

World leaders in cotton

Achievements in Australian cotton
research, development and extension
2008–2013



Australian Government
Cotton Research and
Development Corporation





Australian Government

**Cotton Research and
Development Corporation**

Cotton Research and Development Corporation

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About the Cotton Research and Development Corporation

The Cotton Research and Development Corporation (CRDC) is a statutory authority established in 1990 under the *Primary Industries Research and Development Act 1989* (PIRD Act). CRDC was established by the Australian Government to work with industry to invest in research, development and extension (RD&E) for a more profitable, sustainable and dynamic cotton industry. CRDC has two groups of stakeholders: cotton growers and the Australian cotton industry (represented by Cotton Australia), and the Australian people (represented by the Australian Government).

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Executive summary

This report provides an overview of investments made and outcomes achieved by the Cotton Research and Development Corporation (CRDC) under its five-year Strategic Research and Development (R&D) Plan for 2008–13. Our headline achievements appear in this overview, while the rest of the document gives a more detailed report on program outcomes.

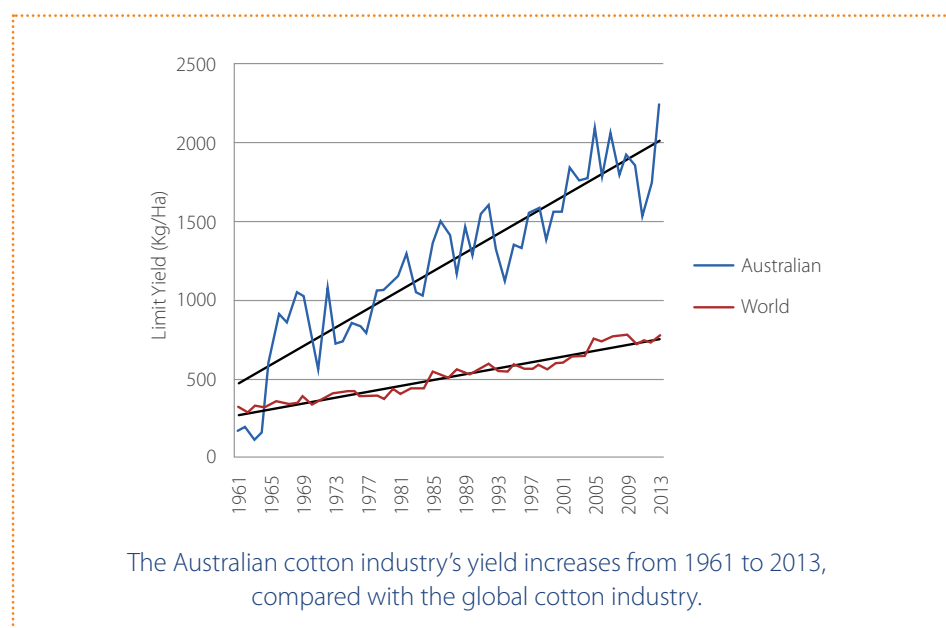


The big picture

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. Cotton is an industry taking responsibility by changing its practices to meet the expectations of contemporary society.

The key to the cotton industry's success in improving efficiency, sustainability and profitability lies in the success of its research, development and extension (RD&E) program, which has created a dynamic culture of innovation within the industry.

Over the past 10–15 years alone, RD&E has helped cotton growers reduce their insecticide use by 95 per cent, increase their water use efficiency by 40 per cent and achieve the highest yields in the world, at almost three times the world average.



Thanks to this RD&E, led by CRDC and delivered in partnership with our research partners, Australian cotton growers are world leaders in resource efficiency, and have reduced their environmental footprint. The 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. The industry is at the forefront of environmental management systems and climate change preparedness and adaptation.

It's an extraordinary story of achievement.

Yet in 2008, at the beginning of the period covered by this report, cotton production in Australia was at its lowest level in 30 years. The 2008–13 period saw unprecedented volatility in cotton production and change within the industry driven by record droughts, floods and fluctuating cotton prices. It was an extremely challenging time, and one that highlighted the vital importance of managing volatility in production, prices and seasons.

In spite of such major challenges, the cotton industry recovered to achieve record production of 5.3 million bales at the end of this period. Cotton prices throughout the period ranged from US\$0.55/lb to new highs of US\$2.25/lb.

The way the industry met these challenges and recovered from them in such a short time indicates the success of our RD&E program, and the CRDC's ongoing research investment underpins a future committed to continuous improvement.

Changes in the RD&E landscape

Throughout five years of sometimes tumultuous circumstances, Australia's 1,250 cotton growers and the Australian Government co-invested \$49.8 million through CRDC into RD&E in the 'quest for sustainable competitive advantage'. For the 'quest' to succeed, the industry needed to meet the new challenges for growing cotton, including the intensifying competition for land, water, energy and labour; changing climate scenarios; and market demands for cotton.

The winding up of the Cotton Catchment Communities Cooperative Research Centre (Cotton CRC) in June 2012 was a significant change for cotton research, bringing to an end 19 years of successful collaborative R&D through three successive cotton CRCs, of which CRDC was a major contributor during the entire period. Fortunately the closure happened during a resurgence in cotton production, which meant CRDC had the investment capacity to maintain important R&D capacity throughout the wind-up.

The benefits of RD&E investment

It can be difficult to quantify exactly the benefits of investment in RD&E – and yet doing so is vital. During the 2008–13 period, CRDC, the National Program for Sustainable Irrigation and the Cotton CRC commissioned cost-benefit evaluations of R&D investments in which CRDC was either the major investor or one significant investor.

Overall, the evaluation estimated that CRDC's minimum return on investment during this period was 7:1 for growers (that is, a \$7 benefit to growers for every \$1 invested) with a flow on benefit of 14:1 for society at large (a \$14 benefit to society for every \$1 invested).

Achievement

CRDC's \$49.8 million investment between 2008 and 2013 delivered a \$348 million benefit to growers and a \$697 million benefit to society at large.



Photo courtesy Kate Dhu

The three research programs

In the 2008–2013 period we categorised our strategic RD&E priorities into three program areas:

- **Value Chain**
- **Farming Systems**
- **Human Capacity.**

Value Chain

The aim of the Value Chain program is to add value to the Australian cotton industry with premium products and improved pathways to market. Some \$6.52 million was invested in 68 research projects in 2008–13.

Knowledge generated by this research was critical to the industry's development of a cotton-to-market strategy. In place since January 2014, 'Cotton to Market' is a Cotton Australia program that tells the Australian cotton story to the world. It includes the supply chain initiatives 'Cotton LEADS™' and the 'Better Cotton Initiative', which provide manufacturers, brands and retailers with both a reliable cotton supply chain, and assurance that their raw material is responsibly produced and identified.

Given that almost 99 per cent of raw Australian cotton is exported, the Cotton to Market strategy is vital to securing international markets and it is a valuable investment for the industry as a whole.

Farming Systems

The aim of the Farming Systems program is to ensure cotton is a highly productive farming system, with improved environmental performance. Some \$31.92 million was invested in 205 research projects in 2008–13.

To date, the cotton industry has successfully implemented resistance management plans to mitigate the risks of resistance developing to the insect protection proteins contained in Bt genetically modified cotton. Preserving the efficacy of Bt cotton is vital to the survival of the Australian cotton industry, and this remained a major R&D priority for CRDC during the 2008–13 period. CRDC has invested in a resistance monitoring program since Bt cotton was introduced – firstly the single-gene Ingard® in 1996–97, then the two-gene Bollgard® in 2002–03 – and it worked with regulators to ensure a pre-emptive resistance management strategy was in place.

Although populations of *Helicoverpa spp.* have been shown to carry resistance alleles to the two current Bt toxins in Bollgard II, no field failures have been recorded, due to the implementation of the resistance management strategy.

Australia is now recognised as having the most rigorous and successful resistance management system for Bt cotton in the world, with an independent review showing that Australia's efforts to manage resistance pre-emptively appear to be more effective than US efforts, and Brazilian growers and scientists actively seek advice from Australia's world leading researchers.

Bt cotton does not control a range of sucking pests and in some countries where it has been introduced there have been substantial increases in pesticide use to control them. However, in Australia, R&D has focused on the development of Integrated Pest Management (IMP) systems, which cotton growers have implemented so successfully that there has been no increase in pesticide use for sucking pests since the introduction of Bollgard II over 10 years ago.

Investment in the Farming Systems program saw the completion of the industry's *Third Environmental Assessment* in 2012. Commissioned by CRDC, this marked 21 years of cotton industry commitment to comprehensive independent environmental reviews, performance monitoring and practice change that is unparalleled amongst agricultural industries.

The *Third Environmental Assessment* identified 10 years of R&D-driven environmental achievements, including chemical use reductions, water use efficiency gains, active engagement in landscape- and catchment-wide natural resource management, and the significant uptake of integrated pest and weed management.

Human Capacity

The Human Capacity program worked to develop a culture of innovation and learning. Some \$7.18 million was invested in 195 research projects in 2008–13.

The development of an industry vision was a major outcome from this program. In 2009, CRDC started the process of visioning the industry's preferred future. In consultation with industry and external stakeholders, CRDC developed a vision that was presented to the industry at the 2010 Cotton Conference:

Vision 2029: Australian cotton, carefully grown, naturally world's best.

As part of this vision, the industry's attributes are: differentiated, responsible, tough, successful, respected and capable. These attributes have been used extensively to guide and describe R&D investment themes in the CRDC Strategic R&D Plan 2013–18.

Another important achievement in Human Capacity was the cotton industry's 'CottonInfo' program, developed in 2012. This is a five-year joint venture between three industry organisations – CRDC, Cotton Australia and Cotton Seed Distributors Ltd – providing extension services to growers in the wake of the Cotton CRC closure.

The 25-strong CottonInfo team consists of regional development officers (located in cotton growing valleys from Emerald in Queensland to Hillston in NSW), technical specialists, and myBMP staff members who help growers participate or seek accreditation in myBMP. The CottonInfo team delivers the latest research outcomes and best management practices to growers, when and where they need them.

Delivering outcomes in RD&E

These are just some of the achievements obtained through CRDC's strategic RD&E investment over this five-year period. In the remainder of this report, you will find many other outcomes delivered by CRDC's investments, making important contributions to growers, the industry and the community.

CRDC's work continues to ensure cotton can remain a profitable, productive and sustainable industry, prepared to overcome its challenges and capitalise on the opportunities ahead. The organisation has formulated its next five-year plan (2013–18) based on the strong direction established in the 2008–13 Strategic Plan.

The new plan recognises continuing and new challenges to the industry's sustainable competitive advantage, and responds with even greater ambition for the outcomes from RD&E. It can be found at the CRDC website: (www.crdc.com.au/publications).



CRDC R&D Manager Tracey Leven with National Centre for Engineering in Agriculture (NCEA) research fellow Dr Alison McCarthy. *Photo courtesy NCEA.*

Background



CRDC is a statutory authority established in 1990 under the *Primary Industries Research and Development Act 1989* (PIRD Act). CRDC was established by the Australian Government to work with industry to invest in RD&E for a more profitable, sustainable and dynamic cotton industry.

CRDC has two key stakeholders:

- Cotton growers and the Australian cotton industry, represented by the Australian Cotton Growers Research Association until its merger with Cotton Australia in November 2008, and then by Cotton Australia
- The Australian people, represented by the Australian Government.

CRDC is based in Narrabri, the centre of one of Australia's major cotton growing regions and the location of the major cotton research facility, the Australian Cotton Research Institute. CRDC's purpose is to support the performance of the cotton industry by helping to increase both the productivity and profitability of our growers.

The Australian cotton industry has always placed great emphasis on the value of its RD&E. This report details CRDC's investment in cotton RD&E for the 2008–13 period, and the outcomes and benefits this investment delivered to growers. For these five years, CRDC's investment decisions were guided by its Strategic R&D Plan 2008–13 (and the annual operating plans devised each year under that plan), which set out the guiding principles for the CRDC:

Vision: A globally competitive and responsible cotton industry

Mission: The quest for sustainable competitive advantage

Purpose: Enhancing the performance of the Australian cotton industry and community through investing in research and development

CRDC works to fulfil its legislative charter, which is to invest in and manage research, development and extension in a portfolio to enhance the ecological, social and economic outcomes associated with cotton production systems and to provide benefits from these investments to cotton industry participants, regional communities and the Australian community.

Five years at a glance

During the 2008–13 period, CRDC, the National Program for Sustainable Irrigation and the Cotton CRC commissioned cost-benefit evaluations of R&D investments in which CRDC was either the major investor or one significant investor.

Overall, the evaluation estimated that CRDC's minimum return on investment during this period was 7:1 for growers (that is, a \$7 benefit to growers for every \$1 invested) with a flow on benefit of 14:1 for society at large (a \$14 benefit to society for every \$1 invested).

As CRDC invested \$49.8 million in R&D between 2008 and 2013, this equates to a \$348 million benefit to growers and a \$697 million benefit to society at large.



Quantifiable benefits of some of CRDC's specific research projects during this time are outlined below:

Project	Return on investment
Soils and nutrition R&D.	An estimated return of \$26 to the industry per \$1 invested over a 20 year period.
A series of small projects with the Women in Cotton Network (Wincott).	A \$25 return per member.
Fibre classification technology.	An estimated return of up to \$12 to the industry per \$1 invested over 20 years.
Lateral move and centre pivot RD&E.	An estimated return of \$11.60 per \$1 invested by CRDC.
Weeds R&D.	An estimated return of \$8.90 per \$1 invested within five years.
The National Program for Sustainable Irrigation Phase II (Managed by CRDC from 2009 to its completion in 2012).	Five projects under the National Program were evaluated: these returned \$7.20 per \$1 invested. One of the projects evaluated – a co-investment by CRDC and GRDC, <i>Water Smart Cotton and Grains</i> , returned 55 per cent of the value of the five projects evaluated (and just over \$6 per \$1 invested in its own right).
'Triple bottom line' evaluation of CRDC's investments during the 2003-08 period.	CRDC's investment in three key areas: Plant breeding, Fusarium wilt and Ingard cotton stewardship/resistance management were found to have delivered a return during or soon after this period. The return was estimated as \$7 to the industry for every \$1 invested.
Cotton CRC activities 2005-2012 (of which CRDC was the major investor).	Five areas under the CRC's The Farm program (for which CRDC contributed over 50 per cent of the funding) were evaluated. Estimated potential returns on investments ranged from \$2.9 per \$1 invested for diseases (specifically black root rot) to \$14.6 per \$1 invested for improvements in water use efficiency. Overall, CRC investments in these five key areas were estimated to return \$7 to the industry per \$1 invested.
Extension services.	A return of between \$1.08 to \$1.62 per \$1 of time invested in seeking information.

Review of RD&E programs



Program One: Value Chain

Program goal: to add value to the Australian cotton industry with premium products and improved routes to market.

The Value Chain program applied four overarching strategies to achieve its goals:

- Building knowledge about products, markets and supply chains
- Developing improvements in current products
- Facilitating development of novel products
- Advancing cotton product processing.

The Australian cotton industry has a shared vision that international mills and brand owners will automatically connect Australia with high quality cotton fibre, recognise the advantages this high quality fibre brings to the goods they produce, and see the value in paying a premium for this superior product.

To help achieve this vision, CRDC convened a forum 'We're Aussie, Wear Aussie' in May 2009, bringing together high level supply chain representatives to challenge industry assumptions around potential market leverage points, and chart a program of agreed future actions. The outcome was the industry's 'Premium Cotton Initiative', a series of partnerships across the cotton value chain that had three goals: strengthening the industry's reputation for quality, promoting industry values in production and providing value across key parts of the value chain.

VALUE CHAIN STRATEGY ONE

Value Chain strategy one focused on building knowledge and intelligence about products, markets and supply chains, through investments in:

- Understanding current markets and potential opportunities
- Developing a market strategy
- Establishing environmental credentials.

Understanding current markets and potential opportunities

The primary advantage of Australian cotton over its international competitors is the quality of the fibre and one of the challenges for Australian cotton has been breaking into high quality yarn markets. The majority of Australian cotton is used for 40Ne yarns. The price of high quality (60Ne-plus) yarn is more than 50 per cent higher, but this market is dominated by Extra Long Staple US Pima and Egyptian cotton.

Funded by CRDC, researchers from CSIRO set out to understand the quality requirements and perceptions of spinning mills regarding Australian cotton fibre. They interviewed 35 companies in China, Japan, Korea, Thailand, Indonesia and Australia about their use of fibres from different origins, the value of Australian cotton and its use in the production of selected yarn types, key fibre properties valued, market considerations regarding the need for sustainable cotton such as best management practices (BMP), and the value of fibre branding and promotions. The evidence pointed clearly to a market opportunity for high quality long staple fibre and the environmental credentials associated with BMP cotton.

By surveying both mill processing and final brand owner stages, a major study conducted by CSIRO (in collaboration with the Australian Cotton Shippers Association) made advances including new knowledge about growth sectors and the demand drivers within them; opportunities for leveraging in the value chain; value chain participants' perceptions of third party licensing and branding arrangements; and supply chain maps for cotton textiles and apparel right through to the consumer.

Fine count fabrics were found to be a niche product for the survey participants. Future projections indicate that premium yarn production (60Ne to 80Ne) is expected to grow by more than 200 per cent by 2016 – providing a strong opportunity for Australian lint. With shrinking production of high-value extra-long staple cotton, particularly in California, there is a potential for Australian Long Staple upland cottons to be used in greater quantities in the 50–70Ne count range. This use of Australian Long Staple should drive awareness of Australian cotton quality right through the value chain.

A major finding was that the European Union and the USA are resilient premium fabric markets, while an expected Chinese focus on premium fabrics and garments should see rapid growth in the volume and value of garment sales in China. The advantages Australian cotton will have in addressing this growing market include very low contamination, good fibre length and maturity, while disadvantages (being tackled elsewhere in the R&D program) are excessive short fibre content and neps (tangled bunches of immature fibres).

Achievement

Sophisticated market intelligence about market opportunities for high quality Australian Long Staple cotton, and how the industry can capitalise on these opportunities.

Developing a market strategy

Armed with this understanding of the market, CRDC worked with Cotton Australia and the Australian Cotton Shippers Association to develop market strategies.

Recommendations included:

- Creating an Australian cotton export market strategy
- Exploring a new premium product category based on Australian Long Staple
- Using best management practices (BMP) to further differentiate Australian cotton and meet retailer and brand needs for authenticity, traceability and sustainability.

The resulting 'Cotton to Market' international program was launched in January 2014, incorporating:

- Cotton LEADS™, designed to satisfy global demand for responsibly produced cotton by providing science-based evidence to back industry claims
- The Better Cotton Initiative, involving a range of major international manufacturers improving cotton product for people, the environment and the industry (see www.bettercotton.org).

Achievement

Establishing 'Cotton-to-Market', an integrated, realistic international marketing strategy to exploit the advantages of Australian cotton.

Establishing environmental credentials

Internationally, nationally and locally, consumers, government and the community are increasingly interested in the sustainability of agriculture and its products. In response many companies and industries are working to define, measure and report sustainability metrics. The downstream cotton supply chain – in particular retailers and brands – are developing tools to assess the sustainability performance of the range of raw materials used to make their products, including cotton.

Tools such as the Clothing Footprint Calculator of the Waste and Resource Action Plan (WRAP) in the UK, the Higg Index of the Sustainable Apparel Coalition (SAC) in California, and the Environmental Benchmark for Fibres from MadeBy in the Netherlands, use production data to generate raw material scores, which are then taken into account in product development and design decisions.

In an effort to achieve recognition for sustainably produced Australian cotton through the industry program *myBMP*, the Australian industry explored the value of participating in global sustainability marketing initiatives. It has established a partnership with the US cotton industry under the Cotton LEADS™ program and is currently pursuing a partnership with the Better Cotton Initiative. Both programs require ongoing performance reporting against key criteria.

CRDC began working with Cotton Australia to promote BMP cotton for its quality and environmental credentials. In 2012–13, a project started developing a sustainability decision and value matrix for the whole value chain and a strategy process model identifying triggers for changes in stakeholder needs. These provide a tool for assessing the competitive advantage of sustainability indicators.

Achievement

Developing and promoting sustainability indicators for the Australian cotton industry through partnership with the US Cotton LEADS™ program and the international Better Cotton Initiative.

VALUE CHAIN STRATEGY TWO

Value Chain strategy two focused on improving current cotton products, through investments in:

- Linking BMP to the marketing strategy
- Maximising on-farm contributions to fibre quality.

Linking BMP to the marketing strategy

CRDC linked its work in BMP to the Premium Cotton Initiative by developing procedures and guidelines for growers, ginners and classers, and for the transport, storage and shipping sectors, to ensure that cotton fibre quality would be maintained through the value chain. These investments in BMP guidelines for environmental management are allowing the industry to develop valuable data on production performance and natural resource management, which can now feed into marketing activities.

Achievement

Building evidence of Australian cotton's field-to-fabric sustainability for the market.

International companies choose BMP cotton

Between 2008 and 2013 there was a growth in the strategic use of Australian cotton by international brand owners. Hong Kong manufacturer, Central Textiles, is working with Japanese brand owner, UNY, to use and promote Australian cotton. Their achievements include designing a new cotton fabric in 2011. The UNY group operates about 1,500 speciality stores within Japan, marketing clothing for women, men and children under separate brands. The Chinese company, Novetex, has established a marketing strategy for promoting Australian premium BMP cotton, which it markets across selected fabrics to brand owners under its eco-products range. These fabrics were launched in New York in July 2010.

Maximising fibre quality on-farm

CRDC made major investments into researching the agronomic factors that affect fibre development, recognising the need to minimise negative fibre traits such as neps and short fibre content, while improving fibre length, strength, fineness and maturity.

Factors examined include grower management practices and the impact of climate variability. The 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 different production conditions.

Research into the timing of crop defoliation and picking – another major factor affecting fibre quality – led to new crop management practices and tools to improve consistency in the production of quality fibre and helped growers estimate fibre quality before harvest.

Researchers have extended their examination of the impact of agronomic management on fibre quality to cover final yarn and fabric quality. This has provided direct feedback to growers about the production of premium yarns, and is allowing for rapid assessment of spinnability without large-scale trials.

Research efforts also developed a fibre quality index to assess yarn quality. When the more sophisticated Cottonscope measures (see Strategy Five) were used instead of micronaire, the relationship between fibre quality index genotype rankings and yarn strength improved. The fibre quality index can be used across breeding programs, and by growers and merchants, to assess crop quality.

These RD&E efforts resulted in the publication FibrePAK, which brings together critical findings from past and current research on fibre quality. Active promotion of FibrePAK has led to practice change across the industry, including in variety selection, irrigation management, crop nutrient management, defoliation management and picker/harvest preparation and management.

Achievement

Increased knowledge about maximising fibre quality in cotton production, ginning and spinning, and as a result, new crop management practices and tools.

VALUE CHAIN STRATEGY THREE

Value Chain strategy three helped develop novel products, through investments in:

- Identifying threats and opportunities in cotton markets
- Developing premium yarns from new cotton varieties
- Developing novel spinning technology
- Supporting collaboration between cotton and wool.

Identifying threats and opportunities in cotton markets

A project with Deakin University has identified threats and major opportunities for Australian cotton in traditional and premium cotton markets, and has defined future R&D needs for these markets. CRDC expects the project to identify opportunities for post-farm gate R&D investment and potential collaborators for innovative fabric design, and to gather valuable intelligence about the future direction of man-made fibres – cotton's greatest competitive threat.

Achievement

Improved understanding of Australian cotton's competitive threats and opportunities for new products.

Developing premium yarns from new cotton varieties

While the development of premium CSIRO-bred cotton varieties may allow Australian cotton to compete in the high-value yarn market, it is important to demonstrate that the new varieties can indeed deliver such yarns. CRDC, through CSIRO, has continued to investigate this issue, with spinning trials showing that Australian Long Staple cotton can produce fine count combed ring-spun yarns. More critically, in blends with Extra Long Staple cotton, the trials found that a 70/30 blend of Extra Long Staple /Australian Long Staple retained yarn quality and processing efficiency. This is a critical finding, as Extra Long Staple-type cotton can trade at prices 60 to 80 per cent higher than traditional Australian cotton. These trials were supported by commercial trials in India, China, Thailand and Vietnam.

Achievement

Evidence that new CSIRO-developed Australian Long Staple varieties can be used to produce top quality yarns.

Grown in Australia's backyard

The Dri Glo Australian cotton collection is unique. Each towel and sheet comes with its own Australian story: where it was grown and by whom. The launch of the product was the result of work through the Premium Cotton Initiative, involving CRDC, Australian Weaving Mills, Cotton Australia, Australian Cotton Shippers Association, CSIRO and a number of grower partners.

The Dri Glo towels are manufactured using premium Australian Long Staple cotton and woven by Australian Weaving Mills in Devonport, Tasmania: Australia's only towel weaving mill. The cotton is grown using best management practices. According to Dri Glo, the premium fibre suffers fewer breaks and is free from contamination, so it is competitive with overseas cotton. The end product is of an extremely high quality.

St George cotton growers Glenn and Julianne Rogan (pictured here with their children Edward and Annabelle), grow Australian Long Staple cotton for supply to Australian Weaving Mills for the Dri Glo towel range. *Photo courtesy Dana Gludze.*



Developing novel spinning technology

In 2010 CRDC established the Nu-Torque project with CSIRO, Deakin University and Hong Kong Polytechnic University to assess the use of Australian cotton in the production of low twist yarns, with the potential to reduce spinning costs and produce a higher quality fabric. The work provided evidence of the capacity for Australian Long Staple cotton to be used in the novel spinning technologies being used with high quality pima cotton types.

Achievement

Evidence that Australian Long Staple cotton can be used to produce low twist yarn, with potential cost and quality advantages.

Supporting collaboration between cotton and wool

To broaden demand for cotton, CRDC initiated a collaborative project with Deakin University, CSIRO and Esquel Textiles Limited (China) to design thermal cotton/wool fabrics using premium fibre from both. The opportunity exists to create a cool-to-wear fabric using one treatment, or a warmer fabric through additional treatments. The combination of finishing treatments and fibre blends may allow the creation of new fabrics with different thermal properties. The project continues to investigate fabric designs that may include cotton, wool and a new man-made fibre, Thermostat, developed by DuPont.

Achievement

Developing new, high quality fabrics incorporating cotton, wool and man-made fibre for future testing in key markets.

VALUE CHAIN STRATEGY FOUR

Value Chain strategy four focused on advancing cotton product processing through investments in:

- Extending best practice through the value chain
- Developing technology for early detection and removal of fibre contaminants
- Developing 'Cottonspec' technology to improve mill efficiency
- Maintaining value with damage-free processing.

Extending best practice through the value chain

CRDC investments in post-farm gate BMPs focused on four areas: harvesting, ginning, classing, and storage and handling. BMP handbooks are available for each of these areas.

For the classing sector, all operational high volume instruments (HVI) were tested in the Cotton Classers Association of Australia (CCAA) Check Test, developed under the BMP program. Results were assessed against the US Department of Agriculture's test program. In all cases, the Australian reproducibility for the Check Test program is better for all six fibre properties measured. The Australian instruments were also tested in the International Cotton Advisory Committee's Commercial Standardization of Instrument Testing of Cotton (CSITC) Round Trials, with all instruments testing within tolerance limits. New standards were developed for objective measurement of fibre colour and as a result, the CCAA recommended that all classing facilities were ready to move from visual to objective colour measurement of Australian cotton. The transition will take up to two years to ensure industry-wide support.

BMPs for warehousing and despatch were finalised in 2012, providing clear, concise guidelines to ensure cotton bales are stored efficiently, safely and effectively, and that road transport operators load and strap cotton bale loads using the most efficient methods.

Achievement

Post-farm gate BMP guidelines extending best practice through the value chain, successful testing of all high volume instruments, and a shift to objective colour measurement of Australian cotton.

Developing technology for early detection and removal of fibre contaminants

The lack of contamination in Australian raw cotton is an important selling point. New picking systems produce round modules wrapped in plastic. If the plastic were to enter the gin, it would pose a contamination risk, and potential loss of this competitive advantage.

Australian ginners and commercial partners, in technical collaboration with the company Truetzschler GmbH, have developed a prototype contamination sensor using existing high-speed image sensors. Truetzschler has commercial air nozzle ejection technology that has the potential to be used with the new sensors for removing detected contaminants.

Achievement

A new device (using existing technology) to monitor and reduce contamination of cotton fibre.

Developing 'Cottonspec' technology to improve mill efficiency

CRDC invested in the development by CSIRO – in collaboration with a range of mills in China – of 'Cottonspec', a novel spinning software technology designed to improve mill efficiency by offering accurate prediction of final yarn quality, based on raw fibre inputs and spinning techniques.

Preliminary results have shown that, used within a modern spinning mill, Cottonspec can accurately predict key properties such as yarn tenacity and evenness. Commercial-scale use of the software has shown its capacity to reduce raw material costs by enabling the replacement of higher-Ne pima cotton with premium upland cotton for premium yarn production, and its capacity to improve mill efficiency. Discussions are continuing with CSIRO about commercialisation plans for the technology.

Achievement

Software technology that predicts fibre properties at the spinning mill stage, improving mill efficiency.

Maintaining value with damage-free processing

Spinning mills prefer cotton that is long, fine, strong and with low nep and short fibre content. Primary processing of cotton at the gin is known to have an impact on fibre quality. CRDC, in collaboration with the Cotton CRC, established ginning research that aimed to preserve fibre length, improve ginning efficiency and prevent fibre damage. This led to the development of a modified lint cleaning device that can be cost effectively retrofitted to existing lint cleaners. Commercial scale evaluation showed improvements of two per cent in fibre length and uniformity, and a decrease of 12 per cent in short fibre content, compared to current commercial lint cleaners.

In relation to the gin stand, research was initiated to assess the impacts of gin seed fingers on fibre quality and ginning efficiency. Tests showed that the angle of seed fingers has a significant impact on classing grade, condition of cotton seed (post ginning), fibre quality, and gin power consumption. The resulting developments in managing gin seed fingers have maintained fibre quality while reducing gin power consumption, and the technology has been protected by a patent application.

As cotton dries, it becomes more prone to damage, and moisture assessment and management is a challenge in the ginning process, given the lack of an accurate measurement for moisture before and after ginning. Value Chain R&D developed 'Siroduct', a novel moisture sensor. Commercial ginning trials showed that Siroduct is more effective than existing devices and its use across integrated moisture management systems can lead to improvements in fibre quality. Additional benefits include a reduction in total energy use in the gin through better management of dryers and humidifiers.

Achievement

New technologies to maintain fibre quality and reduce power consumption in the ginning process.

VALUE CHAIN STRATEGY FIVE

Value Chain strategy five facilitated the development of objective measurement of Australian cotton fibre through investments in:

- Developing technologies to measure fibre fineness and maturity
- Reducing the impact of quarantine treatment.

Developing technologies to measure fibre fineness and maturity

Raw cotton comprises up to 60 per cent of the cost to spinners of producing a fabric, so international mills pay particular attention to the quality of the cotton they purchase. However, in the past mills have lacked the ability to objectively measure the fibre quality attributes of maturity and fineness. The inability to accurately measure these attributes separately was a limiting factor for mill management, and also for breeders in the selection of new varieties.

CRDC, together with the Cotton CRC, invested more than \$1 million in CSIRO's development of two successful technologies to directly measure fineness and maturity. The initial outcome was the development of 'SiroMat', the first instrument to directly measure fibre maturity and provide an accurate assessment of the variability of maturity. SiroMat testing by mills has shown that this accurate assessment can greatly improve the efficiency of yarn and fabric processing techniques.

CRDC's investment in refining the assessment of fibre fineness led to the development of a second instrument, 'Cottonscan', the world's first direct measurement technique for fibre fineness.

Turning research outcomes into commercial benefits

Commercial partner BSC Electronics, licensed by the Cotton CRC, combined the novel fibre measurement technologies of SiroMat and Cottonscan into one machine and released the first prototype in mid-2010 as 'Cottonscope'. Streamlining the two technologies and employing faster image processing and data analysis has reduced the test time for measuring fibre fineness and maturity to 25 seconds. At the end of the CRDC Strategic Plan period, three instruments had been sold and two were being trialled on approval. The benefit to Australian cotton growers is a potentially increased demand for premium Long Staple Australian cotton.



In 2012, a CRDC co-sponsored meeting in Nanjing, eastern China, with representatives of Chinese mills that are major customers for Australian cotton fibre, provided an excellent opportunity to familiarise them with Cottonscan. This technology enables accurate prediction of what a good cotton mill can expect to produce in yarn quality using a particular cotton.

Achievement

World-leading new technologies to accurately measure fibre maturity and fineness.

Reducing the impact of quarantine treatment

All cotton lint imported into Australia is treated to ensure it is free of contaminants, or that any quarantine-risk material present is dealt with. CRDC invested in a project to assess the effect of quarantine treatment on fibre quality. The results indicated that gamma irradiation, even at lower dosages, did have an effect on the physical properties (strength, elongation, length and colour) of the fibre, with these effects becoming more apparent and significant as the dosage strength increased. Armed with these findings, the CCAA asked the Australian Quarantine Inspection Service (AQIS) to amend its procedures. AQIS has agreed that samples will be treated only by ethylene oxide fumigation, provided the facility has an import permit.

Achievement

Changes to the quarantine treatment of imported cotton fibre to reduce associated fibre damage.

Program Two: Farming Systems

Program goal: cotton in a highly productive farming system with improved environmental performance.

The Farming Systems program applied three overarching strategies to achieve its goals:

- Building the industry's understanding of climate and natural resource challenges
- Enhancing industry's capacity to adopt resilient and adaptive farming systems
- Protecting industry from biosecurity threats.

The Farming Systems program lay at the heart of CRDC's R&D effort over the five years of the strategic plan, with investments representing 70 per cent of the funds committed to the three R&D programs.

This program best exemplified the triple bottom line approach that underpinned the entire R&D program. Environmental and economic benefits flowed side by side to growers, as knowledge improved on how to grow better crops, with fewer inputs, without damaging the environment at either farm or catchment level. Better use of water, managing insect pests with fewer pesticides by utilising nature's predators, maximising energy use efficiency, and preserving fibre quality to the farm gate were among the gains made.

Improved sustainability meant cotton valley communities gained economic and social benefits, with greater employment opportunities and economic certainty for the businesses supporting the industry.

FARMING SYSTEMS STRATEGY ONE

The Farming Systems strategy one aimed to build the industry's understanding of climate and natural resource challenges through investments in:

- Carrying out the cotton industry's *Third Environmental Assessment*
- Carrying out a life cycle assessment of an Australian cotton t-shirt
- Researching carbon storage in floodplain soils and native vegetation
- Creating a catchment-scale ecological risk assessment framework.

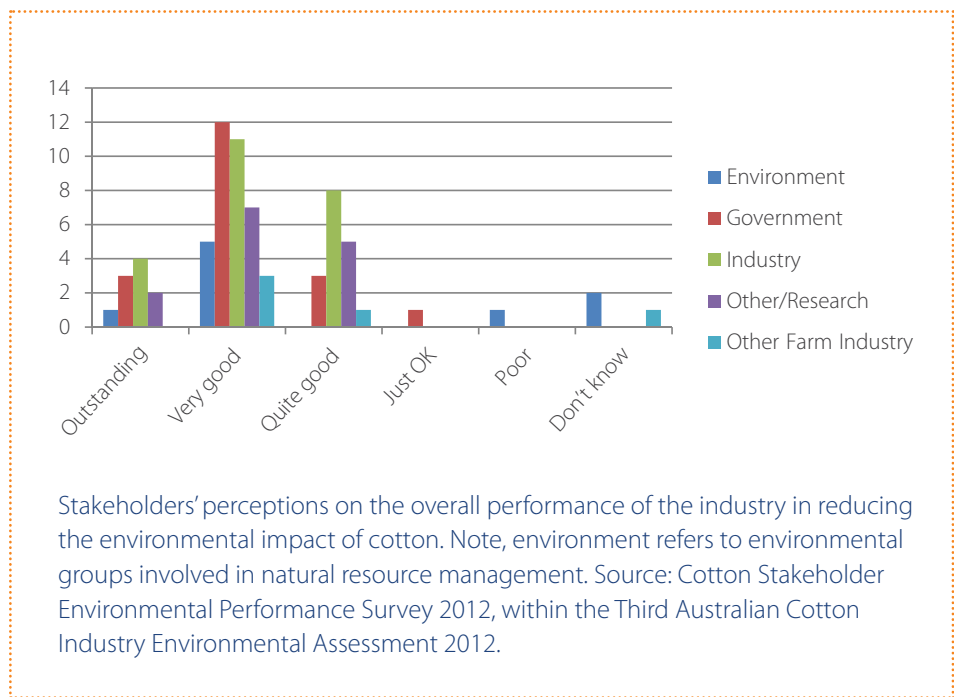
Carrying out the cotton industry's *Third Environmental Assessment*

The *Third Environmental Assessment*, commissioned by CRDC and undertaken by Inovact in 2012, marked a 21-year commitment to comprehensive independent environmental reviews unparalleled amongst agricultural industries. It identified 10 years of R&D-driven environmental achievements including:

- Effective and responsible management of GM cotton varieties
- A substantial reduction in the use of chemicals and impacts on rivers
- Three to four per cent gains in water use efficiency per year
- Active engagement in landscape- and catchment-wide natural resource management (a 40 per cent gain in water use efficiency; 40 per cent of growers managing native vegetation and riparian zones)

- Significant uptake of integrated pest management and integrated weed management
- Development of an integrated RD&E system that delivers priority R&D and extends this to growers through *myBMP*.

The results showed that stakeholders believed good progress had been made over the previous decade to reduce the environmental impact of cotton growing. A highlight was the positive response from government respondents, as shown in the graph.



The *Third Environmental Assessment* made six recommendations for the industry to advance its environmental stewardship agenda and performance. Part of the response was the development of the Australian Cotton Industry's Sustainability Indicators, which are to be reported in 2014.

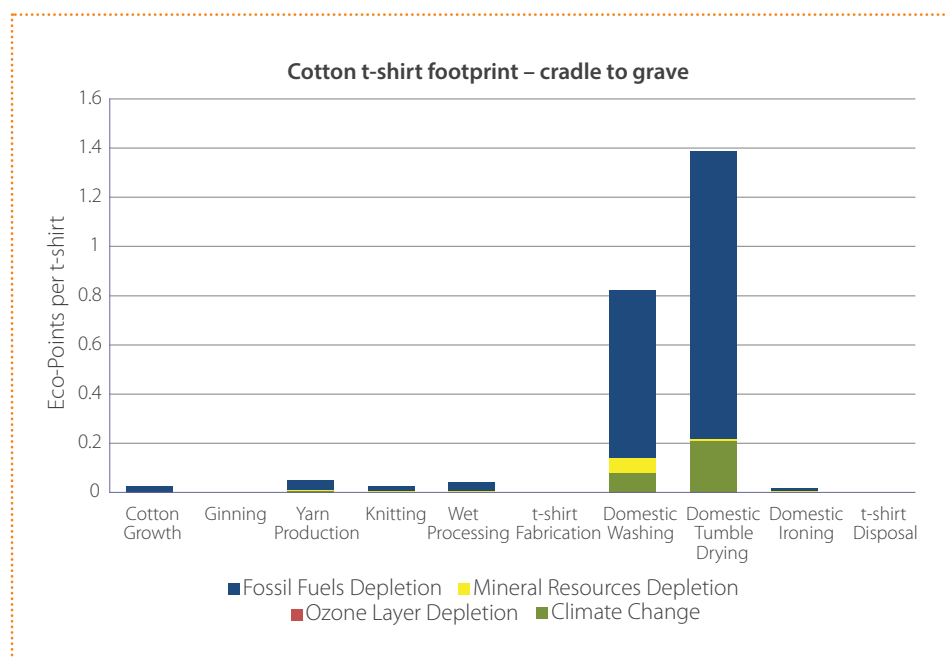
Achievement

Independent assessment showing strong progress in reducing cotton growing's environmental impact, and guidance for future improvements in environmental stewardship.

Carrying out a life cycle assessment of an Australian cotton t-shirt

CRDC commissioned a study that evaluated the environmental impact of a 100 per cent cotton t-shirt throughout its life cycle, from production (including the extraction and production of raw materials) through to use and final disposal. The goal was to measure the contribution of cotton growing and manufacturing to the overall impact of an everyday item, and to examine how the industry could further reduce its contribution to greenhouse gases.

As indicated in the graph of the cotton t-shirt's footprint, the assessment found the major environmental impact to be in the 'use' component of the garment rather than in production and manufacturing, indicating these processes (which lie outside the control of the cotton industry) provide the greatest room for environmental improvement. Within the cotton-growing footprint, the largest contributor was nitrogen fertiliser, followed by pesticides, ginning and harvesting.



Achievement

Detailed estimates of cradle-to-grave environmental impact of a cotton clothing item, including identifying the most significant impacts within the cotton growing footprint.

Researching carbon storage in floodplain soils and native vegetation

PhD scholar Rhiannon Smith (pictured) estimated the amount of carbon stored in the soils and natural vegetation commonly encountered on cotton farms on the Namoi floodplain. Her findings reinforced the value of woody vegetation in carbon sequestration. She found that river red gum-dominated vegetation is particularly important for biodiversity conservation, with a greater habitat complexity bringing plant and bird species richness and retaining more carbon on those sites. As part of the project, Rhiannon developed native vegetation management recommendations for farmers.



Achievement

A detailed assessment of carbon storage in native vegetation and soils on floodplains in cotton growing areas, and management recommendations.

Creating a catchment-scale ecological risk assessment framework

CRDC invested in developing a catchment-based ecological risk model capable of highlighting aquatic ecosystems at risk from pesticide use on adjacent farms. PhD scholar Mitch Burns applied a modelling approach utilising available spatial data, pesticide characteristics and cropping practices to assess catchment-scale risk posed by pesticides in the Gwydir Valley catchment. The use of such a catchment-scale risk assessment framework, in association with active management by landholders (via the *myBMP* system), could allow the continued use of some pesticides that pose higher ecological risks without reaching aquatic toxicity thresholds.

Achievement

Data to improve landholder management of ecological risk from agricultural chemicals and a new catchment risk assessment tool for regulators.

FARMING SYSTEMS STRATEGY TWO

Farming Systems strategy two aimed to enhance the industry's capacity to adopt resilient and adaptive farming systems through investments in:

- Researching on-farm water use efficiency
- Researching and benchmarking energy use efficiency
- Carrying out a pump efficiency case study
- Developing economic, social and environmental performance indicators
- Carrying out cotton comparative analysis
- Researching spray application management and drift reduction
- Researching soil and nutrition management.

Researching on-farm water use efficiency

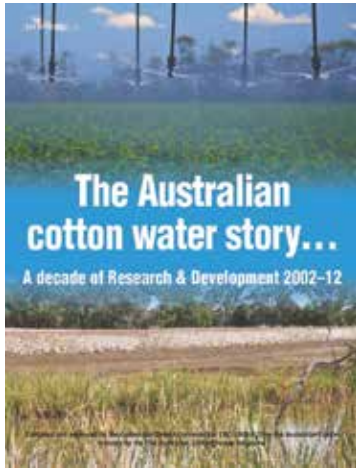
CRDC water-related research focused on individual farms, complementing catchment-scale R&D by the Cotton CRC. R&D included measurement of water use efficiency, optimising the performance of surface-irrigation systems, understanding plant physiology and agronomy, irrigation scheduling strategies, deep drainage (beyond the plant's root system), reducing water losses from on-farm storages, and developing a better understanding of soil-water-plant relationships.

Improvements in water use efficiency have come from higher yields, which have resulted from improved varieties, the adoption of GM varieties, improved crop management, and the adoption of more efficient water management methods and systems. CRDC enhanced water-related R&D through its management of the National Program for Sustainable Irrigation (NPSI) between 2009 and 2012 and maintenance of the NPSI and Land & Water Australia websites.

Ongoing R&D in water management indicates that further improvements in water use efficiency over the next decade are likely to come from improvements in cotton varieties, commercial adoption of new scheduling tools, water storage and channel evaporation loss reduction, reduced deep drainage, and optimised and automated furrow irrigation systems.

Achievement

A 40 per cent improvement in water use efficiency per hectare and an improvement in whole farm irrigation efficiency from 57 to 70 per cent over the last decade.



The Australian Cotton Water Story and the Crop and Pasture Science Journal cotton R&D special editions (Volumes 1–2) provided summaries of research on water and other topics over the past five years and beyond, much of which was funded by CRDC.

Researching and benchmarking energy use efficiency

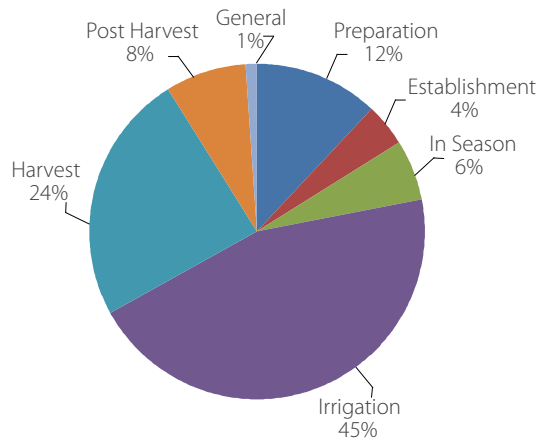
Energy is the most rapidly rising cost facing cotton farmers and is of particular importance to irrigated cotton growers because of their reliance on pumping water. CRDC commissioned the National Centre for Engineering in Agriculture (NCEA) to research case studies to help understand where energy was used on cotton farms, to help identify areas for improving efficiency and reducing costs.

This project produced the first Australian farm-focused energy assessment tool for cropping, the web-based 'EnergyCalc'. This led to CRDC investing in further on-farm studies to develop improved local data on energy use, including new monitoring equipment and a protocol for growers to assess energy use. Improvements were made to EnergyCalc, including accessibility and support for growers. An iPad app, EnergyCalc Lite, was developed as an additional on-farm tool information and assessment, able to be linked to a grower's own *myBMP* site.

Achievement

Benchmarks, assessment tools and protocols to enable growers to measure and manage energy use across a range of operations.

Average distribution of energy use for irrigated cotton production



The average distribution of energy required to produce a bale of cotton based on data gathered on a number of representative cotton farms between 2008 and 2012.

Energy grant: improving industry energy efficiency

CRDC's proactive approach to developing protocols and tools for growers to assess on-farm energy use was recognised in 2013 with the awarding of an Energy Efficiency Information grant from the Australian Government Department of Resources, Energy and Tourism (now the Department of Industry). The grant has allowed the industry to appoint an Energy Technical Specialist, Jon Welsh, as a member of the CottonInfo team to oversee industry efforts to improve energy efficiency by training CottonInfo team members and industry advisers, revising the energy module of *myBMP*, and conducting on-farm energy assessments and benchmarking.

Carrying out a pump efficiency case study

With CRDC project funding, NCEA developed a pump efficiency monitor that can provide data for assessing diesel engine and pump efficiency, and accurate information for on-farm energy assessments. The research indicated that significant savings were possible for individual operators and the industry collectively. A trial using the pump efficiency monitor on one pump on a cotton farm in the Goondiwindi region showed a 44 per cent improvement in diesel consumption for the same water flow rate. This represented a saving of at least \$22,000 per annum for that pump, based on average use.

Achievement

Evidence that significant improvements in irrigation pump efficiencies (44 per cent in one trial) represent a major opportunity for on-farm energy efficiency improvements.



NSW DPI researcher Dr Janelle Montgomery and NCEA researcher Phil Szabo monitoring pump efficiency at 'Macintyre Downs'.

Developing economic, social and environmental performance indicators

The responsible use of natural resources and ongoing performance monitoring are both essential to a modern agricultural industry, helping it to demonstrate its licence to operate, and providing information to consumers about the sustainability of their food and clothing purchases.

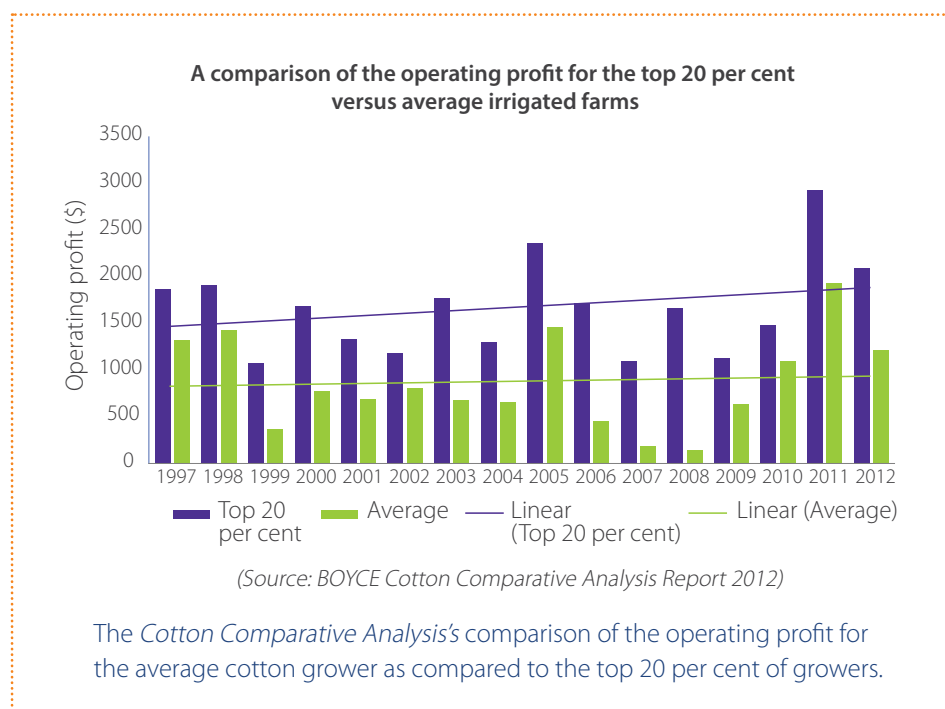
In 2010, CRDC commissioned a project to gather and assess the status and use of more than 100 triple bottom line indicators. The project identified 12 priority indicators that the cotton industry should report on: profitability; yield and fibre quality; gross value of production/contribution to regional economies; water use; water quality; pesticide use and stewardship of technology; soil health/quality; energy; greenhouse and carbon balance; regional biodiversity; industry demographics; community attitudes; and workplace health and safety.

Achievement

Identification of the most important priority triple bottom line indicators that the cotton industry should use.

Carrying out *Cotton Comparative Analysis* reports

CRDC maintains a long-term alliance with Boyce Chartered Accountants, based in Moree, to provide the industry with annual *Cotton Comparative Analysis* reports based on data collected from irrigated cotton growers and their clients. The reports provide a long-term analysis of trends in inputs costs, returns, and operating profit for irrigated cotton production. This information allows cotton farmers to benchmark their operations against the top 20 per cent of growers.



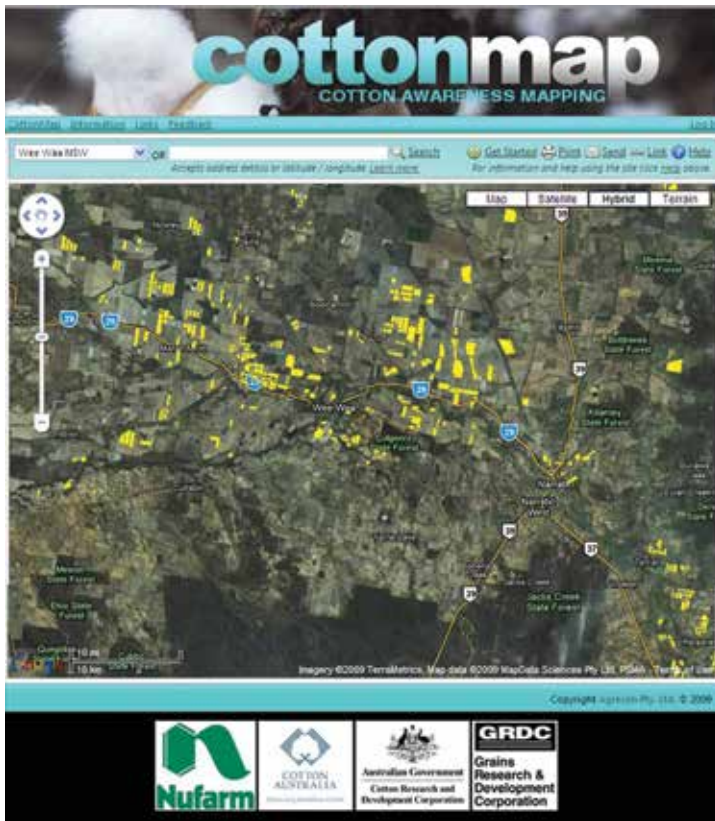
Achievement

Building and maintaining the industry's only longitudinal data set showing comparative production costs for Australian irrigated cotton.

Researching spray application management and drift reduction

Cotton's susceptibility to certain herbicides means it is vital for cotton growers and their neighbours to be fully aware of best practice in spray drift management. CRDC and the Grains Research and Development Corporation (GRDC) contracted spray applicant specialist Bill Gordon to run workshops for growers, farm workers and advisers, and provide specialist 'train the trainer' coaching for members of the CottonInfo team.

CRDC co-funded, with Cotton Australia, GRDC and chemical supplier Nufarm, the web-based tool 'CottonMap' (www.cottonmap.com.au), which allows cotton growers to show where they have planted cotton. CottonMap is an important way that non-cotton growers and neighbours can minimise the potential for spray drift damage to cotton. A flow-on benefit of CottonMap is its use by beekeepers to ensure that hives are placed safely.



The CottonMap web-based tool for cotton growers.

Achievement

Improving spray drift management (and reducing herbicide damage to cotton) through workshops, the 'iSpray' app, and 'CottonMap', a web tool showing where cotton is planted.

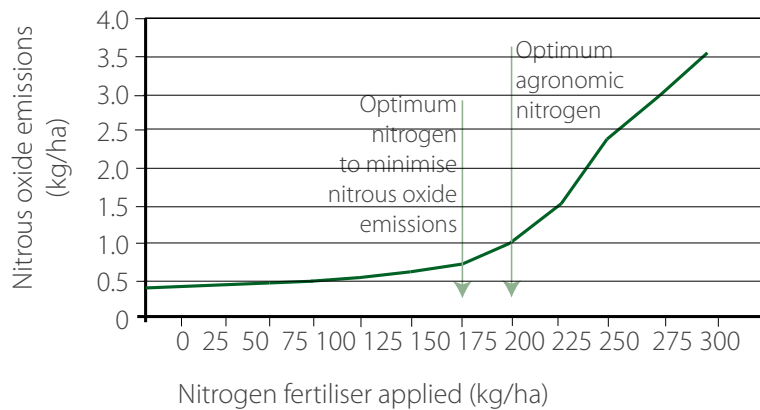
Researching soil and nutrition management

Ongoing long-term farming systems experiments at the Australian Cotton Research Institute (ACRI), near Narrabri, contributed to a wide range of knowledge about crop rotation, crop residue management, nitrogen nutrition and soil quality. Research has included detailed greenhouse gas emission measurements from cotton and legume crop rotations, as well as long-term monitoring of soil carbon under different crop rotation and management regimes. Increases in soil carbon where crop residues are incorporated suggest carbon neutral, or even carbon positive, cotton farming systems are possible.

Achievement

Nitrogen use efficiency and greenhouse gas emission data showing that carbon neutral or carbon positive cotton farming systems are possible.

Nitrous oxide emissions produced by nitrogen fertiliser application



As most commercial cotton farms apply between 200 and 350 kg N/ha, this data clearly identifies an opportunity to optimise nitrogen use and reduce potential greenhouse emissions, while reducing costs at the same time.

FARMING SYSTEMS STRATEGY THREE

Farming Systems strategy three aimed to protect the industry from biosecurity threats through investments in:

- Maintaining the efficacy of Bt cotton
- Improving integrated pest management and secondary pest management
- Developing a new fungal biopesticide
- Improving farm hygiene and biosecurity preparedness
- Managing weed and herbicide resistance
- Combating glyphosate resistance
- Producing the WEEDpak weed identification guide.

Maintaining the efficacy of Bt cotton

Preserving the efficacy of Bt cotton is vital to the survival of the Australian cotton industry, and remains a major R&D priority. CRDC has invested in a resistance monitoring program since Bt cotton was introduced (firstly the single-gene Ingard® in 1996–97, secondly the two-gene Bollgard II® in 2002–03) and worked with regulators to ensure a pre-emptive resistance management strategy was in place.

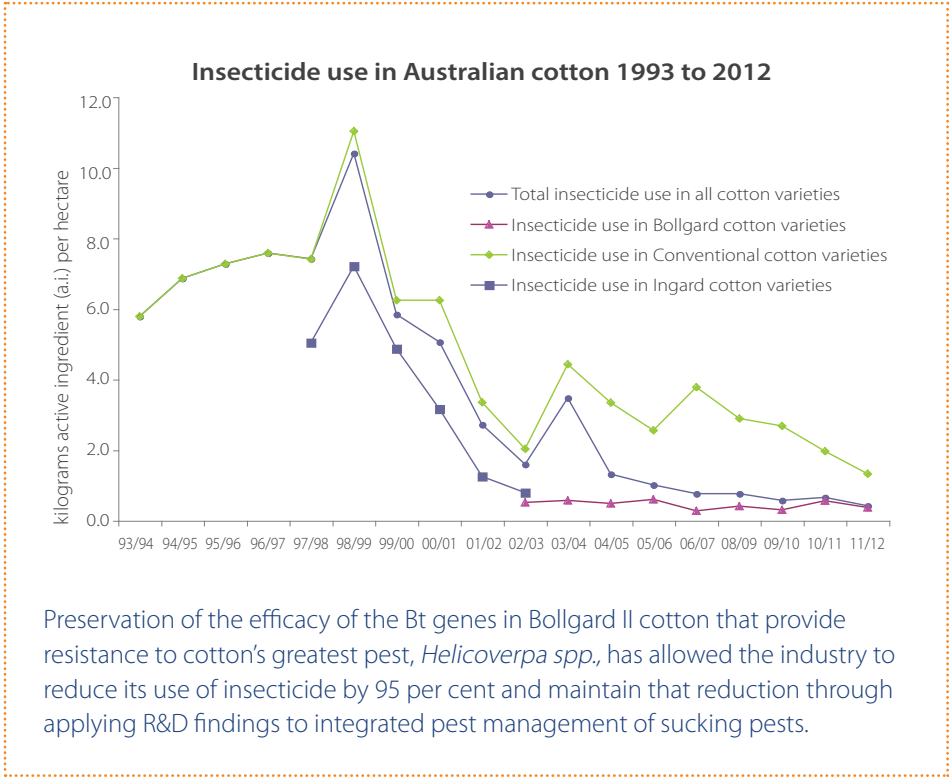
Although there are populations of *Helicoverpa spp.* showing resistance genes to the two current Bt genes (Cry1Ac and Cry2Ab) in Bollgard II, there have been no field failures recorded as a consequence. A recent review of Bt resistance in GM crops by resistance expert Professor Bruce Tabashnick from the University of Arizona found that Australia's efforts to manage resistance pre-emptively appear to be more effective than in the USA, where less rigorous resistance management has been practised. An *H. armigera* incursion in Brazil is causing significant damage to a range of crops, including cotton. Brazilian cotton farmers and scientists have sought advice on resistance management from Australia, and the Australian industry is recognised as the world leader in this area.

Complementing resistance management R&D, research projects are improving understanding of how best to use refuge crops (that attract pests away from the cotton crop) for maximum impact by studying refuge management, *Helicoverpa* flight characteristics and potential alternatives (which were ultimately ruled out) to the dominant refuge crop, pigeon pea.

Maintaining the efficacy of Bollgard II until the expected release of Bollgard III (which contains an additional resistance gene, Vip3A) in 2015–16 remains one of the industry's highest priorities and continues to be a focus of CRDC's R&D investments.

Achievement

Evidence that Australia has the most rigorous and successful resistance management system for Bt cotton in the world.



A cost/benefit assessment by the BDA Group during the early stages of the introduction of Bollgard II showed that, even including initial costs to growers, there was an estimated return of over \$103 over 10 years and \$201 over 20 years for every \$1 invested by levy payers in resistance monitoring and management.

Improving integrated pest management and secondary pest management

With the widespread adoption of Bollgard II cotton, spraying for the two major *Helicoverpa* spp. pests (*H. armigera* and *H. punctigera*) has decreased by almost 100 per cent. However, there are continuing threats from sucking pests including: silverleaf whitefly, cotton aphids, mirids (predominantly green mirid), mites, and green vegetable bug.

CRDC has supported R&D on these pests including:

- Ecological studies to help understand lifecycles, economic or action thresholds, overwintering behaviour, and natural mortality
- Experiments with registered pesticides to determine their effectiveness on pests and impacts on natural predators
- Monitoring programs for pest resistance to registered pesticides
- Packaged information on best practice, such as *Pests and Beneficials in Australian Cotton Landscapes* (2011), *Cotton Pest Management Guide* (annually), and *Australian Cotton Production Manual* (annually).

CRDC has also supported quick responses by the industry's then Development and Delivery team (now the CottonInfo team – see the *Human Capacity program*) when sucking pest incursions occurred. An outstanding example was fast control of a silverleaf whitefly outbreak in 2008–09 that threatened crops in the central cotton growing regions, ranging from the Darling Downs to the Namoi Valley.

Achievement

Effective management of sucking pests with no increase in pesticide use since the introduction of Bollgard II cotton.

Developing a new fungal biopesticide

CRDC supported fungal biopesticide research which found that two entomopathogenic isolates, used alone or in combination with reduced rates of synthetic insecticides, controlled a range of pests including *Helicoverpa* spp. larvae and pupae, mirids, silverleaf whitefly and green vegetable bug nymphs. Many of the natural predators of these pests were not affected by the isolates. Provided a commercial partner can be secured, a registration package for isolate DAT511 is likely to be submitted in 2014–15.

Achievement

A new fungal biopesticide that preserves the pests' natural predators, with very high potential for commercialisation.

Improving farm hygiene and biosecurity preparedness

CRDC invested in a collaborative project managed by Cotton Australia that resulted in the release of the cotton industry's first *Biosecurity Manual* in 2010, raising grower and adviser awareness of biosecurity threats and how on-farm management can reduce the risk of exotic pests and diseases.

CRDC-supported projects with the NSW Department of Primary Industries and Queensland Department of Agriculture, Fisheries and Forestry have continued an annual disease survey program monitoring changes in the incidence of endemic diseases and providing an early warning system for exotic disease incursions. Among potential exotic diseases, cotton leaf curl virus is the greatest potential threat and CRDC has supported development of a contingency plan in case the disease is detected in or near Australia.

Between 2008 and 2013 two new pests, solenopsis mealy bug (2010–11) and reniform nematode (2012–13), were detected. CRDC took immediate action, including funding rapid responses, acquiring background information, running surveys to understand the spread of the pests, and in the case of solenopsis mealy bug, testing control options and developing best practice advice for growers.

A CRDC project with Cotton Australia supported biosecurity training through Plant Health Australia's Emergency Plant Pest Preparedness Training Program to ensure that each cotton-growing district has people trained to respond to biosecurity issues.

As the accumulation of ecological knowledge about insect pests has gathered pace, the Come Clean, Go Clean program to maintain good farm hygiene for weeds has become one of the most important campaigns for the CottonInfo team. By ensuring farms are free of cotton volunteers (self-sown plants), ratoon (regrowth) plants, and weeds over winter, cotton growers can significantly reduce or even eliminate the threats posed by these pests, thus reducing reliance on pesticides during the cotton crop that follows.

Achievement

An integrated program including information, surveys, rapid responses, training and best management practices that reduces risks from endemic and potential exotic pests and diseases.

Managing weed and herbicide resistance

R&D projects in the 2008–2013 period enabled a clearer understanding of the potential for herbicide resistance in weeds, and saw the development of strategies to minimise or contain resistance through changed management. Research efforts also significantly improved understanding of herbicide damage and how cotton responds to it. Recognising that virtually all cotton farmers also grow grains, CRDC worked with GRDC, integrating cotton and grains best management practices to minimise resistance to herbicides.

Achievement

Better awareness and knowledge about herbicide resistance in relation to weed management.

Combating glyphosate resistance

The herbicide glyphosate is one of the main tools for weed control in dryland and irrigated cotton and grain production systems. For cotton, Roundup Ready Flex™ technology has transformed weed control over the past decade. However, as is evident in the south-eastern US cotton belt, over-reliance on one herbicide can lead to serious resistance problems in a range of weeds.

CRDC has supported research focused on the management of weeds such as awnless barnyard grass, in which glyphosate resistance has been confirmed on some farms. The research developed new tools and information for growers to combat glyphosate resistance, including the Glyphosate Resistance Risk Assessment Tool (RAT), and fact sheets about alternative herbicide options and management strategies. CRDC collaborated with GRDC to develop best management practices for using glyphosate in summer cropping areas.

Producing WEEDpak weed identification guide

Proper weed identification is the cornerstone of good weed management. CRDC supported the development of *WEEDpak*, an identification guide for cotton growers and advisers. Built over a decade, *WEEDpak* included up-to-date information on weed identification. It was expanded to include a guide on herbicide damage symptoms in cotton. *WEEDpak* has been available online for several years, and an improved version is under development for the *myBMP* and CottonInfo websites.

Achievement

Comprehensive weed identification guide to help growers identify and control weeds, minimise herbicide damage to cotton, and reduce herbicide resistance.

Program Three: Human Capacity

Program goal: a culture of innovation and learning.

The Human Capacity program applied three overarching strategies to achieve its goals:

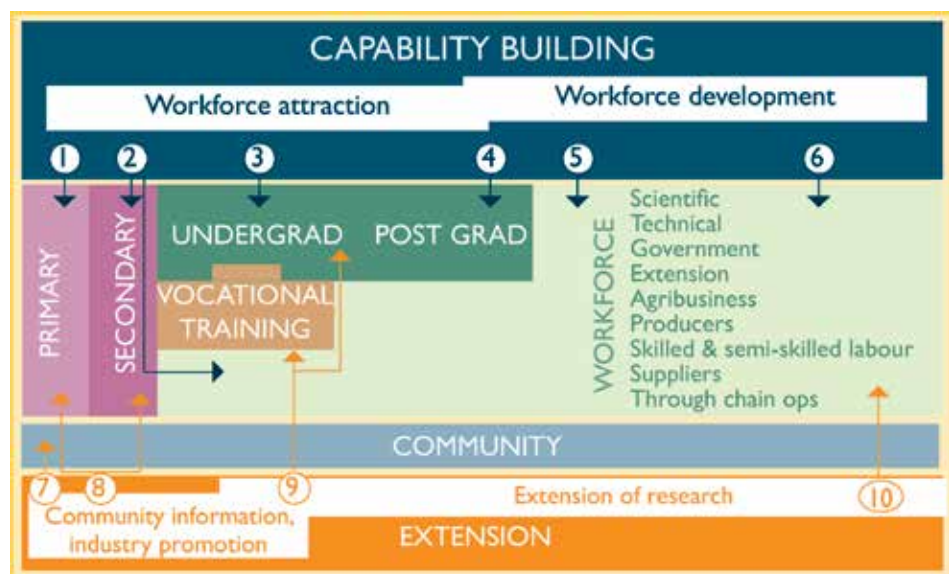
- Identifying, understanding and planning for future industry capacity needs
- Improving human resource development and capacity
- Enhancing capacity to innovate.

The Human Capacity program aimed to build on the inherent learning and innovative capacity of the industry. The cotton industry is often linked to innovation and a can-do attitude. Cotton farmers are strong supporters of industry R&D efforts and many farmers work closely with researchers and farm advisers to test new approaches at an early stage.

Census data also shows that:

- Cotton farmers, overall, are much younger than other farmers (although this can differ from region to region)
- In 2011, cotton farmers had higher average incomes than other farmers
- Cotton farmers work hard – more than 40 hours per week for 80 per cent of them in 2011
- Their education level continues to improve, with 50 per cent having diploma level or above in 2011 (compared to 30 per cent in 1991).

The Human Capacity program used a systems approach to examine the elements that together support the young, dynamic and innovative cotton industry. The capability building diagram below shows the key components of the human capability system, and was used by CRDC to communicate broadly about its investments in this program under the three key strategies highlighted here.



HUMAN CAPACITY STRATEGY ONE

Human Capacity strategy one aimed to identify, understand and plan for future industry capacity needs through investments in:

- Developing the Cotton Innovation Network
- Building an innovative workforce for sustained competitive advantage
- Engaging with agribusiness.

The need for educated, knowledgeable and committed people – growers, processors and staff at all levels – is becoming even more vital as the cotton industry moves towards an increasingly technology and research-driven future. Agricultural industries face competition, particularly from the mining industry, in attracting high quality staff. Five years ago, for example, growers did not anticipate the importance of backpackers in the irrigation and harvest season. The industry needed to explore how it could offer attractive careers at all levels and maximise the potential of people within the industry.



Backpackers, like Wiebke Herrmann from Germany, have helped provide vital labour to cotton growers during peak on-farm times. Wiebke is pictured here with Heath Estens on his mixed cotton/citrus farm, just north of Moree. “We wouldn’t survive without them,” says Heath of his backpacker employees.

Developing the Cotton Innovation Network

The Cotton Sector RD&E Strategy began in 2011–12 after several years of development by an industry-wide Strategy Working Group. It was a major efficiency tool for CRDC, setting out five priorities for the sector's RD&E organisations and industry that addressed better cotton plant varieties, farming systems, people, businesses and communities, product and market development, and RD&E development and delivery. The strategy was part of the National Primary Industries Research Development & Extension Framework.

In 2012 the Cotton Innovation Network was formed to coordinate the cotton industry's research and development activities and ensure a collaborative and cohesive approach to achieving the industry's long-term goals. The network's role was (and is) to improve the coordination between the bodies implementing the Cotton Sector RD&E Strategy.

CRDC provides the secretariat and funds the services of an independent consultant to support the network, which was independently chaired and comprised senior representatives of the Australian Government Department of Agriculture, Cotton Australia, Cotton Seed Distributors, CSIRO, NSW Department of Primary Industries, Queensland Department of Agriculture, Fisheries and Forestry and the Australian Council of the Deans of Agriculture.

Collaborative action improved the quality and efficiency of RD&E by coordinating:

- Strategy and investment across cotton and with other sectors – to maximise focus and leverage
- Research pathways to define what RD&E is needed and ensure it is sound and aligned
- Development and delivery to ensure adoption of research is optimised
- Capability to ensure capacity is maintained and developed.

The network continues to develop a deeper shared understanding of how these functions occur and where opportunities exist for improvement. It mapped the RD&E that is needed against current effort, using 2012–13 as a reference year. The level of RD&E investment is greatest within farming systems and increasing emphasis is being given to plant varieties, product and market development (to increase the value of the crop), and development and delivery (to support grower adoption and adaptation). CRDC's involvement extends to greater than 80 per cent of the R&D effort, with all the major RD&E organisations playing a significant role in at least two, and in many cases more, priorities.

Achievement

A collaborative network that coordinates cotton RD&E and maximises efficiency and effectiveness.

Building an innovative workforce for sustained competitive advantage

CRDC supported a project by the University of Melbourne (in collaboration with the University of Sydney) to build data on the industry's current and future workforce needs. The project involved three case studies in different cotton regions: Emerald (competition from mining for on-farm and service industry employment), Gwydir (established area with boom/bust cycles due to water availability), and southern NSW (a relatively new cotton industry based in the Lachlan and Murrumbidgee Valleys). Suggested areas for ongoing development are: identifying and developing sustainable sources of labour, building a critical mass of good practice in employment relations (a culture of innovation and excellence), developing skill and career pathways with the future in mind and building capacity to work on workforce development. These are being pursued under the CRDC Strategic R&D Plan 2013–18.



Cotton Australia's education coordinator Sophie Davidson, former CRDC human capacity program manager (now retired) Bruce Pyke, Cotton Australia's Macquarie regional manager Bec Fing and research analyst Gail Power of the University of Sydney's Workplace Research Centre discuss the industry's workforce needs.

Achievement

Baseline data and insights in relation to current workforce needs and future workforce challenges to inform an industry workforce development strategy.

Engaging with agribusiness

In 2011 CRDC engaged social research consultant Gordon Stone to survey/interview agribusinesses servicing the cotton industry about their current and future staff needs. The survey found that many businesses needed to replace retiring staff and build capacity to meet demand from the industry, but struggled to find staff, particularly professional staff. More than 100 professionally trained people would be required between 2011 and 2016 to meet these needs. A follow-up study in 2012 showed many agribusinesses were interested in an engagement strategy establishing an industry network to help them find potential employees from the ranks of late-year high schoolers, undergraduates and new graduates. This interest ranged from a financial commitment (such as a scholarship, summer or gap year job), through to in-kind support in the form of work placement or mentoring.

Achievement

A network linking agribusinesses with school leavers, undergraduates and new graduates seeking careers in agriculture.

HUMAN CAPACITY STRATEGY TWO

Human Capacity strategy two aimed to improve human resource development and capacity through investments in:

- Engaging with schools
- Engaging with undergraduates
- Engaging with post-graduates and post-doctorates
- Developing workforce capacity.

Additional funds from increased cotton production after the drought meant CRDC could increase its investment in education and capacity building from 2010–11.

Following the closure of the Cotton CRC in June 2012, its very successful summer scholarship/honours program and Cotton Production Course continued under the CRDC. The popular CSIRO Field to Fabric program also continued, and new opportunities included a cotton ginners training initiative in quick response to the rapid return to full production.

Support for professional development included the Cotton Production Course, post-graduate and post-doctoral fellowships and a range of other short scholarships and awards. Also significant was the successful application of recognition of prior learning principles to the managers of farms, who could achieve certification under the industry's best management practice program, enabling them to seek and achieve a Diploma of Agriculture.

Engaging with schools

The Primary Industries Education Foundation (PIEF) seeks to improve the understanding of our primary industries within the Australian education system. In 2011–12, CRDC facilitated a potentially valuable membership of the foundation for Cotton Australia, representing the cotton industry.

As the scale of potential shortages of young professionals entering the industry became apparent, CRDC invested in a dedicated Cotton Primary Industry Centre for Science Education (PICSE) centre to encourage and influence high school students to consider a career in the cotton industry and expose them to the many industry roles open to tertiary trained people.

Prior to 2012–13, CRDC co-invested with the Cotton CRC in a part-time Cotton Education Officer, Trudy Staines. As well as acting in a supporting role with PICSE, Trudy increased the cotton industry's presence in schools and provided teachers with resources that gave students a greater understanding of the cotton industry and the environment. With the winding up of the Cotton CRC, CRDC continued to support the role to provide PICSE support, envirostory competitions in primary schools, Horizon Scholar industry placements, Field to Fabric courses for schools, engagement with schools/careers events, support for honours and PhD scholarship holders and support for undergraduates in the Summer Scholarship scheme.

CRDC's grassroots capacity building program facilitated high school student participation at the Cotton Conference and grower-driven schools initiatives (see strategy three for more on Grassroots Grants).

Students from Narrabri High School participating in education programs at the Australian Cotton Research Institute, with support from CRDC and under the tutelage of Cotton Education Officer, Trudy Staines.
Photo courtesy Melanie Jensen.

Achievement

A greater awareness in schools of career opportunities in the cotton industry and encouragement for students to choose subjects for agricultural/cotton careers.



Engaging with undergraduates

CRDC has supported nine scholars through the Rural Industries Research and Development Corporation (RIRDC)'s Horizon scholarship program from 2009 to 2013 (with a further five supported in 2014). The scholarship offers cash, an annual workshop, annual industry placements and access to university and industry mentoring for students during each year of their degree.

CRDC's Summer Scholarships allow undergraduate students to work with established researchers over their summer breaks, or complete a scientific study as an honours project. CRDC continued to support these scholarships, which were initiated by the Cotton CRC, with five offered in 2012–13.

The University of New England's Cotton Production Course was established during the first Cotton CRC (CRC for Sustainable Cotton Production) in 1994 and was maintained by the two subsequent CRCs, with CRDC providing financial support since the CRC's cessation. The course is for undergraduate students and industry personnel wanting to increase their knowledge of cotton production, with more than 200 people having graduated from the course since it commenced. The course experienced record enrolments in 2011–13.

Achievement

Scholarships and university-level courses aimed at building the industry's future professional workforce.

Engaging with post-graduates and post-doctorates

Between 2008 and 2013, CRDC offered 21 PhD scholarships to new students, 15 students supported by CRDC were awarded PhD theses and one was awarded a Master of Science. In 2013, CRDC invested in 13 PhD scholars and one Master of Science scholar, as well as managing a further nine Cotton CRC PhD scholars through to completion. CRDC invested in 14 post-doctoral fellows between 2008 and 2013, 11 of whom were new students and six that were former CRDC PhD scholars.

CRDC supported PhD scholar (2012–14), Kate Marshall, at the Australian Cotton Research Institute. Kate's PhD is investigating molecular genetic methods to detect neonicotinoid resistance in cotton aphids.



Achievement

A significant supply of early career researchers supported to address R&D relevant to the cotton industry.

Developing workforce capacity

Between 2008 and 2013, CRDC invested in the following skills development and training initiatives for the cotton industry:

- *Field to Fabric Course*. CSIRO's popular course investigating fibre quality and its journey from field to fabric was conducted five times, with 15 to 25 participants per course.
- *Ginner training*. CRDC funded much-needed training for cotton ginner post-drought, as the industry capacity started to rebuild. Forty cotton ginner were trained in 2012–13.
- *Vocational Education and Training (VET) sector training*. CRDC funded research to assess the value of VET-sector training for on-farm employees.
- *Department of Agriculture, Fisheries and Forestry (now Department of Agriculture/ABARES) Science & Innovation Awards*. These awards recognise emerging research leaders across the agricultural sector. CRDC supported five cotton awards during this period.
- *Development of an online Skills Assessment Survey Tool*. This tool, developed through CRDC funding, was applied successfully by Cotton Australia and Tocal College during a Workforce Development Fund pilot project to upskill 60 cotton workers in three cotton production valleys.
- *Workplace placements for Aboriginal students*. CRDC, in association with the Aboriginal Employment Service, supported three students through workplace placements, helping them achieve post-secondary success.
- *Aboriginal workforce development*. CRDC supported Caring for Our Country and Goomeri Skills projects for Aboriginal workforce development.
- *Cotton Professional Development Coordinator*. CRDC, continuing previous collaboration with the Cotton CRC, supported a cotton professional development coordinator.
- *Development of a Diploma of Agriculture pathway*. CRDC was involved in developing a Diploma of Agriculture pathway based on recognition of prior learning, for managers of certified BMP farms.
- *Grassroots grant program*. CRDC supported a project funding small capacity-building projects by grower and industry associations.
- *Workplace Health and Safety*. CRDC was a partner in two RIRDC-managed primary industry health and safety partnerships with other rural research and development corporations. The projects included the revision of Cotton Farm Workplace Health & Safety resources and two editions of a Harvest Safety video.

Achievement

Numerous skills development and training initiatives to build workforce capacity and increase participation by Aboriginal communities.

HUMAN CAPACITY STRATEGY THREE

Human Capacity strategy three aimed to enhance capacity to innovate through investments in:

- Creating the cotton industry's Vision 2029
- Developing leadership
- Using extension to deliver research, knowledge and information to growers
- Developing and implementing *myBMP*
- Supporting conferences and forums
- Local R&D benefits.

Innovators and innovations are vital to an industry because this is where the quantum leaps in farming profitability or sustainability often come from, complementing the steady progress made through the cycles of learning from experience, research, development and adoption. An important area of investment for CRDC is building the industry's capacity to conceive of and adopt innovations.

Creating Industry Vision 2029

In 2009, CRDC started the process of visioning the industry's preferred future. In consultation with industry and external stakeholders, CRDC developed a vision that was presented to the industry at the 2010 Cotton Conference. It was '*Vision 2029: Australian cotton, carefully grown, naturally world's best*'. As part of this vision, the industry's attributes are: differentiated, responsible, tough, successful, respected and capable. These attributes have been used extensively to guide and describe R&D investment themes in the CRDC Strategic R&D Plan 2013–18.

Achievement

Industry Vision 2029, a shared strategic focus for the future of the cotton industry.

Developing leadership

Leadership capacity is vital to a successful industry. Current leaders need to be supported and developed, and future leaders encouraged. CRDC supported cotton industry people to participate in the following programs:

- Australian Rural Leadership Program
- Future Cotton Leaders Program
- Peter Cullen Trust scholarship
- Rabobank scholarship
- Nuffield Farming Scholars scholarship
- Managing Climate Variability Climate Champions
- Department of Agriculture/ABARES Science and Innovation Awards
- RIRDC's Horizon Scholars.

Achievement

High-level support for existing and new generation industry participants to improve leadership capacity.

Using extension to deliver research, knowledge and information to growers

A review of the Cotton CRC's adoption program in 2009–10 showed that the extension team played a central role in developing and delivering R&D-based information resources to growers and industry advisers. This review coincided with the revision of the industry's BMP program and the launch of its web-based successor, *myBMP*.

Following the closure of the CRC, in 2012 a cotton industry joint venture, CottonInfo, was established between CRDC, Cotton Australia and Cotton Seed Distributors to provide extension services to growers and the wider industry. CRDC provides the resources for specialist technical positions, including the CottonInfo program manager and communications manager. Cotton Australia manages the *myBMP* system, and Cotton Seed Distributors supports regional development officers. The objectives of the CottonInfo team are to support improvement in industry practices, R&D communication and industry responsiveness to emerging or emergency issues.



Achievement

An enhanced focus on extension, including development of the CottonInfo program, and enrichment of *myBMP* resources.

Developing and implementing *myBMP*

Between 2008 and 2010, the conversion of the cotton industry's paper-based best management practices manual into a web-based system, called *myBMP*, was completed and the new system was launched at the 2010 Cotton Conference.

myBMP allows growers to:

- Access the latest information from research via the CottonInfo team
- Compare their practices with standards related to industry and legislative requirements
- Apply best practice knowledge to lift farm performance above industry standards
- Apply for industry audits to gain BMP certification for their farms.



Achievement

The user-friendly, online system *myBMP* enabling adoption and benchmarking of on-farm best practice for economic and environmental gain and workplace safety.

Supporting conferences and forums

CRDC continued to provide foundation sponsorship and strong support for the industry's biennial cotton conference in 2008, 2010 and 2012.

CRDC, with the Cotton CRC, supported 11 cotton scientists to attend the World Cotton Research Conference, held in India in November 2011, and contributed to establishing the World Cotton Research Council, the first international network for cotton scientists. Following the conference, Australian cotton scientists formed a national group called the Association of Australian Cotton Scientists to interact with their international counterparts and to convene the inaugural Cotton Research Conference in September 2013. CRDC sponsored this event.

CRDC and the Cotton CRC ran two innovative and successful conferences in 2011 and 2012, with a third successful event in 2013 coordinated by CRDC in collaboration with, and with sponsorship from, the Namoi Catchment Management Authority.

As its investments in human capacity started to gain some traction, CRDC convened a series of forums for researchers and industry advisers to discuss workforce development issues. These forums have been important for industry in developing a longer-term workforce development plan. While the plan is still to be finalised by Cotton Australia and CRDC, its development has been encouraged by R&D investments made by CRDC.

Three Big Day Out field days were held: in 2009 (focusing on energy use), 2010 (successful dryland production systems) and 2011 (workforce management). These built on the Innovative Grower of the Year award by convening a major field day and associated extension activities on the property of the awardee.

Forty-seven travel grants were awarded during the five-year period, enabling researchers and scientists to travel to conferences, visit international collaborators and experts or host visits from them, and undertake further training .

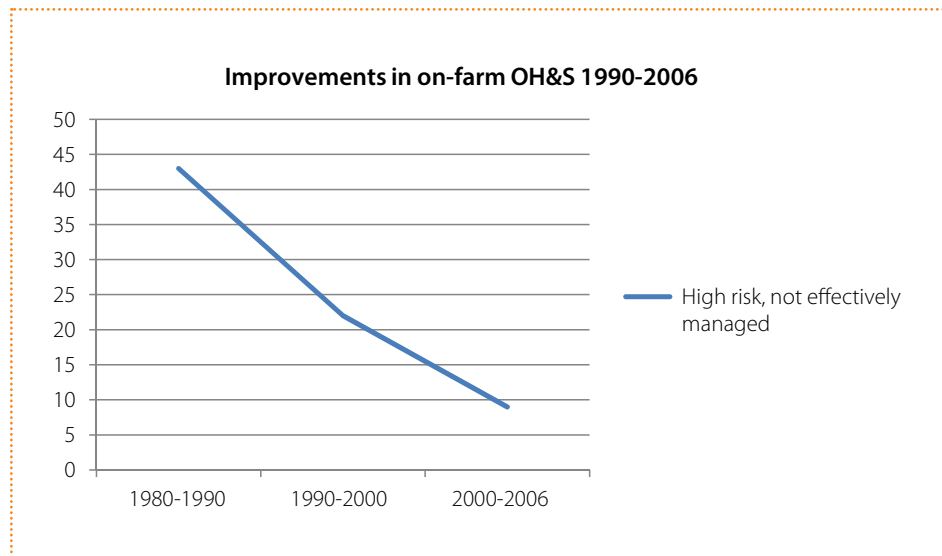
Achievement

High-level scientific exchange and collaboration within in Australia and overseas.

Increasing industry engagement in R&D

CRDC's capacity building program, initiated in 2011, has taken R&D out into cotton valleys from central Queensland to southern NSW, with cotton grower associations running projects in 2012–13 that provided skills and knowledge to members and local communities.

In 2009, a study into the impact of genetically modified (GM) technology also tracked improvements in farm safety by assessing both hazards, and industry's capacity to manage them over three decades. It showed that the cotton industry, through the application of new technology and best management practices, has vastly reduced farm hazards.



Achievement

Greater industry engagement in R&D and a demonstrated reduction in on-farm hazards.

Towards the future

The strong foundation of CRDC's investments during the 2008–13 period in the program areas of Value Chain, Farming Systems and Human Capacity, provided the building blocks for CRDC to formulate its 2013–18 Strategic Plan.

CRDC's 2013–18 plan, which began in July 2013, broadens CRDC's research focus to include the areas of: Farmers, Industry, Customers, People and Performance, recognising that all five are critical in ensuring a strong and sustainable industry for the future.

CRDC will continue its primary goal of strategically investing in RD&E to support the world-leading Australian cotton industry.



*Photo courtesy
Ruth Redfern.*

CRDC Roll Call 2008–2013

AUSTRALIAN GOVERNMENT

Ministers The Hon. Tony Burke MP;
Senator the Hon. Joe Ludwig

AUSTRALIAN COTTON GROWER'S RESEARCH ASSOCIATION

(CRDC's legislated industry body until March 2009)

Chair Ben Stephens

COTTON AUSTRALIA

(CRDC's legislated industry body from March 2009)

Chair Joanne Grainger; Andrew Watson; Lyndon Mulligan

CEO Adam Kay

Research Advisory Panel Leads Value Chain: Bob Dall'Alba
Biosecurity: Damien Erbacher
Farming Systems: John Cameron
Human Capacity: Mike Beeston

Research Advisory Panel Members Mitch Abbo; Stephen Ainsworth; Tony Bailey;
Hugh Ball; Mike Beeston; Shane Bodiam; Geoff
Brownlie; Jonathan Burrell; John Cameron; Tobin
Cherry; Rob Collins; Nigel Corish; Don Crothers; Gavin
Dal Broi; Bob Dall'Alba; Scott Davies; Stewart Denston;
Damien Erbacher; Phil Firth; Wal Friend; Andrew
Garnsey; Andrew Greste; Scott Hogan; Matt Holding;
David Kelly; Will Kirkby; Rob Lowe; Toby Moore; Neek
Morawitz; Greg Morris; Lyndon Mulligan; Andrew
Parkes; Mal Pritchard; Joe Robinson; Glenn Rogan;
Alex Roughley; Rod Smith; Jamie Street; Pat Sullivan;
Tony Taylor; Tony Thompson; Bill Tyrwhitt; Nev
Walton; Matt Ward; Brendon Warnock; Peter Watson.

COTTON RESEARCH AND DEVELOPMENT CORPORATION

Chair Mike Logan

Vice-Chair Richard Browne (until September 2008);
Leith Bouilly (from October 2008 to September 2011);
Mary Corbett (from October 2011).

Executive Director Bruce Finney

Non-executive Director (Until 30 September 2009)
Richard Browne; David Connors; TJ Higgins;
(From October 2009 to September 2011)
Kerry Adbey; Leith Bouilly; Mary Corbett; Glenn Fresser;
Juanita Hamparsum; Peter Hayes; Lisa Wilson
(From October 2011)
Mary Corbett; Richard Haire; Hamish Millar; Michael
Robinson; Cleave Rogan; Lorraine Stephenson

CRDC staff: Bruce Pyke; Paula Jones; Helen Dugdale; Greg Kauter;
Tracey Leven; Susan Maas; Bruce Pyke; Ian Taylor; Jane
Trindall; Allan Williams; Rohan Boehm; David
Coleman; Graeme Tolson; Elizabeth Eather; Heather
Martin; Fiona Mead; Lee-Anne Melbourne; Dianne
Purcell; Kara Taylor; Margaret Wheeler; Amy
Withington.

COTTON RESEARCH PARTNERS

AgVance Farming Pty Ltd
Australian Bureau of Agricultural and Resource Economics and Sciences
Australian Cotton Shippers Association
Australian National University
Australian Rural Leadership Foundation
Australian Society of Agronomy
Bill Gordon Consulting
Blast Industries Pty Ltd
Boyce Chartered Accountants
Central Highlands Cotton Growers and Irrigators Association
Central Queensland University
Collin Higgins Consultancy
Comet Sustainable Farming Association
Cooperative Research Centre for Irrigation Futures
Cooperative Research Centre for Polymers
Cotton Australia
Cotton Catchment Communities Cooperative Research Centre
Cotton Compass
Cotton Growers Association
CRC for Irrigation Futures
Crop Consultants Australia
CSIRO Entomology
CSIRO Material Science and Engineering
CSIRO Plant Industries and Cotton Seed Distributors (CottTech Unincorporated Joint Venture)
Curtin University of Technology
Deakin University
Department of Agriculture, Fisheries and Forestry Queensland
DW Consulting Services
Emergent Futures Pty Ltd
Farm Plus
FSA Consulting
Fundbase
Gary Goucher & Associates
GHD Pty Ltd
Gordon Stone & Associates
Goulburn-Murray Water
Graham Spackman & Associates
Grains Research and Development Corporation
Gwydir Valley Irrigators Association
Inovact Consulting Pty Ltd
Irrigation Australia Ltd
James Cook University
John Kent
Judith Stubbs & Associates
Land and Water Resources Research and Development Corporation
Lower Namoi Cotton Growers Association
Namoi Catchment Management Authority
Narrabri Local Aboriginal Land Council
National Centre for Engineering in Agriculture, University of Southern QLD
National Centre for Farmer Health
New England North West Landcare Network Chairs Inc
NSW Department of Primary Industries
Peter Cullen Trust
Peter R Day Resource Strategies Pty Ltd
Plant Health Australia
Primary Industry Centre for Scientific Education
Queensland Department of Employment, Economic Development and Innovation
Queensland University of Technology
Quick Test Technology
Roth Regional & Rural
Rural Industries Research and Development Corporation
Soils Research Pty Ltd
South Australian Research and Development Institute
Spackman Iker Ag Consulting
Sugar Research and Development Corporation
Tailored Agricultural Systems Pty Ltd
TechMAC Pty Ltd
Technopak Advisors Pty Ltd
Tocal Agricultural Centre
University of Adelaide
University of Central Queensland
University of Melbourne
University of New England
University of New South Wales
University of Queensland
University of Southern Queensland
University of Sydney
University of Technology Sydney
University of Western Australia
University of Western Sydney
Victorian Department of Primary Industries
Walgett Community College Primary School
Warden Agriculture Services
Waters Consulting
West Australian Vegetable Growers Association
Western Rivers
Wincott Women in Cotton Network



Australian Government
**Cotton Research and
Development Corporation**