the shared research facility with upgrades to the plant breeding facilities, computer systems and experimental equipment, and the expansion of facilities. ACRI stands as one of the most successful collaborative research centres in Australia and is the envy of many other primary industries.

CRDC's very early belief that the complex, long-term issues of sustainability facing the industry would be best resolved through cooperative research projects was realised with CRDC's initiation and original submission to the Australian Government for the first Cotton Co-operative Research Centre (CRC), which received resounding support from all sectors of the industry.

The CRC for Sustainable Cotton Production was announced in December 1992 under the directorship of CSIRO Plant Industry's Principal Research Scientist Dr Greg Constable and Chairman Richard Browne. Along with CRDC, core partners were the then NSW Agriculture, QLD DPI, CSIRO Divisions of Plant Industry and Entomology, the University of New England and the University of Sydney.

This laid the foundations for two successive CRCs, spanning 18 years: the Australian Cotton CRC (1999–2004) and Cotton Catchment Communities CRC (2005–2012). According to

studies conducted by the then NSW Department of Trade and Investment, these CRCs generated more than \$1 billion dollars in economic, environmental and social benefits for Australia.

Under the Cotton Catchments Communities CRC, CRDC contributed more than 50 per cent of the funding for 'The Farm' program, which alone had an estimated return of \$7 per \$1 invested, to name just one example.

'Collaboration enables bigger picture' questions to be tackled among disciplines and with industry partners. Hence, it provides opportunities to commercialise R&D, with the benefit of the CRC's access to specialised skills and resources across state and industry boundaries,' says former Australian Cotton CRC Director Guy Roth.

An independent review of the Australian Cotton CRC in 2004 reported that the CRCs had been successful in providing the industry 'immediate, feasible solutions to their on-farm production problems as well as long-term solutions addressing sustainability of their environment for future generations.

'The success of the CRC is reflected in the exceptionally high levels of adoption of its innovative research developments,' Guy says.

'The industry not only demonstrated that it was totally supportive, but also provided leadership and interacted strongly with the research activities and technology transfer approaches used to deliver solutions to the major problems associated with cotton production in Australia.

'Importantly, the dividends from this research and development journey will continue for many years to come for the industry and for the catchments and communities in which it operates.'

CRDC is proud of its ability to collaborate and undertake cross-industry research and information sharing. CRDC works with

numerous R&D corporations and research providers on collaborative projects for mutual benefit, and is seeking to further industry profitability and productivity through Australian Government initiatives such as the Rural R&D For Profit programme.

RDCs collaborate with each other, and with research providers, primary producers, processors, exporters, governments and farm networks. No other nation has a similar system using a levy base with government co-funding to undertake research that ties industry, government and research communities.

As such, CRDC continues to work with the other RDCs in research and development of irrigation technology, human capacity, novel fibre products, herbicide resistance, best-practice spray application, and farm health and safety. The RDCs also collaborate on major cross-sectoral strategies around soils, water and diseases, and they are major partners in the National Primary Industries Research, Development and Extension (RD&E) Framework, which aims to improve efficiency and coordination of rural research efforts.

A 2012-13 Cotton Innovation Network study found that the total number of RD&E projects in progress during that year was 149, with a total investment value of \$49 million. By comparison, in 2014-15, the number of projects had risen to 195, with a total investment value of \$66 million.

AN INNOVATION INDUSTRY

Formed in 2012, the Cotton Innovation Network co-ordinates the cotton industry's research, development and extension (RD&E) activity and ensures a collaborative and cohesive approach to achieving our industry's long term goals. With the closure of the Cotton CRC, the commencement of the network was a timely endeavour. The key participants include representatives from CRDC, Cotton Australia, Cotton Seed Distributors, CSIRO, the Australian Government's Department of Agriculture and Water Resources, Queensland Government Department of Agriculture and Fisheries, NSW Department of Primary Industries and universities through the Australian Council of the Deans of Agriculture.

The network's role is to improve the coordination between the bodies implementing the Cotton Sector RD&E Strategy to ensure the industry receives the best value for its investment and drives the industry's research program by mapping investment in research and planning future research requirements. The network is also tasked with reviewing the strategy to ensure it remains relevant and appropriate. All member organisations have aligned their strategic plans with the Cotton Sector RD&E Strategy and now have a better understanding of what each organisation contributes to the overall RD&E effort. This helps researchers better understand where their work fits into the overall priorities of the cotton industry and ultimately create better end results for growers.



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BMP
COTTON

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PRACTISING WHAT'S BEST

There are many benefits to the Australian cotton industry's commitment to sustainability through best practice.

Australian growers are the most efficient in the world; they have safer farm workplaces, healthier natural environments; they use natural resources better, and have significantly reduced many farm inputs.

As a result, Australian cotton farmers are internationally recognised as leaders in sustainable cotton production and domestically they are used as a model for change by other agricultural industries.

The cotton industry's flagship environmental program, BMP (Best Management Practice), has driven much of this achievement and has significantly changed the way cotton is grown in Australia. The evolution of the BMP program and the production of 'BMP cotton' has also led to better marketing opportunities through initiatives such as CottonLeads and the Better Cotton Initiative which aim to return premiums to growers and provide quality assurance to our customers.

BMP has its origins in a 1993 joint research program *Minimising the Impact of Pesticides in the Riverine Environment* undertaken by the newly-established CRDC, the then Land and Water Resources Research and Development Corporation, and the Murray Darling Basin Commission. This program sought to minimise the impact of pesticides on riverine and aquatic ecosystems in cotton-producing areas.

As a result of the research a 'best management practices' approach to addressing pesticide management was agreed upon. Current CRDC R&D Manager Allan Williams led the development of the BMP manual, released in 1997.

'Outcomes of the research informed the industry and CRDC as to what management actions needed to be taken – the BMP manual was then created to translate this information to growers and industry,' Allan says.

'While focused on protecting and improving river health, it was also concerned to ensure that any response was founded in science and a good understanding of pesticide movement so that well-targeted recommendations on how minimising their impact could be developed.'

The BMP manual was developed with a farmer-focused implementation strategy delivered by Cotton Australia. This led to an improvement in the way pesticides were used.

'From being seen as a poor environmental performer in the 1980s and 1990s, the Australian cotton industry is now a world leader in the implementation of more sustainable farming practice,' Allan says.

Australian cotton farmers are internationally recognised as leaders in sustainable cotton production and domestically they are used as a model for change by other agricultural industries.

'This is evidenced by the Better Cotton Initiative accepting BMP as meeting their requirements for growing "Better Cotton", and by the continual meeting of environmental targets set out in independent industry environmental reviews undertaken by CRDC in 2003 and 2012. Since these early days, the BMP program has been expanded to include water management, workplace health and safety, petrochemical storage and handling, energy use, fibre quality management and more.'

Between 2008 and 2010 CRDC supported the conversion of the paper-based system to the web-based 'myBMP'. This was done to enhance delivery and usability in time with the evolution of growers' internet connectivity.

'The philosophy behind the BMP program was that the adoption of a best management practice system which is scientifically sound, credible and continually improving could demonstrate the industry's commitment to minimising its environmental impacts,' Allan says.

'No other country has such a comprehensive system to assure we produce the world's most sustainable and quality product.'

'Over CRDC's lifespan, nearly all investments in research have informed best practice, from the field to the warehouse.'



Cotton Australia Chief Executive Officer Adam Kay says it is hard to imagine an initiative of more importance to Australia's cotton industry than BMP, and its successor myBMP.

'myBMP's practical tools and processes are highly valued by participating growers, but myBMP is far more than just an environmental management system for farmers. It is a system that provides benefits to the entirety of our industry,' Adam said.

'It is fair to say that BMP capably defended Australian cotton at its darkest hour. When the very existence of the industry was threatened in the late 1990s, BMP was created to lead growers to implement better practices. The system worked so well that our cotton industry was able to successfully defend its place within Australia's agricultural system.'

'Having succeeded in defending cotton, BMP subsequently became the tool by which the industry continued to silence its unreasonable critics, but also became the program by which growers committed to sustained improvement.'

'Today, myBMP has evolved to play a crucial role in the everyday lives of growers, and is the mechanism by which Australia's cotton industry will grow and prosper.'

'The reality of today's world fibre market is that sustainability and responsible production practices are valued extremely highly, and myBMP is the tool by which Australian cotton growers demonstrate these criteria.'

'Furthermore, Cotton Australia has worked to ensure that growers producing myBMP-certified cotton can place their fibre in the Better Cotton Initiative (BCI) system. Not only does this provide the potential for real premiums for growers, but the reputation for sustainability and responsibility is a dividend that flows throughout the industry.'

'Cotton Australia looks back upon its involvement with BMP and myBMP with pride, knowing that the system that we, the CRDC and other industry partners helped nurture has served us well, and will continue to do so into the future, for the benefit all in the industry.'





CRDC R&D Manager Allan Williams presents the Australian cotton industry sustainability story at the ICAC plenary meeting in Greece, 2014.

TRACKING SUSTAINABILITY

All over the world, consumers, governments and communities are becoming increasingly interested in the sustainability of agriculture and its products.

Assessing, reporting and improving on environmental performance provides assurance that the Australian cotton industry takes sustainability seriously and is committed to continuous improvement.

The Australian cotton industry has a strong history of taking ownership of areas where it is having environmental impacts and minimising them through improved management based on sound R&D. Despite past achievements, the long-term success of the industry continues to depend on how its practices, products and reputation are perceived by customers and the wider community.

The release of the *Australian Grown Cotton Sustainability Report* in 2014 marked 23 years of independent environmental reviewing, performance monitoring and practice change that is unparalleled among agricultural industries. The report was developed through collaboration between CRDC and Cotton Australia in response to the *Third Environmental Assessment*.

The assessment identified ten years of R&D-driven environmental achievements, including chemical use reductions, water use efficiency improvements, active engagement in landscape and

The industry's long history of monitoring its environmental performance began in the early 1990s, around the time that Australian cotton production exceeded one million bales for the first time.

catchment-wide natural resource management, and the significant uptake of integrated pest and weed management.

The industry's long history of monitoring its environmental performance began in the early 1990s, around the time that Australian cotton production exceeded one million bales for the first time.

The industry was becoming aware it needed to improve its environmental performance. Criticism of industry practices had come from the public, media and environmentalists for perceived poor environmental performance over pesticides, water use and soil degradation. As such, in 1991, the Australian cotton industry became the first major Australian agricultural industry to seek a comprehensive external assessment of its environmental performance and this marked an industry-wide commitment to continuous improvement in environmental management on cotton farms. This initial audit provided an overview of the entire value chain, and identified key issues and concerns associated with its practices and assessed overall performance. The audit made 69 recommendations to which the industry responded with research, development and extension.

By the time of the second independent environmental audit commissioned by CRDC in 2003, all 69 recommendations had been met. A major joint R&D initiative to come out of the audit was the Pesticides in the Riverine Environment project co-funded by CRDC, the then Land and Water Rural Research and Development Corporation, and the Murray Darling Basin Commission between 1993 and 1998. This research spawned the industry's *Best Management Practice Program* (BMP) in 1997, also an initiative of CRDC.

The second environmental audit found that BMP was a major driver of improved environmental management on farms. Key recommendations for improvement covered familiar issues – water use and management, agricultural chemicals, waste and vegetation management.

In 2005, *Taking Responsibility for our Future – The cotton industry action response to the Second Australian Cotton Industry Environmental Audit 2003* was released detailing industry's response to the 2003 recommendations and gave a public

commitment to the next stage in the process of continuous improvement in environmental management within our industry.

In 2012, CRDC initiated the cotton industry's *Third Environmental Assessment*, which identified achievements since the 2003 audit, future environmental priorities and made specific recommendations for the industry to continue to reduce its environmental footprint.

The industry responded to this assessment through the *Australian Grown Cotton Sustainability Report*, which in a first for the industry tracked the environmental, social and economic impact of Australian cotton against a set of sustainability indicators. Released in 2014, the report was prepared according to the principles and framework of the Global Reporting Initiative for Sustainability Reporting. It reported data on 45 economic, environmental and social attributes.

CRDC and the industry's strong R&D culture are key components to adopting sustainability targets, and in delivering this report the industry showed a clear commitment to its ongoing sustainability. The report has been referenced internationally, helping the Australian cotton industry secure access to valuable markets through initiatives such as CottonLEADS and the Better Cotton Initiative.



The launch of the *Australian Grown Cotton Sustainability Report* by CRDC and Cotton Australia in November 2014. Pictured: CRDC Executive Director Bruce Finney, CRDC Chair Dr Mary Corbett, Cotton Australia Chair Lyndon Mulligan and Cotton Australia CEO Adam Kay.



RESPONSIBLE MANAGEMENT THROUGH PRACTICE CHANGE

Research into the best practice for spraying all agricultural chemicals is vital to the cotton industry. Best practice spraying methods protect the natural environment, improve efficacy, reduce inputs, manage resistance and deliver on industry's commitment to sustainability.

A project with the then QLD DPI and the then Cotton Council in 1989, which received ongoing support from CRDC, assessed the suitability of buffer zones containing foliage; assessed the suitability of certain plants for use to capture pesticide droplets; and investigated the behaviour of 'droplet clouds' moving across crops.

In 1990 when CRDC was formed, aerial spraying was the preferred method of insecticide application – but it came with limitations due to a lack of knowledge about the nature of drift and the science governing it. Reducing the movement and impact of agricultural chemicals became a core objective of the newly formed CRDC.

Investigations into spray application came with significant investment in the collaborative *Minimising the Impact of Pesticides in the Riverine Environment* project, of which best practice spray application was a major component. Other early research included the development of a prototype ground sprayer for use as an alternative to aerial spraying; and research to investigate improvements to ground rigs to reduce drift, and explore the nature of air movement. During this decade CRDC sought to initiate research to improve the understanding of the efficient and safe use of ground-based spraying equipment. Innovations from farmers and researchers were evaluated and adapted to improve the safety, efficiency and capability of spraying equipment.

Concurrently, research and extension of integrated pest management (IPM) principles was underway to reduce spray drift from another angle, with CRDC investing in many initiatives to extend the research into IPM and its subsequent uptake.

The best management spraying manual, *SPRAYpak* was updated and released in 1994. The first *SPRAYpak* edition was edited by John Whitehead and Bruce Pyke, then the CRDC technology transfer coordinator (later the CRDC General Manager of R&D).

SPRAYpak was developed for growers and focuses on pesticide application and usage in cotton. However, the principles apply to all similar spray application jobs in agriculture. As part of the industry's commitment to BMP, the manual was designed to be used in conjunction with the then Australian cotton industry *Best Management Practices Manual*.

Through significant investment, CRDC and its research partners have been able to produce some very specific guidelines to ensure best practice in spray application.

In line with improving environmental outcomes on cotton farms through better application, *the Trees on Cotton Farms* guide was published with CRDC support during the 1990s and the *Review of Spray Application Research and Extension for Australian Cotton Farming Systems* was commissioned in a bid to improve spraying practices.

Along with pesticides, herbicides also have the potential to impact the broader environment. Not only does herbicide drift have the potential to affect the environment, cotton and other crops, it doesn't make economic sense for growers.

Today, thanks to a range of CRDC-supported projects relating to best-practice spray application, we know a lot more about the



best use of spray equipment, and how to avoid drift, improve efficacy, sustainability and the bottom line. Most importantly, this information has been successfully conveyed to end users. CRDC's long-term project on delivering best-practice spray application knowledge has resulted in 24 application and drift management workshops to more than 500 cotton growers, advisers and applicators.

Thanks to long-term research undertaken with spraying specialists, today the industry understands more about the physics behind air movement such as pooling and inversions. The research into weather, the appropriate use of nozzles, and the technology required a change in thinking, as the science and the interaction with natural environments began to become better understood.

Through significant investment, CRDC and its research partners have been able to produce some very specific guidelines to ensure best practice in spray application. Of particular importance to CRDC is that the uptake of this knowledge has been fantastic among growers, and this has come about through the work of key spray specialists such as Bill Gordon who has run very successful spray workshops. CRDC has in recent years collaborated with the Grains Research and Development Corporation (GRDC) in extension and research in this area.

Technological advances in computing have also allowed the development of CottonMap with GRDC, Nufarm and Cotton Australia to map cotton fields in Australia, and to alert spray operators as to their presence in an effort to mitigate phenoxy damage to cotton crops.

Along with a concerted drift management campaign from industry partners including agri-business, phenoxy herbicide damage has been lessened. However, the issue remains a key focus for RD&E. CRDC research has investigated the effects of herbicides on cotton in terms of yield and maturity to aid growers to make more informed, better decisions about recovery management and current efforts are focusing on the development of an early warning system for surface temperature inversions.

Along with Cotton Australia, CRDC has also worked closely with the Australian Pesticides and Veterinary Medicines Authority (APVMA) regarding label recommendations and best-practice spray application. The most recent work has re-investigated the use of vegetative buffer zones on farms to even further mitigate drift risk and has supported the erection of weather stations through Grassroots Grants funding to give real time weather conditions for best-practice spraying.



THE SCIENCE OF *Farming*

Lint yield from Australian cotton crops has almost doubled since the adoption of locally bred varieties during the early 1980s.

PLOT
11
Sow-2
Stress

CRDC has been a long term supporter of the development of CottASSIST, a web tool offering a unique way to capture and integrate research outcomes to assist cotton growers and consultants make complex tactical and strategic decisions. CottASSIST contains tools to guide grower decision making in specific areas. Such programs include NutriLOGIC, the tool to optimise input efficiency while minimising greenhouse gas emissions, a crop development tool to optimise management and yield in Australia's variable climate, and as a cotton day degree calculator.

Long-term records show that whole-of-industry yield had more than doubled from the 1960s to the 2000s, when yields were 1890kg lint per hectare (8.39 bales/ha per acre). There are now many examples of yields in excess of 3400kg lint per hectare (15 bales/ha).

While there is no doubting the part plant breeding has played in this, the role of Australian cotton growers' world-class crop management, and their willingness to adopt best practice based on sound and relevant research, cannot be understated.

Recent analysis by the CSIRO Plant Breeding team shows that variety contributes about 48 per cent of the yield gain (160kg per hectare per year); management 28 per cent (95kg per hectare per year); and the interaction between variety and management contributes 24 per cent (80kg per hectare per year).

Farming systems research has been a particular focus for CRDC over the past ten years as an area of significant investment.

During the time of the 2003–2008 Strategic Plan, CRDC invested \$9.9 million in farming systems research (not including crop protection and integrated natural resource management program investments) in a time of severe drought. However, cotton yields over the five seasons showed a 17 per cent yield improvement. A survey of cotton crop consultants indicated that the major drivers of improved yields over those years were improved water and nitrogen use efficiency; new cotton varieties; management of other plant nutrients; and crop rotations.

During 2008–13 CRDC invested a further \$31.92 million in 205 research projects (from a total research output of \$49.8 million) and the 2013–2018 Strategic Plan has allocated 35 per cent of an estimated \$100 million toward the 'Farmers' program under which farming systems research sits.

Farming systems research covers agronomic factors and decisions in crop production, including research into configuration, nutrient management, rotations, crop protection, water use efficiency, weeds, climate/weather and tillage. It is aimed at improving gross margins for Australian cotton growers

and developing on-farm innovations and partnerships to drive profitability.

'The advent of Bt technology and uptake of integrated pest management has allowed both CRDC and farm managers to shift more of their attention to crop management, and we have had to make sure agronomic information based on science is available to them,' CRDC General Manager of R&D, Dr Ian Taylor says.

'In the past ten years alone, CRDC has invested more than \$20 million in farming systems research, which has delivered improved irrigation, nutrition and tillage information.

Lint yields of up to 3500kg per hectare are now being reported in some fully irrigated Australian crops. Researchers use this value to calculate "yield potential" which is increasing through time as crop management and genetics improve.'

Theoretical yield meanwhile, helps us understand what could be achieved if we are able to manage stress with improved varietal adaptation or management.

Former head of CSIRO Plant Breeding Dr Greg Constable and CSIRO Agriculture's Dr Mike Bange recently reassessed this figure. They calculated the theoretical yield for irrigated cotton to be 5000kg of lint or 22 bales per hectare in a long-season growing environment.

Comparing yields to the 'yield potential' can help to identify the 'yield gap' and can assist in identifying the production constraints in any cropping system, which will remain a focus for CRDC as it considers investment in farming systems into the future.

CSIRO plant breeder Warwick Stiller said the last season set a new benchmark of what can be achieved, and with varieties like Sicot 74BRF there is still the potential for higher average yields.

'It's really pleasing to see the potential growers are extracting from our Australian-bred varieties and adapting management to achieve impressive yields in contrasting climates from Emerald in the north to Hay in the south,' Warwick says.



WORLD-LEADING BT STEWARDSHIP

Australia is recognised as having the most rigorous and successful pre-emptive resistance management system for transgenic cotton in the world.

A review in the journal *Nature* in 2013 analysed results of 77 studies from five continents reporting field monitoring data for resistance in *Heliothis* to Bt crops of the genes Cry1Ac and Cry2Ab. It found that after more than a decade of exposure to Bt cotton, the frequency of individuals with alleles conferring resistance to Cry1Ac and Cry2Ab in Australia remained at less than one per cent for *H. armigera* and *H. punctigera*, as opposed to an increase to between one and five per cent for *H. armigera* in China for Cry1Ac.

The report said that in comparison to China and the US, Australia has applied the most stringent refuge requirements, which may have substantially delayed resistance, starting with Ingard in the mid-1990s which required a minimum of 70 per cent non-Bt cotton on each farm versus four per cent in the US. For Bollgard II, Australia requires ten per cent non-Bt cotton or equivalent per farm, whereas the US eliminated refuge requirements in many regions.

In some countries the key targets of Bt crops overcame the technology in situations where no Resistance Management Plan (RMP) was in place. No field failures have been recorded in Bollgard II in Australia.

Prior to the release of the first Bt cotton, Ingard, in 1996, the industry acknowledged that the potential for *H. armigera* to develop Bt resistance was very real and that it was vital to be proactive.

CRDC supported projects aiming to establish how to monitor for Bt resistance, and understand its characteristics and what they meant for its potential evolution. The work also focused on obtaining a better understanding of the ecology of *H. armigera* populations in an Australian landscape, particularly the aspects that can affect selection.

During 1997–98, varied results from Ingard's second season led to further projects around the deployment of Bt cotton and a reappraisal of sampling relationships and feeding behaviour of *Helicoverpa* on Bt cotton. Area-wide management strategies for *H. armigera* were launched in collaboration with GRDC, which proved successful.

A CRDC project with the then QLD DPI at Emerald investigated the value of chickpeas and pigeon peas as trap crops grown on every cotton farm as an area-wide strategy to reduce *H. armigera* populations. This proved successful and refuges became an integral part of the RMP.

Around this time CRDC also supported investigations into other transgenes or mechanisms to enhance the efficacy of the products of transgenes and to monitor field populations for resistance. This was the start of the Resistance Monitoring Program, which CRDC still supports today. The success of the industry's RMP paved the way for the approval and release of Bollgard II in 2004–05, which contained two genes. Prior to its

release, the industry worked with regulators to ensure a pre-emptive resistance management strategy was in place.

Bt cotton has virtually eliminated yield losses from *Helicoverpa* and back-up from insecticides is rarely required to achieve this.

While the threats from *Helicoverpa* are less obvious than the situation experienced by the industry in the mid-1990s, the underlying resistance risks for Bt cotton are potentially much greater than that for conventional insecticides. Bt toxins are expressed by the cotton plants all season long, greatly increasing exposure and selection pressure when compared to individual spray events. Furthermore, genes for resistance to two of the three Bt toxins, Cry2Ab and Vip3A, are common in both *H. armigera* and *H. punctigera* populations. Genes for resistance to the new toxin in Bollgard 3, Vip3a, were found to be present in populations prior to its release in the Australian market.

Before the release of Ingard, both the industry and the technology provider recognised that the success of transgenic cotton cultivars in Australia would be dependent on an effective and well-supported resistance management strategy.

In order to develop a robust RMP to support the release of Ingard, representatives of the Australian cotton industry and the scientific community worked closely with Monsanto in providing scientific research relevant to the Australian pest species and the Australian cropping environment as well as industry knowledge as to how the management of resistance risks might be best achieved in practice.

Since then, the process of making changes to existing RMPs or introducing new RMPs has largely remained unchanged. The Transgenic and Insect Management Strategy (TIMS) Bt Technical

Panel reviews relevant research to formulate an RMP for the Bt technology. This strategy will be supported by research into how to manage this third generation Bt cotton to maintain Australia's exemplary reputation for stewardship of the technology.

Major cotton-producing countries such as Brazil and the US are now learning from Australian researchers and R&D to manage recent incursions of *H. armigera*.

CRDC supported projects aiming to establish how to monitor for Bt resistance, and understand its characteristics and what they meant for its potential evolution.

The RMP for Bt cotton is reviewed annually based on monitoring undertaken by CSIRO, supported by CRDC and CSIRO, into resistance in *Helicoverpa* to Bollgard II. CSIRO's Dr Sharon Downes leads the Bt Resistance Monitoring Program.

'Our testing provides independent advice to industry on how well the resistance management strategy is performing – a confidence in the RMP, and reassurance that the industry is taking a pre-emptive rather than reactive approach to resistance management,' Sharon says.

'This is important because the strategies in place to prolong efficacy of the technologies can be practically arduous to a grower, yet Australia is arguably one of the most vulnerable countries in terms of resistance risk due to the profile of our pests – they are not particularly susceptible to Bt and have a history of developing rapid resistance to insecticides.'







A FUTURE OF CAPABLE AND CONNECTED *People*

The Australian cotton industry employs up to 14,000 people, depending on seasonal and market conditions. When it comes to an industry's sustainability and success, outstanding people make the difference.

A significant problem facing the Australian agricultural sector, including the cotton industry, is finding and retaining qualified, skilled employees.

One of the reasons for this situation is that the agriculture sector has experienced the largest decline in skilled labour of any industry in Australia. According to the National Farmers' Federation, it has decreased by 27.7 per cent in the past ten years. Within the Australian cotton industry there is an understanding that success requires the right people with the right skills, and that it is therefore essential to invest in initiatives and research to understand the dynamics and attract and retain qualified, skilled people with a passion for the industry.

CRDC is working with industry to address workforce needs and improve human capacity. For CRDC, this involves a two-pronged approach – supporting initiatives to upskill current people, and researching and investing to attract and retain talented people. There are also many roles needed to be filled in the industry, from farm workers, to ginners and marketers.

According to the University of Sydney, in 2010 in the tertiary sector alone there were just 743 agricultural science graduates but more than 4500 advertised agricultural science jobs.

Since then, however, there has been an increase in enrolments in agricultural-related studies at our universities: from a 15 to 20 per cent increase in 2013 to a 30 to 35 per cent increase in 2015. The Primary Industry Centre for Science Education (PICSE) runs a program which exposes students and teachers to career opportunities in agriculture and science, supported by CRDC. It is likely that such programs have contributed to the increase in enrolments in agriculture, along with industry-specific education programs like those run by the cotton industry. Collectively, CRDC, CottonInfo, CSIRO, PICSE and Cotton Australia are working with industry to engage students at all levels – from primary school to PhD.

In response to direct requests and feedback through Cotton Australia grower panels which identified building industry people/workforce capacity as a priority, 'people' became a stand-alone investment area in CRDC's 2008–12 Strategic Plan. This commitment has extended to the current 2013–18 Strategic Plan.

CRDC also invests in many studies into labour markets and workforce research through partnerships with universities and consultants to better understand the state of the workforce, industry challenges and research priorities to meet future

requirements. These studies have confirmed that the industry is facing a people shortage that is likely to persist at least into the near future. CRDC's investment and support for initiatives over a number of years is something the corporation is very proud of, but there are still challenges to overcome in attracting and retaining people on farms. By proactively investing in programs to address these issues, we are starting to attract people to the industry in key sectors.

Between 2012 and 2015, almost 3500 students were engaged in a cotton industry education activity through such programs as the Young Cotton Professionals Program and PISCE which includes the Science and Engineering Investigation Awards, industry camps, placements and undergraduate internships. All these initiatives are supported by CRDC. An undergraduate internship program run by PICSE has seen 21 students engaged in cotton industry placements since December 2014.

Between 2012 and 2015, almost 3500 students were engaged in a cotton industry education activity.

In an example of industry programs working in unison, interns from the PICSE program have graduated into the Young Cotton Professionals Program, which places university students into internships within the agribusiness sector of the cotton industry. Since December 2014, 12 undergraduate interns have been placed into positions with cotton businesses.

As these students embark on their careers in cotton, future development and leadership opportunities await, from the Future Cotton Leaders Program to the Australian Rural Leadership Foundation's program, supported by CRDC and partners.

Further capacity-building programs supported by CRDC and partners include: the UNE Cotton Production Course, the Australian Rural Leadership Program, Training Rural Australians in Leadership (TRAIL), the Nuffield Scholarship, the Peter Cullen Trust, the Horizon Scholarship, international research leadership, CRDC summer and honours scholarships, Field to Fabric, the Cotton Ginning course and PhD Postgraduate Tours. Many of these initiatives are aimed at improving the capacity of those already in the industry such as growers, researchers, managers and consultants, which we also cover in this publication.





Supporting EMERGING RESEARCHERS

The first post-doctoral fellowship awarded by CRDC was to Dr Stuart Gordon – and the doctor is ‘still in the house’ as the now Principal Research Scientist at CSIRO Manufacturing, where he leads the post-harvest cotton research effort.

Stuart is also the inventor of the world’s quickest and most direct technology to measure fibre maturity, Siromat.

Stuart’s continued contribution to the Australian cotton industry through his research, innovation and leadership stands as a testament to the value of identifying talented researchers early and supporting them through their journey to, in Stuart’s case, become world-leading scientists and industry leaders.

It was Stuart’s post-doctoral research with CRDC which spawned the idea for Siromat, which has now been coupled with Dr Geoff Naylor’s Cottonscan to develop Cottonscope – the first instrument to measure both fineness and maturity directly and accurately. CRDC has been a supporter of both these innovations.

‘While my PhD was to examine cotton’s physical and chemical properties, it ended up looking at measuring fibre maturity and properly distinguishing low-micronaire cotton, which at the time, was being discounted, for fear that it immature,’ Stuart says.

‘This situation still occurs, albeit now there is an accurate instrument that can separate coarser, immature fibre from fine, mature premium fibre.’

As the resident CSIRO post-harvest cotton expert, he was also responsible for building CSIRO’s cotton infrastructure (laboratories, a gin and Australia’s last surviving ring spinning mill) and capability, and for recruiting scientists to support industry in this area.

Stuart started his PhD in 1990 with CRDC’s predecessor the Cotton Research Council, and then Managing Director Ralph Schulze, who was looking at the cotton post-harvest area in terms of promoting and managing Australian cotton fibre quality and developing future expertise in this area.

On finishing his PhD at the end of 1993, Stuart was awarded a CRDC post-doctoral fellowship, spent in New Orleans with the US Department of Agriculture and in the Australian cotton spinning industry.

At the end of this invaluable fellowship Stuart began working with Rocklea Spinning Mills, then Australia’s largest cotton spinning company. Here, Stuart says, he became overtly aware of the importance of fibre quality and its impact on yarn quality and the spinners’ bottom line.

‘Rocklea used 100 per cent Australian cotton and half of its yarn was exported, however the cotton at that time was not really good enough to spin fine count ring spun yarns – it wasn’t long or strong enough,’ Stuart said.

‘Rocklea operated Australia’s only ring spinning mill at the time and we could not consistently spin Ne 40 (15 tex) yarn to be used in fine knits and fine-medium weight wovens and this was the same for overseas mills using Australian cotton.

‘It was the mills (largely from Japan at the time and Australia) who exerted pressure on the Australian cotton industry via the merchants to improve its fibre quality.’

In late 1999 Stuart joined the CSIRO Division of Textile and Fibre Technology, which was looking to diversify its research capability away from wool and Stuart’s work began into creating Siromat.

Geoff Naylor had already started a year before with a small grant from the CRDC to develop instrumentation for measuring cotton

fibre fineness. Luckily for Stuart and the industry, Ralph Schulze and others were keen to have cotton valued properly for fineness and maturity, and also to grow Australia’s expertise and R&D profile in the post-harvest area.

Two patents – one for fineness and one for maturity – were licensed and incorporated to form Cottonscope, which is now commercially available and used by cotton breeding programs in Australia and the US and spinners elsewhere. It is estimated that more than 20 per cent of the world’s new cultivars are selected on the basis of Cottonscope values for fineness and maturity.

Stuart’s contribution did not end there. As the resident CSIRO post-harvest cotton expert, he was also responsible for building CSIRO’s cotton infrastructure (laboratories, a gin and Australia’s last surviving ring spinning mill) and capability, and for recruiting scientists to support industry in this area.

Stuart’s is not an isolated success story; there are many PhD students who have continued to become valuable members of the industry. CRDC also supports young scientists through programs such as Horizon, Summer Scholarships and thesis scholarships. A recent University of Southern Queensland agricultural engineering graduate Simon Kelderman said the support from CRDC through a thesis scholarship showed him that CRDC is interested in attracting and supporting new researchers to the cotton industry.

‘As I looked at potential PhD research project topics, I considered the cotton-related projects more favourably because of the support I have already received,’ Simon says.

‘Motivationally, it also made a big difference: I felt that others were interested and even had a stake in the project, so I wanted to produce something of high quality.’



PRODUCING A QUALITY PRODUCT

Australian cotton continues to compete at the premium end of the world market. It has achieved and maintained this market advantage with the aid of CRDC investments and the uptake of Australian-bred varieties that produce cotton fibre with the strength, length, fineness and maturity sought by spinners.

The Australian industry has combined this with excellent agronomic practices, producing consistent high quality and efficient ginning and shipping systems that deliver cotton on time.

Research into the measurement and control of fibre properties of Australian cotton began with the CRDC's predecessor, the Cotton Research Council. With the formation of CRDC, reducing post-harvest costs and improving the industry's response to market needs became the major objectives and work began to assess the quality of Australian cotton.

An independent assessment undertaken in the early 1990s confirmed the excellence of Australian cotton fibre and this information was used by marketers to the benefit of growers. At the same time, CRDC initiated a joint research project with spinners and other industry sectors to evaluate the fibre of different Australian cotton varieties. The research also delved into dye affinity differences and more detailed characterisations of local varieties. CRDC kicked off its post-doctoral program with a fibre quality assessment by Stuart Gordon.



At the farm level, in general 'yield is king'. However, the buyers of Australia's cotton are more concerned with quality, fineness, strength, maturity and low contaminant levels. Knowing the needs of our customers and consumers helps guide R&D to deliver a consistent, high quality product. Cotton goes through many hands before landing at a mill, and CRDC set about making sure all links in the value chain were working to preserve fibre quality.

Today, Australian cotton is highly sought after by spinning mills around the world thanks to achievements in the post-harvest and agronomic research sectors and uptake by sectors along the value chain. Australian bred and grown varieties lead the world in strength, maturity and fineness. BMP audits of Australian gins, and classing houses are supported by CRDC, and they are routine. Our gins employ methods to reduce fibre breakage and contamination during ginning.

CRDC has invested more than \$1 million in the development of fibre measurement technologies offering additional objective measurements to mills and dyeing houses. The fibre quality prediction tool Cottonspec, and research into the management of crop physiology for fibre quality, have given rise to new approaches for improving fibre quality at the grower end. Fibre classification technology has returned an estimated \$12 to the industry per \$1 invested.

CRDC has invested more than \$1 million in the development of fibre measurement technologies offering additional objective measurements to mills and dyeing houses.



To promote sound agronomic and management practices, a major initiative – the EMS Fibre Pathways – was undertaken by CRDC and the National Heritage Trust in the mid 2000s.

The report, released in 2007, helped to define how fibre quality can be maintained through the processing chain and led to the development of post-farm gate BMPs. The EMS Fibre Pathways project encouraged the industry to investigate the opportunity to develop a brand based on fibre quality and then determine whether this could be further strengthened in sectors of the marketplace by linking environmental best practices through a BMP program to a differentiated fibre.

CRDC has worked closely with CSIRO's Textile and Fibre Technology Division, now CSIRO Manufacturing. Currently, collaborative work is underway with Deakin University's Institute for Frontier Materials on CRDC and Cotton Inc. projects in the areas of product development, instrumentation, fibre processing, cotton cellulose structure and creating new materials from cotton.

During the mid-2000s, the CRDC's EMS (Environmental Management System) Fibre Pathways projects helped to define how fibre quality can be maintained through the processing chain, and this led to the development of the first post-farm gate best management practices. A survey of neps (tangled fibre) levels in Australian cotton enabled traceability back to farms, fields and practices for the first time, and CRDC has invested in research to determine how best to manage neps.

Agronomic research has examined grower management practices and the impact of climate variability. This work led to improved modelling of fibre quality across a range of production conditions and growing regions, which is a valuable tool to help growers assess risks to fibre quality under varying conditions. Research into the timing of crop defoliation and pick has led to new crop management and tools, such as Cottonscope. CRDC research has examined the impact of the agronomic management of fibre quality right through to final yarn and fabric quality. This has provided direct feedback to growers about the production of premium yarns and allows for rapid assessment of spinability without the need for large-scale trials.

These RD&E efforts resulted in the publication of *FIBREpak*, which brings together critical findings from past and current research on fibre quality. This resource, and associated research and extension, has led to practice change across the industry in areas including varietal selection, crop irrigation, nutrition, defoliation and harvest management.





MEASURING TO *Manage*

Australia's cotton growers lead the world in the area of water use efficiency, producing more lint per megalitre than any other nation, at around two bales per megalitre of irrigation water.

At the same time, in terms of yield per hectare, Australian growers produce almost three times the world average. Grower innovation and uptake of directed, tangible research has played a major role in this achievement.

CRDC's strategic investment with research partners on behalf of cotton growers and the Australian Government has played a major part in this achievement. It's the result of an enormous research and extension effort with adoption and innovation by growers particularly over the past 15 years.

In the early 2000s, against a backdrop of the worst drought on record and a national agenda for water reform, the Australian cotton industry set itself the challenge of improving its water use efficiency (WUE) by 100 per cent over a decade. Due to the innovation of Australia's cotton industry, by 2010 our most efficient growers almost doubled their Irrigation Water Use Index from 1.1 to 1.9 bales per megalitre (ML).

According to the CRDC-commissioned Australian cotton industry *Third Environmental Assessment* (2012), Australia's cotton growers have improved their water use efficiency by three to four per cent per annum since 2003. Importantly, lint yield per hectare of cotton has been increasing, while at the same time the average total amount of irrigation water applied has decreased. Research has found that growers are as efficient in full production years as they are in years of low planting. In the record 2012–13 season,

the Gross Production Water Use Index (GPWUI) was 1.12 bales/ML, compared to 1.17 and 1.14 bales/ML in the low production years from 2006 to 2009.

Australian cotton growers today produce more cotton with less water per hectare than ever before, and the improvements continue as research focuses on the automation of irrigation and better predictive and monitoring equipment for irrigation scheduling.

Recent CRDC surveys show that 96 per cent of irrigators have made changes to their furrow irrigation systems to improve efficiency.

Research over 25 years has enabled the development of a range of techniques to constantly improve WUE. From CRDC's perspective, the first step in radically improving WUE was to have accurate measurements of how much water crops were using, and to standardise and benchmark these measurements. With that in mind, a project with long-term industry irrigation and energy researcher Dr Janelle Montgomery, NSW DPI, began.

Standardisation of water use efficiency measures and improved water measurement techniques for surface irrigation were vitally important research outcomes to enable valid irrigation benchmarks to be established and compared.

'CRDC undertook projects to measure the industry's WUE, and the fact that the industry has robust data for various indicators of WUE is important,' Janelle says.

'How do you improve, if you don't know your current performance?'

'The IrriMATE work was really pivotal in changing grower practice, as increasing flow rates and reducing run times has resulted in improved application efficiency, reduced water logging and losses through deep drainage.'

Janelle says that further widespread surveys and research into water storages was extremely useful in obtaining data on storage seepage and evaporation across the industry.

'This is really important, given that loss through evaporation from on-farm water storages is one of the largest water losses on farm.'

Through major, long-term projects, CRDC research also explored in-field moisture monitoring, improvement to field and irrigation system design, reducing evaporation, scheduling technology, improved soil health and new irrigation techniques. As a result, growers have embraced research outcomes to more closely monitor water use, adopt new technology and undertake capital works such as improving and redesigning water storages and channels to reduce leakage and evaporation, with more efficient delivery of water to the field.

While RD&E investment has been successful in assisting growers to optimise drip and sprinkler irrigation systems, at least 80 per cent of the Australian cotton growing area is irrigated using gravity surface irrigation systems and recent CRDC surveys show that 96 per cent of irrigators have made changes to their furrow irrigation systems to improve efficiency. Application efficiency and uniform application have been maximised, as have monitoring efficiencies and calculations of water use. The portfolio of research has extended across crop, farm, catchment, community and industry scales.

Increases in WUE have been achieved by both yield increases and more efficient water management systems. Over the last decade to 2012, the whole farm irrigation efficiency index for Australian cotton farms improved from 57 to 70 per cent, and crop water use indexes are also high by international standards. Yield increases can be attributed to plant breeding advances, the adoption of genetically modified varieties and improved crop management. There has also been an increased use of irrigation scheduling tools and furrow system optimisation evaluations. This has reduced in-field deep drainage losses.

The Australian cotton industry is one of the most advanced agricultural industries in Australia in terms of its use of irrigation scheduling tools, and it has the highest use of soil moisture monitoring probes of any agricultural industry. In addition to yield, irrigation management has a significant impact on fibre quality. CRDC grower surveys show that growers today recognise irrigation timing and variety choice as the most critical management tools for fibre quality.

Recently, CRDC has invested in projects that use satellite telemetry, canopy temperature sensors and soil water monitoring technology to better schedule irrigations using real time adaptive

control of irrigation applications. Row configuration trials also allow growers to make the most of water availability, particularly in seasons of low allocation.

Water R&D knowledge has been compiled and extended through the CRDC-supported industry publication *WATERpak*. This resource has been revised and extended to include grain production to integrate with the *myBMP* program.

CRDC grower and consultant surveys, the Boyce Cotton Comparative Analysis, and studies such as the *Third Environmental Assessment*, along with studies by industry researchers and specialists, show there are still noticeable variations in WUE on a farm-by-farm basis. CRDC is focused on ensuring, through RD&E, that all growers are aware of the technology and have the know-how needed to maximise their water use efficiency. Future work will look at the optimisation of interactions between water, soil, labour, carbon emissions, energy efficiency and nutrition.



An analysis of 36 farms in 2006–07 using a comprehensive standard for water use, the Gross Production Water Use Index (GPWUI), measured an increase of 40 per cent in water use efficiency compared with a similar study nine years before.

In 2003–04, CRDC coordinated production of *WATERpak*, a resource package on irrigation management in cotton with a major focus on water use efficiency. And, for the first time in 2004, the BMP manual included the new land and water management module.



VALUING CARBON IN COTTON FARMING

CRDC-supported research has highlighted the critical importance and role soil carbon has in promoting soil health, improved productivity and sustainability.

Additional investment by CRDC has targeted how growers can reduce their carbon footprint and optimise their management systems. Research has shown that practices for optimising energy and input efficiency and reducing emissions in cotton production are also those that deliver maximum yield and environmental benefits such as improved soil health.

CRDC has supported RD&E efforts into understanding and reducing nitrous oxide emissions on cotton farms, understanding of carbon in soils and response to management practices in reducing greenhouse gas (GHG) emissions. Research has found GHG emissions can be reduced through modifying farming practices. Eliminating inversion tillage, minimising groundwater use, choice of rotational crops, optimising applied nitrogen fertiliser rates and substituting legumes all contribute towards reduced emissions.

Research into carbon storage and carbon sequestration on floodplain soils, riparian zones and native vegetation (in particular river red gums) has shown that emissions from farming activities can be entirely offset by these non-cropped areas and carbon-neutral cotton farms are a reality.

A recent assessment commissioned by CRDC to determine the carbon footprint of cotton production at a cotton farm near Mungindi in Northern NSW found the farm to be carbon neutral. The assessment found that healthy riparian zones are the greatest contributor to this. Riparian zones are the quiet achievers in the cotton system and research findings on carbon sequestration rates of river red gums only adds more value to these areas.



Long-term studies over 20 years supported by CRDC at the Australian Cotton Research Institute into the effect of management practices on soil carbon, temperature and rainfall has led to a better understanding of the role of rotation crops, cover crops, stubble management and legumes which can lead to better water holding capacity, improved soil carbon levels and improved yields. These research activities have been the subject of continued cotton RD&E efforts, and are captured in *myBMP*, the industry's best management practices program, which includes components on energy and input efficiency, water management and soil health.

In 2008–09, CRDC commissioned a Life Cycle Assessment study to evaluate the environmental impact of a 100 per cent cotton t-shirt throughout its life and thus examine how the industry could further reduce its carbon footprint. This groundbreaking research demonstrated that the major environmental impact of the t-shirt was in the 'use' component, rather than in the growing or manufacture of the garment. The study showed that during the growing phase, the biggest contributor to cotton's carbon footprint was related to synthetic nitrogen fertiliser use and subsequent losses from the field. This was confirmed in later CRDC studies.

CRDC has been investigating nitrous oxide emissions from cotton fields since 2002, and in 2014 supported a study into losses of nitrous oxide from the irrigation system to identify how they can be mitigated. Since this study, CRDC has directed significant investment to better understand the uptake and use of nitrogen by the cotton plant, optimal rates and timing of applications and how management can be improved to improve efficiency and reduce emissions.

This has led to the development of a whole-of-farm web-based carbon footprint calculator, due for release in 2016.

Accompanying products developed with assistance from CRDC, such as the web-based applications EnergyCalc and EnergyCalc Lite, are aimed at helping growers evaluate and reduce energy and inputs which can lead to a reduction in their carbon footprint and a greater level of sustainability.

CRDC has supported the development of a Crop Carbon Management Tool (CCMT). This web-based calculator enables land managers to better understand the sources and extent of greenhouse gas emissions from their farming operations. The CCMT is the most scientifically advanced carbon footprint calculator available, especially for estimating nitrous oxide emissions associated with fertiliser use. The CCMT is fully aligned with the life cycle assessment methodology and the International Greenhouse Gas Protocol for product life cycle accounting.



MELANIE JENSON



Advancing BIOLOGICAL INSECT CONTROL

Integrated pest management (IPM) is a critical aspect of pest management in cotton and although challenged with resistance to conventional insecticides, the industry has always looked for ways to conserve beneficial insects and become more targeted in managing particular pest species as part of an overall IPM approach.

When CRDC was formed in 1990, the season was described as one of good prices and yields and high quality cotton, but growers were battling heavy insect pressure and resistance to conventional insecticides. Given the high risk of devastating insect damage and the highly intensive nature of cotton production, CRDC placed a heavy emphasis on R&D activities related to crop protection and environment protection. R&D objective one in the first strategic plan was that 'the protection of the crop should be achieved by far less dependence on chemicals'.

Crop protection with a reduced dependence on pesticides was also a core research objective of the first Cotton Co-operative Research Centre in 1993, which CRDC was integral in forming, having initiated the submission to the Australian Government for the formation of the centre.

Since 2001 CRDC has been funding innovative R&D projects that seek to discover and commercialise alternative insect pest control options that involve the use of biological compounds.

CRDC has invested in a number of long-term studies to develop biologically-based products for insect control, most notably Sero X which is in the advanced stages of registration led by Innovate Ag. The product is the result of a ten-year study led by Dr Robert Mensah (pictured), Senior Principal Research Scientist and Director of the Australian Cotton Research Institute with NSW DPI, followed by a further seven years of investment, research and product development by Innovate Ag. Sero X is for the control of *Helicoverpa* and sucking pests (mirids, aphids, whiteflies and small nymphs of green vegetable bugs) in conventional and Bt cotton crops.

Sero X was developed from secondary plant compounds (SPC) obtained from an extract of a plant species (*Clitoria ternatea*) prevalent in Australia that can deter pest feeding and egg laying, as well as causing direct kill of a number of insect pests. The product is in the advanced stages of registration by the Australian Pesticides and Veterinary Medicines Authority and growers could use the product against *Helicoverpa* and sucking pests in the 2015–16 cotton season.

These SPCs are biological compounds or semiochemicals used as biological pesticides and are preferred in IPM programs as they can provide effective control of a pest with minimal impacts on beneficial species and the environment.

Another significant benefit of this type of natural compound in the Sero X product is the low risk of resistance developing within insect pest populations because the pest control properties of the

PAUL GRUNDY



Preserving beneficials through soft-option insect control allows predators like ingenious green lacewing larvae to help control pests such as aphids, thrips and mites. The larvae place the bodies of their dead prey on their backs to camouflage themselves – in this case using mealybug carcasses.

product are not due to one or two unique bioactive compounds, but consist of many different chemical compounds providing a number of modes of action, so it is unlikely that resistance will develop to these complex organic compounds.

The development of biological pesticides such as Sero X is a long and challenging process, involving not only the study of the production aspects, but also working through the compliance and registration processes in Australia. Dr Mensah is also developing an entomopathogenic fungus for the control of *Helicoverpa* and sucking pests on cotton with support from the CRDC. The research has been ongoing since 2005 and is in the advanced phase of negotiation and commercialisation.

A number of other IPM support products have been funded both directly by the CRDC and indirectly via the cotton CRCs in the past 25 years, including Magnet which was registered in 2009 following ten years of research.

Developed by researchers Professor Peter Gregg and Dr Alice Del Socorro from the University of New England (UNE) through the Cotton CRC, Magnet was designed for use in conventional cotton, however CRDC recently funded a follow-up project studying this 'lure and kill' product's potential use in resistance management for Bt cotton.

Most recently, CRDC now invests in blue sky research into biopesticides with NSW DPI and Western Sydney University to develop novel IPM products for the Australian cotton industry. CRDC is supporting research on fungal biopesticides and semiochemicals, novel insecticides and synergists from endemic and exotic flora and the evaluation of pheromone-based monitoring for green mirids.

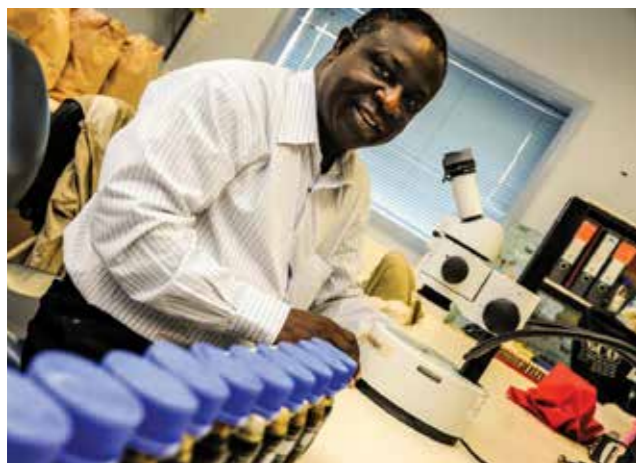
Working through the process of commercialisation of these types of products provides great benefits for the industry and for the scientists involved. Additionally, there is now a greater appetite among some of the more established pest management companies to explore biological pesticides. Without its early investments, CRDC and the industry's researchers would not be in a position to work with some of these companies to introduce biologicals into the cotton farming system.

Crop protection with a reduced dependence on pesticides was also a core research objective of the first Cotton Co-operative Research Centre.

CRDC General Manager for R&D, Dr Ian Taylor says there is no silver bullet when working to manage highly adaptive and successful insect pests.

'However with carefully planned strategies and a multi-pronged approach that incorporates the judicious use of GM technologies such as Bt cotton, targeted and specific conventional insecticide chemistries, and the use of soft options including bio-pesticides, the cotton industry is developing a platform that will enable us to grow cotton sustainably into the future while minimising our environmental footprint,' he says.

MELANIE JENSON







CREATING DEMAND FOR *Australian Cotton*

In recent years the Australian cotton industry has stepped up the promotion of the quality and sustainability aspect of our product to customers – who are spinners, manufacturers, apparel brand-owners and the people who buy cotton products.

Twenty-five years ago, reducing post-harvest costs and better meeting market requirements was one of the first objectives of CRDC. To reach this goal required agronomic and market research as well as improved consultation with the post-farm gate sector and customers such as spinning mills.

In its first years of operation, CRDC held a 'marketing seminar' and a value-adding conference, bringing together researchers, marketers and processors to identify issues warranting research. A joint industry and CRDC program was initiated with spinning mills to assess fibre characteristics of importance to the textile industry, as part of a long-term plan to characterise the fibre qualities of Australian varieties. The results confirmed the excellent fibre quality and spinning characteristics of our cotton. An independent review confirmed this, and the results were used by marketers to the benefit of growers.

'Remarkable progress with respect to fibre quality has been made in Australia since the first joint variety evaluation project of this nature six years ago. Considering the continuous technological and engineering advance in all segments of the textile industry and the fierce and truly global competition among textile producers, the Australian cotton community is encouraged to continue focusing on and striving for further fibre quality improvements to adjust to the future and perhaps even more challenging demands of their customers.'

Chris Faerber, Truetszschler GmbH & Co, Germany,
The Spinning Value of Australian Cotton, 1990.

The goals of strengthening the industry's reputation for quality, promoting industry values in production and providing value across key parts of the value chain continue to this day. The focus is on adding value to the industry with premium products and improved routes to market. This has required understanding current markets and potential opportunities, developing a market strategy and establishing environmental credentials.

CRDC convened the 'We're Aussie, Wear Aussie' forum in 2009 to chart a program of agreed future actions. The forum brought together high-level supply chain representatives. The outcome was the industry's Premium Cotton Initiative supported by Cotton Australia, Cotton Seed Distributors and the Australian Cotton Shippers Association. The initiative has a strong collaborative network in the industry and included trials of the premium varieties Sicala 340BRF and its predecessor Sicala 350B.

Through international mill and brand owner surveys, promoting the uptake of Best Management Practices (BMP) throughout the value chain, and premium yarn production, CRDC gained sophisticated market intelligence about opportunities for marketing Australia's high quality cotton and responsible production practices.



Armed with this new understanding, CRDC worked with Cotton Australia, Australian Cotton Shippers Association and Cotton Incorporated (USA) to develop the CottonLEADS program in 2014. This program now complements Cotton Australia's broader 'Cotton to Market' program which incorporates both CottonLEADS and the Better Cotton Initiative.

Beyond market research, the CRDC has made major investments in researching the agronomic factors affecting fibre development, in order to minimise negative fibre traits such as neps and short fibre content, while concurrently improving fibre length, strength, fineness and maturity. The results have been extended through the *FIBREpak* publication which brought together critical findings from past and current research into fibre quality. Active promotion of this resource has led to practice change across the industry, including variety selection, irrigation and nutrition management, defoliation and picker/harvest preparation and management.

Through support of the Field to Fabric course, participants were opened up to the effect growing and handling practices had on fibre quality and processing.

Further investment has seen the development of novel technology to improve spinning of Australian long staple cotton; the world-first Cottonscope software to assess fibre maturity and fineness; Cottonspec, which allows mills to predict final yarn quality; cotton-wool blend fabrics; contamination sensors and modified lint cleaners for gins; the gin moisture sensor Siroduct; and changes to quarantine treatments of cotton which were affecting quality.

CRDC has played a major role in increasing knowledge about maximising fibre quality in cotton production, in the ginning sector and in the spinning sector, which has resulted in improvements in fibre quality, reduced contamination and better market access for our cotton. Significant investment over 25 years in agronomic and varietal research has given growers the tools to grow cotton suited to world markets.



WAGING A CONTINUAL WAR ON WEEDS



Weed control and herbicide resistance have been major considerations throughout CRDC's history.

Controlling nutgrass in the first cotton crops in the Namoi Valley was the first weeds research project CRDC supported in 1990. In its first year of operation CRDC enlisted Graham Charles of NSW DPI (who today is still working with CRDC) to undertake the project and from its inception, weeds' resistance to herbicides was on the research agenda. Initial research centred on how to best control weeds while avoiding development of resistance to herbicides.

Glyphosate-tolerant and glyphosate-resistant weeds are now a reality in the broader farming and more recently in cotton farming systems, and CRDC has been proactive in its approach to the issue.

'Right from the start growers were battling weeds such as nutgrass and discussions around research priorities centred not only on controlling them but how to avoid going down the path of resistance,' Graham Charles says.

'Some growers were experiencing such heavy losses due to nut grass infestation they were forced to plough crops in.

'We acknowledged resistance would come, and quickly realised we needed a whole systems approach to weed management which laid the foundation for what we now refer to as integrated weed management (IWM).

'Early research was focused on identifying weeds on cotton farms and developing the best control strategies to fit the whole farming system.

'Today we are very good at managing weeds in cotton fields: it is the fallow areas where the bigger challenges lie.'

CRDC supported the development of *WEEDpak*, a hefty, 200-plus page guide to integrated weed management (IWM). It was released in 2002, and at the time nothing like it had been produced by any agricultural industry in Australia.

WEEDpak highlighted weeds research and an integrated approach to weed control, stressing the need to use a range of management tools. It also covered the use of Roundup Ready cotton and the potential development of resistant weeds by overuse of various

herbicides including glyphosate. An accompanying *Weeds Identification Guide* was also published.

Today, *WEEDpak* has further evolved to contain three tools: the Weed ID guide, the Seedling ID guide, and the Herbicide Damage ID guide.

Graham Charles was a major contributor to the initial, and subsequent, editions.

'Prior to this publication I remember Dave Anthony (then Auscott Namoi manager and CRDC board member) said to me, "I want to know everything you know about weed control, what works and what doesn't work,"' Graham says.

'The Australian cotton industry was way ahead of the curve nationally and internationally with the release of *WEEDpak*, and has remained so to this day.

'You only have to look to the US cotton industry to see the impact resistance can have, or in Australia to dryland cropping systems where most resistant weeds are found.'

CRDC's support for weeds and herbicide resistance research and development culminated in the release in 2014 of an industry Herbicide Resistance Management Strategy (HRMS).

CRDC commissioned this document to provide crop managers with the knowledge to manage herbicide resistance. Supporting workshops to extend weeds knowledge has also been ongoing.

The 2013 *World leaders in cotton* report to industry says, weeds R&D showed a return of \$8.90 per dollar invested over the five years (2008–13) of the last CRDC Strategic Plan. In recent years CRDC has supported researchers and long-term projects which have been responsible for cracking open the resistance enigma through understanding the genetics of glyphosate resistance, modelling for resistance, management, and the annual weeds surveys. CRDC supported the development of the online Glyphosate Resistance Tool for growers and futuristic research is underway into robotic mechanical weeding.

CRDC's support for weeds and herbicide resistance research and development culminated in the release in 2014 of an industry Herbicide Resistance Management Strategy (HRMS).

Practices to either delay or avoid herbicide resistance, or to control glyphosate-tolerant species bring with them the need to allocate additional resources for weed management. Farm managers are faced with difficult trade-offs between maintaining current profitability and the cost efficiency of increasingly difficult-to-manage weed situations in the future.

Crop managers can't spray their way out of herbicide resistance, as this inevitably selects for resistance, and since there have been no new modes of action since 1982, we would very quickly cycle through the existing modes of action for weed control. There are no silver bullets, but by using what has been learned from the research, growers can select key tactics that will maximise the longevity of the farming system. It requires IWM – controlling survivors and managing the seed bank, and of course good farm hygiene underpins weed and resistance management.

Through R&D, CRDC is tasked to create new capacity for growers to improve input efficiency, maintain the current minimal yield losses due to unmanageable weeds, and shift towards practices that offer reliable weed management in the long term. CRDC is currently investing in blue sky projects to create alternative forms of control using robots with sensors and the ability to spray or mechanically control weeds.

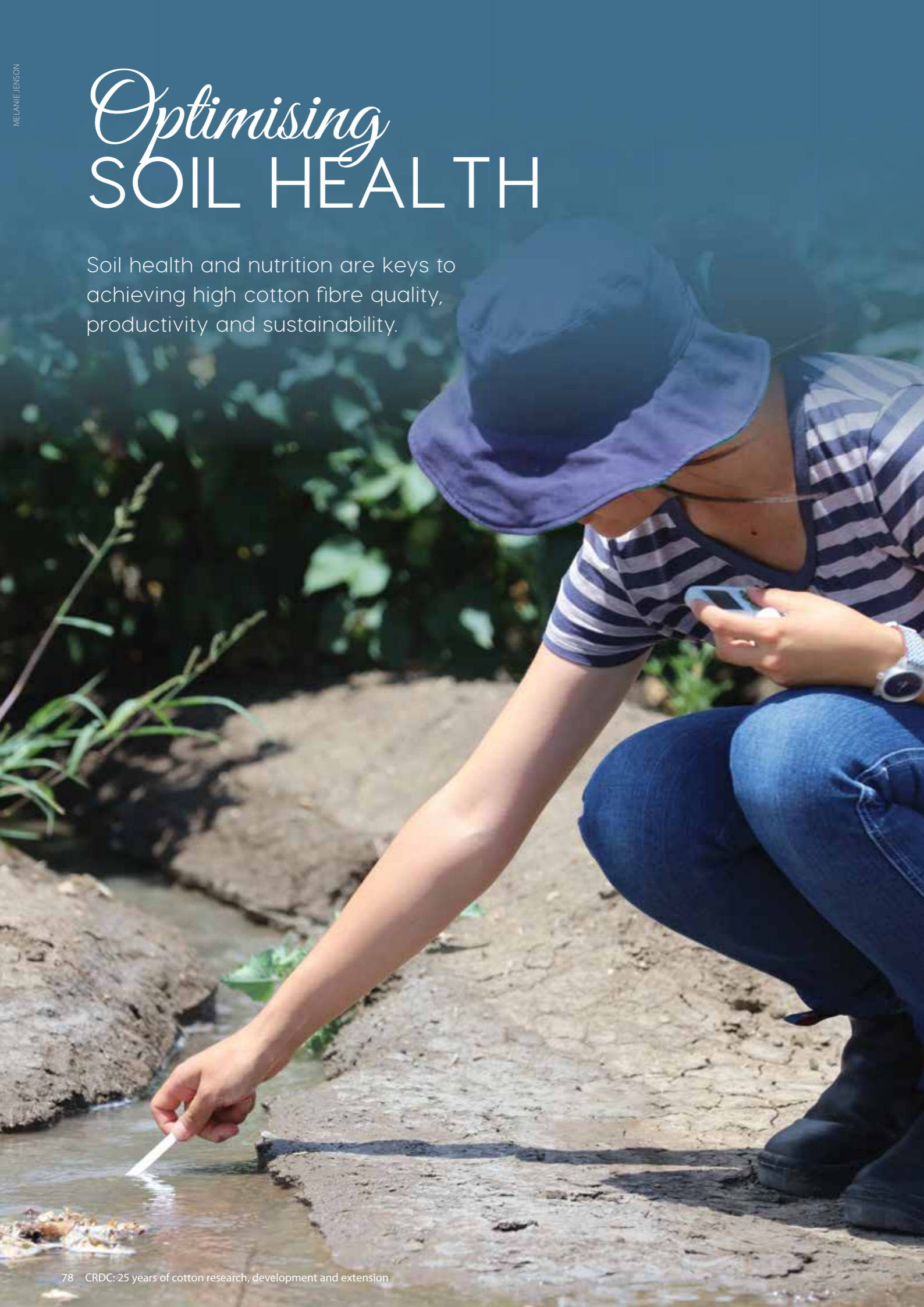
In 2004, in response to the CRDC-commissioned Second Environmental Audit of the industry, a goal was set to achieve a 20 per cent reduction in quantities of residual herbicide in five years.

This target was met ahead of time. Just 18 months later, Crop Consultants Australia reported a 32 per cent reduction in residual herbicide use since the introduction of Roundup Ready technology and strong support from cotton growers in the application of integrated weed management (IWM) practices.



Optimising SOIL HEALTH

Soil health and nutrition are keys to achieving high cotton fibre quality, productivity and sustainability.



Long-term soil research has laid the foundation for the industry to continue to build a bigger 'profile' on cotton growing soils and how best to manage them. Soils are a complex of minerals, organic matter, water and air, so research includes many streams to understand these interactions and how to manage them for long-term sustainability, and to produce the best returns in terms of yield. In CRDC's early days, the Australian-bred cultivars were performing well, but knowledge gaps existed in terms of understanding the interaction between them and the soil, and in terms of understanding the needs of a cotton plant for nutrient availability.

The earliest CRDC projects focused on soil structure management and remediating soil compaction; improving soil biological health; amelioration of potassium deficiency; safeguarding against salinity; and studies into the value of permanent beds. With assistance from CRDC, crop rotation trials in several cotton regions were established to study crop nutrition, soil physics and chemistry, entomology, economics and biology. One of the first grower workshops convened by CRDC in 1993 was on soil health. It also convened industry meetings to aid coordination and planning for future soils research.

Another of the 'pak' series, *SOILpak*, was funded by CRDC who held subsequent field training programs to extend the plethora of information it contained. The resource drew together all cotton-related soil research into one publication. A committee was formed to coordinate the updating of *SOILpak*, and today many years of research now underpins this resource. In 1993, one of the core programs of the CRC for Sustainable Cotton Production (of which CRDC was the instigator and a major supporter) was protecting the resource base, particularly soil and water, and this priority continued throughout all CRCs to 2012 and through CRDC programs since.

Independent appraisal of CRDC soils and nutrition R&D found an estimated return of \$26 to the industry per \$1 invested over the 20-year period from 1994 to 2014.

Of great benefit to the industry has been the long-term rotation and nutrition trial project which began under CRDC in 1994 at the Australian Cotton Research Institute and continues to be supported by CRDC. Investigating rotation crop stubble management options for water conservation, nutrition needs and soil carbon levels are just a few areas of research undertaken through this investment. Part of this research has now shifted from the impact of rotation crops on nitrogen fertiliser requirements to whether new higher yielding varieties have different nutrition requirements.

'This long term research has also shown that carbon neutral cotton farms are a possibility. A CRDC study into the effect of management practices on soil carbon, temperature and rainfall indicates that rotations such as corn may have multiple benefits, including higher soil carbon and higher cotton yields, lower disease, such as black root rot incidence; and are more energy efficient in terms of energy produced relative to that used,' says former researcher Dr Nilantha Hulugalle.

Nilantha has more than 20 years' experience in soil research and has focused on the impact that management has on soil quality issues such as sodicity and salinity, greenhouse gas emissions and soil water storage. Outcomes of this research have included the increased use of rotation crops in cotton farming systems, uptake of minimum and no-till cotton, and stubble retention from rotation crops that can improve soil water holding capacity.

'We now know that soil water storage can be increased by leaving standing stubble from rotation crops, with less frequent irrigation, while also conserving moisture from rainfall,' he says.

Research undertaken by the late Dr Ian Rochester showed that very high yields (14 bales/ha) were achievable using leguminous rotation crops, which improved overall soil health and the soil's ability to sequester carbon. Ian also developed a method to easily identify nitrogen fertiliser use efficiency (NUE). This and associated research has developed optimal rates for nitrogen application and has seen significantly increased fertiliser uptake efficiency from 30 per cent to as high as 70 per cent.

This research was also channelled into the development of NutriLOGIC with CRDC support, which allows growers to assess the nutrient status of the soil or crop and tailor management decisions. It is a part of the CottASSIST program developed with support from CRDC.

Compaction was flagged as a looming issue in CRDC's early years, and with the evolution of larger, heavier machinery CRDC has invested in several projects recently which have led to a better understanding of compaction and methods to alleviate it. Growers now have the science to measure plasticity, and more knowledge of the positive outcomes associated with controlled traffic farming and precision agriculture. CRDC is also investing in robotics to take the place of heavier machinery in operations such as weed control.

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Soils research is also inextricably linked to irrigation research. The soil-water holding capacity or propensity for deep drainage is critical knowledge in irrigation management and in improving water use efficiency. Cotton growers now have better soil maps than ever thanks to research and the use of technology in research to 'see inside the soil' and avoid deep drainage and run off, and achieve better uniformity, fibre quality and yield. It forms the ever-widening scope of research into soils which includes regional research in growing areas such as the Macquarie Valley, where little data is available on soils.

Crop nutrition is another arm of soils research and is a high priority area of RD&E for CRDC. Based on feedback from growers and consultants, significant investment has been made into understanding nutrient cycling and measuring, plant uptake nutrients and the effect of irrigation has led to better use of synthetic fertilisers, manures and composts. As with irrigation research, by firstly 'measuring to manage', important groundwork is laid for future research about how to improve outcomes. Recent research has quantified nutrient use and losses from cotton fields and this has allowed growers to adjust their practices accordingly.

It is this better understanding of soil, and the balancing of its needs with the crop's needs, that CRDC sees as a priority as we strive to make both large and incremental gains in quality, yield, efficiency and sustainability.



MANAGING DISEASE

Diseases of plants and diseases in the soil occur across all areas of agriculture. The challenge for any industry is to manage plants and soil to mitigate the risk of disease, or to overcome it.

This can be handled physically through farming practices, backed by research, through plant breeding to give immunity or tolerance, and via research into the physiology and control of diseases through innovation.

Managing the threat from disease has been a focus for CRDC from its beginning, with the breeding of Verticillium-tolerant cotton one of the first CRDC projects in 1990. This was alongside continuing the support for the young scientist Stephen Allen's disease work at the then Narrabri Agricultural Research facility, later to become the Australian Cotton Research Institute. Stephen was to become a stalwart in the industry. He retired in 2015 after 39 years as a pathologist, mostly in the cotton industry. It would be fair to say that, along with a team of other talented researchers, Steve's research has played a major role in the resilience and success of the cotton industry as we know it today. His research has had impacts globally and he's been named the Australian Cotton Industry Researcher of the Year – twice.

Steve's first foray into understanding the microbes and diseases of cotton came with understanding and managing bacterial blight, fusarium wilt and seedling diseases. The young scientist discovered the incidence of black root rot, boll rot and fusarium wilt in Australian cotton and initiated the disease surveys in NSW in 1983 and later QLD, which today with CRDC support have become the cornerstone of industry disease management and preparedness.

CRDC's current RD&E focus is on collaborative efforts to better understand the ecology of endemic and exotic threats by developing industry strategies and management tactics to address them. According to one of the world's leading disease experts, 'Australian research presents a comprehensive and coordinated approach to the management of major cotton diseases in Australia.'

On a visit to Australia to meet with industry, Professor Craig Rothrock of the University of Arkansas said it was obvious from speaking with our growers that research is responsive to growers' concerns. Along with other leading US researchers, Craig was

attending the FUSCOM (Fusarium Wilt Research and Extension Coordinating Committee) - an annual event supported by CRDC. This gathering is vital in bringing together Australia's pathology and virology research community, plant breeders, growers and consultants to share information and coordinate efforts in disease control. Originally formed to focus on Fusarium wilt, today the FUSCOM research focus has broadened to other fungal and bacterial diseases.

While it was recognised that breeding would be the cornerstone of a solution, CRDC has supported all aspects of the Fusarium problem.

It is this industry response to Fusarium that has shaped the collaborative and integrated approach to disease research. In 1993, Fusarium wilt of cotton (caused by *Fusarium oxysporum f.sp. vasinfecta*) was identified for the first time in Australia, and the industry immediately embarked on an extensive RD&E program to manage the disease. While it was recognised that breeding would be the cornerstone of a solution, CRDC has supported all aspects of the Fusarium problem, including containment, farm hygiene practices, rotational crops, stubble management, weed management, ecology (including role of planting temperature), biocontrol, and molecular characterisation of the pathogen.

By 2000, Fusarium wilt had spread to all production areas except for Emerald in QLD, Tandou or Hillston in NSW and WA, and it was estimated that Fusarium wilt caused \$57 million in losses to the Australian cotton industry in that year.

Darling Downs grower Graham Clapham has supported more than 20 years of Fusarium research on his farm 'Cowan'. He recounts that in the late 1990s and early 2000s, Fusarium wilt was very serious for the Darling Downs, along with some other growing regions.

'The Darling Downs irrigated areas probably had the biggest risk,' Graham says.



MELANIE JENSON

'In extreme cases, on our cotton enterprise, there were total losses – we would take fields out as they simply didn't have enough plants left. The majority of affected fields had a minimum of 30 to 40 per cent yield loss.'

Graham says that the research effort has been 'invaluable'.

'By understanding the conditions that promote Fusarium, we can adopt practices to minimise the risks.'

'Accompanied by varieties that have been bred for tolerance, we are at the stage where we can sow cotton in previously affected fields with a high degree of confidence.'

Annual disease surveys are a major element in CRDC's long-term disease management investment and play a major role in its success. Survey data from around 32 years in NSW and 13 years in QLD indicate the relative importance of diseases present and the impact that management practices and the adoption of new varieties have on disease distribution, incidence and severity. Biosecurity of the Australian cotton industry has also been enhanced with the inclusion of surveillance for exotic diseases.

CRDC continues to invest in pathology research capacity for disease management for pathogens such as black root rot, Fusarium and Verticillium wilts, seedling disease and reniform nematodes. It also continues to invest in maintaining biosecurity preparedness and pathology services for disease identification. Research topics range from understanding the ecology of pathogens including weeds and other crop hosts, the spread of pests and favoured environmental and microbial conditions, through to management tactics to reduce spread or severity.

Communication of these findings has also been supported by CRDC through the support of signature publications *DISEASEpak*, the *Cotton Pest Management Guide* and *Cotton Symptoms Guide*, as well as field days, conferences and forums. These publications continue to inform growers on best management techniques relating to crop management and strategies for minimising the impacts of disease on crop health.

In 1995, CRDC commissioned a review of the cotton plant pathology research program. The outcome was clear – this research area was grossly under-funded and under-resourced. Following this review, CRDC and Cotton Seed Distributors joined forces with CSIRO and the then NSW Agriculture to fund the building of the new plant breeding and pathology laboratory at the Australian Cotton Research Institute at Narrabri. The new laboratory created much need additional space to continue the efforts of the breeding program and research into disease pathogens which are a threat to the industry.





MELANIE JENSON

PROTECTING THE CROP FROM FOREIGN THREATS

Beyond competition from man-made fibres, CRDC's main focus in protecting the cotton industry is investing in its capacity to deal with biosecurity threats through surveillance and the development of diagnostic protocols and contingency plans.

Throughout CRDC's history, it has been responsible for raising awareness through biosecurity campaigns, RD&E of integrated pest and weed management, supporting related industry campaigns to promote Come Clean Go Clean, and vigilance around identifying and recording possible harmful diseases, insects and weeds.

Australia's geographic isolation has meant that we have relatively few of the pests and diseases that affect agricultural industries overseas. From its beginnings, CRDC has helped to ensure that the Australian cotton industry was aware of potential threats through the support of international travel and science exchanges. This meant the industry was on the front foot following the identification of silverleaf whitefly (*Bemisia tabaci* Type b) in 1994. While most infestations were in the nursery industry, CRDC provided funds to survey cotton growing areas. No reports of damage to cotton were reported, but due to the pest's ability to develop resistance to insecticides, CRDC supported a preliminary investigation to determine the resistance status of these introduced strains found in Australia, believed to have entered through nursery stock.

Working with the horticulture RDC, a coordinated R&D program was established to determine distribution, rate of spread, biology and ecology of silverleaf whitefly (SLW), establish a resistance profile, and study potential sources of viruses that could be released from other plants into cotton by this pest. When SLW flared in Emerald some years later, CRDC was able to transition the research focus to pest management. This experience provided a reminder of the need for preparedness in the event of a pest or disease incursion.

Biosecurity planning provides a mechanism for the cotton industry, government and relevant stakeholders to actively determine pests of highest priority, analyse the risks they pose, put in place procedures to reduce the chance of pests becoming

established, and minimise the impact if a pest incursion occurs. With the assistance of the Australian Cotton Growers' Research Association (now Cotton Australia), an Industry Biosecurity Group (IBG), coordinated by Plant Health Australia, was formed to work on the development of a cotton industry biosecurity plan in 2004.

CRDC was actively involved in the development of the plan and also funded pathology and entomology researchers contributing to the knowledge and research capacity that underpinned its development. CRDC responded by expanding the scope of the annual disease surveys to include the presence and absence of high priority diseases, supporting the development of diagnostic and contingency plans for many of the high priority pests, and investing in industry training on biosecurity.

Insect vectored viruses, such as cotton leaf curl virus and blue disease have been a particular focus of recent research given their ability to spread very quickly and cause significant crop losses. Investment in this area has resulted in an increased understanding of the location of these threats, development of capacity to accurately detect virus, assessment of risks and development of contingency plans.

In recent years, CRDC projects have identified the presence of defoliating strains of Verticillium wilt in cotton production areas of Australia, the ASIA II silverleaf whitefly in the Northern Territory and the aphid vectored blue disease (cotton leaf roll virus) in East Timor. As a result of CRDC investment in assessing risks associated with cotton leaf curl virus, there have been changes to importation conditions for high risk species to ensure that potential symptomless hosts such as some hibiscus species are screened for the virus.

CRDC backed the 2015 review of the *Industry Biosecurity Plan* and continues to ensure the cotton industry has the capacity to minimise the risks associated with pests and to respond effectively to any pest threats. This is a vital step for the future sustainability and viability of the industry.



SAFER COTTON FARMS

The Australian cotton industry is at the forefront of agricultural farm safety.

The Australian cotton industry is a leader in Workplace Health and Safety (WHS) investment and outcomes in agricultural terms, both nationally and internationally.

CRDC has been a long-term contributor to safety research and initiatives that help growers to implement approaches in a practical way. This investment is having a significant impact on reducing injuries and increasing returns to growers.

The lower workers compensation premiums paid by the cotton sector in comparison to other agricultural sectors, and the steady decline in these premiums, are strong indicators of how good health and safety performance can reduce costs and contribute to better profitability. Workers compensation rates for the cotton industry are considerably lower than that for other comparable sectors. The rate is 56 per cent below that of beef cattle producers and 32 per cent below sheep producers and mixed cropping-livestock farmers.

CRDC investigated farm worker health in its first year of operation, when it commissioned a study into the effect of pesticides on farm workers. Soon after, CRDC developed the *Managing Cotton Farm Safety* resource for cotton farms. This comprehensive resource was later used for the *Managing Farm Safety on Cotton Farms* course supported by CRDC, with over 500 cotton businesses participating.

In the years since, CRDC has been involved with various safety campaigns and the production of safety resources to keep up to date as the industry evolved. With the advent of round bale cotton pickers, this has included the Cotton Harvest Safety material.

CRDC was also a partner in the Farm Health and Safety R&D Program managed by the Rural Industries Research and Development Corporation.

This *Managing Cotton Farm Safety* resource remained a pivotal resource and has been updated over time. With the advent of the web-based *myBMP* program, most of the industry's WHS resources were transferred to the system, and the manual is an important reference tool. Helping growers identify risks on cotton farms, providing practical resources, and agricultural extension to help growers strive for best practice, have all contributed to the industry's improved safety record.

Recent independent reports by the Australian Centre for Agricultural Health and Safety have shown that through implementing best management practices and the application of new technology such as transgenic cotton, hazards on cotton farms have been drastically reduced.

Recent independent reports by the Australian Centre for Agricultural Health and Safety have shown that through implementing best management practices and the application of new technology such as transgenic cotton, hazards on cotton farms have been drastically reduced.

The industry's focus on good health and safety has also been a beneficial part of the Better Cotton Initiative, which takes into account work health and safety.

The attention paid to health and safety through the *myBMP* platform allows growers to more easily meet the health and safety requirements of the industry and the Better Cotton Initiative.

Because it is committed to continual improvement to WHS, and to making Australian cotton farms even safer, CRDC is a partner in the Primary Industry Health and Safety Partnership (PIHSP). The partnership seeks to make farms safer by studying barriers to the adoption of farm safety measures. Through PIHSP the cotton industry is focusing on delivering a clear message – that systematic hazard and risk management can improve the safety and sustainability of Australian cotton farms.

- The relevant proportion of time lost and related compensation costs within the cotton sector represented approximately 0.1 per cent of all time lost and costs in Australian agriculture.
- The median time (weeks) off for injuries in the cotton sector (1.35 weeks) was around one-third of that for the grains sector and less than half that of all agriculture.
- The median cost of all injuries was around \$2,150 in the cotton sector, which was significantly lower than the median for the grains sector (\$4,275) and all Australian agriculture (\$7,100).

Source: Cotton Health and Safety Profile 2014 Update, authored by the Australian Centre for Agricultural Health and Safety, with support from CRDC.



MELANIE JENSON

Agronomy for Future Farming Systems

- Vegetative Growth Rates and Pix responses
- Future Dryland Cotton Systems.
 - Strategic approaches including Planting time, row configuration and Varieties.
 - Novel approaches including use of growth regulants and hormones.
- Late season options due to weather and pest damage.



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INDUSTRY'S CROWNING EVENT

The Australian Cotton Conference exemplifies the saying that 'from little things big things grow'.

The conference the industry knows today, which attracts some 1800 delegates, started as the Australian Cotton Growers Research Conference in 1982 with a small gathering at a church hall in Goondiwindi in Southern Queensland. This biannual event is now one of the biggest of its kind anywhere in the world, and perhaps the most anticipated event on the cotton industry calendar.

Held at the Gold Coast Convention Centre, the three-day event features a group of speakers and session leaders from Australia and around the world, all of them leaders in their fields of research or business. It's a place where growers, researchers, business and industry can come together to meet others in the industry, share ideas, ask questions and gain knowledge. The event also hosts a trade hall and the Cotton Industry Awards.

The Australian Cotton Growers Research Association (ACGRA) held the conference, and the events associated with it, until 2010 when ACGRA and Cotton Australia merged. In that year, the Australian Cotton Shippers Association (ACSA) also came on board. ACSA's involvement broadened the scope of the event to cover the entire production chain, with information and speakers related to all aspects of shipping and marketing, and an examination of cotton in a global context. The conference has come a long way since the small gathering in 1982. In 2014 at the 17th conference, more than 100 presentations were made to the 1850-plus delegates.

At its inception 25 years ago, CRDC became a foundation sponsor of the conference. Since then, CRDC has continued to grow its support for this vital conduit of information and opportunity for the industry to come together to share ideas and knowledge.

Support for the conference forms an important part of CRDC's commitment to research, development and extension, as described in its objectives outlined in its first annual report in 1990-91.

CRDC is proud to be a foundation sponsor of this event which provides a direct channel for communicating information on research to growers, consultants and agribusiness, for relationship building between growers and researchers, and for researchers to communicate with each other. CRDC is committed to the importance of this event and the role it plays in ensuring the industry remains cohesive and progressive. The conference is organised and run by a committee of dedicated growers, researchers, shippers and representatives from CRDC, Cotton Australia, ACSA and supply chain partners including consultants. It is no mean feat to pull it together.

Darling Downs' cotton grower Stuart Armitage is the 2016 conference chair and says support from CRDC as a foundation sponsor underpins the viability of the event.

'CRDC's support enables the conference to secure interesting and informative speakers that provide not only great insights to the cotton industry, but also stories of personal development,' Stuart says.

'CRDC's support also assists in keeping delegate registration rates affordable.

'The Australian Cotton Conference is Australia's largest agricultural conference and is well regarded not only within our industry, but also by other agricultural sectors and internationally.

'There's no other conference like this within the cotton industry on the world stage: there are conferences specifically for farmers, for merchants and supply chain partners, but not an all-encompassing industry event like our very own Australian Cotton Conference, which is testament to the cohesiveness of our industry.'

MELANIE JENSON



The Australian Cotton Comparative Analysis (ACCA) report is an important document which CRDC and all irrigated cotton growers can use to identify where gains, efficiency and sustainability can be achieved in their own businesses.

Now in its 31st year, it provides an insight into the impact of technology or practice change on profitability, and gives CRDC indicators as to where research and development and extension is having an impact – or where it needs to focus.

The ACCA report has been compiled independently by Boyce Chartered Accountants since 1984. CRDC began investing in the report in 2005 to promote the collation and value of benchmarking information for improving the economics of cotton production to the entire industry. The primary purpose of the ACCA is to benchmark, on a per hectare basis, the income and expenses associated with growing fully irrigated cotton.

The reliable, independent figures in the analysis provide the starting point for growers to compare, question, understand and drive improvements in the financial performance of their own cotton production.

CRDC and Boyce see the ACCA report as a management tool to identify best practice and where effort might best be directed to improve both financial and sustainability outcomes. The comparative statistics can be used by growers to identify relative strengths and weaknesses in their enterprises, and to better develop budgets and long-term business plans to focus on strategies to improve farm profitability and build on their strengths.

The report provides industry with the capacity to analyse trends and understand the range of performances in production, costs and

profitability. For CRDC that's incredibly helpful: to understand where in the production system it can focus RD&E to facilitate improvements in profitability.

Boyce's Paul Fisher says having 30 years of data gives the cotton industry perspective in terms of the profit outcomes related to physical changes over that time. Profit results can be overlaid on events such as the introduction of Bollgard, and the adoption of round bale technology, GPS, improved irrigation methods and so on.

Furthermore, the report enables an analysis of the cotton industry from birth to its effective maturity today. Coupled with other information on factors like asset values and physical indicators such as people, water and horsepower, it also allows for scenarios to be mapped in the developing growing valleys. This combination of data and physical information promotes more effective decision-making and improved performance.

Paul Fisher also says that in terms of information sharing in agriculture, the cotton industry is 'out in front' and CRDC's support in promoting the benefits of benchmarking and extending the results of the analysis has been beneficial in bringing awareness of the project to the broader cotton community. Growers participating in the analysis are able to compare their own figures to their valley's average, and to all farms and longer-term averages. The opportunity for participants to discuss results in an open forum, along with the open publication of the analysis, benefits the industry more broadly.



smallest crop

The 2007-08 cotton crop was the smallest produced in over 30 years – directly influenced by the worst drought in living memory – with only 63,000 hectares planted, producing 600,000 bales.

largest crop

Australia's average yearly cotton production has risen dramatically from 9,000 bales in the 1960s to its peak 5,300,000 bales in the 2011-12 season.

MELANIE JENSON







Encouraging growers to instigate local research and development projects is achieved through the CRDC Grassroots Grants program, introduced in 2011.

The program enables Cotton Grower Associations (CGAs) to apply for funding to support capacity building projects in their regions. Grants of up to \$10,000 are made available for CGAs to help fund projects aimed at increasing the engagement of growers in the industry, and at solving specific regional issues and improving skills, knowledge bases and networks.

From 2011 to 2015, CRDC has invested more than \$380,000 in 44 projects across the cotton growing valleys – from weather stations to crop nutrition workshops.

CRDC Executive Director Bruce Finney says the promotion of local, grower-led research to the greater industry is invaluable.

‘Grassroots Grants provide growers with opportunities for local action and innovation to complement whole-of-industry RD&E, making beneficial on-the-ground gains,’ he says.

‘The grants also have a legacy effect - they provide skills to growers to increase their ability to address local issues or needs, improve their capacity to devise and manage projects, and offer the option to collaborate with other funding bodies to extend or enhance projects.’

‘Projects like spray workshops, health and safety workshops, on-farm trials or BMP workshops offer participants the long-term benefits associated with practice change. Investments in technology, such as weather stations, enhance growers’ decision-making capabilities. And projects that engage local communities, particularly schools, have been highly successful in introducing people to, and building understanding of, the cotton industry.’

One such example was a Grassroots Grant awarded to the Menindee and Lower Darling CGA in southern NSW to help build the relationship with a local high school. Under the grant, Tandou Farms provided a small spray rig and agronomy staff to assist the school’s agriculture students develop and maintain the school’s ag plot. This helped build awareness of the industry, develop practical skills among the students, and educate them about future career opportunities. Meanwhile in QLD, high school teachers in the Dawson Valley have developed a greater understanding of the cotton industry through attending the CRDC-supported Field to Fabric course through a Grassroots Grant secured by the Dawson CGA. This upskilling of the teachers has a natural flow on benefit to students and the local community.

Other projects supported thus far under the CRDC Grassroots Grants program have a more immediate community benefit, such as those that address mental health through empowerment workshops. The Border Rivers region received an overwhelming response to their support and education days which targeted women on cotton farms through a Grassroots Grant.

Other Grassroots Grants have a more on-farm focus. The industry as a whole benefits through projects on issues such as soil compaction: a workshop undertaken in the Gwydir Valley was able to transfer its learnings across the industry.

The flexibility of the Grassroots Grants program adds to its relevance and popularity, and allows local RD&E projects to be targeted to specific grower needs – be it through formal workshops or informal on-farm tours. The program remains an ideal way for growers to identify and address a local issue or need, and participate in the industry’s inclusionary RD&E.



Thinking positively about the long-term future of the Australian cotton industry in the midst of a record drought and downturn in production is possibly counter-intuitive.

But a group of industry leaders saw this as the absolute best time to develop ‘a shared vision that inspires and unifies the Australian cotton industry’. That vision is now known as Vision 2029. In 2009, industry leaders came together through the Australian Cotton Industry Council to develop a plan for the future that could enhance the industry’s performance, collaboration and capacity. As a result, the Vision 2029 project commenced and included representatives from organisations involved in all aspects of the industry from input suppliers through to marketers.

CRDC Executive Director Bruce Finney has been instrumental in the creation of this shared industry vision. He says a 20-year timeframe was chosen in order to stretch thinking beyond the short-term and to ensure a longer-term strategic focus.

Vision 2029’s tag line is ‘Australian cotton: carefully grown, naturally world’s best.’

‘The goal is to reposition the industry in the global marketplace and achieve superior industry performance underpinned by collaboration, and by the passion and innovative nature of people within the Australian cotton industry,’ Bruce says.

‘Through consultation with industry via stakeholder surveys and scanning activities, the trends, assumptions and driving forces that could influence the industry’s future were identified.

‘Four scenarios were developed identifying possible futures our industry might face: Boom, Bust, Food Replaces Fibre and Present Day Projection.

‘From these scenarios the Vision 2029 was developed, and more importantly, we identified what the industry would need to be to achieve it.’

Vision 2029 identified that our industry needs to be:

- **DIFFERENTIATED** – world leading supplier of elite quality cotton that is highly sought in premium market segments.
- **RESPONSIBLE** – producer and supplier of the most environmentally and socially responsible cotton on the globe.
- **TOUGH** – resilient and equipped for future challenges.
- **SUCCESSFUL** – exciting new levels of performance that transform productivity and profitability of every sector of the industry.
- **RESPECTED** – an industry recognised and valued by the wider community for its contribution to fibre and food needs of the world.
- **CAPABLE** – an industry that retains, attracts and develops highly capable people.

‘In the six years since its inception we have come a long way towards achieving our goal,’ Bruce says.

‘Industry organisations have aligned their strategic plans with the vision and there has been good progress towards our objective.

‘Two examples particularly stand out: firstly Cotton Australia, with the support of CRDC’s past and current research, commenced the Cotton to Market strategy in 2014. The strategy leverages cotton industry best management practices, via the myBMP program, to differentiate Australian cotton. It does this directly to apparel brand owners and indirectly through partnerships with the Better Cotton Initiative and CottonLEADS.

‘A second related achievement has been the development of the world-first cotton industry sustainability report which benchmarks the social, environmental and economic performance of Australian cotton.’



CRDC STAFF Alison Carberry, Executive Director Ralph Schulze, Kym Orman and Technology Transfer Specialist Bruce Pyke.



CRDC STAFF (back row left to right): R&D Manager Jane Trindall; General Manager Business and Finance Graeme Tolson; Accountant Emily Luff; Executive Assistant Dianne Purcell; CottonInfo Program Manager Warwick Waters; and Communications Manager Ruth Redfern. **At front:** Executive Director Bruce Finney; Clarity Assistant Marg Wheeler; Project Admin Assistant Megan Baker; Assistant Accountant Ginny Taylor; Project Admin Assistant Amy Withington; General Manager Research and Development Investment, Ian Taylor. Absent: R&D Managers Allan Williams and Susan Maas.

CRDC was established in October 1990, replacing the Cotton Research Council, which was also based in Narrabri, NSW.

At this time, CRDC's stated functions were to:

- Evaluate the industry's R&D needs
- Co-ordinate or fund R&D activities
- Monitor and report on the activities co-ordinated or funded
- Encourage the dissemination, adoption and commercialisation of the results of the R&D

CRDC's R&D activities during 1990-91 were based on the Cotton Research Council's five year R&D plan and Annual Operating Plan for that year. The 1990-91 season was described as one of good prices, good yields and high quality cotton. Despite heavy insect pressure in all regions and cyclones in Queensland, the Australian crop at 1.8 million bales was 42 per cent more than the previous season.

The key issues identified as requiring R&D focus included:

- The industry's dependence on agricultural chemicals, particularly for pest control
- The sustainable use of resources
- Product quality and market requirements
- Cotton growing profitability
- Transfer of technology to industry
- The human and other resources involved in the R&D effort

The overall emphasis was on maintaining the productivity lead that the Australian cotton industry had over many competing overseas suppliers, and on reducing costs. The Cotton Research Council's program had included projects to investigate the

development of non-chemical means of pest control and CRDC gave increased priority to these projects in its own planning.

The first CRDC-led R&D program in 1990-91 was implemented through partnership with growers, researchers, consultants and the Australian Cotton Growers Research Association (ACGRA). ACGRA offered sound practical advice, assisted with the development of various research projects, and proffered constructive advice about CRDC's future programs.

CRDC 1990 BOARD

CHAIRMAN
John Blood, consultant, Collingwood Victoria.

EXECUTIVE DIRECTOR
Ralph Schulze, agronomist, Narrabri NSW.

GOVERNMENT DIRECTOR
Dr George Reeves, (then) Department of Primary Industries and Energy, Canberra ACT.

DIRECTORS
Dave Anthony, Auscott Namoi Valley, Narrabri NSW.
Don Dyer, Textile, Clothing and Footwear Development Authority, Canberra ACT.

Dr Vic Edge: Biological and Chemical Research Institute, Rydalmere NSW.

John Grellman, cotton grower, Wee Waa NSW.

Dr Jim Peacock, CSIRO Division of Plant Industry, Canberra ACT.

Ian Thomas, cotton grower, St George QLD.

2015 marks 25 years of CRDC: 25 years of driving continuous improvement and transformation in Australia's cotton industry.

CRDC's purpose continues to be to enhance the performance of the Australian cotton industry and community through investing in research and development, and its application.

In 2014-15, CRDC invested \$22.8 million in 239 RD&E projects on behalf of Australia's cotton growers and the Australian Government. Activities were based on the five key areas identified in the CRDC 2013-2018 Strategic Plan: farmers, industry, customers, people and performance.

Highlights of this year included the release of the first *Australian Grown Cotton Sustainability Report* and the first Herbicide Resistance Management Strategy; the inaugural CRDC Strategy Forum; the commencement of four feasibility studies under the Cotton Futures program; the announcement of the \$4 million Smarter Irrigation for Profit project under the Rural R&D for Profit programme; and several major events taking key researchers out into the field with growers.

Australia's high yields and reliability as a supplier of high quality cotton with attributes of superior staple length and strength, uniformity and low contamination continued to be the industry's competitive advantage.

The 2014-15 season saw record yields across many valleys, with average lint yields of 11.8 bales per hectare. This was despite challenging early season weather and low water allocations. A total of 197,000 hectares was planted, down 50 per cent on the previous season, producing 2.3 million bales.

Weather was but one of a number of challenges faced by the industry during the year, with fluctuating cotton prices and international market changes providing external pressure, prompting CRDC to invest in a unique world-leading project in agriculture to assess the resilience of the cotton industry at multiple scales. The key issues identified as requiring R&D focus included:

- Cotton industry profitability
- Biosecurity and input stewardship
- Production variability
- Competition for and access to resources
- Environmental performance
- Climate variability
- Social awareness
- Competitiveness to man-made fibre
- Competitiveness to other cotton producers

CRDC 2015 BOARD

CHAIR
Dr Mary Corbett, company director, Boonah QLD.

DEPUTY CHAIR
Cleave Rogan, cotton grower, St George QLD.

EXECUTIVE DIRECTOR
Bruce Finney, Narrabri NSW.

DIRECTORS
Greg Kauter, consultant, Emerald QLD/Sydney NSW.
Elizabeth Alexander, consultant, Emerald QLD.

Dr Michael Robinson, CEO Plant Biosecurity CRC, Canberra ACT.

Kathryn Adams, agricultural scientist and lawyer, Gold Coast, QLD.





Where to from here?

COTTON RD+E AND THE NEXT 25 YEARS

The Australian cotton industry has been a ground-breaker since its first days in the 1960s. The pioneers overcame a lack of infrastructure, inexperienced labour, floods, weeds and pest infestations.

They could see the potential and knew that help comes to those who help themselves. In this spirit, they sought solutions through attracting agronomists, plant breeders, entomologists and other scientists to the fledgling industry.

These foundations of forward-looking leadership, tenacity and commitment to R&D-based solutions have been, and will continue to be, important to the success of the Australian cotton industry.

CRDC recognises that while it can plan for the future, it also exists in a changing operating environment and it is not just its ability to identify possible change that is important, but also the ability to respond to these challenges and seize opportunities.

As the industry matures and cotton's place in the textile market evolves, expectations for R&D outcomes must become more ambitious.

CRDC and the industry are not only seeking to protect its current competitive advantages of high yield, superior quality and responsible production practices, but most critically, CRDC is also driving profitability through innovation: the application of digital technologies to transform cotton production and supply chains.

Similarly, the industry must look for new competitive advantages for Australian cotton in the face of increasing competition from man-made fibres for market share in apparel.

The application of material science and knowledge from unrelated industries could enable the creation of new uses for cotton in high value products such as flexible batteries.

Equally, there are exciting opportunities for introducing open innovation processes and new R&D collaborations with existing and new research partners to ensure CRDC remains at the cutting edge in delivering impact from industry and Australian Government investment in cotton RD&E.

The next 25 years could see the Australian cotton industry entirely transform as we embrace, and capitalise on, the opportunities, technologies and partnerships ahead.

CRDC has started this process through its Cotton Futures program, which invests in progressive, innovative concepts that have the potential to add \$4 billion per annum to the gross value of Australian cotton production.

Concepts like agri-intelligence systems, autonomous farming, atmospheric water resources, carbon neutral farming, alternative cotton gin trash uses, dissolving cotton, cotton as a substrate for carbon fibre, and using cotton for 3D printing – are all potential blue sky concepts that could rapidly change our cotton system.

The future may be complex and uncertain, but, as it was in the beginning, it will be the extraordinary capacity of our people that will keep us on track to achieve the industry's vision for the future.



25 Years

To acknowledge 25 years of CRDC-led cotton RD&E, 25 industry identities have been enlisted to provide their thoughts on the importance of cotton RD&E and the role of CRDC. These 25 voices represent the many facets of the Australian cotton industry – from growers to government, researchers to representative bodies.

In addition to these 25, each individual who has worked in, or contributed to, the Australian cotton industry over the past 25 years has helped to shape the industry into the success story it is today. CRDC wishes to thank all the growers, researchers, scientists, policy makers, advocates, consultants, educators, students, industry partners, communities and other supporting individuals and organisations who have given their time for the betterment of the industry. The cohesive nature of the industry has been integral to its success.

CRDC's ability to remain close to the coal face, as first Executive Director Ralph Schulze says, remains a shining light for other agricultural industries, and has resulted in targeted and strategic research that delivers real benefits to Australian cotton growers and the wider industry. It has been, and continues to be, a combined and collaborative effort.

“The demand for Australian cotton world-wide did not happen by accident. The Australian cotton industry is like a wooden bucket made from many planks. All the planks must be sound and put together in such a way that there are no leaks for the bucket to fulfil its role.”

Ralph Schulze



RALPH SCHULZE

Executive Director, CRDC (1990–2004)

Before CRDC there was a great culture of respect for research in our industry through ACGRA. With such a good foundation to build on, the formation of CRDC brought with it additional funds and people, and specifically placed CRDC in its role of coordinating RD&E.

Australian cotton growers are extremely quick to adopt new technology. The cotton industry is unique in the close relationship between researchers, growers and consultants, who have built up a mutual dependence born out of respect. With the early challenge of insects and resistance, mutual respect between researchers and growers was forged. This relationship grew when researchers developed strategies to successfully manage resistance issues.

There is one essential ingredient in the success of research: uptake. Facilitating the rapid adoption of research has always been a focus for CRDC. A crucial part of this is guiding and encouraging feedback from growers to researchers. CRDC has remained close to the coal face and this is in part a bonus of being based in Narrabri. At present, it is the only rural industry research and development corporation based in a production area.

The cotton industry should be proud of the relationship between CRDC and industry. The industry should also be proud of CRDC's relationship with other research providers.

Early in the piece we knew that developing a program to get a Cooperative Research Centre going would give us more research opportunities and capability and CRDC also expanded the research base to universities. This willingness to bring in research providers and collaborate is a credit to the corporation. This extends to international collaboration through continuing strong support for researcher participation in events such as the World Cotton Research Conference.



BRUCE FINNEY

Executive Director, CRDC

In 1990 the average Australian cotton yield was 6.5 bales per hectare, with grower profitability impacted by floods and rain at harvest. I lived in the Macquarie Valley at that time, and well recall the devastation caused by the floods.

At the same time the whole industry was under intense government and public scrutiny for its use of pesticides due to three fish-kill incidents and media stories regarding a report into childhood leukaemia in Emerald. Some shire councils were proposing bans on cotton production or spray buffer zones of up to eight kilometres. Plainly, these were incredibly challenging times for growers and the Australian Cotton Foundation (now Cotton Australia).

In 2015 the average Australian cotton yield was a world record high of 11.8 bales per hectare, with grower profitability constrained by a lack of water to grow more area. That said, it was another year of significant expansion of cotton production in southern NSW, with many first-time growers enjoying good results. As an industry we enjoyed ongoing recognition by governments and brand owners for being a cohesive, innovative industry committed to improving upon its existing best practices for responsibly producing cotton.

There have been many ups and downs in between but throughout, Australia's cotton growers have enthusiastically sought and placed great importance on the value of R&D based solutions to what at times were seemingly insurmountable challenges. Today, when a first-time grower achieves industry average or better yields, it demonstrates not only their significant skills but also the results of 25 years of strategic leadership by CRDC in world leading research with our partners. I could not be more optimistic about the future of the Australian cotton industry and the contribution R&D will continue to make towards its success.



JOHN BLOOD

Inaugural Chair, CRDC (1990–2000)

A key to the success of CRDC and the cotton industry is that it started with a group of dedicated and passionate people with a wide range of interests. CRDC had the support of growers, research providers (in particular CSIRO), government bodies and agriculture departments. We also had a great foundation to build on laid by the Cotton Research Council.

CRDC was made up of people who had the capacity to connect with growers. To get growers involved in RD&E was a significant step at the time. The linkages that occurred were tremendous, and a lot were new farmers with open-minds and a taste for innovation. Growers were at the heart of the industry and bought new ideas with them.

When CRDC was formed, we had our work cut out for us. The industry was under pressure and environmental concerns meant that for it to grow, it had to be nurtured and encouraged. CRDC had a role to play in helping researchers and growers to find a way through this, while at the same time improving the environmental outcomes to build a strong, sustainable industry with a social licence to farm. We were acutely aware of our social responsibilities and the development of the Best Management Practices (BMP) Manual was a great outcome and achievement for CRDC and the industry. The BMP program has continued to serve the industry well.

Integrated pest management and in particular the early and continued development of Australian varieties were game changers. The continuing and sustained support by CRDC for plant breeding has been a key to the industry's success. Much of the success of the modern industry is based on the well suited, high yielding and disease tolerant varieties available to growers, backed by further research to get the best out of them.



BRIDGET JACKSON

Chair, CRDC (2000–2006)

Cotton growers rely on continued research in difficult world market conditions to maintain their competitive advantage. RD&E has been almost totally responsible for cotton's yield increases, and for decreases in inputs and management costs.

This has occurred at such a rate that cotton has continued to be competitive with other summer crops, shown by the expansion of the regions where cotton is grown.

Water for irrigation is a scarce resource in Australia, and a major effect of RD&E has been to increase yield of cotton per megalitre of water. This is a result of improved varieties and RD&E into water use efficiency and technology.

CRDC has used its funds wisely to make strategic investments into RD&E with key research providers, including improved varieties incorporating transgenic traits, pest and weed management research and cropping systems.

It has put considerable effort into employing proactive and skilled people, and has had a major input into ensuring, for instance, that transgenic varieties have been adopted appropriately using IPM and world-leading stewardship of the technology. CRDC has also been instrumental in ensuring communication throughout the industry is built and maintained.

CRDC has been a leader in ensuring that the industry maintains its social licence. It was the first to instigate regular environmental audits and assessments of the industry, and remains at the forefront of sustainability through the development and adoption of best management practices.

CRDC invests heavily in skills development across the industry. The cotton industry has always been progressive, with a culture of equality that is clearly evident today in the number of vibrant young women in the industry. It has been a delight to have been involved in CRDC and the Australian cotton industry's progress. Its innovative modus operandi is watched with interest and envy by other agricultural industries around the world.



DR MARY CORBETT

Chair, CRDC

The Australian cotton industry has long been lauded as unified, innovative and responsible, and is renowned globally for producing the highest yielding quality product in the world.

This doesn't just happen. It is the result of sustained investment in RD&E, a shared industry vision, and a commitment by all sectors of the value chain to upholding this legacy while demonstrating environmental, social and commercial stewardship of the land.

Of course the output from RD&E is limited without the resolve and foresight of the many cotton growers who are not content with the status quo and who are prepared to push the bounds of knowledge and know-how and take risks experimenting with, and implementing, new, leading edge practices and technology. Therein lies the real strength of the cotton industry: its ability to identify needs, engage in the investment process, and be ready to adopt the outputs for continued sustainability.

CRDC has always been much more than a coordinator and prudent investor of levies and government contributions. In partnership with other industry bodies, CRDC led the development of the Cotton Industry Vision 2029. This important statement about the future not only identifies challenges and opportunities, but guides future investment in RD&E.

CRDC, with input and collaboration from across the cotton industry and other agricultural sectors, has taken a strategic perspective of the varied cotton landscapes to determine core areas of need. The organisation has played a vital role in driving innovation whilst harnessing and expanding the talents of researchers and growers alike. And throughout this process, CRDC has diligently managed their investment portfolio to ensure maximum benefit to industry even through times of drought.



CLEAVE ROGAN

Cotton grower, St George QLD
Deputy Chair, CRDC

Cotton research has guided our industry to a level that is now the envy of the rest of the world. With our fibre marketed on a global scale, it is imperative that we continue to operate at the top of our game in both growing and research, to keep up with changing markets, consumer perceptions and an appetite for increasingly higher quality cotton.

The cotton community's respect for research and the relationships and links between growers and researchers is a credit to our stewardship and the resilience of the modern cotton industry.

Growing cotton has thrown up many challenges to growers, researchers and the CRDC over the years. Along with issues such as insects, resistance and disease, we also are managing crops in an ever-variable climate, with severe drought and flooding, coupled with fluctuating commodity prices. Against this backdrop we want to grow more cotton using less water and fertiliser, at a lower cost and with less environmental impact. CRDC's investment in research has informed action to produce knowledge that is applicable to building this successful industry.

This is highlighted in the foundations in applied sciences and the fluid approach to new ideas that is the basis of the success of the modern Australian cotton industry. Despite many early challenges, and the new challenges that have emerged along the way, we have become more efficient and our industry has responsibly grown to operate alongside and within the constraints of our land and communities, wherein lies the value of CRDC research investment.

It is a credit to the industry as a whole that, due to the passion and hunger for innovation, combined with world leading researchers and growers, Australia produces cotton that is world renowned.



DR IAN TAYLOR

General Manager R&D, CRDC

When I first joined the cotton industry as a researcher at the Australian Cotton Research Institute almost 20 years ago I was in awe of the research leadership and the willingness of established researchers to give up their time to discuss ideas and impart their understanding of the cotton system.

As I got to know the industry better, the same cohesiveness, leadership and willingness to collaborate was also evident throughout the leading cotton organisations and it became easy for me to understand how a country that only produces three per cent of the world's cotton could be such a dominant force in the global arena.

While I loved conducting my own research, I also determined that it would be a privilege to work alongside so many of the people that have helped shape the industry through RD&E, so in 2005 I joined the CRDC team. I was fortunate to work alongside very capable and influential people in Bruce Finney, Bruce Pyke and Adam Kay; thought leaders who are passionate about this industry and its future. The heart of this industry is its people, the resilience of growers and the support they give to R&D, the researchers who work diligently on the many challenges of maintaining the highest cotton yields in the world, and the CRDC team who strive to ensure that the research we invest in meets the needs of growers now and into the future.

World leading RD&E has underpinned the Australian cotton industry since its inception, and CRDC has been a significant contributor to this research effort for the last 25 years. We look forward to being a part of this vibrant and dynamic industry for another 25 years.



BRUCE PYKE

R&D Manager and Extension Coordinator,
CRDC (1992–2012)

Much of the success of the Australian cotton industry is due to its growers who, compared to other agricultural industries, are younger, more heavily weighted with early adopters, more innovative and generally have been better led.

However, in spite of these advantages, without its RD&E, the Australian cotton industry would probably have failed some time during the late 1980s to early 1990s. This would have been due to high costs and declining yields as a result of uncontrollable *Helicoverpa armigera*, increasing disease pressures and soil structural decline.

Instead, the industry survived these threats through world leading management of resistant insects and cotton varieties with increased disease tolerance and increased yields, as well as improved soil management and crop rotation practices – all based on the application of knowledge and products from research. In addition, having survived the challenges of the 1980s and 1990s, the industry was in great shape to exploit and manage the new production era of the 2000s underpinned by biotechnology and world leading Australian bred varieties.

When CRDC was established, the capacity to strategically invest in and lead the direction of cotton R&D was greatly enhanced by the vital oversight of the Australian Cotton Growers Research Association (ACGRA) and more recently by Cotton Australia. CRDC has been a central and key player in the leadership, direction and support of much of the industry's R&D effort for the last 25 years. It provided important leadership in the establishment of the first Cotton CRC and its support was essential to the success of all three cotton CRCs.

If CRDC had not existed and the industry had not increased its level of R&D funding to compensate, it is highly likely that the industry would have taken many more years to reach its current size and level of productivity.



ALLAN WILLIAMS

R&D Manager, CRDC

The importance of research to the Australian cotton industry – and critically, the strong support for investing in research from growers, who agreed (voluntarily) to pay 25 cents per bale in 1973 – was fundamental in its successful establishment.

Actively participating in on-farm research and setting a research direction was part of cotton farming for my family. While too young to remember my father Richard's involvement in establishing the Australian Cotton Growers Research Association (ACGRA) in 1972, I have strong memories of that time: of hours spent roaming the labs at CSD while he discussed variety and seed quality testing, of plugging the handpiece of the phone into the modem to dial into the industry's first decision-support tool SIRATAC, and of waiting for him to return from Canberra after discussions with CSIRO, or after the changeover negotiations for the transition from the Cotton Research Council to CRDC with Minister John Kerin.

While a career in cotton research was far from my mind when I left Wee Waa to study, in hindsight it was probably inevitable. And CRDC has been at the heart of my involvement in cotton since returning to Narrabri.

CRDC's relationship with growers and consultants has been a key component of the industry's success, through ACGRA, Cotton Australia and Crop Consultants Australia. The close and active involvement of growers in prioritising research, hosting farm trials and recognising researchers all contribute to an informed and highly regarded RD&E effort.

It is a privilege to continue to play a role in managing the research effort that is so important to the ongoing success of the Australian cotton industry.



THE HON. BARNABY JOYCE MP

Deputy Prime Minister, Minister for Agriculture and Water Resources

Agriculture sits at the heart of the Australian economy, and Australian farmers are some of the most productive, resilient and sustainable producers of food and fibre on the planet. Investment in research and development is one of the ways governments can help them keep this deserved reputation.

R&D is critical to agricultural productivity. For the past 25 years, the Australian Government has recognised this through its investment in the research and development corporations (RDCs). Established in 1990 as a joint government and industry partnership, the RDCs – including CRDC – continue to invest in research, development and extension, driving improved farm-gate returns.

ABARES has found that for every dollar the government invests in agricultural R&D, farmers generate a \$12 return within ten years. So it's a simple equation for us to invest.

Investment in smarter approaches to farming underpins the productivity of our food and fibre industries. Cotton's R&D investment, led by CRDC, has reduced insecticide use by 92 per cent and improved water use efficiency by 40 per cent over just 15 years. This reduces costs to our cotton growers, helping ensure that in a good year, they can expect decent terms of trade.

We want cotton growers – and all agricultural producers – to continue to have access to the most advanced technologies and practices as well as the skills and labour to drive innovation and growth. The government already provides around \$700 million a year for rural RD&E and that's why we'll continue to invest in this critical area.

I congratulate CRDC on its 25 years of service to the cotton industry.



DARYL QUINLIVAN

Secretary, Australian Government Department of Agriculture and Water Resources

Innovation is recognised as a driver for productivity growth. The Australian cotton industry is highly technical and innovative and has transformed itself through the uptake of new technology.

The ongoing success of the Australian cotton industry depends on adoption of research and development to drive on-farm productivity growth. CRDC has achieved much over its 25-year history and has returned significant benefits to growers and society at large from the investments it has made.

Much of this benefit resulted from the partnership between CRDC and the industry in developing and successfully adopting transgenic (Bt) cotton varieties. This has been much more than a quick fix, and it has enabled chemical use reductions and the significant uptake of integrated pest and weed management. For gains to be realised, advances identified via research must be developed into tools that can be readily adopted.

Past innovation has increased productivity in agriculture and there is wide scope for future gains. Future productivity gains may come from the integration of developments from other sectors such as engineering, mining, information and communication technology (ICT) and data analytics. Technologies that may increase productivity include robotics, imaging, nanotechnology, gene technologies and integrating ICT with farm equipment.



ADAM KAY

Chief Executive Officer, Cotton Australia

Australia's cotton industry has a commanding place in the world cotton market. We produce the highest quality fibre in the most responsible and sustainable fashion. We did not achieve this enviable position by accident – it took a commitment to continuous improvement, innovation from our growers, and a solid basis in research and development.

The latter's role in our industry's achievements has been critical. Our world-leading plant breeding, farming systems and management practices are due in no small part to the commitment by all in our industry to invest in research and development (R&D) and apply it intelligently.

The results of our hard work and innovation speak for themselves. Australia's yields per hectare are three times the world average, producing a desirable fibre with virtually no contamination. Our industry has also made substantial progress in sustainability, which has become a key focus for the sector. Today, Australian cotton growers grow more cotton on less land, with more efficient water use and with less impact on the environment than ever before. In the past decade alone we have made a 40 per cent increase in water productivity, and reduced insecticide use by 92 per cent.

Without our commitment to R&D, Australia's industry could not have achieved these successes, nor held its valued position in the world market.

CRDC and the grower co-investment model have been essential catalysts for our industry's progress, guiding funding to the areas where it will do the most good and helping growers to make substantial efficiency and productivity gains. Cotton Australia and our growers value the strong relationship with the CRDC and the important work it funds on behalf of the industry.



PETER GRAHAM

Managing Director, Cotton Seed Distributors Ltd

It is great to have the opportunity to congratulate CRDC on 25 years of excellence in RD&E.

Among the many CRDC initiatives, I am particularly pleased to be part of the evolution of the CottonInfo team concept that originated from CRDC and has brought Cotton Australia, CRDC and CSD into a professional and synergistic partnership which continues to create real value for our industry. This team provides the conduit between research and the end user.

More broadly, this forward looking approach has seen CRDC develop, leverage and extend cotton research, demonstrating a significant return on investment of existing government funded infrastructure, and the prudent and valuable nature of ongoing government support for the Australian cotton industry.

In addition, I have seen firsthand how CRDC's work helps to sustain rural communities through enhancing cotton production at the field level. This has driven positive flow-on effects socially and commercially, including maintaining and growing employment opportunities, supporting high volume, quality crop input businesses and localised primary processing, transport and logistics.

For CSD, CRDC continues to deliver calculated and coordinated RD&E that supports our strategic aims of increasing cotton cropping areas and reliability, as well as cotton yields while improving the efficiency of cotton production in Australia. Global agriculture is continually changing. To maintain our competitive advantage we need industry leading organisations like CRDC.

Well done to everyone at CRDC.



DR GUY ROTH

CEO, Cotton CRC (2003–2007)
Program Manager, CRDC (2002–2003)

Agricultural research is important to continually improve farming practices, productivity and efficiency. Research is also important to solve problems and in some cases a crisis such as a biosecurity incursion.

A major aim of R&D investment is to accelerate the uptake or adoption of better farming practices. Blue sky research is correspondingly necessary to make revolutionary long-term breakthroughs with new and sometimes radical approaches. Getting the right balance between short-term tactical requests and longer-term strategic desires is challenging for any R&D manager. The outcomes of all this research will ultimately be increased enterprise viability or improved sustainability of the agricultural system.

CRDC has played an essential role in the development of the Australian cotton industry. The improvements in yields and resource use efficiency are well documented. However, other significant achievements by CRDC include the successful integration of the environmental and social pillars of sustainability.

Research to investigate cotton's role in landscapes has included a landmark literature review on biodiversity, followed by fostering the concept and importance of improved riparian land management along the creeks and rivers, specific investigations into soil health, birds on farms, native vegetation, and ecosystem services. Investigations into deep drainage, salinity, surface and groundwater connectivity and water quality have provided important knowledge for water resource management. The Australian cotton industry was the first in the world to report to the International Cotton Advisory Committee's sustainability standards and those of the Global Reporting Initiative in 2014. This was made possible by CRDC-funded research.

In comparison to the origins of cotton which dates back some 5000 years, science-based agriculture is a relatively recent occurrence of the last 150 years. In just 25 years, CRDC has played a significant role in this agriculture and science partnership that has led to agriculture being one of Australia's true globally competitive success stories.



DALLAS KING

Consultant, St George QLD Chair,
Crop Consultants Australia

During the 20 years I have been involved with the cotton industry, I have quite often heard comments that the Australian cotton industry is such a small market, we only account for two per cent of the world industry, so we need to just accept the status quo - I disagree completely. We have a proud history of being at the forefront of the global industry.

Continually producing the highest quality and yields in the world is due to the tenacity of our growers and the dedication and commitment of our researchers. Examples of this include Australia being the only country to have a working insecticide resistance management strategy (IRMS) prior to the introduction of Bollgard, thanks to researchers such as Neil Forrester, Lewis Wilson, Robyn Gunning and many others. Australia has also been at the forefront with new varieties which are now exported and grown all around the world thanks to people such as Norm Thomson, Greg Constable, Steven Allen and many current researchers. That Australia is the first country to grow Bollgard 3 further endorses our high standing in the world cotton industry.

Our industry has transformed from one being shaped by American pioneers to a world leader. This has only been possible due to the dollars invested in RD&E. CRDC has played the major role in ensuring a great return on investment from levies over 25 years. CRDC has provided the perfect environment for growers, scientists and consultants to come together to determine and decide what research is pertinent to the industry at any given time. In this way the CRDC has been an integral cog in linking growers, industry partners, scientists and consultants together to achieve industry's goals and ensure a great future for the Australian cotton industry.



DR MICHAEL BANGE

Senior Principal Research Scientist, CSIRO Agriculture and Food
President, Association of Australian Cotton Scientists

For me personally the CRDC has played an important role in my development as a cotton researcher and leader within the industry.

Throughout my career the CRDC has supported and facilitated research that I have undertaken personally and with others to develop new knowledge on cotton physiology and agronomy. CRDC has also helped the teams I have led to ensure research has been delivered, and has had impacts through the numerous decision aids and publications we have delivered. Sometimes, these outcomes were not always popular but certainly led to discussions that helped bring about continual improvement in the industry.

Much of our research was the benchmark which most growers and consultants were able to improve on. Ultimately though, there is nothing better for a research team than knowing that their efforts are used and valued.

CRDC has continued to invest in our research to help the industry become world class in their production practices, ensuring higher yields and quality. A recent CSIRO analysis suggested that 45 per cent of yield gains across the industry could be attributed to crop management improvements. CRDC's research has helped ensure this outcome.

Finally, CRDC has played a pivotal role in building industry capability and capacity. I have been lucky to supervise students who CRDC sponsored and who we can all now proudly promote. They are all still working in the industry today in prominent roles. I am also looking forward to supporting and leading research with the help of the CRDC; the confidence that CRDC has had in me and my teams is one of the reasons I remain committed to the Australian cotton industry.



DR JANELLE MONTGOMERY

Water Use Efficiency Technical Specialist,
CottonInfo/NSW DPI.

It is unfathomable to imagine what the Australian cotton industry would have been like without RD&E. In all likelihood we may not have had an industry at all – taking into account the early issues with pests, disease and community concerns.

The RD&E effort has given us the social licence to grow cotton today and has allowed me to become part of an industry of which I am immensely proud.

RD&E has guided us through many changes in the way we grow this intensively managed broadacre crop. CRDC has funded and partnered a whole range of organisations to ensure the needs of the cotton industry are met through good science, which is connected to appropriate delivery and extension partners. We are united in terms of being a big community which supports each other at all levels of research, growing or governance.

The doors are always open, as are our people with their ideas, concerns and research questions. There are many conduits leading back to CRDC through which research needs are expressed, whether that is through regional development officers, directly to researchers or CRDC, surveys, cotton consultants, or grower panels. Direct contact between growers and researchers has been fostered by the many and varied CRDC initiatives.

The intensive nature of cotton farming requires a certain mindset. Because it is a high risk commodity, growers are always looking for ways to reduce that risk – taking up sound, relevant research provides an avenue for this.

The cotton industry will continue to face new challenges and RD&E will continue to play a critical role. There is always something new to learn and research. I wonder where we will be in another 25 years?



DR ROBERT MENSAH

Senior Principal Research Scientist, NSW DPI
Director, Australian Cotton Research Institute

The establishment of CRDC and its location in the cotton growing region around Narrabri has helped to bond researchers to the funding body. Additionally, the CRDC research model has been very successful due to the close integration of the industry with researchers and across the supply chain.

The formation of the Cotton Innovation Network in 2012 by CRDC has helped coordinate the industry's research and development activities. The Network has ensured a collaborative and strongly cohesive approach by research provider organisations and individual researchers to achieve the industry's long-term goals of sustainability and profitability. The Network has become a channel that has enabled research provider organisations to align their strategic plans with the cotton industry, promote opportunities for improved R&D and helped individual researchers better understand where their work fits in the overall priorities of the cotton industry, delivering better outcomes for cotton growers.

I was appointed as a cotton entomologist by NSW Department of Primary Industries (then NSW Agriculture) in July 1992. Prior to my appointment I had worked overseas in many agricultural industries and also in universities. Over the years the CRDC has challenged researchers to develop innovative ideas. In my case, I developed an idea that resulted in the setup of a new Centre for the Development of Biopesticides and Semiochemicals (CBS) which is currently funded by CRDC. The newly established CBS is developing novel biopesticides and semiochemical integrated pest management products/tools to minimise synthetic insecticide use, and to provide additional revenue for cotton research through commercialisation of the products.



DR LINDA SMITH

Senior Plant Pathologist, Queensland Department
of Agriculture and Fisheries

Cotton RD&E is important because it helps growers manage diseases and pests, resulting in improved productivity, profitability and sustainability. Without the investment in research by CRDC, Australian cotton growers would not continue to achieve the highest yields and best quality cotton in the world, with the lightest environmental footprint.

A key role CRDC has played is the research support and investment of funds to address pathology and pest concerns quickly. This was the case with the detection of both Fusarium wilt (*Fusarium oxysporum f. sp. vasinfectum*) and more recently, reniform nematode (*Rotylenchulus reniformis*).

Initial investment by CRDC was crucial for the identification, monitoring and extension of farm hygiene to minimise the spread of the Fusarium pathogen to unaffected areas. Concurrently, improved host resistance was developed as well as essential research into management strategies to alleviate and avoid the disease. Today the industry has the tools to successfully manage Fusarium wilt.

In 2012 CRDC provided immediate investment to understand the distribution of reniform nematode in Theodore when it was identified. This enabled growers to quickly introduce practices to minimise the spread of the nematode to clean fields. Funding enabled the commencement of research to understand how to reduce the build-up of the population in the soil. CRDC has contributed significantly to controlling diseases in cotton, which benefits the long-term profitability and sustainability of the industry and associated rural communities.



JOHN GRELLMAN

Cotton grower, Merah North NSW
Director CRDC (1990–2000)
Chair ACGRA (1997–1999)

One of the most important roles of CRDC is the interface it provides between research and the corporation's major stakeholders, Australia's cotton producers. Since its inception, CRDC has played a major part in encouraging a climate of cooperation between the various research, grower and industry groups.

This has been best exhibited in the proactive stance CRDC has taken to enhance both the effort and resources required to address any potential threats to the production of cotton. This has come through providing support and facilities for research, along with collaboration with major partners.

CRDC gives growers the confidence to grow into the future, supported by world-leading researchers, collaboration and extension. By maintaining a close link to growers through the Australian Cotton Growers Research Association (ACGRA) and now the Cotton Australia grower panels, research priorities have remained those of growers and consultants. The Australian cotton industry is a stand-out among agricultural industries in this regard. Collaborating for the common good is intuitive but also takes leadership to enable it to happen successfully. CRDC has allowed the industry to handle complex issues in a successful way.

Support for extensive in-field testing and trials, surveys, monitoring and grower education is another crucial role CRDC has played over 25 years. Without taking research to the field we cannot give growers the confidence in research needed for widespread uptake. CRDC is perhaps fortunate to be involved with such a progressive and innovative group of farmers, who have been, not only drivers of research, but excellent adopters, which has led to the successful industry we have today.

Farming takes place in an ever-changing environment and the challenge for CRDC into the future will be to continue as a strong advocate for the already robust collaboration between producers and the research community, enabling the cotton industry to keep pace with these changes.



JOANNE GRAINGER

Cotton grower, Mungindi NSW Chair, Cotton Australia (2007–2010)
President, Queensland Farmers' Federation (2011–2015)

The Australian cotton industry is highly regarded for driving and embracing RD&E and for being an enthusiastic adopter of research outcomes. This has been key to industry success.

RD&E is important to growers because it identifies solutions for all kinds of issues and challenges. CRDC research has covered all aspects of crop and farm management, from production processes such as pests and nutrition, plant physiology and energy inputs through to broader aspects of the industry such as labour and skills, climate and weather. Research has investigated technology to drive efficiencies and sustainability which has increased cotton quality and yield. We are global leaders in agronomic management, based on relevant and useable research, coupled with the use of leading varieties. This makes for a powerful combination.

CRDC's commission of research and reporting, such as our environmental assessments or benchmarking studies, play an important role in providing data to the broader industry to support policy and advocacy positions to government and in demonstrating accountability to the wider community, ensuring our social license to operate. The result is a strong global reputation as the most environmentally and socially responsible growers of some of the best cotton in the world.

In its corporate role, CRDC has successfully established the strategic direction of R&D and leveraged public funding for a return to both industry and the Australian community. By remaining close to the industry's grassroots, CRDC has captured the passion and ideas of growers, channelled their drive, and enabled them to be closely involved with setting a research direction relevant to their needs. Beyond the farm gate, CRDC has worked with the whole of the supply chain through to processors, and it has collaborated with other industries and government on common themes to deliver the best outcomes to the grower, and thus the overall industry.



NIGEL CORISH

Cotton grower, Goondiwindi QLD
Nuffield Scholar

The Australian cotton industry is progressive, special and innovative. We've got a lot to be thankful for in our pioneers who had a vision to grow cotton here and embrace research.

Research makes us better farmers on a day-to-day basis as well as from season to season. Studies have shown the return to growers on research investment. Specialised researchers and relevant research projects are critical to getting this job done, and if we want to be the best we need to be specialists in R&D.

Australian cotton growers are early adopters of research and technology. CRDC's extension work has been very important, through the process of communicating research to growers. We've seen this with how quickly transgenic cotton has been taken up; to enable that to happen the RD&E had to be done beforehand. Research has to continue to help us get the best out of these varieties by managing them in ways which ensure the highest quality and yield return on inputs like water.

One of the biggest game changers I've seen is the research into water use efficiency and how quickly we have changed our methods and techniques. The benchmarking information was valuable to help us see what was possible and how we were performing. Other research into deep drainage, scheduling, dynamic deficits and crop requirements has been taken up, and as a result our water use efficiency has improved dramatically.

CRDC is made up of a group of forward-thinking people who aim to keep the industry continually progressing and moving forward. We haven't seen the productivity gains in other forms of agriculture that we have in cotton, and this goes back to R&D. Growers will continue to get the full benefit of research as long as it remains viable to growers and the industry.



BARB GREY

Cotton grower, Mungindi NSW
Director, Cotton Australia

There is no doubt that the Australian cotton industry wouldn't be enjoying its current position as best practice world-leader had it not been for our constant and comprehensive approach to RD&E across all fronts: environmental, economic and social.

As a grower who has lived through, in retrospect, the poor environmental practices of the 1990s, I know that we committed to, and successfully altered, cotton's then unpleasant reputation. We have relied on dedicated science to help us be better managers of resources: water, soil, people, technology, energy, waterways, riparian areas etc. We cannot underestimate the role of RD&E in maintaining our productivity and profitability, as well as our 'social licence to operate.'

From the early pioneering days of the CRDC, our researchers have continued to steer us and they have driven improvements in water use efficiency, yield increases, crop disease management, upskilling and educating our talented people, pest management - to mention a few from a diverse landscape of contributions. CRDC's RD&E enables us to be the best at what we do, with care and consideration for the environment and community in which we live and operate.

On a personal level, my professional development has been propelled along enormously thanks to CRDC's co-investment in the Australian Rural Leadership Program (ARLP). Participating in the ARLP provided me the confidence, skills and networks to step forward for industry's decision-making roles. It was all together life-changing!

Congratulations CRDC, for the past 25 years of excellent RD&E.



DAVE ANTHONY

Chair, Auscott Limited, Australian Farm Institute
Director, CRDC (1990–1999)

It may be hard for us to imagine the Murray-Darling Basin and Central Queensland without cotton production – vastly reduced economic activity; no shimmering fields of white gold in April and May dotted with harvesting activities; significantly lower GDP from agriculture; less innovation; and less employment and investment opportunities in many Basin communities. These are just some of the benefits that an industry firmly founded on research, development and adoption investment delivers.

In the early days of the modern Australian cotton industry, professional agronomists and savvy information-hungry growers were leading the way on improved and higher efficiency farming techniques. In 1972 the growers set up a voluntary research levy to fund the type of research work the industry felt was essential for its future success. They believed in science. The levy was supported 100 per cent. That support has rolled on, and with the investments by the CRDC and the three cotton-based CRCs along with the activities of CSD and various research organisations, the industry is seen as the most professional and responsible of the major agricultural industries in Australia.

Investments in varieties have been overwhelmingly successful, but optimising the genetic opportunities has come through greatly improved agronomy based on high quality research and development, mostly funded by the CRDC. Every industry faces challenges but cotton has been exceptional in that it has taken ownership of problems, and then with the aid of science and best practice, it has set about dealing with and solving these issues, being more innovative and setting high standards in stewardship and professionalism in its operations.

It has been the support and investment in science, coupled to the strong adoption ethic by an industry based on professional producers and processors, that has made this industry great.



JUANITA HAMPARSUM

Cotton grower, Breeza NSW
Director, CSD

R&D provides the foundation to progress modern farming methods and crop understanding through science. R&D creates the cutting edge technology we utilise to grow our cotton – in germplasm development, in crop management and in crop protection.

Every component has an information and technology element base which allows us to improve on the 'trifecta' – productivity, profitability and sustainability. The value of R&D is in its tested, credible and scientific rationale.

CRDC is well known for its successes in R&D investment and it is envied by many other industries. The way in which CRDC asks the right research questions about short and long term issues allows them to prioritise and allocate investments year in year out, despite the cyclical challenges of farming and fluctuations in the value of levies raised.

To get the best RD&E, the closer you are to research providers the better. CRDC has never walked away from its regional investment and ties. Locating its head office in Narrabri in the heart of a growing region where the bulk of cotton research takes place - at ACRI - was a very astute move. The industry is also unique in the link between researchers and growers. Understanding the questions or issues you are addressing ultimately gives a better outcome. This began with the Australian Cotton Growers Research Association and its relationship with CRDC was integral to CRDC's success. This culture of respect and enthusiasm for research, and its adoption by growers, are demonstrated across all growing regions. The biannual pilgrimage of the majority of growers to attend the Australian Cotton Conference is a reflection of the culture CRDC has fostered in R&D.

We would not be as sustainable and profitable as we are without the RD&E provided through the CRDC. R&D enables us to become better at what we love to do.





Australian Government
**Cotton Research and
Development Corporation**