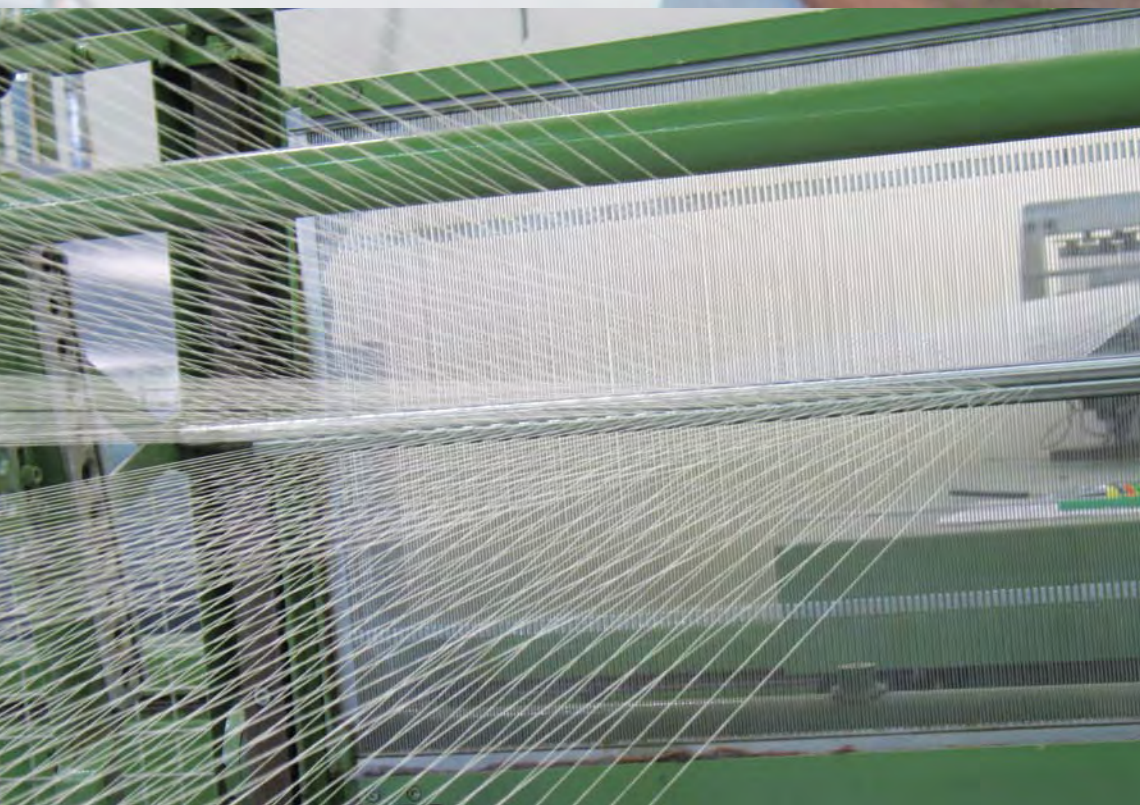


R&D in action 2003–2008



Australian Government

Cotton Research and
Development Corporation



About CRDC, 2003-2008

The 2003-2008 Strategic R&D Plan was the key document that guided R&D investment decisions over five years. Before this plan was devised, seasonal conditions and markets favoured large-scale cotton planting and the average industry production exceeded three million bales of cotton. Production since then has declined, primarily as a result of drought in cotton production regions. Given that background, and guiding the 'big-picture', were the following vision, mission and outcome statements.

Our Vision

A globally responsible cotton industry

Our Mission

Invest and provide leadership in research, innovation, knowledge creation and transfer

Our Outcome

A more sustainable, profitable and competitive cotton industry providing increased environmental, economic and social benefits to regional communities and the nation

CRDC is one of Australia's 16 Rural Research and Development Corporations. The Corporation became established in 1990 under the Primary Industries and Energy Research and Development Act 1989 (PIERD Act). This Act outlines CRDC's accountability to the Australian Government through the Minister for Agriculture, Fisheries and Forestry and to the cotton industry through the Australian Cotton Growers' Research Association.

CRDC remains committed 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 benefit from these investments to cotton industry participants, regional communities and the Australian community.

The key stakeholders of CRDC are cotton growers and the Australian cotton industry, represented by the Australian Cotton Growers Research Association, and the Australian people, represented by the Australian Government.

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From the Chair and Executive Director

Challenging circumstances – a resilient industry

The Strategic Plan covering the five years to June 2008 was devised during the first year of what has become a severe and protracted drought. Australian cotton production in 2002-03 plummeted to 1.62 million bales from the previous five-year average of 3.2 million bales. However, there was no crystal ball to reveal that drought would impact the industry for many years and, with it, the operations and research activity of CRDC.

In addition to unprecedented drought, the five years saw the industry tested by lower cotton prices and increasing competition for available water from irrigated grains, together with uncertainty in terms of trade and a volatile Australian dollar exchange rate.

Despite this, Australian cotton growers continued to produce the highest yields per hectare of premium quality cotton in the world. The low water availability in 2007-08 did, however, mean that crop was the smallest in 30 years: 0.6 million bales that were estimated to be worth \$275 million in export value, compared with a historic average of near \$1 billion.

CRDC obtains most of its income from production-linked industry levies that are matched on a rolling-basis with Australian Government contributions. CRDC expenditure on R&D fell significantly by the end of the period of the five-year plan and this made for increasingly difficult investment decisions to maintain R&D capacity.

In this publication, we have sought to explain what CRDC undertook over the five years – how we did it and what benefits our R&D has delivered to our stakeholders.

We would like to acknowledge the immense contributions of Bridget Jackson as Chair of CRDC from 1999 to the end of 2006, and Ralph Schulz as Executive Director from CRDC's inception through to 2004. Bridget and Ralph oversaw preparation and implementation of the Strategic Plan 2003-2008, aided by a Board of Directors that included, at the time, Dick Browne as Vice-Chair, Kathryn Adams, Jeff Bidstrup, Neil Forrester, Graeme Hamilton, TJ Higgins and Adam Kay. Thanks also to Dick Browne for holding

the reins as Acting Chair between January and August 2007.

The industry was well represented, particularly through the work of the Australian Cotton Growers' Research Association, in establishing industry priorities for the five years of the plan. Following the amalgamation of Cotton Australia and ACGRA, Cotton Australia, became our new industry stakeholder in 2009, and have retained the industry R&D priorities formulated by ACGRA.

CRDC's other stakeholder, the Australian Government, released and subsequently refined four National Research Priorities in the period leading up to formulation of this Strategic Plan and released revised Rural R&D Priorities in March 2003.

Industry (ACGRA) and Government priorities, formed an integral part of our planning and reporting processes and ensured our R&D program addressed the national interest.

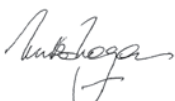
We have reported extensively on how we addressed these priorities on pages 11 to 15.

Looking to the future with a new R&D Plan

Each succeeding five-year R&D Plan brings opportunities. The 2008-2013 Strategic R&D Plan describes a quite different operating environment for the Australian cotton industry.

The new five-year plan is an outward-looking response to the views of industry and government on important future challenges. While it expresses a five-year vision, the investments made beyond the 2003-2008 Plan requires initiatives that will have impacts that continue well into the future.

High-quality R&D has placed the Australian cotton industry at the forefront in meeting new challenges. Quality cotton produced more efficiently and in a sustainable farming system will be undertaken by an industry that remains youthful and forward-looking.



Mike Logan

Chair



Bruce Finney

Executive Director



R&D securing the Australian cotton industry's future

Evolving to meet new challenges

From its beginnings in the 1960s, the Australian cotton industry has placed great emphasis on the value of its R&D. The partnership with the Australian Government has led to Australian producers' adoption of world-leading research that has contributed to unparalleled productivity growth and improved practices in cotton production. This is borne out by the industry returning world's best cotton yields with continued improvements in measured environmental performance. This partnership now looks to sustain these achievements and address new challenges effectively.

A new future beckons for Australian agriculture and the cotton industry. The impact of user-driven R&D, with its inherent high rates of adoption, remains as important to the future as it has been in the past. To enable cotton to compete successfully for available land and water resources, CRDC works closely with the industry to understand the technical needs of our farmer and value-chain customers and to demonstrate the benefits the industry is bringing to the Australian economy and people. A major part of the R&D Plan has been to focus on achieving the fibre qualities that are important to the spinners and perhaps even a branded point of differentiation for Australian cotton. This remains a key focus for the future.

CRDC's R&D planning is undertaken in cycles of five-years; however, R&D initiatives and achievement of outcomes do not fit neatly into this time frame. In response to the operating environment at the time, the Strategic Plan for 2003–2008 streamlined the previous five-year plan. It reduced eleven programs to six to achieve a more integrated approach to R&D while addressing the five-year mission to 'invest and provide leadership in research, innovation, knowledge creation and transfer.'

In pursuing CRDC's new mission of 'the quest for sustainable competitive advantage,' the Strategic R&D Plan 2008–2013 has further streamlined the previous plan's six programs to three: Value Chain, Farming Systems and Human Capacity. Over-arching the future R&D effort remains the challenge of building industry capacity to underpin innovation, adoption of R&D outputs and allow the industry to adapt its science and

respond to cotton production in this climate of change.

A quality product for a competitive market

The difficult environment over recent years has challenged those of us involved in the R&D effort to think of how best to obtain a further competitive advantage in the world market. Implementation of the Strategic R&D Plan 2003–2008 saw new thinking and great advances in maintaining and enhancing fibre quality right through the value chain, from field to fabric.

A major three-year Australian Government Natural Heritage Trust-funded *Pathways to EMS* project has extended cotton's Best Management Practices (BMP) program beyond the farm gate to the production chain. This has begun to create not only a quality assurance supply chain but also an enhanced environmental performance measured beyond the farm gate. The EMS investment aimed to create a point of market differentiation that could drive market incentives for environmental performance. In the meantime, IZUMIYA, a Japanese chain with 86 department stores, continues to successfully market garments made exclusively from Australian BMP cotton under their environmentally branded in-house 'Good-I' label – a vote of confidence in the Australian product.

Objective measurement

During 2003–08, the Australian industry continued to address the lack of effective technology to objectively measure cotton fibre quality as defined by fineness and maturity. Aided by CRDC investments, the Textile and Fibre Technology program in Geelong (now part of CSIRO Materials Science and Engineering) has developed two instruments for objective cotton fibre measurement – *SiroMat* and *Cottonscan*. With the assistance of R&D investments from CRDC, both technologies are progressing towards commercialisation. *SiroMat* has potential for use as a stand alone, medium volume instrument in mill and merchant laboratories; however, its greatest value may be as a tool to aid cotton breeders to select improved varieties. *Cottonscan* has been demonstrated to give consistent and valid readings of average maturity and fineness. This is believed to benefit spinners by delivering an ability to more effectively

differentiate fibre quality and improve efficiency while differentiating Australian fibre in the market place for its desirable fibre qualities.

Plant breeding

For the first three years of the plan, CRDC continued its significant investment in the CSIRO plant-breeding program. Growers testify this world-leading research effort has produced cotton varieties that compete at the premium end of the world market with fibre that has the strength, length, fineness and maturity sought by spinners. Coupled with R&D-driven agronomic practices that produce consistent high quality and efficient ginning and shipping systems that deliver cotton on time, this means Australian producers remained competitive in a world market unassisted by market support incentives and payments from government.

CRDC reviewed the strategic direction of its future investments in research and development in breeding and biotechnology in 2006–07. In doing so, we recognised the significant changes that have occurred in the commercial environment for cotton plant breeding and concluded that market failure for investment no longer existed. This was evidenced in September 2007 when CSIRO Plant Industry and Cotton Seed Distributors Ltd announced the formation of the Cotton Breeding Australia (CBA) joint venture to fund future cotton breeding and targeted research.

CRDC is proud to have been the major investor on behalf of the cotton industry in this highly successful, multiple award-winning breeding program. CSIRO-bred cotton varieties currently represent over 90 per cent of the Australian market. Australian-developed germplasm is well represented in leading varieties and strains of premium upland cotton grown around the world. The fact that Australia's plant breeding research program reached a point where it can be funded by industry without additional grower levies or government funding is also a measure of its long-term success.

CRDC will continue to consider strategic investments in plant breeding and biotechnology research to address market failure in quality improvements, climate change tolerance and input efficiency, stewardship of traits and biosecurity outcomes.



Australian cotton's shrinking environmental footprint

The CRDC-commissioned second Environmental Audit of the industry in 2003 (the first was in 1991) found that the industry had achieved high compliance with 75 per cent of the recommendations set down by the original audit, mainly in the preceding five years and mostly attributable to the BMP program which focused on improved water use efficiency and Integrated Pest Management.

In May 2005, CRDC published *Taking Responsibility for our Future* – the cotton industry's comprehensive response to the audit's range of recommendations. It is noteworthy that the Australian cotton industry was the first major agricultural industry to seek and respond to such a rigorous examination of its environmental performance.

Natural Resource Management (NRM) has been a major strategic focus for CRDC in the past five years and evaluation has shown the R&D effort has had an impact on environmental outcomes from the field to catchment scale. These outcomes include a remarkable reduction in pesticide use, substantially improved water use efficiency, waste recycling and disposal, and a strong focus on wildlife management and biodiversity.

Best Management Practices

By 2008, in excess of \$10 million invested in the industry's BMP program by CRDC resulted in the Australian cotton industry being recognised nationally and internationally as a leader in sustainable cotton production and as a model for change in Australian agriculture. The BMP program is undergoing comprehensive revision in 2008 and beyond to respond to new producer needs and challenges in sustaining viable irrigation enterprises and extending the benefits of an industry-wide environmental performance program to the markets where Australian cotton fibre is consumed.

Climate

As far back as 2003 when climate change had not become broadly perceived as a significant future challenge for agriculture, CRDC established a specific strategy within the Natural Resource Management program to address this issue. The resulting research has established a strong foundation for tackling climate change mitigation and adaptation. It has helped to clarify the level of greenhouse gas emissions resulting from cotton production and increased awareness of the environmental and economic cost of over-fertilising. An on-line calculator, developed with the assistance of CRDC investments, now allows cotton farmers to calculate their greenhouse gas footprint.

This research has provided a pilot on-farm energy use calculator known as EnergyCalc. This tool assists farmers to become more fuel and energy-efficient by developing new understanding and management responses to the greenhouse gas inputs resulting from use of fertilisers, fuel and irrigation practise. Early results point to simultaneous profit boosts together with improvements in environmental sustainability. The outcomes from further research on crop rotations and nutrition have assisted growers to improve management practices for fertiliser efficiency and storing carbon in the soil.

Building human capacity

The People and Knowledge program was a centrepiece of the 2003–2008 plan. It brought a commitment that ranged from increasing the leadership capacity of men and women within the industry to providing extension-related courses for cotton growers and consultants, furthering the education of current and potential agricultural and natural resources scientists, and even supporting programs to encourage school

students to think about a range of cotton-related careers. This has combined with travel grants for researchers, growers and consultants, investment in a National Cotton Training Coordinator whose input has greatly advanced accreditation of industry training, and an extensive program of undergraduate, post graduate and post-doctoral scholarships. CRDC also invested in the Cotton Catchment Communities CRC Cotton Production Course at The University of New England.

The five years 2003-08 saw a major review of Extension, Education and Training, undertaken in conjunction with the Australian Cotton CRC (the predecessor of today's Cotton Catchment Communities CRC). This was the beginning of an extensive process of refining, refocusing and extending extension services that was completed in 2007–08. Cotton producers retain access to National Cotton Extension Team services as well as to a range of technical specialists.

A response focus

Notable extension achievements over the five-year period included a response to a potentially catastrophic outbreak of Silverleaf whitefly in central Queensland. CRDC investments in 2003–04 ensured the outbreak was well-managed through the development of good extension information and cross-industry communication, combined with area-wide monitoring and management, the introduction of pest-specific insecticides, careful monitoring and management of resistance to insecticides. This has had the added flow-on benefit of increasing industry-wide adoption of Integrated Pest Management and Area-Wide Management techniques.

The new Strategic R&D Plan for 2008–2013 retains a major focus on supporting the cotton industry's people to conduct research, transfer research outcomes and improve the skills and capacity of the whole industry and its local communities.



CRDC submitted two cotton-related R&D entries for judgement at a Rewards from Innovations forum held at Parliament House, Canberra, in September 2005 by the Rural R&D Corporations. Both the BMP program and the CSIRO Cotton Breeding Team were short listed, with the Cotton Breeding Team taking out the Australian Government Prize for Rural Innovation. Above, John Grellman (CSD), Bridget Jackson (CRDC) and Jeremy Burdon (CSIRO) collect the prize from former Deputy Prime Minister, Mark Vaile

Delivering return on investment

Return on investment (ROI) studies of CRDC's R&D activities in 2003–2008 have shown that CRDC investors have received excellent value for money.

An independent study by the BDA Group sampling major projects managed by CRDC in the five years found a 1:4 ratio for major impact. That is, one in four projects demonstrated a major economic, social or environmental impact – well in advance of other rural industry R&D performances. The BDA analysis showed \$500 million returned to stakeholders just from the major projects studied and a minimum return of \$813 million from all projects over the period.

BDA highlighted major impacts from CRDC's investment as the developments in BMP, water use efficiency, Fusarium wilt management, Bt resistance stewardship, EMS Pathways and cotton breeding, and identified a further 13 important project impacts.

A key to success across these vital areas was the collaborative approach taken by CRDC in managing R&D investments. Over the five years to 2008, CRDC invested around one in every five dollars invested in cotton industry R&D but was involved in around 60 per cent of all cotton R&D undertaken in Australia. Cross-industry collaboration between cotton and other rural industry R&D activity also grew substantially during the period.

Results from this study highlighted the ongoing impact of R&D as a key driver in productivity growth and improved environmental performance. A key aspect of improved performance measured at the farm level was the capacity of producers to adapt to climate change, economic and environmental challenges.

Looking at the improvements made on-farm in the five years to 2008, ongoing assessment of the progress made by CSIRO's breeding program shows that approximately half of the increases in yield and productivity resulted from the R&D investments in plant breed and the use of improved varieties coming from that field of R&D investment. An ROI study by the Centre for International Economics in 2002 had shown a return of over \$5 billion since 1973, with a benefit cost ratio of 86 and internal rate of return of 34 per cent. However, the remaining half was due to cotton farmers' management and application of the improved knowledge and technology available as a result of CRDC R&D investments.

With significant taxpayer dollars invested in industry R&D through the Rural Research and Development Corporations, in 2006, the Council of Rural Research and Development Corporations' Chairs developed a rigorous external process to determine the value of these R&D investments to the industries involved and to the Australian taxpayer. CRDC submitted two projects for analysis. Reports released in December 2008 confirmed a high level of return on public and industry investment in these areas.

The first of the two independent analyses examined the deployment of Bt transgenic

cotton and related research inputs across a number of scientific areas, in partnership with other public and private organisations. CRDC's investments have allowed the successful management of potential resistance to the transgenic cotton varieties by major pest species. The cost benefit analysis estimated that the CRDC investments would return \$201 over the next 20 years for each levy payers' dollar invested across the entire supply chain in Bt technologies. The return on matching funds provided by the Australian Government was estimated at \$488 for each dollar invested.

The second research area studied was the development of tools and techniques to measure irrigation water use efficiency more accurately. This project provided a foundation for water savings and supported the development of Irrimate™ technology, which has enabled cotton irrigators to 'measure and manage' their water resources for furrow irrigation more effectively. The analysis showed a return of \$131 for each dollar of levy payers' investments and \$184 on the Australian Government's matching funds.

Value-adding through collaboration

Collaboration in the R&D efforts of research providers and rural industries remains a key mechanism for maximising the efficiency and effectiveness of R&D investment. In particular, the Corporation continued to engage with research providers, the Cotton Catchment Communities CRC and sister RDCs on matters ranging from small individual projects and large national programs such as the National Climate Change Research Strategy for Primary Industries (CCRSPI) and the National Program for Sustainable Irrigation (NPSI). In 2007–08, more than 79 per cent of CRDC funded projects involved collaboration between three or more partners and co-investment in excess of \$16 million in collaborative investment projects.

Future challenges for R&D

The world's capacity to meet the rapidly growing global demand for food and fibre will be fully stretched in coming years. The new pressure on land and water resources from biofuels is yet another distortion of the world food equation. The markets have already factored into their thinking the notion of a tipping point, where demand just cannot be met – or, at least, not without major changes to the way challenges are met.

These emerging issues have led CRDC to summarise its R&D priorities for the next five years as 'the quest for sustainable competitive advantage'. While a realignment of R&D investments to target incremental improvements remain important, this change in emphasis means that investments in higher risk and potentially transformational research will be essential for the future of the cotton industry.

To address global competitiveness, Australian cotton must find a market niche where its superior quality is recognised in the market place. The bulk of the cotton breeding challenge will be met by Cotton Breeding Australia – the new

venture by CSIRO and Cotton Seed Distributors Ltd. To complement this breeding effort, CRDC will focus on enhancing and extending the work of the last five years by actively seeking new services and evolved products along the supply chain to create additional value in both cotton lint and cottonseed for the benefit of the Australian cotton industry and the nation.

Agriculture faces new challenges in how it responds collectively to national issues such as climate change. The Australian Government has now ratified the Kyoto Protocol and announced a Carbon Pollution Reduction Scheme. CRDC is investing an additional 23 per cent of funds in climate change mitigation and adaptation research in 2008–09. The industry's commitment to addressing this challenge was evident in the theme of the Australian Cotton Conference in August 2008, *New Beginnings – Cotton in a Climate of Change*. CRDC is a foundation sponsor of the Cotton Conference and played a key role in planning, managing, creating content, media liaison and distributing information presented at the 2008 conference.

In seeking to improve profitability, the Australian cotton industry has identified connections between improved productivity, natural resource management and addressing climate change. CRDC research and development investments are seeking avenues to further improve water, fertiliser and energy use efficiency while at the same time further reducing greenhouse gas emissions.

Continuous improvement

R&D impact assessment will continue to be an important focus, as the Rural R&D Corporations collectively evaluate returns on investment. Following the success of the pilot cost benefit analyses in 2007–08, the RDCs have committed to study a random sample of research projects using the methods developed in the initial studies. Beyond this, CRDC is actively improving its use of assessment of potential returns in its R&D investment decisions. This will be of great assistance in determining future investment priorities for the benefit of the Australian cotton industry and nation as a whole.





Triple Bottom Line Performance

Evaluating ENVIRONMENTAL Performance

Planned Environmental Output 2003–2008: Sustainable production systems and catchments

ENVIRONMENTAL OBJECTIVE
 Industry-wide adoption of improved integrated pest management systems

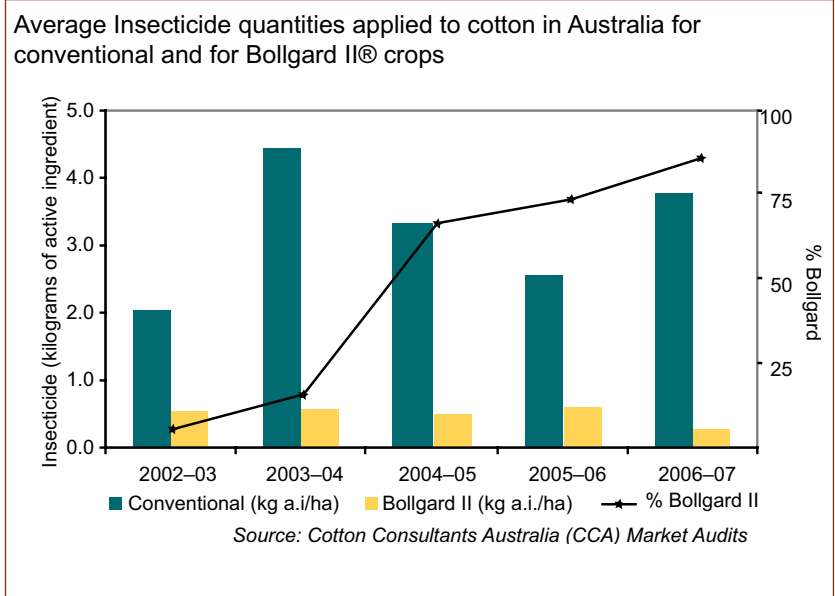
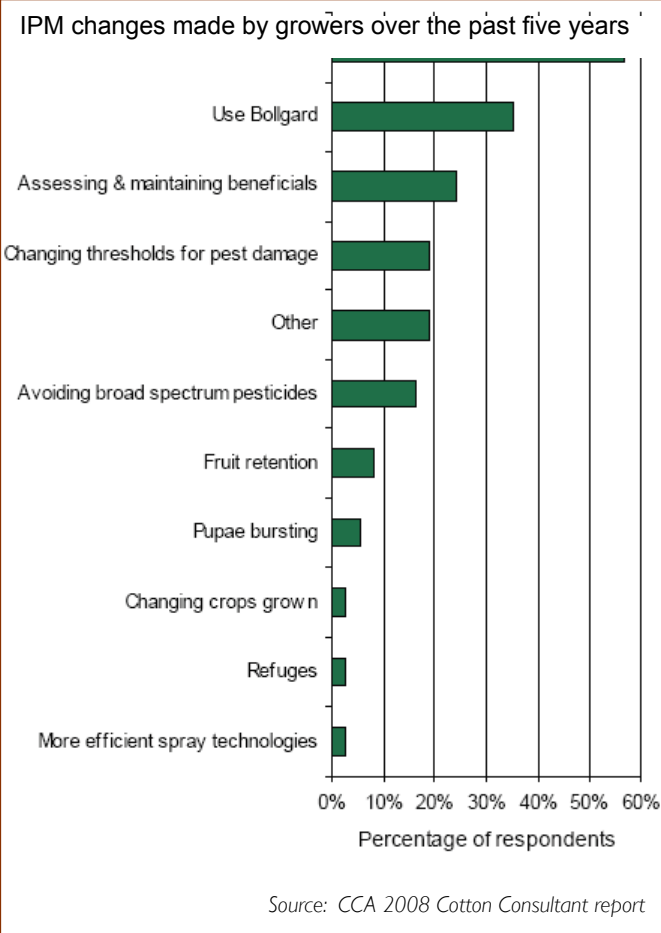
TARGET A 50 per cent reduction by 2008 in 2004 quantities of insecticide used

RESULT
 Target has been met ahead of time through high levels of adoption and good stewardship of Bt cotton (Bollgard II®) and application of Integrated Pest Management (IPM).
 Results from the five year period:

- ▶ 2003–04: 3.47 kg ai/ha (kilogram of active ingredient per hectare)
- ▶ 2004–05: 1.32 kg ai/ha (a reduction of 62 per cent from 2003–04)
- ▶ 2005–06: 0.97 kg ai/ha (a reduction of 71 per cent from 2003–04)
- ▶ 2006–07: 0.77 kg ai/ha (a reduction of 78 per cent from 2003–04)
- ▶ 2007–08: data not available due to low production.

The period 2003–04 to 2006–07 showed a reduction of 68 per cent compared with the period 1998–99 to 2002–03, which had an average insecticide use of 5.12 kg ai/ha. *Source: Cotton Consultants Australia (CCA) Market Audits*

Integrated Pest Management (IPM): The CCA 2008 consultant survey reported on 220 growers. Ninety per cent had implemented Best Management Practices (BMPs) in IPM over the 2003 to 2008 period.



ENVIRONMENTAL OBJECTIVE

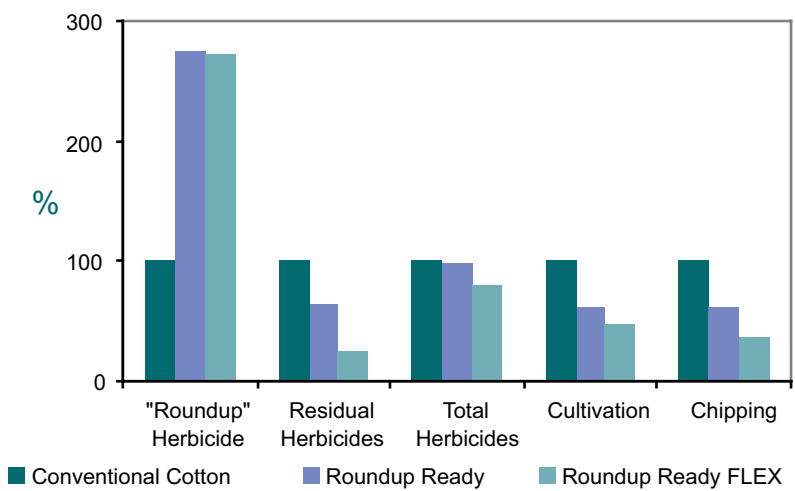
Industry-wide adoption of improved integrated weed management systems

TARGET A 20 per cent reduction by 2008 in 2004 quantities of residual herbicide used

RESULT

Target met ahead of time. In the period up to 2005-06, Cotton Consultants Australia reports a 32.4 per cent reduction in residual herbicide use since the introduction of Roundup Ready® technology and strong support from cotton growers in the application of Integrated Weed Management (IWM) practices. No data available for the 2007-08 season due to record low production areas planted.

A comparison of weed control measures in Australian cotton crops 2006-07 for Conventional (100%), Roundup Ready® and Roundup Ready FLEX® crops



This graph shows weed control measures for GM crops - Roundup Ready® and Roundup Ready FLEX® - with weed control measures in non-GM (conventionally-bred) crops as a benchmark at 100%

Source: Monsanto Australia Ltd

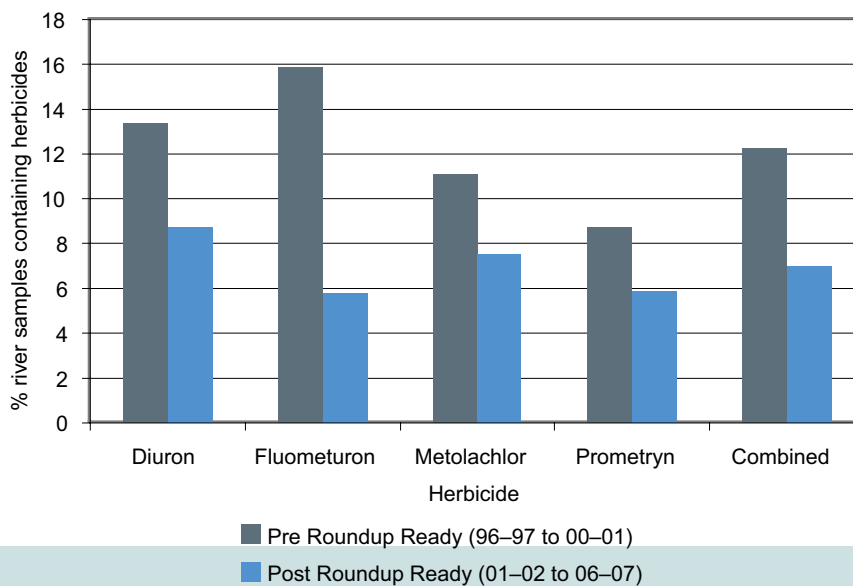
TARGET A continued decline in riverine contamination by herbicides used only in cotton production

RESULT

On target. Combined average detections of four residual herbicides used on cotton in north west NSW rivers declined by 29 percent over the four seasons 2003-04 to 2006-07 compared with the previous five seasons (1998-99 to 2002-03). Source: NSW Department of Natural Resources

This decline is thought to be correlated with a reduction in the use of environmentally contaminating herbicides due to the adoption of Roundup Ready® technology. The reduced river flows associated with the drought has also had an impact, however this is not measured directly.

Percentage of north west NSW river samples containing herbicides used on cotton



Source: NSW Department of Natural Resources

ENVIRONMENTAL OBJECTIVE

Increased adoption of Best Management Practices (BMP) that meets legal requirements, industry benchmarks and catchment scale targets

TARGET 80 per cent of cotton production audited against BMP Minimum Certification Standards by 2007

RESULT

Target was not achieved. Survey results below and recent feedback from cotton consultants indicate that there is probably more to be gained in terms of demonstrating improved environmental outcomes by developing the capacity to report on the adoption of the BMPs and practice change, in addition to overall numbers of farms that have completed the BMP audit process.

In January 2007, Cotton Australia estimated that 40 per cent of farm entities were either fully certified against BMP standards or had received a Pre-Certification Assessment and produced an estimated 45 to 50 per cent of the national cotton crop. In addition, surveys by Crop Consultants Australia have indicated that many additional growers are satisfied that they have adopted BMP practices but have not sought formal certification.

New steps to increase implementation:

- ▶ CRDC, Cotton Australia and the Cotton Catchment Communities CRC appointed a BMP General Manager in 2007. This new position is responsible for developing the industry's BMP program to meet future challenges in environmental and business sustainability. Extensive focus on BMP during the 2003-08 Plan allows the industry to continue upgrading the content and importance of BMP as a key future tool for cotton production management, and extending the system beyond the farm gate to become a whole-of-industry initiative.

A Cotton Consultants Australia survey relating to the BMP Land and Water Management module commissioned by CRDC and Cotton CRC showed a larger proportion of the BMP accredited growers, compared with the non-BMP accredited growers during the period:

- ▶ Measured water use efficiency (WUE)
- ▶ Monitored ground water
- ▶ Measured soil sodicity
- ▶ Assessed erosion risks
- ▶ Monitored soil structure
- ▶ Established and protected native trees in riparian areas
- ▶ Provided alternative watering points for stock away from creeks and rivers
- ▶ Conducted annual soil tests

For further information and data on BMP adoption, see "CCA BMP LWA Benchmarking 2006 Final.pdf", pages 188–191

ENVIRONMENTAL OBJECTIVE

Improved water use efficiency (WUE)

TARGET A 20 per cent improvement in farm WUE on farms by 2008, measured against the 2004 median, in bales per megalitre

RESULT

Target effectively met. While it has not been possible to gather the data to directly measure this target, other measurements indicate significant progress by the industry in improving water use efficiency.

Since this target was set in 2004, CRDC has contributed to initiatives within the cotton industry to further improve water use efficiency and its measurement.

An analysis of 36 farms in 2006-07 using a comprehensive standard for water use, the Gross Production Water Use Index (GPWUI) which takes into account rainfall and soil moisture, measured an increase of 40 percent in water use efficiency compared with a similar study nine years before.

Significant progress on water use efficiency has also been made through the industry's yield improvement, due in part to improved higher yielding varieties and continuous improvement in agronomy and achieved with no net increase in the quantity of water required per hectare.

An increased focus on improving the management of water on cotton farms is underway in the industry with all sectors – growers, consultants, irrigation specialists, researchers and extension staff – working towards better measurement of water use in order to understand where inefficiencies exist in their systems and where the most cost effective savings can be made. A recent survey of cotton consultants reported on the water management of 233 cotton growers indicating that over 70 percent had implemented on-farm changes since 2003 to improve water use efficiency. In a separate survey of 71 cotton growers in June 2008, 97 per cent reported that they had improved their water use efficiency since 2003.

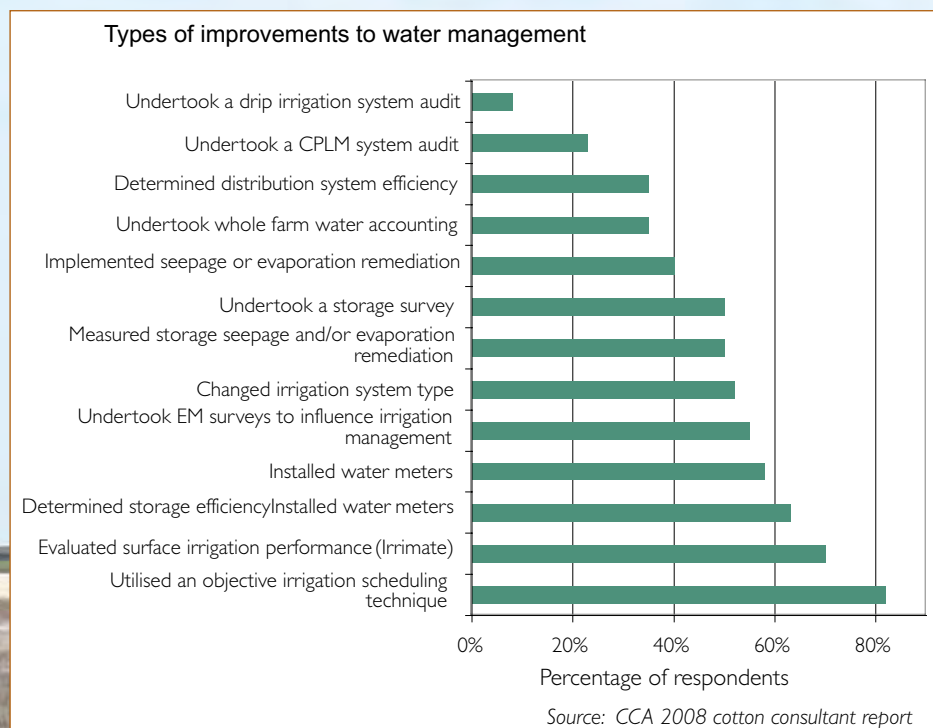
Extract from CCA cotton consultant 2008 report (page 38):

'Changes in WUE management practice

In total, respondents provided estimates of changes in WUE management since 2003 for 233 growers.

Seventy two percent of the growers increased implementation of WUE management practice since 2003. The remaining 28 per cent of growers 'stayed the same' since 2003. No grower was noted to have decreased the implementation of changes in WUE management practice since 2003.'

Evidence of improved water use efficiency 2003–2008



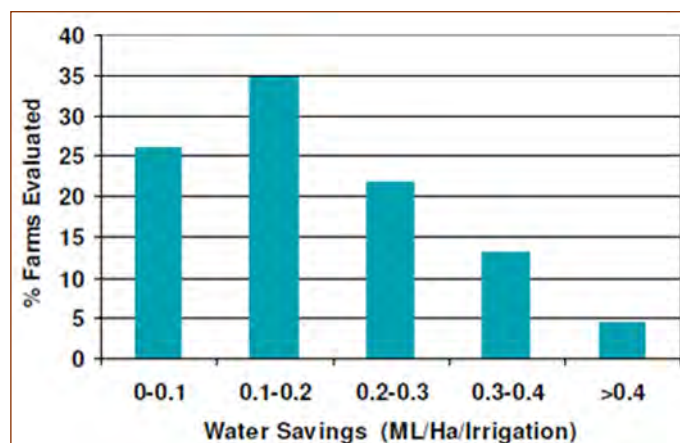
This graph shows the changes made by 233 grower clients in water management over last five years. All of these practices have been encouraged by the Extension Team's Water Focus Team under a range of initiatives delivered through the Cotton CRC

But there is still room to optimise systems

Although a significant component of the improvements in water use efficiency achieved by cotton growers over the last decade has been due to improved yields, by applying irrigation monitoring technology and methods developed by CRDC research investments, many farms may still have room to optimise their furrow irrigation systems.

A series of 23 evaluations on nine cotton farms in 2006–07 by the Cotton Water Extension Team show that by making some minor modifications, such as reducing the time siphons are running or increasing the rate water is applied to the field, the average saving was 0.18 megalitres per hectare for each irrigation with higher savings in nearly 40 per cent of the events measured (see the graph to the right).

To put this in perspective, for a farm of 500 hectares applying seven irrigations, the saving of 0.18 megalitres per hectare of irrigation would total 630 megalitres. This amount of water could grow an extra 80 hectares of cotton or provide sufficient water for one full irrigation cycle. Alternatively the water saved could be traded.



Evaluating ECONOMIC Performance

Planned Economic Output: Profitability and international competitiveness

ECONOMIC OBJECTIVE

Improved yield (through improved management and breeding of higher yielding, disease, insect and herbicide-tolerant cotton varieties)

TARGET A ten per cent improvement in cotton yield per hectare (two per cent annual or ten per cent over five years)

RESULT

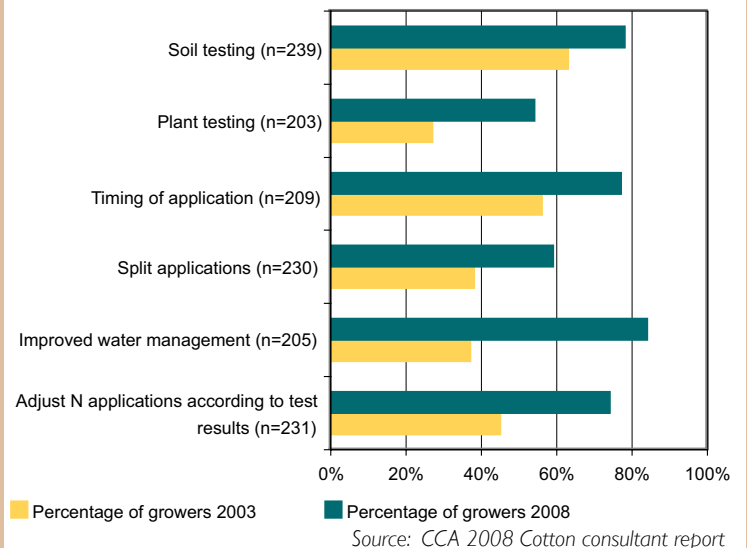
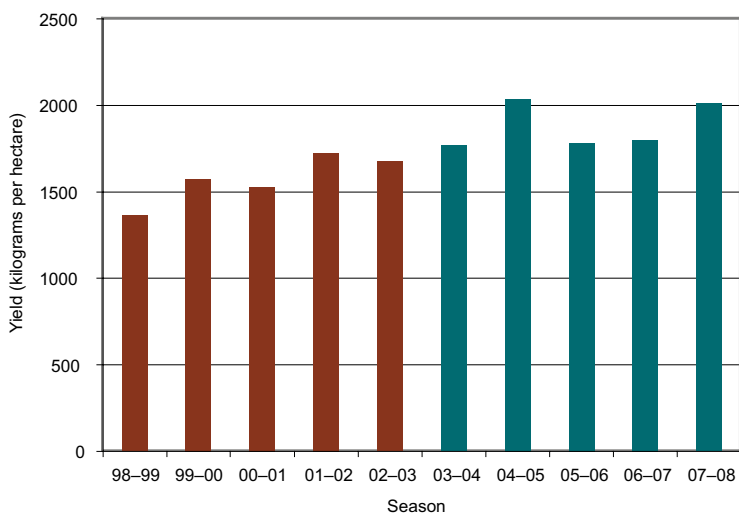
Target achieved ahead of time. Cotton yields over the five seasons covered in CRDC's just completed Strategic Plan have averaged an estimated 1,880 kilograms of lint per hectare, compared to an average of 1575 kilograms in the previous five years: a 17 per cent improvement. Australian cotton farms have the world's highest yields for a major producer (30 per cent ahead of the nearest country).

A recent survey of cotton crop consultants indicated that the five major drivers of improved yields over the last five years were improved:

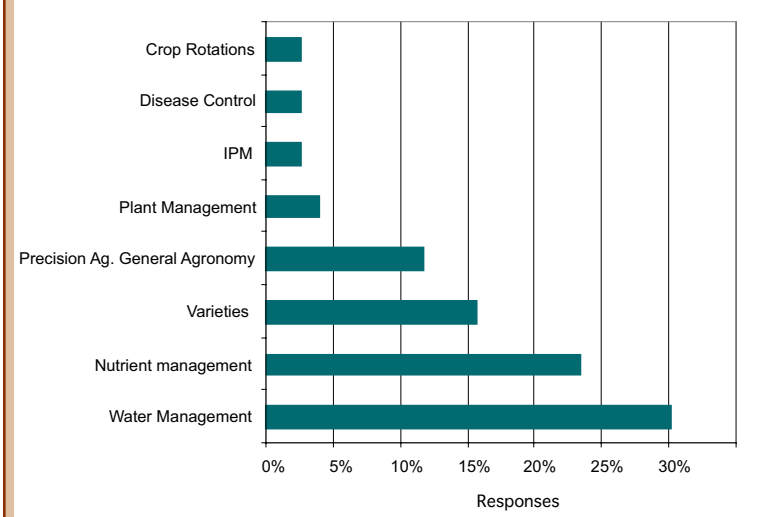
- ▶ Water use efficiency
- ▶ Cotton varieties
- ▶ Nitrogen fertiliser efficiency
- ▶ Management of other plant nutrients
- ▶ Management of crop rotations.

The figure below shows cotton yield in kilograms per hectare for the five-year periods of the two previous CRDC Strategic Plans. The mean yields for each five year period are significantly different (t-test $p < 0.05$)

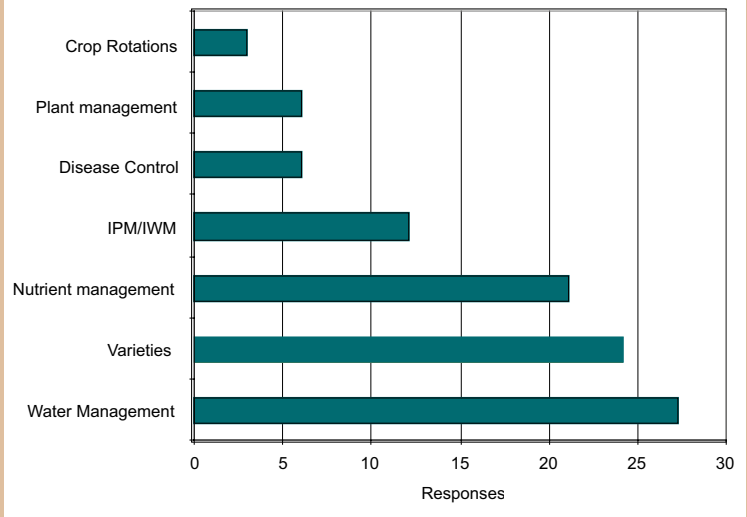
Cotton yield per hectare during the last two CRDC five-year plans Nitrogen use efficiency practices



Key factors for improvements in yield 2003-2008



Key R&D impacting on management of cotton 2003-2008



Source: CCA 2008 Cotton consultant report

<p>ECONOMIC OBJECTIVE Improved cotton fibre quality that meets market and spinner needs</p>
<p>TARGET Evidence of continuous improvement in five key parameters measured in spinning mill benchmark surveys by 2007</p>
<p>RESULT</p> <p>Target met, with improvements in micronaire, fibre length and strength, contamination and short fibre content.</p> <p>Despite drought conditions, the quality of the 2007–08 crop was excellent, with almost all micronaire in the acceptable range.</p> <p>The Australian Cotton Shippers Association (ACSA) received feedback (in 2003) from key international clients concerned about the fibre micronaire of Australian cotton being too high. High micronaire has not been a problem in recent years and this was the case in 2007–08.</p> <p>Feedback from mills regarding Australian cotton continues to show that it is preferred over many of our competitors because of the high quality, efficient delivery and very low contamination. The latter is a feature that the industry is seeking to maintain through the development of ginning and potentially storage and application of BMP post-farm-gate.</p>
<p>TARGET Evidence that prices for Australian cotton remain above those for competitive cotton growths</p>
<p>RESULT</p> <p>Despite drought, the 2007–08 season delivered high quality cotton and Australian cotton remained among the top prices listed for the highest category of upland cotton on the Liverpool <i>Cotton Outlook</i> 'A' index and continued to perform well against the industry SJV benchmark.</p>

<p>ECONOMIC OBJECTIVE Increased profitability through better whole farm management</p>
<p>TARGET Evidence that profit margins are maintained or improving over time (2003 to 2008 both annually and trends over time)</p>
<p>RESULT</p> <p>Target not met due to unfavourable external factors.</p> <p>Profitability trends for average performing farms are declining. In contrast, the trend for the top 20 percent of farms is stable, based on their capacity to produce higher yields at lower cost, as shown in the graph on page 31. (Source: the CRDC-supported <i>BOYCE Cotton Comparative Analysis 2006</i>).</p> <p>Ongoing and widespread drought conditions, relatively low prices and escalating fuel, fertiliser and chemical prices exerted a significant impact on whole-farm profitability on most cotton farms since 2003, and particularly 2007–08. This data was collected at the conclusion of the 2003-2008 R&D Plan.</p>

Evaluating SOCIAL Performance

Planned Social Output: Empowered people and communities

Progress towards Planned Social Output 2003–2008

<p>SOCIAL OBJECTIVE Improved skills and qualifications of people at all levels of the industry</p>
<p>TARGETS</p> <ul style="list-style-type: none"> ▶ At least 15 new post-graduates working in areas of high priority future need ▶ At least ten new post-doctoral positions working in areas of high current need ▶ 80 per cent of cotton growers having attended a relevant training course in OH&S, IPM or Water Management
<p>RESULT</p> <p>Post-graduate target was met. New post-graduates commencing during the period number two in 2003–04; three in 2004–05; six in 2005–06; three in 2006–07, and one in 2007–08, totalling 15 in all.</p> <p>A 2007 survey of the 79 PhD students supported to date by CRDC found that 47 still work in cotton related science, 18 are working in other science-related fields and three are working on farms.</p> <p>Post-doctoral target was met. CRDC supported 11 projects involving post-doctoral scientists during 2003-2008. Of these, seven have been new post-doctoral projects.</p> <p>Training target was met. In 2003-2008:</p> <ul style="list-style-type: none"> ▶ 80 per cent attended spray application courses ▶ 60 per cent attended OH&S training ▶ 58 per cent attended IPM courses ▶ Over 50 per cent attended water management and soil health courses. <p>During 2007–08, courses on spray drift, water management and fibre management were among the most popular with cotton growers and consultants. Approximately 20 per cent of cotton growers attended at least one module of the new water management course program.</p>

SOCIAL OBJECTIVE

Healthy and resilient communities in cotton producing regions

TARGETS

- ▶ A reduction in the cotton industry's environmental footprint (e.g., reduced pesticide use, improved water use efficiency, reduced greenhouse gas production)
- ▶ Contribution to career opportunities in cotton producing regions
- ▶ At least a ten per cent reduction in cotton farm related injuries
- ▶ Improved industry economic viability

RESULT

The activities planned to address these targets were achieved.

The adoption of biotechnology and sound integrated pest and weed management programs has contributed to a 68 per cent reduction in the quantities of insecticide applied and up to a 32 per cent reduction in total (residual and non-residual) in-crop herbicide use, addressing cotton's impact on regional environments.

The importance of addressing climate change issues extends well beyond the cotton industry to the entire community – both Australian and global. An ongoing collaborative program commenced under this Strategic Plan continues to benchmark the contribution of nitrous oxide in irrigated cotton systems to greenhouse gas emissions. BMPs for minimising emissions have been identified and are being further developed through research.

CRDC had a range of Investments in R&D across its whole portfolio that have provided the industry with information that will allow growers to mitigate production of greenhouse emissions and adapt to climate change. Research outputs achieved under the Strategic Plan 2003–2008 are guiding future work in this area. Conservative estimates of investments by the final year of the Strategic Plan, 2008–09, included:

- ▶ **Adaptation-related:** Farming systems R&D accounts for ten per cent of the total research project budget for 2008–09. In addition to CRDC research, there is also a very significant 'adaptation' investment from the plant breeding research of CSIRO, Cotton Seed Distributors Ltd and Monsanto Australia Ltd, which is developing regionally adapted varieties providing heat tolerance, drought tolerance and improved water use efficiency.
- ▶ **Mitigation-related:** R&D accounts for 12.8 per cent of the total research project budget, including crop nutrition, extension, BMP development, greenhouse gas research and energy-related research.

Encouraging cotton-related careers: CRDC assisted with a range of school-related activities, such as coordination of the Moree Rotary 'Careers in Cotton' tour of the Australian Cotton Research Institute for secondary school students from north west NSW.

Farm health and safety: CRDC-funded training material has been used during the Strategic Plan period and continues to be used by Farmsafe Australia in their farm OH&S courses.

Workers compensation claims for the cotton industry for the five years 1998–99 to 2002–03 averaged 86 per year and for the three years 2003–04 to 2005–06 averaged 67 per year: a reduction of over 20 per cent. *Source: Farmsafe Australia*

Profitability: A 17 per cent increase in yields achieved since 2003, compared with the average for the previous five seasons, lower chemical inputs, and continued improvements in the use of limited water supplies have helped to maintain returns in a period affected by both drought and low market prices.

SOCIAL OBJECTIVE

Adoption of research outcomes that is leading to improved and more sustainable management practices

TARGET

At least five adoption evaluations conducted per year by members of the National Cotton Extension Team

RESULT

Target met each year.

The Cotton CRC water extension team conducted over 40 on-farm evaluations of water use efficiency using the commercial program WaterTrack Rapid during 2007–08.

A survey commissioned in May 2008 and completed by 41 cotton consultants evidenced practice change and adoption of research by their clients over the past five years. These consultants worked with grower clients who produced over 60 per cent of the 2007–08 cotton crop.

R&D Program reviews

2004: Recommendations from an external review of the entire Plant Breeding and Biotechnology Program allowed CRDC to fine-tune research in 2004–05 and increased the overall level of funding for this area.

2005: An external review of Extension, Education and Training, in conjunction with the Cotton Catchment Communities CRC (cotton CRC) led to a refinement and sharpening of the extension effort in following years.

2006: Recommendations from an external review of Soil Health Research contributed to the design of new research and extension initiatives in conjunction with the Cotton CRDC and Grains R&D Corporation.

A forum to review research methodologies and the resistance status of *Helicoverpa armigera* resistance status to *Bt* led to improved cooperation and understanding between research agencies in the techniques being used for resistance monitoring and testing.

An external review of research investments into cotton fibre, particularly through biotechnology, provided a basis for CRDC to prioritise its fibre quality research.

2007: An external review of CRDC cotton disease investments identified priorities, gaps, overlaps and other issues important to future research, which guided consultations with researchers and others involved in this area of R&D.



Addressing stakeholder research priorities

CRDC R&D planning and investment decisions address a range of R&D priorities adopted by the Corporation's stakeholders – the Australian Government, representing the Australian people, and the Australian Cotton Growers Research Association (ACGRA), representing the Australian cotton industry. Below is a listing of those priorities in related groupings and a 'broad brush' description of how they have been addressed from 2003 to 2008 and the resulting outcomes.

Australian Government priorities

National Research Priority:

- ▶ An environmentally sustainable Australia

Rural R&D Priority:

- ▶ Sustainable natural resource management

Australian Cotton Growers Research Association priorities

- ▶ Improve the sustainability of the cotton industry and its catchments
- ▶ Create and support a strong, focused and committed research program

Principal contributing Inputs 2003–2008 to achieve Outputs and Outcome

R&D INPUT

Ongoing improvement, expansion and implementation of the Best Management Practices (BMP) program

RESULT

CRDC investments were a key contributor to development of the industry's BMP program during 2003–08, and continues to be so. An independent review in early 2004 as part of an Australian Government National Heritage Trust project found significant positive change in all areas of farm management covered by the BMP manual. BMP has gained recognition by external stakeholders as a valid, effective and measurable environmental management system. The Queensland Government has recognised BMP as an alternative to the Land and Water Management Planning process required under the state's water licensing regulations contained within the Queensland Water Act 2000.

By 2007–08, the number of cotton farms involved in the BMP program at a pre-certification or full certification level, although impacted by the drought during 2007–08, reached 40 per cent, representing some 50 per cent of the crop (Source: Cotton Australia). Whether producers are BMP-certified or not, it is believed around 90 per cent of growers indicate informally that they follow BMP guidelines.

The Land and Water Management BMP module was trialed in 2003–04. It was introduced fully the following year and continued to be delivered throughout the industry between 2004–05 and 2007–08. An external review of BMP, commissioned by CRDC, found this module

"... effectively addresses most key NRM issues of relevance to cotton growing regions and as such presents a tool that has the potential to deliver NRM and profitability outcomes."

BMP was further enhanced during the period by a petrochemicals module, completed in 2003–04. Post-farm gate BMPs for ginning were developed for release in 2005–06 and classing BMPs are being finalised. The preparatory work to support both sets of BMPs was developed in the 2003–2008 period with the support of CRDC investments.

In 2007–08, a revision of the existing BMP manual and the development of an electronic version have set the groundwork for a full revision of the program in 2008–09. BMP will then provide a clearer value proposition for participation by the remaining 60 per cent of growers by clearly linking BMP to better outcomes – not only for environmental management but also for the farm business – and reinvigorate the link between research knowledge of the BMP guidelines. A strategic plan has been developed for the revision of the program and a BMP General Manager appointed to ensure the revision process is focused and coordinated. The new BMP program will also enable more effective data collection and monitoring, which will aid future R&D.

R&D INPUT

R&D and extension work to improve spray drift management and reduce the impact of cotton growing on catchments

RESULT

Cleaner waterways have been achieved both on and off-farm. As shown in the graph on page five, combined average detections of four residual herbicides used on cotton in north west NSW rivers declined by 29 percent over the four seasons 2003–04 to 2006–07 compared with the previous five seasons (1998–99 to 2002–03).

Declines in herbicide contamination in rivers correlated with changes in residual herbicide use as a result of the introduction of CSIRO Roundup Ready® cotton varieties developed with the assistance of CRDC investments in plant breeding and biotechnology.

Thirty five workshops on spray drift management were conducted in 2007–08 under an extension project by CRDC and the Grains Research and Development Corporation (GRDC), in conjunction with local catchment management bodies; however, damage caused by spray drift from application of the herbicide 2,4-D was still significant for many cotton crops during 2007–08. Cotton is highly sensitive to this herbicide and the season saw the largest planting for many years of other summer crops in which it is widely used.

R&D INPUT

R&D and extension work to improve spray drift management and reduce the impact of cotton growing on catchments

RESULT

Contamination of rivers by herbicides used in cotton has declined in direct relationship to the introduction of Roundup Ready® and Roundup Ready FLEX® cotton, with further gains made in 2007–08.

The latest research findings show that IWM continues as the main weed control focus, with more than 90 per cent of growers using some or all IWM measures.

R&D INPUT

Research to improve integrated chemical and non-chemical management of insect and mite pests

RESULT

The first year of the plan, 2002–03, saw the first commercial release of Bollgard II® varieties with two genes of resistance to *Helicoverpa* spp. and the last year for INGARD® varieties with a single resistance gene. This means the 2003–2008 period saw a dramatic fall in the use of residual insecticides, reducing costs and improving environmental performance. Averaged over the past five seasons, Bollgard II® crops required less than 15 per cent of the insecticide required for conventional crops.

The Environmental Impact Quotient (EIQ) scores for insecticide use in the 2006–07 season show a fall of up to 91 per cent from the highs measured in the late 1990s. Bollgard II® varieties' market share increased another six per cent to 96 per cent in 2007–08.

The integrity of the Bollgard technology has been maintained by a major industry-wide R&D-driven resistance management plan. During the 2007–08 season the CSIRO resistance monitoring program, supported by CRDC, detected for the first time, a significant increase in the frequency of alleles, which confer resistance to Cry 2Ab, one of the two *Bt* proteins present in Bollgard II® cotton. CRDC will be paying particular attention to results of the monitoring program over the next few years to ensure that the appropriate measures to minimise further increases in resistance are put in place.

A side-effect of reduced insecticide spraying of Bollgard II® crops for *Helicoverpa* has been an increase in the incidence of some sucking pest species such as mirids, green vegetable bugs and Silverleaf whitefly, and an outbreak of Pale Cotton Stainers in the 2007–08 years, making the role of Integrated Pest Management in recent years vitally important.

Biopesticides developed with CRDC investments are now showing the potential to control green mirids biologically and should provide significant environmental benefits when commercialised.

R&D INPUT

Research addressing deep drainage and salinity on-farm and at a catchment scale, and sodicity on-farm

RESULT

R&D has led to a better understanding of how to achieve sustainable groundwater use and catchment health. Options for reducing water losses through deep drainage are being clarified and research utilising evidence from 35 lysimeters has shown how farmers can reduce deep drainage. Detailed measurements have been made of soil water, distribution of irrigation water and changes to the water balance in an irrigated cotton system, using electromagnetic induction (EM).

Research has identified crop rotations that can reduce the impact of sodicity and offer both improved environmental benefits and increased profitability. Research on management of sodic soils with the addition of gypsum and/or lime is underway.

Research has shown that only a limited salinity risk exists in cotton growing areas. Extensive information is now available on geographic information systems (GIS) and able to predict where salinity problems might occur.

R&D INPUT

Research addressing deep drainage and salinity on-farm and at a catchment scale, and sodicity on-farm

RESULT

CRDC contributed to the successful development of the National Climate Change Research Strategy for Primary Industries (CCRSPI). Further contributions to implementation will be made in 2008–09. An on-farm energy use calculator, EnergyCalc, now provides a useful tool to help growers to become more fuel and energy-efficient, and thus more environmentally sustainable and profitable.

Workshops for irrigated cotton and grain farmers on efficiency for irrigation pumps are heightening awareness of the potential for energy efficiency gains and cost savings.

Over 700 people used a greenhouse gas on-line calculator developed with the assistance of CRDC investments to calculate their greenhouse gas footprint.

Research using specially designed automated mearing chambers has shown that although losses in irrigated cotton can reach levels of up to 40 per cent of applied nitrogen, only 0.5 to one per cent is the greenhouse gas nitrous oxide.

Nitrogen Use Efficiency farm trials held in all cotton growing valleys show that an average saving of 40 kilograms of nitrogen per hectare is possible without affecting yield. This would represent annual savings of \$7.4 million to the industry and has the potential to reduce greenhouse gas emissions of nitrous oxide by 21,500 tonnes.

R&D INPUT

A major water use efficiency research effort: development of measurement that is more viable; whole farm water use and efficiency linked to BMP; better irrigation timing and water placement

RESULT

New case studies and information resources are assisting on-farm water use efficiency: improved pump efficiency, options for leaky water storages, new irrigated grain supplements for WATERpak.

An analysis of 36 farms in 2006–07 using a comprehensive standard for water use, the Gross Production Water Use Index (GPWUI) which takes into account rainfall and soil moisture, measured an increase of 40 percent in water use efficiency compared with a similar study nine years before.

Significant progress on water use efficiency has also been made through the industry's yield improvement, due in part to improved higher yielding varieties and continuous improvement in agronomy, and achieved with no net increase in the quantity of water required per hectare.

R&D INPUT

Investment in the CSIRO cotton breeding and biotechnology program

RESULT

To date, CRDC has invested more than \$46 million in plant breeding and biotechnology-related research. During 2007–08, CRDC reviewed the strategic direction of future investments in research and development, including plant breeding and biotechnology. In view of the significant changes that have occurred in the commercial environment for cotton plant breeding, CRDC concluded that market failure for investment in this area no longer existed. This was evidenced in September 2007 when CSIRO Plant Industry and Cotton Seed Distributors Ltd (CSD) announced the formation of the Cotton Breeding Australia (CBA) joint venture, which will fund future cotton breeding and targeted research.

CSIRO-bred cotton varieties developed with CRDC investments represent over 90 per cent of the Australian market and are well represented around the world. They have introduced many new features: improved fibre quality, disease resistance, growth habit, maturity and regional adaptability. All Australian-bred cotton varieties planted in 2006–07 had F-Ranks (the measure of resistance to Fusarium wilt) of 100 or more for the first time. In 2007–08, the average F-rank of planted varieties reached 128: a significant improvement in a single year.

Although CRDC did not invest directly in the CSIRO breeding program in 2007–08, two new varieties commercially released in 2008 were products of previous CRDC investments: one containing Bollgard II® and Roundup Ready FLEX® and the other containing Roundup Ready FLEX® technology alone.

CRDC investments made during 2003–2008 resulted in the development of gene technology for healthier cottonseed oil. A business case has identified commercial opportunities and now further work will depend on market interest.

R&D INPUT

Multidisciplinary approaches to farm management to complement catchment and landscape environmental outcomes

RESULT

An initial simple set of environmental performance indicators has been developed for use on multi-commodity (cotton, grains, beef) enterprises to measure soil health, water quality, biodiversity, industry health and carbon emission performance.

Research shows native fish are more abundant, as a percentage, compared to exotic varieties in on-farm water storages than in nearby rivers. One hundred indigenous tree species were identified in one cotton valley, providing growers with better identification and conservation information.

Landholders have responded enthusiastically to Groundwater Field Days based on CRDC research outcomes and seek to use updated information to benefit catchments. CRDC and the Rural Industries Research and Development Corporation's Growing Trees on Cotton Farms is now used more widely in the agricultural sector and is to be reprinted due to high demand.

Australian Government priorities

National Research Priority:

- ▶ Promoting and maintaining good health

Rural R&D Priorities:

- ▶ Improving Competitiveness through a Whole of Industry Approach
- ▶ Maintaining and improving confidence in the integrity of Australian agricultural, food, fish and forestry products
- ▶ Improved Trade and Market access

Australian Cotton Growers Research Association priority

- ▶ Improve the profitability of the cotton industry

Principal contributing Inputs 2003–2008 to achieve Outputs and Outcome

R&D INPUT

Collaborative research with a wide range of key partners over the period, along with a large number of additional organisations through programs such as the National Program for Sustainable Irrigation, Cooperative Venture in Capacity Building and Farm Health and Safety Joint Venture; an investment of four million dollars in the Cotton Catchment Communities CRC each year for research that addresses both organisations' strategic needs

RESULT

A wide range of gains that can be described in environmental (sustainable irrigation), economic (financial benchmarking) and social (community benefits, capacity building, Farm Health & Safety) were made.

R&D INPUT

Monitoring of signals from the cotton textile and oil seed marketplace to ensure Australian cotton maintains a place at the high end of the market.

RESULT

Throughout 2003–2008, Australian cotton remained among the top prices listed for the highest category of upland cotton on the Liverpool Cotton Outlook 'A' index and continued to perform well against the industry SJV benchmark.

Trials in 2007–08 showed that opportunities may exist for blending premium Australian upland cotton types with Pima cotton to increase textile value.

R&D INPUT

Support for the CSIRO plant breeding and biotechnology program. This includes development and progress towards commercialisation of healthier cottonseed oil.

RESULT

After eighteen years, and investments of more than \$46 million, CRDC anticipates that the major investment it has made to the CSIRO cotton plant breeding and biotechnology program will effectively cease following a Cotton Breeding Australia joint venture by CSIRO and Cotton Seed Distributors Ltd, indicating that CRDC no longer needs to address market failure. CSIRO-bred cotton varieties, developed with CRDC support, currently represent over 90 per cent of the Australian market and are well represented around the world. Two new varieties commercially released in 2008 were products of previous CRDC investments.

Continued improvements in the Fusarium wilt resistance measure (F-rank) of major CSIRO-bred commercial varieties: 100 per cent of the varieties sown in NSW in 2006–07 had an F-rank of 100 or more and levels of resistance improved further to an average of 128 in 2007–08.

R&D INPUT

Research and promotion to achieve safe, healthy workplaces

RESULT

Biotechnology and Integrated Pest Management have delivered major reductions in on-farm pesticide use. High levels of adoption of insect resistant and herbicide-tolerant cotton varieties have led to significant reductions in worker and farm family exposure to toxic agricultural chemicals. CRDC, in conjunction with the Australian Centre for Agricultural Health and Safety, has begun a project to document and quantify the impact new technologies have had on health and safety in the industry. When completed, the study will aid a more integrated approach to health and safety risk assessment, management and reporting for the industry. It showed a flow-on of positive health and safety benefits from Bt cotton, such as less use of pesticides, less farmer ill-health, less tractor movements meaning fewer accidents and, in general, more peace of mind in growing cotton.

The Collaborative Partnership for Farming and Fishing Health and Safety has been established and includes cropping-based industries plus the Fisheries Research and Development Corporation (FRDC).

CRDC has begun the process of updating the *Safe Harvesting of Cotton* video into a new DVD format with the latest information.

Australian Government priorities

National Research Priority:

- ▶ Frontier technologies for building and transforming Australian industries

Rural R&D Priority:

- ▶ Use of frontier technologies

Australian Cotton Growers Research Association priorities:

- ▶ Invest in the skills, knowledge and occupational health and safety of the human resources in the cotton industry and its communities
- ▶ Create and support a strong, focused and committed research program

Principal contributing Inputs 2003–2008 to achieve Outputs and Outcome

R&D INPUT

Investment in the CSIRO cotton biotechnology program (cotton is one of only two major rural industry in Australia using biotechnology)

RESULT

Cotton varieties with a range of enhanced characteristics are using less insecticide and herbicide, and have increased quality and yield and resistance to pests and disease.

The CottTech suite of cotton biotechnology projects concentrates on fundamental science and allows researchers to undertake more creative and original research. Genes that reduce the impact of waterlogging are being investigated within CottTech. A number of genes have been isolated and the first small plot field trial was conducted in 2008. Refining the technology will occur after assessment of the 2007–08 yield results. A new short-term CottTech project is determining whether the genome for the Australian strains of Fusarium wilt fungus can be sequenced.

Early stage quality assurance for new transgenic traits means Australian researchers gain commercial access to them within six to twelve months of their commercial release in the USA.

R&D INPUT

Investment in the development of innovative SiroMat and Cottonscan fibre measurement technologies

RESULT

Further development and testing in 2007–08 confirm that they offer more precise and sophisticated measurement of cotton maturity and fineness. Business cases have been prepared and commercialisation opportunities are being investigated.

R&D INPUT

Implementation of recommendations from a major 2005–06 review of Extension, Education and Training

RESULT

The establishment of new generalist and specialist positions, rigorous evaluation of activities and collaboration and coordination with other organisations such as Catchment Management Authorities means all major cotton regions now have access to newly focused, coordinated and high-level extension services.

2006–07 saw the establishment of three National Priority Teams in the areas of crop protection, water and soils and nutrition. Technical specialists in the areas of water management, resource management, soil health and BMP aid the work of the network and the priority teams.

R&D INPUT

PhD scholarships and post-doctoral awards for research related to the cotton industry or natural resource management

RESULT

Fifteen new post-graduates commenced during 2003–2008. CRDC supported eleven projects involving post-doctoral scientists in 2003–2008, with seven of these commenced during the period.

R&D INPUT

Sponsorships for industry personnel to attend conferences, exhibitions and leadership courses in Australia and overseas.

RESULT

Human capacity has increased across the cotton industry, with skills and knowledge acquisition in a range of cotton-related and natural resource management areas that will enhance the capacity of the cotton industry and wider agricultural sector. A range of national and international R&D collaboration have been facilitated. Nineteen sponsorships in 2007–08 included growers, scientists, and tertiary and secondary students. In addition, a number of research projects have allowed for travel related to the research project.

R&D INPUT

Investment in the 2007–08 inaugural Australian Future Cotton Leaders Program, initiated by Cotton Australia with the support of the Australian Government's Department of Agriculture, Fisheries and Forestry

RESULT

Participants gained improved self-confidence and the skills to present their ideas effectively and take on leadership roles. Participants also undertook successful individual short-term projects.

R&D INPUT

Sponsorship of the Australian Cotton Conference

RESULT

A high proportion of cotton growers and consultants attend the conference to learn about new industry R&D. In 2008, the conference amalgamated for the first time with the Australian Cotton Shippers Association conference and encompassed the entire cotton industry, from researchers through to brand owners. CRDC played a pivotal role in 2007–08 in planning the conference held in August 2008.

R&D INPUT

Financial support for WINCOTT (Women Industry Network – Cotton) until it became self-sustaining in 2005–06, with continuing logistical support for women in the cotton industry through WINCOTT; financial support for women to undertake leadership courses.

RESULT

Women hold senior positions across the cotton industry and associated organisations such as Natural Resource Management bodies and Catchment Management Authorities, R&D organisations and industry bodies.

By June 2008 CRDC-supported WINCOTT had 280 women associated with the cotton industry formally involved in the organisation, with additional women participating in WINCOTT-sponsored activities. Women now comprise over 30 per cent of participants in the Queensland FarmBi\$ course.

Owing to participation in the WINCOTT initiative, many more women have confidence to compete for entry to leadership courses. All six women selected competitively to participate in the Australian Future Cotton Leaders program in 2007–08 are active in WINCOTT.

R&D INPUT

Support for development and delivery of important short courses for industry personnel.

RESULT

Highlights for 2003–2008 included the Integrated Pest Management short course, completed by a total of 221 people from 2001 to 2005, the Cotton and Grains Irrigation Management course and the *Cotton Field to Fabric Training Course: Managing for Quality through the Production Chain*. Fifty industry participants in the fully booked 2007–08 Field to Fabric courses demonstrated a strong recognition of the importance of maintaining quality through the production chain: a major focus of CRDC's new Strategic Plan for 2008 to 2013. Demand for places in the course from countries that consume Australian cotton is also increasing.

R&D INPUT

Support for externally recognised qualifications for industry personnel

RESULT

CRDC has jointly invested in appointment of a National Training Coordinator for the cotton industry. He has worked with a range of organisations to deliver industry training that is quickly responsive to current industry needs and aligns with national competencies associated with the Australian Quality Training Framework. A highlight in 2007–08 was the development of a Diploma of Agriculture, Certified BMP Farm Manager, which has seen participants gain formal recognition of cotton industry skills. The development process has also enabled identification of potential cotton industry training requirements.

R&D INPUT

Investment in the Cooperative Venture in Capacity Building (CVCB)

RESULT

This collaborative program of investments was completed in 2007–08 and the planned outcome achieved. It has improved the skills of rural industries personnel and demonstrated the strength of the Rural Research and Development model. CRDC and many other rural research corporations derived significant long-term benefits from this research and its findings greatly assisted CRDC devise the 2008–13 Strategic R&D Plan.

CRDC undertook seven projects within the CVCB *On the Fast Track* program, including:

- ▶ Upskilling whole-team extension groups for improved Integrated Pest Management

- ▶ Investigating External Models for delivering irrigation knowledge and services
- ▶ Growing the capacity of indigenous communities to sustain a skilled cotton workforce through engaging school-based trainees.

Australian Government priorities
 National Research Priority:
 ▶ Safeguarding Australia
 Rural R&D Priority:
 ▶ Protecting Australia from invasive diseases and pests
Australian Cotton Growers Research Association priority
 ▶ Create and support a strong, focused and committed research program

Principal contributing Inputs 2003–2008 to achieve Outputs and Outcome

R&D INPUT

Research relating to endemic or potential pest threats.

RESULT

CRDC was actively involved in the development of the Cotton Industry Biosecurity Plan that was coordinated by ACGRA and launched in late 2006. This plan provides an industry-wide framework for the Australian cotton industry to manage biosecurity risk, ensuring that pest threats are minimised and that there is a capacity to respond urgently should plant pests capable of damaging the cotton industry be detected.

Silverleaf whitefly infestations continue to spread, making vigilance for resistance very important. R&D and extension work enabled whitefly control in central Queensland following a major outbreak in 2001–02. As a result of this, CRDC now has a resistance-monitoring program with the Queensland Department of Primary Industries and Fisheries.

Research is aiding in development of a compound that utilises the plant's own defence mechanism to resist infection by Fusarium wilt and Black Root Rot. The rate of spread of cotton's major disease, Fusarium wilt, is reducing, due to improved management and hygiene. Improvements in resistance in newer varieties allow growers to plant-back into fields known to have Fusarium.

Tobacco Streak Virus was confirmed in cotton that was in close proximity to the principal host, parthenium weed. Monitoring and investigation of its impact will continue. Both Fusarium wilt and Black Root Rot were problematic in the 2007–08 season. Research indicated a link to specific soil factors and further research will be undertaken.

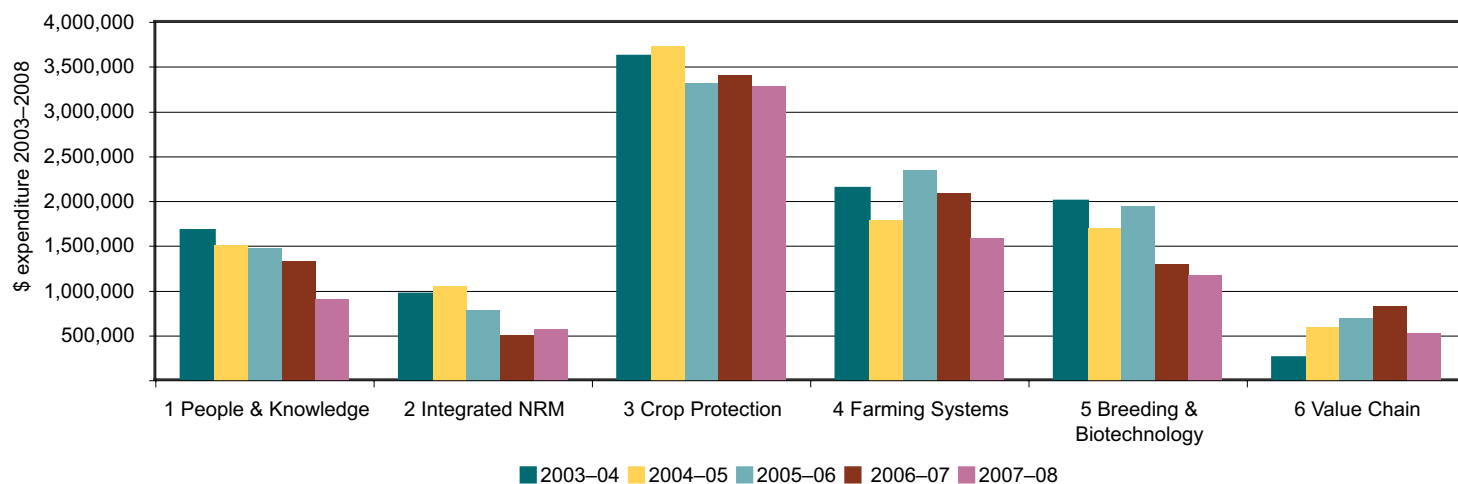


Andrew Inglis AM (centre – Chair of Plant Health Australia at the time), launched the Cotton Industry Biosecurity Plan in November 2006 at the Dalby farm of CRDC Director, Glenn Fresser. With him are Hamish Millar (left), ACGRA Chair at the time, and Chris Adriaansen, General Manager of Plant Biosecurity, Queensland Department of Primary Industries and Fisheries on the right.



Research and Development 2003–2008: a summary

CRDC expenditure by R&D program 2003–2008



PROGRAM ONE People and Knowledge

Objective

To improve the capacity of industry and the community to use the knowledge and innovations gained through research and development. A continuing culture of innovation in the cotton industry, creating viable rural communities.

Outcome

Innovative people in the cotton industry and community creating a sustainable industry and viable regional communities.

Overview

The modern Australian cotton industry contains, overall, probably the most highly trained and highly skilled people working in agriculture today. One of the keys to this level of expertise has been CRDC's long-term investment in people and their capacity to access and use knowledge.

Strategy One

Support and coordinate a highly trained, efficient and effective cotton extension team

During 2003–2008, CRDC was the major investor in the National Cotton Extension Team and the CRDC program management team is closely involved in ongoing evaluation and development of the team's extension activities. Over the five years CRDC invested in seven extension positions.

A comprehensive review of extension, education and training in 2005–06 led to the appointment of a Knowledge and Extension Manager in 2006 and a three-year revision process for extension services. By 2007–08 there was a significant sharpening and focusing of the team's activities, with improved coordination with officers from associated organisations and formal links to Catchment Management Authorities and Cotton Australia, which enables coordinated and collaborative activities in each region and avoids costly duplication. In 2008, the team has technical specialists in water management, resource management, soil health, crop protection and BMP.

Throughout the five years, the extension team delivered the latest research outcomes for insects and weeds, water, soils and disease, plant nutrition and fibre quality. There were many well-attended collaborative field days

and research meetings for the industry. Diverse subjects such as water use, spray drift, birds on farms, healthy soils, irrigated cotton and grains, overhead Irrigation systems, efficient pumps and biodiversity were covered regularly.

Among major extension achievements from 2003 to 2008 were management of silverleaf whitefly in central Queensland – a catalyst for the increased adoption of integrated pest management and area-wide management, improved water management and a protocol for measuring nitrogen use efficiency.



Many growers and researchers have worked with CRDC Project Coordinator, Helen Dugdale, on a wide range of CRDC's 'People and Knowledge' activities



ABOVE TOP: Growers at an Extension Team Birds on Farms workshop in 2007
ABOVE BOTTOM: An Extension Team workshop in Toowoomba in 2008 set future directions for the industry's extension effort

Strategy Two

Foster the professional development of innovative and highly trained researchers, extension and technical officers, administrators, consultants and growers

CRDC has met and often exceeded its education and training targets. Fifteen new post-graduate and several undergraduate scholarships were awarded from 2003–2008. A 2007 survey of the 79 PhD students supported to date by CRDC found that 47 still work in cotton-related science, 18 are working in other scientific fields and three are working on farms.

Since 2003, CRDC has supported 11 projects involving post-doctoral scientists. Of these, seven have been new post-doctoral projects, including one established in 2007–08.

CRDC has also invested in industry training, with highlights during the period being the Integrated Pest Management (IPM) short course and the Cotton Field to Fabric Training course. In addition, many individual R&D projects contained a training component.

CRDC, together with the Cotton CRC, held a range of Farming Systems Forums on an area of major agronomic importance. These were well attended by growers, research agronomic consultants and extension personnel and provided an opportunity to disseminate information and identify any research gaps. The forums were held on topics such as water management, soil health and precision agriculture.

Over the past five years 80 per cent of cotton growers attended spray application courses, 60 per cent attended occupational health and safety

Demand for the *Cotton Field to Fabric Training Course: Managing for Quality through the Production Chain*, held at CSIRO Materials Science and Engineering in Geelong, has gone from strength to strength since its inception, with the two courses held in 2007–08 attended by 50 industry participants. The level of interest demonstrates a strong and ever-growing recognition within the industry of the importance of maintaining quality through the production chain: a major focus of CRDC's new Strategic Plan for 2008 to 2013. This unique and highly regarded course provides an Australian perspective on the global marketplace. It covers in depth cotton distribution, yarn manufacture, fabric formation, marketing, dyeing and finishing, fibre properties, quality assurance, agronomy impacts, picking, ginning and classing.



Participants comment on the Field to Fabric course

"As well as the diverse range of topics, there was an equally diverse range of participants – a mixture of growers, ginners, marketers, industry personnel and a reasonably large contingent of overseas visitors from China, America, South Africa and Singapore. This gave all the participants a chance to discuss their own area of knowledge and to gain an understanding of an international view of Australian cotton."

Alison Young

Grower and Consultant, Wee Waa

"The technology, innovation and research that are being conducted at this facility alone show the endless possibilities that textiles hold. We, as Australian producers, must continue to be research orientated and innovative if we are to be a part of this future, producing longer, stronger, uniform and contaminant-free fibres."

Scott Armstrong

Grower, St George

training, 58 per cent attended IPM courses and over 50 per cent attended water management and soil health courses.

During 2007–08, courses on spray drift, water management and fibre management were among the most popular with cotton growers and consultants; some 20 per cent of cotton growers attended at least one module of the new water management course.

A major landmark during the plan's period was the development of the IPM Course Coordinator's position into a National Cotton Training Coordinator, with joint investment by CRDC and the Cotton Catchment Communities CRC. In this position, Mark Hickman has worked with a range of organisations to deliver industry training that is quickly responsive to current industry needs and aligns with national competencies associated with the Australian Quality Training Framework.

Among the advances this new approach made possible has been the development in 2007–08 of a Diploma of Agriculture, Certified BMP Farm Manager, which has seen participants gain formal recognition of the skills they have acquired in bringing farming enterprise to BMP-certified status. The development process for this qualification also enabled identification of potential cotton industry training requirements.

CRDC also contributed to development of an irrigation water training course and Cotton Australia's Cotton Basics courses.

Many growers, researchers, other industry personnel and tertiary and some secondary students have received sponsorships or travel grants from CRDC to attend R&D-related conferences and exhibitions in Australia or overseas. CRDC has also sponsored participants in leadership courses: four in the Australian Rural Leadership Program, two in the Cotton



CRDC has supported several tours by post-graduate students to north west NSW to familiarise them with the industry and encourage them to convey clearly and simply to the cotton industry the relevance and benefit of their research projects

Catchment Communities CRC Cotton Production Course at The University of New England and, from 2007–08, 21 in the Australian Future Cotton Leaders Program. As well as enhancing skills in the cotton industry and other agricultural industries, these activities improve the skills base in local communities.

Strategy Three

Foster the development of opportunities for women in the cotton industry

CRDC seed funding for the Women's Industry Network – Cotton (WINCOTT) allowed the organisation to become self-sustaining by 2006. WINCOTT has developed as an effective means of furthering Strategy Three. CRDC staff members (and CRDC-supported researchers)

continued to provide a range of logistical and in-kind support beyond direct investment and this input assists WINCOTT to provide information and linkages to the wider industry, community and government. A survey of members in late 2007 showed an overall high satisfaction rating for WINCOTT services.

WINCOTT now has 280 women associated with the cotton industry formally involved in the organisation, with additional women participating in WINCOTT-sponsored activities. A WINCOTT survey of members found that leadership and

"I already have an applied science degree but still think the BMP certificate is worthwhile for farm employees like myself. When an employee moves on, it proves to be valuable evidence of the skills they have acquired."

Brian Strand

Brian Strand (right) with CRDC-funded National Training Coordinator, Mark Hickman, manages a farm that has been BMP-certified for several years. He completed the Certified BMP Farm Manager Diploma of Agriculture in 2007–08



CRDC continued to assist with activities aimed at promoting careers in the cotton industry, such as the annual Moree Rotary 'Careers in Cotton' tour for secondary school students from north west NSW and other school-based activities to encourage an interest in science.



investment by an external agent such as CRDC had been crucial to the achievement of current outcomes.

In line with recommendations in the 1998 National Plan for Women in Agriculture, WINCOTT activities have been responsible for an increase in participation of women across industry, government and community groups.

Women comprised in excess of 30 per cent of participants in the Queensland FarmBiz business information course which concluded in early 2008.

In 2007–08, CRDC awarded a scholarship for the Cotton Catchment Communities CRC Cotton Production Course, conducted by the University of New England, to consulting agronomist Jemima Maslen, from Hay. This unique course has four study units developed by cotton researchers and other industry personnel. Much of the information contained in the course is a result of CRDC investments in research, development and extension outputs.



21 competitively selected industry personnel completed the inaugural Australian Future Cotton Leaders program in 2007–08. It is worth noting that the six women who participated are all active in WINCOTT. CRDC, Cotton Australia and the Australian Government Department of Agriculture, Fisheries and Forestry fund this program.

Strategy Four

Continue to develop a variety of effective decision support systems that support the implementation of research and extension outcomes and shorten the time to adoption

Major decision support tools released in this period aided by CRDC investments included HydroLOGIC, the Early Season Diagnostic Tool and a CD Rom containing a wide range of CRDC-supported tools such as SPRAYpak, ENTOPak, NUTRIpak, WEEDpak and Managing Riparian Lands in the Cotton Industry.

After a number of years of investing in the decision support program, CRDC discontinued financial support in 2007–08. This change was based on an evaluation of the usage by cotton growers and consultants of a range of

the more complex computer-based tools. The evaluation showed that overall usage did not justify further investments by CRDC during this period of financial constraint. The review indicated that a number of the simple web-based decision support tools developed with CRDC investments are used on a more regular basis and the Cotton Catchment Communities CRC has maintained many of these on its website, www.cottoncrc.org.au.

Strategy Five

Support the ongoing development of information packages and tools that consolidate and disseminate research outcomes

In 2003–04 CRDC co-invested in, and coordinated production (in hard copy and on CD) of, WATERpak: a resource package on irrigation management in cotton with a major focus on water use efficiency. For the first time in 2004, the BMP manual included the new Land and Water Management module. An electronic version of the BMP manual enabled easier and quicker navigation between sections. The second edition of the Australian Cotton CRC/CRDC IPM Guidelines was released in 2005. FIBREpak, released by CSIRO in 2007, utilised research outcomes from CRDC investments.

The release of *Managing Riparian Lands in the Cotton Industry* in 2003 has aided cotton growers to safeguard and improve the health of rivers and associated riparian zones on their farms. Most of its management approaches can be applied where other field crops are grown and it is well used in the broader agricultural sector.



Former Deputy Prime Minister and Member for Gwydir, John Anderson (centre), launched WATERpak on the banks of the Namoi River in 2004, with CRDC Executive Director Bruce Finney and former CRDC Chair Bridget Jackson

The *Knowledge Management in Irrigated Cotton and Grains* project, supported by the National Program for Sustainable Irrigation (NPSI), CRDC and the Grains Research and Development Corporation (GRDC), is regarded as a key success in Program One. This project drew on commitment from the cotton and grains industry to develop a farming systems approach to water use efficiency across the whole farm. The upgraded WATERpak manual, developed with the assistance of CRDC investments and involvement, has been a key element in communicating best practice irrigation and 2007–08 saw a supplement on irrigated grain crops added.

In 2007–08, CRDC invested in the development of an on-farm energy use calculator, EnergyCalc, using seven farms as case studies to measure the total energy used in growing crops. Further testing of the tool is likely to lead to it being offered on-line through the CRDC website and/or the National Centre for Engineering in Agriculture website.

CRDC also facilitated the completion of the first revision of the BMP manual in 2007–08 and supported a project to develop the first electronic version of the manual. In 2007–08, the Australian Cotton Industry Council's BMP Committee received CRDC co-investment with Cotton Australia and Cotton CRC for the development and adoption of a fully revised BMP system with online access.

Strategy Six

Promote safe, healthy workplaces through the adoption of appropriate Occupational Health and Safety work practices

CRDC continued its investment in the joint venture Farm Health and Safety R&D program managed by the Rural Industries Research and Development Corporation (RIRDC) throughout the period of the strategic plan. A replacement joint venture, the Collaborative Partnership for Farming and Fishing Health and Safety, was established in 2007–08.

CRDC has also supported the Sustainable Farm Families project to address the personal health and safety issues that are important to farming families. In association with WorkCover, training materials developed with CRDC support has been used by Farmsafe Australia in NSW.

The introduction of genetically modified cotton and the resulting use of lesser quantities of toxic

chemicals and a greatly reduced need for spray applications means that the risks associated with farm practices such as the application of pesticides have decreased significantly. To address the need to study and report comprehensively on farm health implications of new technologies, CRDC joined with the Australian Centre for Agricultural Health and Safety and Monsanto to document and quantify the impact of new technologies on health and safety in the industry. When completed, the study will aid a more integrated approach to health and safety risk assessment, management and reporting for the industry.

In 2008, CRDC began the process of updating the Safe Harvesting of Cotton video into a new DVD format that reflected current best practice. This project involves broad industry collaboration aided by a widespread awareness of the need and responsibility to avoid injuries and fatalities in one of the more hazardous operations within the industry.

Strategy Seven

Facilitate effective coordination and partnerships with research and development providers, industry and community organisations

Over the five years 2003–08, CRDC collaborated with a wide range of R&D providers, and industry, government and community organisations to add value to outcomes of R&D investments. Collaboration has extended beyond co-investment; cooperation, coordination and communication have been equally important to avoiding duplication in research and maximising the impact of research outcomes. In 2007–08, 79 per cent of the 121 projects involved collaboration between three or more partners, bringing co-investment in excess of \$16 million.

For the past three years, CRDC's largest financial investment has been in the Cotton Catchment Communities CRC: four million dollars each year, with all but \$100,000 of that tied to specific projects which were required to directly address both CRDC's and the CRC's strategic objectives through a collaborative research framework.

Major collaborative projects involving CRDC have included:

- ▶ the Climate Change Research Strategy for Primary Industries (CCRSPI).

- ▶ the Cooperative Venture in Capacity Building and Innovation in Rural Industries (CVCB) with the Australian Government Department of Agriculture, Fisheries and Forestry, the Murray-Darling Basin Commission and other Rural R&D Corporations.
- ▶ the new Collaborative Partnership for Farming and Fishing Health and Safety, with other RDCs: a project to improve the standardisation of Life Cycle Assessments across rural industries, together with the Rural Industries Research and Development Corporation, Sugar Research and Development Corporation, Meat and Livestock Australia, Dairy Australia, Australian Pork Limited and the Australian Chicken Meat Federation.
- ▶ a project to investigate economic impacts of an emissions trading scheme on agricultural industries, together with the Australian Farm Institute, Australian Wool Innovation and Dairy Australia. This has proved to be timely, with the recent announcement by the Australian Government of a Carbon Pollution Reduction Scheme.

CRDC continues to work closely with Catchment Management Authorities and other regional bodies on natural resource issues and is one of 14 funding partners of the National Program for Sustainable Irrigation (NPSI), which also includes irrigators, water authorities, research agencies, commodity groups and state and Australian Government departments.

Community collaboration in 2007–08 included sponsorship of primary school students to attend the 2007 NSW Youth River Health Conference.

CRDC developed a new Aboriginal school-based traineeship program with the cotton industry, with assistance from the Aboriginal Employment Strategy. Five Indigenous students from Narrabri and Wee Waa High Schools are undertaking paid work experience at the Australian Cotton Research Institute and CRDC.

Chloe Pokarier (right) with CRDC Executive Assistant Dianne Purcell, is undertaking work experience at CRDC as part of a school-based traineeship program developed by CRDC with the help of the Aboriginal Employment Strategy.



In 2007–08, CRDC sponsored students from Wee Waa Public School, Walgett Community College Primary School, Narrabri Public School and St Francis Xavier School, Narrabri, to attend the 2007 NSW Youth River Health Conference. This conference aims to build the capacity of our future leaders and form a lasting commitment to our youth and the sustainable use of the environment and the industries it supports

PROGRAM TWO

Integrated Natural Resource Management

Objective

Improved delivery of research, knowledge and management strategies related to natural resources that enhance the ecological, social and economic values associated with cotton production systems, both on and off farm, and reduce negative environmental impacts.

Outcome

Increased ecosystem health, community wellbeing and economic wealth of cotton growing regions and a reduction of the negative environmental impacts on cotton production systems.

Overview

The CRDC Strategic Plan 2003–2008 was predicated on '... a Triple Bottom Line approach to planning, implementation and reporting that seeks to ensure economic, environmental and social benefits for the Australian cotton industry, cotton valley communities and the Australian people.' Program Two became major part of the Corporation's effort to achieve the vital environmental part of this equation.

This means that Natural Resource Management (NRM) has been a strategic focus for CRDC over the period of the strategic plan, with the R&D effort ranging from field to catchment scale. The past decade has seen vastly increased understanding of natural resource management and recognition of improved management of these resources as an outcome.

There have been remarkable improvements in pesticide use and pest management, as well as improvements in water use efficiency, vegetation and land management, waste recycling and disposal, wildlife management and biodiversity.

Strategy One

Incorporate a broader range of environmental issues in the Cotton BMP program and facilitate their adoption

CRDC has been the major contributor to development of the cotton Best Management Practices (BMP) voluntary environmental management program. This has helped to focus industry on continuous improvement in farm and environmental risk management. BMP has gained recognition by external stakeholders as a valid, effective and measurable environmental

management system. The Queensland Government recognises BMP as an alternative to the Land and Water Management Planning process required under the state's water licensing regulations contained within the Queensland Water Act 2000.

By 2007–08 BMP had reached a point where around 40 per cent of cotton farms (representing around 50 per cent of the crop) have attained stage one of certification, or have achieved full certification. Some 90 per cent of growers have indicated that they follow BMP guidelines, whether certified or not. The 2003–2008 period saw considerable CRDC-driven advances in BMP. The Land and Water Management module was trialed in 2003–04, fully introduced the following year and delivered throughout the industry between 2004–05 and 2007–08. According to an external review of BMP, this module '... effectively addresses most key NRM issues of relevance to cotton growing regions and as such presents a tool that has the potential to deliver NRM and profitability outcomes.'

The BMP program has been expanded, with the addition of new modules: a petrochemicals module completed in 2003–04 and post-farm gate BMPs. Draft Ginning BMPs were completed in 2005–06, with most gins participating on a voluntary basis in the 2007–08 season to test the BMPs and the individual gins' levels of compliance. The 2008–09 season is expected to see a move to ginning BMP audits and certification. Classing BMPs are currently under development.

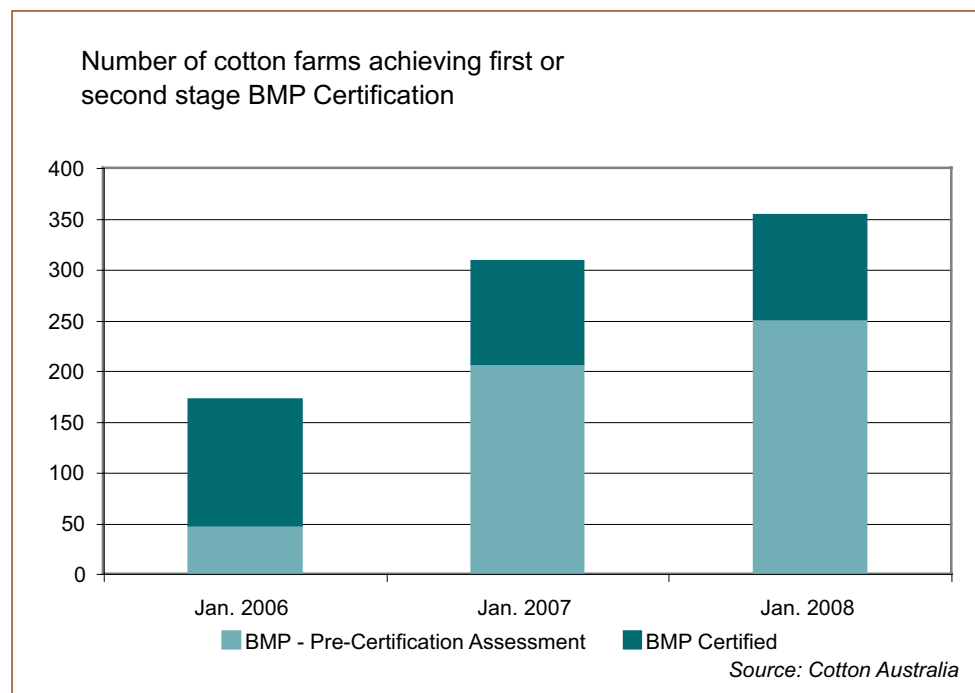
A recent revision of the BMP manual and development of the first electronic version have set the groundwork for a full revision of the program in 2008–09 under the leadership of the Australian Cotton Industry Council's BMP Committee. A 'new' BMP is expected to deliver clearer value propositions for participation of all growers by clearly linking BMP to better



business outcomes – not only for environmental management.

To help drive and support this process CRDC, Cotton Australia and the Cotton CRC have jointly funded a new position of BMP General Manager. The position was filled in September 2007 and a Strategic Plan for the revision of BMP was released in January 2008.

The revision of the BMP program provides some exciting opportunities for the industry. From CRDC's perspective, the revision will see a reinvigoration of the linkage between research knowledge and the BMP guidelines, and recommendations that growers use to improve their practices. The new BMP program will also enable more effective delivery of services to support best practice production through improved data collection, monitoring and evaluation of user needs.



Strategy Two

Investigate and evaluate environmental management systems as an industry-led approach to improved natural resource management.

The development and adoption of BMP as the Australian cotton industry's environmental management system means Strategy Two has essentially been accomplished. Catchment Management Authorities (CMAs) and regional bodies regard on-farm practice change – the major BMP objective – as integral to achieving improvements at a catchment level and many of the catchment bodies covering cotton valleys have become more involved in working with the BMP program to achieve best practice outcomes.

In 2007–08 CRDC established a new project, *Environmental Indicators: Cotton, Grains and Beef*, under the Australian Government's EMS Pathways to Sustainable Agriculture program. Environmental Performance Indicators (EPIs) developed through the project are broadly consistent beef and grains industry EPIs and provide landholders with a means of scoring soil health, water quality, biodiversity, industry health, and carbon emission performance of an enterprise. The soil and water indicators can be used to translate changes in practice to changes in soil and water resource conditions, while biodiversity indicators provide a semi-quantitative indication of vegetation and riparian condition. Carbon emission indicators are included in recognition of greenhouse gas emissions being a future issue that requires development of understanding, while industry health has been included to provide a gauge of the industry's commitment to environmental management.



This photo by Dr Des McGarry of Queensland Department of Natural Resources and Water shows a barrel lysimeter that is part of a network at six agricultural sites in southern Queensland that is quantifying water loss beyond the plant's root zone with furrow irrigation systems



The Golden-headed Cisticola lives in grasses, shrubs and reeds along creeks, irrigation channels and other wetlands in more easterly cotton growing areas. It is one of the many birds that benefit from the maintenance of healthy riparian zones on cotton farms, aided by knowledge gained from CRDC R&D investments, extended through Birds on Farms field days conducted by the Australian Cotton Extension Team

Strategy Three

Support multi-disciplinary approaches to developing farm management strategies that complement catchment and landscape outcomes in relation to salinity, water quality and quantity and biodiversity.

CRDC research investments in the past five years have led to a better understanding of how to achieve sustainable groundwater use and avoid impacting on catchment health. On-farm irrigation practices are critical in managing the quality of catchment water and soil. At the field level, work during 2003–2008 focused on optimal management of new irrigation techniques. This work has extended to improving the management of whole-farm water management, ranging from furrow and overhead delivery irrigation systems to water storages and channel delivery systems.

By 2007–08, CRDC was investing in research on water quality in relation to pesticide remediation, water quantity in terms of modelling and surface/groundwater interconnectivity, deep drainage and biodiversity.

CRDC continues to invest in deep drainage research to identify and quantify water losses

through deep drainage. Research under Program Two related to catchment aspects of deep drainage, while on-farm deep drainage research is reported in Program Four.

Deep drainage beyond the plant root zone has proven to be a complex issue that must be minimised in order to achieve water use efficiency but a certain level is required to move excess salts away from the roots. At the same time, it must also be balanced with the risk of salts moving off-field into the broader environment.

Deep drainage also carries the risk of developing sodic soils, although these, unlike salt, are not transportable off-farm. CRDC-supported research has identified crop rotations that can reduce the impact of sodicity and offer both improved environmental benefits and increased profitability. Research on management of sodic soils with the addition of gypsum and/or lime is progressing as part of a long-term farming systems field of research.

In 2005 a major investment by CRDC enabled the installation of a large variable tension lysimeter at the Australian Cotton Research Institute to measure deep drainage. This has provided a means of testing the accuracy of results from a network throughout southern Queensland and northern NSW utilising less expensive methods of measuring deep drainage, such as barrel lysimeters and chloride mass balance. Ongoing research indicates that the comparison of the variable tension lysimeter with these simpler methods is allowing results from the network to be better understood and interpreted, thus adding value to this widespread measurement program. Research utilising evidence from this network has shown how farmers can reduce deep drainage.

In the nine years prior to 2002–03 CRDC invested in research mapping salinity risks, showing that only a limited salinity risk exists in cotton growing areas. This information has now been collated and stored in various Geographic Information Systems (GIS) for a range of

irrigated cotton growing areas, with funding from the Australian Government's National Heritage Trust program. Using this information, growers in these areas can identify where salinity has occurred or may occur in the future.

Strategy Four

Facilitate the necessary environmental impact research for any new transgenic traits introduced into cotton varieties

While the responsibility for assessing environmental impact of any new transgenic traits falls to the registrant during the registration process, CRDC has invested in research to help understand the impact of the broader application of transgenic technologies after they have been released commercially.

For example, a CRDC-commissioned study of pesticide residues in cotton gin trash from the 2006 harvest, completed in 2007–08, compared residues in gin trash from both conventional and Bt (Bollgard II®) cotton crops as well as two methods of trash management following separation at the cotton gin and found lower levels of insecticide residues from Bollgard II® cotton than conventional varieties. The study also compared active composting of gin trash by adding water, nitrogen and regular mechanical mixing. Gin trash piles were untouched and showed composting to be highly beneficial in speeding up the breakdown of pesticide residues.

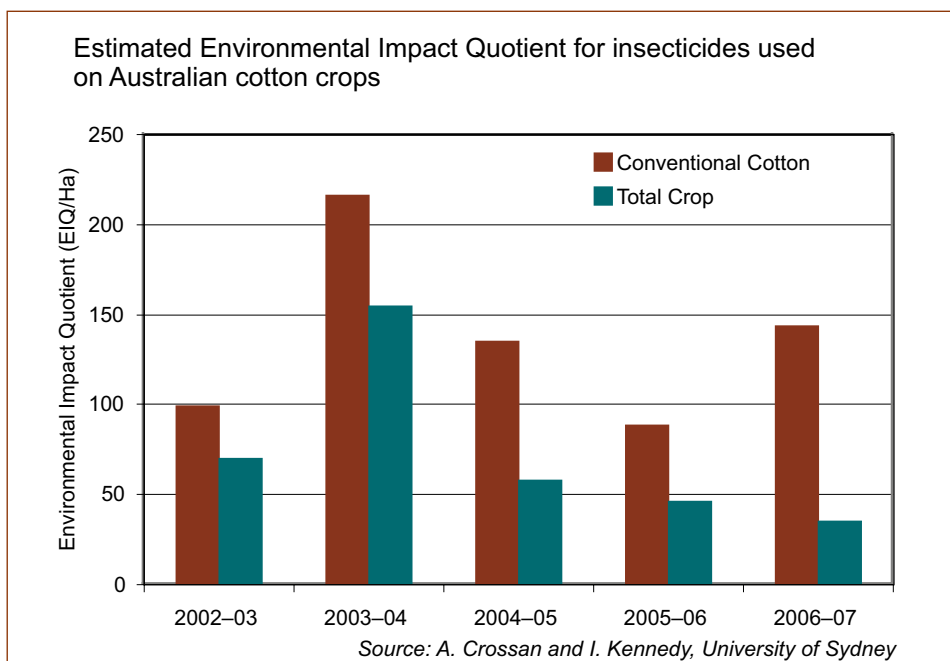
Another study has utilised data on insecticide and acaricide use compiled by Cotton Consultants Australia Inc. and purchased by CRDC to estimate the Environmental Impact Quotient (EIQ), an internationally recognised scoring system that converts the quantity of active ingredient applied for each chemical into a score based on a range of environmental indicators such as toxicity to mammals, birds, beneficial insects and fish. The EIQ scores for insecticide use in the 2006–07 season show a fall of up to 91 per cent from the highs measured in the late 1990s.

Strategy Five

Investigate the potential impact of climate change on cotton production, benchmark the industry's contribution to greenhouse emissions and energy use and develop integrated management strategies to reduce emissions.

Research investments by CRDC during 2003–2008 have helped to clarify the level of greenhouse gas emissions resulting from cotton production. As a result, more farmers are becoming aware that over-fertilising increases the amount of nitrogen gases released into the atmosphere and of the environmental and economic cost this represents. Nitrogen Use Efficiency farm trials held in all cotton growing valleys show that an average saving of 40 kilograms of nitrogen per hectare is possible without influencing yield. This would represent savings of \$7.4 million to the industry annually and has the potential to reduce greenhouse gas emissions of nitrous oxide by 21,500 tonnes across the industry (Source: BDA Group Benefit Cost Analysis April 2007.)

CRDC invested in the development of an on-farm energy use calculator, EnergyCalc, which divides energy usage of cotton production into six broadly distinct processes: fallow, planting, in-crop, irrigation, harvesting and post-harvest. Because these operations are generic, EnergyCalc can be used to estimate energy requirements for a range of crops and is seen as potentially a useful tool to help farmers become more fuel and energy efficient and hence more profitable and environmentally sustainable. Further testing of the tool is planned and it is likely to be available on-line through the CRDC website and/or the National Centre for Engineering in Agriculture website. Other research which overlaps and influences greenhouse gas production and energy use is included in Program Four – Farming Systems: in particular, excellent outcomes from research on crop rotations for fertiliser efficiency and storing carbon in the soil.



PROGRAM THREE

Crop Protection

Objective

Improved integrated management of major pests, weeds and diseases, reflected by continued reductions in chemical insecticide and residual herbicide inputs to crops; and responsible management of transgenic technology.

Outcome

Continued reduced reliance on chemical inputs and more effective management strategies for pests and weeds.

Overview

The introduction of genetically modified (GM) cotton has changed the face of cotton production in Australia. This set of technologies has been described as the dawn of a new era for crop protection throughout the industry, and has resulted in improvement in the broader environmental and social health across the cotton regions. The efficacy of the technology has been maintained through a rigorous resistance monitoring program. The dramatic reduction in the quantity of pesticides applied to Australian cotton crops over the past six years has been accompanied by the emergence of new challenges and opportunities, which have been addressed through a sustained and targeted R&D effort within this program during the life of the Strategic Plan 2003–2008.

While Bollgard II® cotton varieties been very successful in reducing insecticide use, some are still required to control insects and weeds – in fact, the spectrum of pests has changed and what were once secondary pests have become a new focus. This resulted in R&D to develop new environmentally sustainable technologies to combat these pests, with promising results achieved.

Strategy One

Improve integrated non-chemical and chemical management of insect and mite pests

The first year of the Strategic Plan, 2003–04 marked the first commercial release of Bollgard II® varieties with two genes resistant to *Helicoverpa* spp. and the last year for single resistance gene INGARD®. In 2003–04, GM varieties with Bollgard, INGARD or Roundup Ready® technologies represented some 54 per cent of total plantings. By the 2007–08 season,

GM cotton varieties comprised 96 per cent of plantings across all regions, with 93 per cent containing both the Bollgard II® and Roundup Ready® genes. Very high *Helicoverpa punctigera* infestations in 2003–04, which extended well beyond former geographic boundaries and duration, quickly proved the efficacy of the new two-gene technology, with a significantly reduced need for insecticides compared to both INGARD® and conventionally-bred varieties.

The Bollgard II® technology continued to perform well in the 2007–08 season, during which *Helicoverpa* pressure was relatively light, principally due to ongoing severe drought conditions. Some survivors were noted in St George in the 2006–07 year and CRDC, in conjunction with CSIRO, initiated a research project to try and better understand the reasons for their survival in this region. The few conventional cotton crops grown in the 2007–08 season required a number of sprays for *Helicoverpa* control, whereas generally Bollgard II® crops required none.

An effect of reduced insecticide spraying of Bollgard II® crops for *Helicoverpa* has been an increase in the incidence of some sucking pest species such as mirids, green vegetable bugs and silverleaf whitefly. The industry observed an outbreak of pale cotton stainers in the 2007–08 year. These insects had rarely been found in sufficient numbers to be problematic; however, in the 2007–08 year they were particularly troublesome for the industry. Pale cotton stainers feed through a very fine stylet, hence damaged bolls are difficult to detect. Female cotton stainers also feed upon the seeds located within the bolls, causing further devaluation of the crop.

To tackle these pests that were previously of minor concern, CRDC, in conjunction with the NSW Department of Primary Industries and a commercial partner, Becker Underwood, has been instrumental in developing a new biopesticide for use in Bollgard II® cotton. This

biopesticide, developed from a native fungal pathogen, appears to be highly selective against specific sucking insect pests in cotton and offers the potential to further decrease the amount of pesticide used in cotton. When used as part of an integrated pest management (IPM) system, the Bollgard II® technology, combined with the biopesticide, has the potential to deliver significant environmental benefits through the reduced use of 'hard' chemical sprays.

Green mirids continue to prove problematic in Bollgard II® cotton systems and require chemical control. CRDC research has developed threshold guidelines for the control of mirids to minimise pesticide use and continues further ecological studies to understand mirid behaviour.

Strategy Two

Improve integrated non-chemical and chemical management of weeds

By 2003–04, improvements such as minimum tillage, permanent bed systems and the introduction of glyphosate-tolerant Roundup Ready® varieties had encouraged changes in the weed spectrum. CRDC R&D investments focused on the development of Integrated Weed Management (IWM), to control all weed species at some point in the annual cycle in the farming system using a combination of methods such as herbicides from different modes of action, strategic cultivation, hand chipping and rotation crops. By these means the size of the weed seed bank can be reduced and system sustainability improved by reducing reliance on the prophylactic use of residual herbicides.

IWM continues to be the central focus of weed research in cotton, with WEEDpak the knowledge and practice change resource. By 2007–08, growers had information on the biology and ecology of 89 weed sets in WEEDpak.



Pale Cotton Stainer can cause staining of cotton lint and tight locking of bolls, reducing both quality and quantity of harvestable cotton lint



Seed damage caused by female Pale Cotton Stainers (left) compared with seeds from bolls fed on by males (right)



Strategy Three

Develop practices and technologies that reduce the spread and impact of cotton diseases

Two soil-borne diseases, Fusarium wilt and Black Root Rot, remained particular threats throughout 2003–2008. The widespread adoption of improved farm hygiene practices, based on research and extension activities supported by CRDC investments, helped to slow spread of the disease. The most dramatic improvement has come from improvements in Fusarium resistance levels in new cotton varieties.

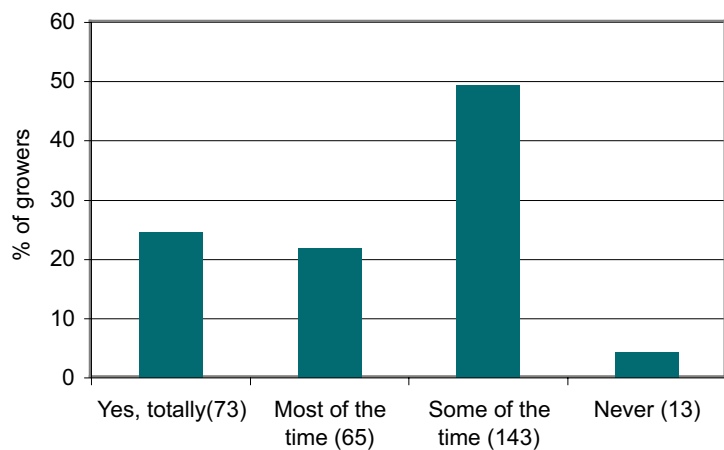
An F-Rank (the measure of resistance to Fusarium wilt) of 200 equates to total Fusarium wilt immunity and a variety is not classified as Fusarium wilt-resistant unless its F-Rank is at

Reductions in the use of residual herbicides since the introduction of Roundup Ready® cotton varieties, while beneficial from both environmental and economic perspectives, indicate an increasing reliance on glyphosate for weed control; hence, the importance of IWM in minimising resistance risks. CRDC has invested in the development of IWM systems that aim to ensure knockdown herbicides are not overused, by utilising infrared biomass sensors for the precise delivery of herbicides when and where they are required, taking into account the competitive influences of weeds on cotton. This mitigates environmental risks and the risks associated with the evolution of resistance. The herbicides used in these systems break down more quickly and thus are unlikely to affect riverine environments through movement of soils.

By 2007–08, the majority of Australian cotton growers were using IWM practices in managing weeds on their farms, which is particularly important as the next generation of herbicide-tolerant cotton varieties become available to growers. The availability of Roundup Ready FLEX® technology is providing a wider window for glyphosate application, bringing greater flexibility in weed control options and Liberty Link® cotton varieties are expected to increase the range of broad leaf weed species that can be controlled, while minimising risks for onset of herbicide resistance among the key species. These technologies offer full tolerance to specific herbicides and need to be managed carefully to ensure that resistance to the herbicides does not develop. CRDC, in conjunction with the Australian Cotton Growers Research Association, assists in the development of robust crop management plans to assist growers to minimise resistance risks associated with these important technologies in managing their farming systems.

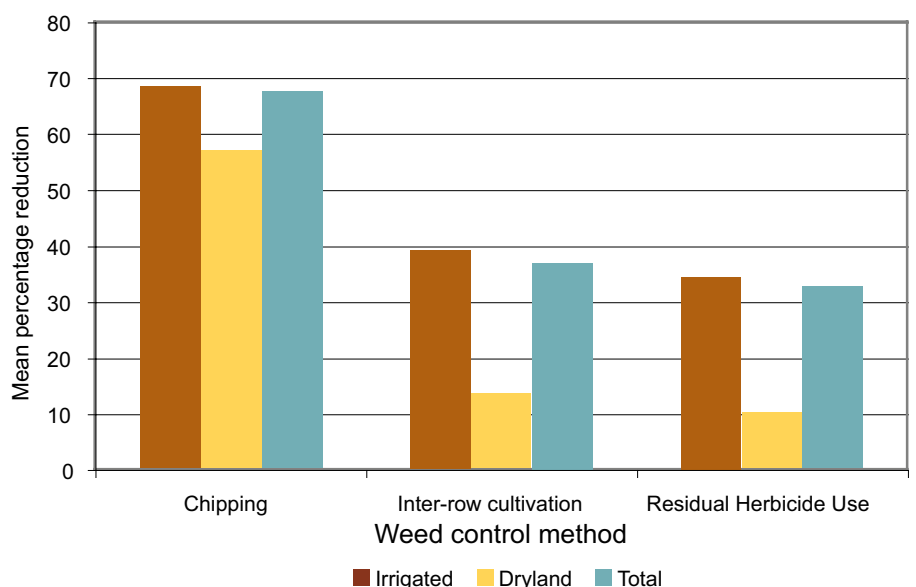
Fleabane is an increasing weed problem across a number of farming systems, including cotton. CRDC research into the ecology and management of this weed in cotton farming systems continues.

Percentage of growers who follow Integrated Weed Management guidelines



Source: CCA 2006 cotton consultant survey

Reduction in weed control methods since the introduction of Roundup Ready®



Source: CCA 2006 cotton consultant survey

least 100. In 2006–07, all Australian-bred cotton varieties planted had F-Ranks of 100 or more for the first time. In 2007–08, the average F-rank of planted varieties reached 128: a significant improvement in a single year. This means that growers can more confidently plant into fields known to have Fusarium.

Current research into Fusarium wilt includes ecology, field management, novel sources of resistance and conventional breeding objectives. The search for novel resistance genes and markers continues and researchers are optimistic of providing the industry with solutions to this disease. Research in the 2007–08 year indicated that the severity of the disease was linked to specific soil factors, including the calcium/magnesium ratio of the soil. Further research will be undertaken in this area to determine whether manipulation of soil properties would enable growers to better manage Fusarium wilt.

Black Root Rot continued to spread during 2003–2008 and is now found on the majority of cotton farms. While it does not have the same impact on cotton as Fusarium wilt, it predisposes the crop to insect infestation and makes it more sensitive to weed pressure. CRDC has invested in research that evaluated a new seed treatment, Bion®, (Syngenta Crop Protection Pty Ltd) that initiates the natural self-defence mechanisms of cotton. This seed treatment is now being used commercially in the Australian cotton industry to provide enhanced protection against both Black Root Rot and Fusarium. In addition, research initiated during the period of the Strategic Plan 2003–2008 continues to seek to identify genes that may confer a high level of resistance to Black Root Rot for Australian cotton varieties.

Tobacco Streak Virus, which is endemic in parthenium weed, has been found in sunflowers, chickpeas and mung beans in central Queensland in recent years. Surveys undertaken in cotton

in 2007–08 confirmed the presence of this virus in cotton, with plants in close proximity to parthenium weed exhibiting various levels of symptoms. Cotton pathologists will continue to monitor crops in the central Queensland region to determine the likely impact of the disease in Australian production systems.

Strategies Four and Five

Ensure the development of resistance is minimised through the design and implementation of resistance management strategies for both insecticides and transgenic technologies;

and

Ensure the benefits of transgenic crop technology are maximised through responsible management based on sound scientific risk assessment

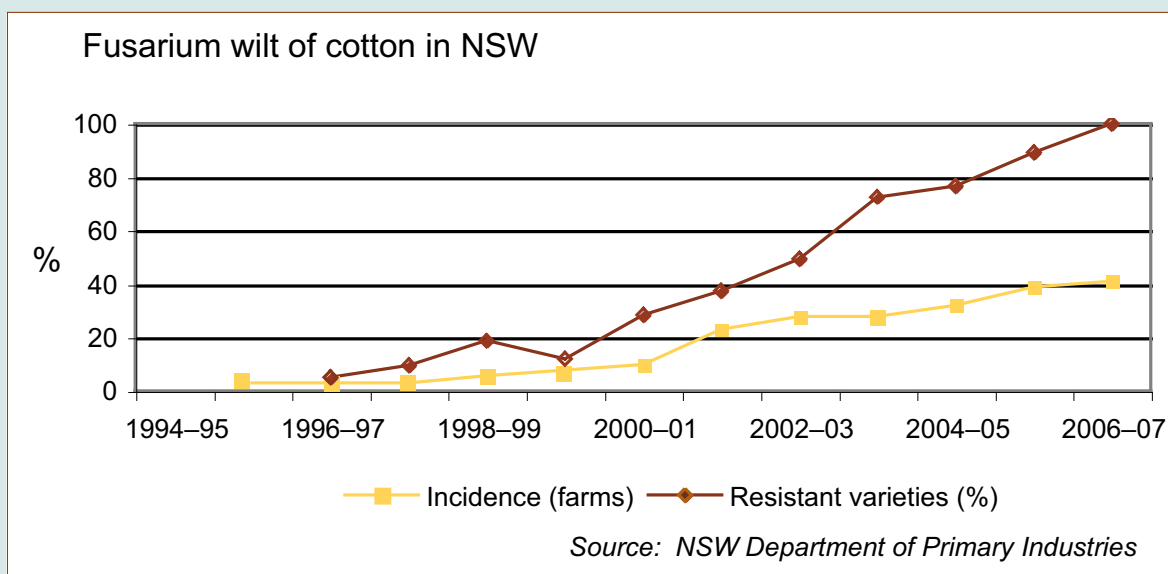
CRDC invests in the crucial research areas of monitoring for resistance and developing an understanding of the mechanisms that lead to resistance in conventional insecticides and the Bt proteins. Resistance management strategies formulated through wide industry consultation ensure sustainability and stewardship of the technologies and chemistries available for insect control in the cotton industry.

In the 2007–08 season the CSIRO resistance monitoring program detected for the first time a significant increase in the frequency of alleles (one of two or more hereditary genes at the same location), which confer resistance to Cry 2Ab, one of the two Bt proteins present in Bollgard II® cotton. CRDC and the cotton industry will be paying particular attention to results of the monitoring program over the next few years to ensure that the appropriate measures to minimise further increases in

resistance will be put into place through the Australian Cotton Growers' Research Association's Transgenic Insecticidal Management (TIMS) Committee.

When the results of the monitoring program were known late in the 2007–08 season, CRDC sponsored a resistance roadshow through all of the major cotton producing valleys to update growers and consultants on the change in resistance status. The TIMS Committee oversees the stewardship of the technology for the industry, in conjunction with the technology providers, Monsanto Australia. Despite the increase in frequency of resistance alleles detected, the Bollgard II® technology that has been so important during the period of the Strategic Plan will continue to serve the industry well for many years to come.; however, TIMS and Monsanto will be looking jointly at a range of measures to ensure that resistance does not increase to unsustainable levels.

While Bt cotton has underpinned the management of *Helicoverpa* spp., it is only one aspect of good pest management. The continued presence of secondary pests such as green mirids, silver leaf whitefly and green vegetable bug emphasises the importance of an integrated approach to pest management. A fundamental component is the judicious use of conventional insecticides; to ensure the continued effectiveness of these compounds, CRDC continues to invest in a number of resistance monitoring projects that quantify the level of resistance in certain insect species. The success of the resistance management strategy and implementation of science-based integrated pest management strategies was demonstrated by a decline in the resistance levels to a number of important insecticides in both the 2005–06 and 2006–07 seasons.



PROGRAM FOUR

Farming Systems

Objective

Integrated farm management practices that enhance the sustainability and profitability of cotton farming systems.

Outcome

A more sustainable and profitable cotton farming system.

Overview

Australian cotton growers face financial pressures from the ever-increasing costs of land, water, fertiliser, fuel, energy, machinery and labour, coupled with prevailing drought and low global cotton prices relative to alternative crops. CRDC investments under the Strategic R&D Plan 2003–2008 have helped to maintain the viability of the industry by offsetting these pressures significantly through a combination of yield improvements delivered by new cotton varieties and improved management of the cotton farming system, underpinned by the adoption of research outputs and new technology.

Cotton yields over the five seasons covered in the plan have averaged an estimated 1,850 kilograms of lint per hectare compared to an average of 1575 kilograms in the previous five years: a 17 per cent improvement, or 3.4 per cent on an annualised basis. In addition, CRDC has focused research investments in areas that will improve production input and resource use efficiency, particularly in the key areas of water, soils, nutrient, fuel use and energy. Improved efficiency not only increases returns to growers, it reduces adverse environmental impacts such as greenhouse gas emissions through efficient use of water, nutrition, fuel and energy.

Cotton Producer Johannes Roellgen, of Brookstead on the Darling Downs, is using an information-based cotton production system with plant and crop information overlaid to manage his lateral move irrigation.

By combining information on crop development and water use, he is seeking to optimise inputs such as water, fertiliser and growth regulators to maximise yield and profit.

Strategy One

Improve water use efficiency on farms using new and existing infrastructure, new tools and technologies

Water, or rather its lack, has defined the crops from 2003–04 to 2007–08 (with a brief respite in 2005–06). This period was characterised by low levels of stored water; combined with restricted water allocations, which placed even greater emphasis on improving on-farm water use efficiency. CRDC has invested in a broad range of water-related R&D to achieve that key objective by identifying plant and soil factors that influence water use efficiency, developing better irrigation strategies when water supply is limited, optimising production and water use in cotton with high fruit retention, developing precision technology for monitoring plants and more accurately controlling large mobile irrigation systems, and testing demonstrating technology

to monitor and measure water use on-farm as well as improve the knowledge and capacity of both growers and consultants through improved training and information resources on water management.

Following development of an important new irrigation management resource, WATERpak, in 2003–04, CRDC coordinated the development of a CD version. WATERpak was included on a new searchable edition of the COTTONpak CD: a 'one stop shop' for a number of decision support tools developed by CRDC or with CRDC investments. In 2007–08, new irrigated grain supplements enhanced WATERpak further.

Throughout the period, CRDC was a partner in the National Program for Sustainable Irrigation (NPSI), managed by Land and Water Australia, with Phase Two commencing in 2007–08. This investment encourages a collective consideration of irrigation research issues and needs across the





Postdoctoral researcher Simon White is undertaking research to optimise irrigation scheduling to achieve water use efficiency

national irrigation industry and contributes to a greater sharing of information and innovations between partners and commodity industries involved in irrigated agriculture.

Accurate measurement of the whole water balance on-farm has proved difficult and there is a general lack of access to, and consistency of, on-farm water use data. Regional variations in climate and soil types also mean it is impractical to do more than use available industry-wide data on water use as a broad indicator of improvement.

Available data from the Australian Bureau of Statistics and the cotton industry in relation to irrigation water used for cotton production and related yield indicate that a broad measure of the industry's Irrigation Water Use Index (IWUI), expressed in bales per megalitre of water applied, in both NSW and Queensland has been improving steadily since the year 2000. Based on the available information, the efficiency

of irrigation water use by the cotton industry may have increased by up to 28 per cent over this period – or approximately 4 per cent per annum. Similar trends have been measured at the farm level using a better water use index, the Gross Production Water Use Index (GPWUI) which relates total production to water used from all sources not just irrigation. David Williams, NSW DPI/Cotton CRC, measured water use on 36 cotton farms from Hillston to Emerald in 2006-07 and showed that the average GPWUI had risen by 40 per cent in the last decade from 0.79 bales/ML (measured in a similar study completed by CSIRO's Sunnil Tennakoon in 1999) to 1.13 bales/ML – or approximately 4.5 percent per annum.

While these statistics are encouraging as indicators of industry-wide improvement, the application of indices like the IWUI at regional or even sub-catchment scale is found

to be impractical as a benchmark to encourage improvement at the individual farm scale. Consequently, CRDC has invested in projects focused on encouraging practice change linked to improved water use efficiency; in particular, to help build cotton growers' capacity and knowledge to better manage their available water and maximise their returns per megalitre, as well as encouraging improved on-farm water monitoring and measurement.

As part of two collaborative projects involving CRDC, the Grains R&D Corporation, NPSI, the Cotton Catchment Communities CRC, the CRC for Irrigation Futures, and several regional bodies and Catchment Management Authorities, a range of detailed case studies and new information resources has been completed to demonstrate how WUE improvements can be achieved at the individual farm level. These are widely disseminated through the National Cotton Extension Team.

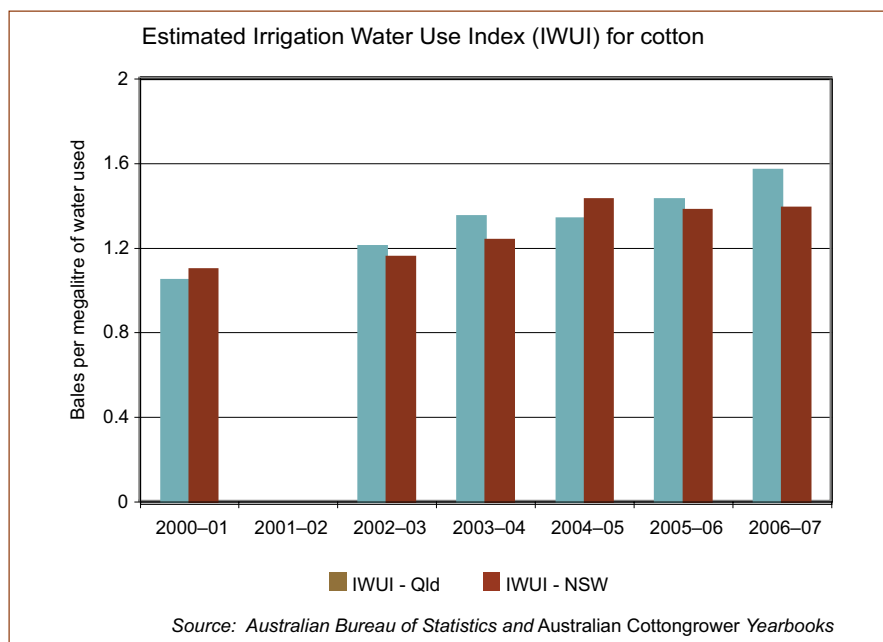
Strategy Two

Understand salinity, sodicity and deep drainage on farms and develop appropriate farm management strategies

The need for ongoing research on salinity in current cotton production areas has diminished because of significant investments by CRDC and its R&D partners over many years. The limited number of areas where salinity poses a significant threat to production have been identified and growers in these areas have acted, or are planning to act, upon the risk maps, advice and technology developed by this research.

Sodicity is considered to be a more significant problem in many cotton growing areas due to the chemical composition of the soils; however, in most situations it is managed effectively with sound crop rotations, irrigation management and, if required, the addition of soil conditioners such as gypsum. More strongly sodic soils do occur in some regions and management of these soils with the addition of gypsum and/or lime is the focus of ongoing research. Research conducted under Strategy Three has identified crop rotations that can reduce the impact of sodicity and offer both improved environmental benefits and increased profitability.

Under this strategy, research on deep drainage (the loss of water beyond the plant's root zone) involves a network of lysimeters located on commercial cotton fields in southern Queensland and northern NSW, buttressed by a large lysimeter at the Australian Cotton Research Institute. By measuring the deep drainage under a range of soil types, management systems and rainfall events, options for reducing water losses through deep drainage are being clarified. Research on catchment-related deep drainage is reported in Program Two. CRDC-supported research utilising evidence from the network of lysimeters has shown that farmers can reduce deep drainage by shortening furrow irrigation run times and using lateral move overhead irrigation systems.



Strategy Three

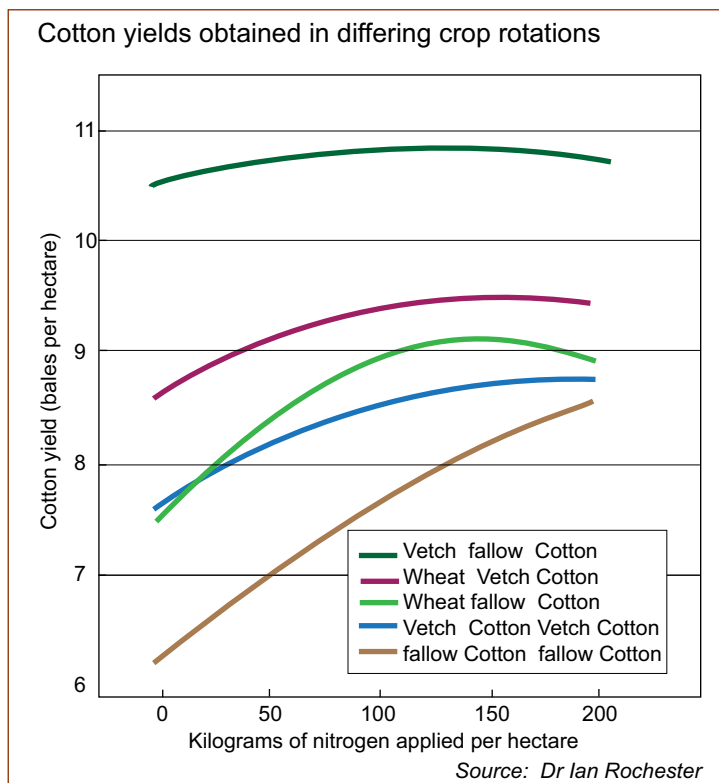
Strengthen our understanding of soil health and improve crop nutrition management

The emphasis on soils R&D in the Strategic R&D Plan 2003–2008 moved from issues of soil structure and chemistry covered in previous research to a focus on improving knowledge and management of soil biology for healthy soils.

A survey commissioned by CRDC in 2006 found that cotton growers consider nutrition, soil fertility and crop yield performance to be the most important factors for sustaining the health or quality of their soils, with issues such as plant pathogens and pesticide residues of lesser importance. Growers were also asked whether they believed their soil health had improved over the last ten years. 67 per cent indicated it had improved, 28 per cent believed it had remained steady and only 5 per cent were unsure. These results demonstrate that growers are concerned about, and committed to, sustaining the productive capacity of their soils. These levels of improvement have been confirmed in the most recent survey, in June 2008, in which cotton consultants reported on the outcome of 238 growers. The survey found that 60 per cent of growers had achieved better soil health over the previous five years.

Because of this survey, CRDC was confident that its investment in the Healthy Soils for Sustainable Farms program, in collaboration with Land and Water Australia, the Cotton Catchment Communities CRC and a number of Catchment Management Authorities, would address an increasing demand from growers for information on soil health. To date the Healthy Soils for Sustainable Farms project has initiated 18 well-attended workshops in NSW and Queensland, run six demonstration sites and held eight focus group meetings. In addition, a range of publications and twelve case studies on soil health issues were produced.

The high importance growers place on crop nutrition and soil fertility for maintaining healthy, productive soil has been the focus of research



on nitrogen use efficiency and crop rotation (nitrogen use efficiency in relation to greenhouse gas emissions is covered in Program Two.)

In relation to crop rotation research, there is a strong indication that a new cotton farming system is evolving. Based on a five-year study, a rotation program involving cotton, wheat and the legume vetch promises high yields coupled with lower production costs in comparison to a range of traditional rotations such as cotton–cotton, cotton–fallow and cotton–cereal.

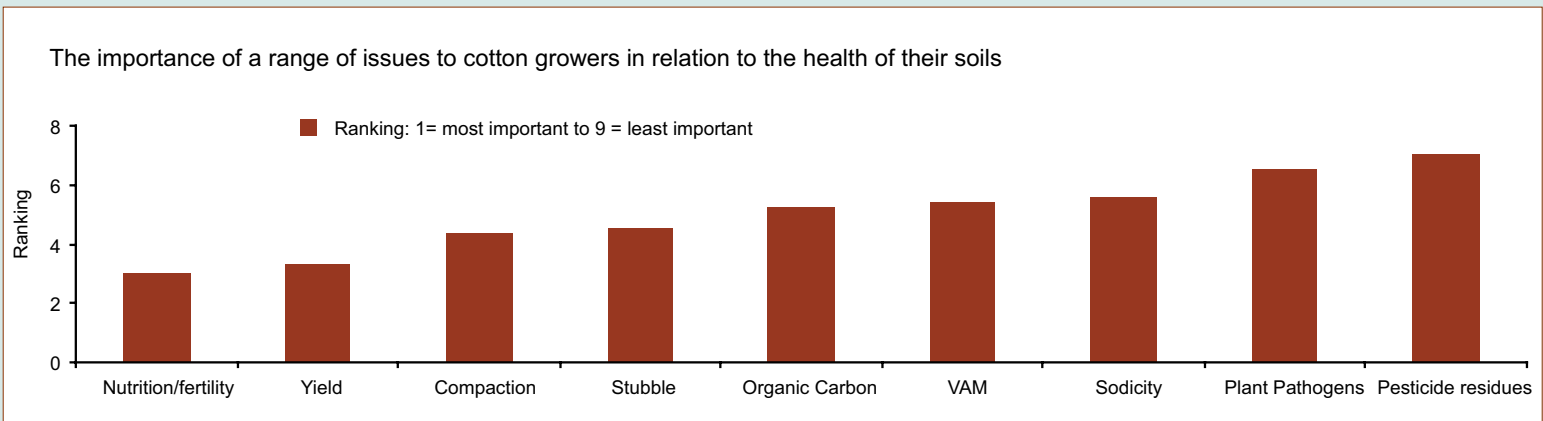
Reduced irrigation frequency and lower nitrogen requirements, both key inputs in today's cotton farming system, are the primary benefits of the rotation. Reduced erosion and runoff, improved water infiltration with much lower pesticide and nutrient runoff, are among the positive environmental performance benefits.

Where irrigation water, rather than area of land, is the limiting resource on a farm, the study shows a cotton–wheat–vetch rotation system to be more profitable. These results also highlighted the importance of assessing the whole rotation system when assessing profitability and crop selection, rather than just using individual crop gross margins analysis.

Strategy Four

Increase profitability with better whole farm management strategies and innovative precision agricultural systems

Each year of the strategic plan CRDC invested in a Cotton Comparative Analysis, produced in association with BOYCE Chartered Accountants (and, latterly, the Cotton Catchment Communities CRC) and using comparative statistics gathered from collaborating growers



and BOYCE clients. The comparative analysis is a management tool to implement change and to identify where effort should be directed on a day-to-day basis. It helps growers identify relative strengths and weaknesses in their own operations, which they can then use to develop long term business plans to overcome weaknesses and build on strengths.

The latest report presented some key trends between 1997 and 2006:

- ▶ The net price per bale of cotton decreased from \$460 to \$440: a 4 per cent decrease
- ▶ The yield of bales per hectare increased from 7.4 to 9.3 bales: a 26 per cent increase
- ▶ The average operating profit per hectare for the average grower is decreasing
- ▶ The operating profit per hectare for the top 20 per cent of growers is relatively flat; hence, the gap between the operating profit per hectare for the top 20 per cent and the average grower is widening.

While some of these trends are beyond the control of the grower, the industry and the influence of R&D outputs, they do show that well managed cotton farms can continue to return good profits and there is still scope for average growers to improve profit margins. Since this report was produced, the combined impacts of drought, relatively flat cotton price returns in Australian dollar terms and escalating input costs have continued to affect the profit margins for the cotton industry. Nevertheless, high cotton yields per hectare from the 2007–08 harvest indicate that the industry continues to benefit from the improvements to management that are underpinned by research.

In a survey on precision agriculture, commissioned by CRDC and conducted after the 2006–07 season, 54 per cent of growers indicated that they had used one or more of the precision agriculture elements listed in the survey, with over 90 per cent using navigation systems and yield monitoring and 55 per cent using electromagnetic surveys. At the same time, nearly 30 per cent of the respondents who used precision agriculture in their cotton production

system indicated that there was insufficient information available on how to obtain the best results. From this feedback, CRDC has concluded that the private sector is able to provide cotton growers with good precision agriculture technology. Adoption levels are high but there is a need for greater sharing of grower experiences with the technology in terms of positives, negatives, economics and innovations, which are addressed in the new Strategic R&D Plan 2008–2013.

Strategy Five

Continue fundamental research on cotton agronomy and plant physiology and explore the interactions of different components for both conventional and transgenic varieties

Bt cotton, with the ability to control the insect pest *Helicoverpa* spp., has led to a significant reduction in crop damage, which, in turn, has influenced the structure and growth habit of Bt cotton plants. CRDC research has investigated the significance of changing growth habits in relation to nutrient use and water use efficiency. In situations of low or no water stress, Bollgard II® cotton uses ten per cent less irrigation water than conventional cotton varieties because reduced pest damage means it retains a higher early boll load and therefore has a shorter growing season. Bollgard II® cotton, though, was less able to compensate for high water stress, producing lower yields than conventional cotton under these conditions. As well as having a potential impact on nutrient and water use efficiency, the changing growth habit of the Bt cotton plant may also affect the quality of the cotton fibre produced. When Bollgard II® cotton is water stressed at peak flowering time, the reduction in cotton fibre length is greater than with conventional cotton; thus, it is difficult to improve the management of Bollgard II® cotton in limited water situations without affecting both yield and quality.

Crop physiology and agronomic research outcomes are widely disseminated to industry through CRDC, as well as in agricultural science journal articles and trade publication articles by researchers and CRDC staff.

Three of the range of Healthy Soils case studies produced with the aid of CRDC investments and available through the National Cotton Extension Team

Difference between the top 20 per cent and average grower operating profit per hectare for the period 1997 to 2006

Year	Top 20% of growers (\$ profit per hectare)	Average grower (\$ profit per hectare)
1997	1850	1350
1998	1950	1450
1999	1100	400
2000	1700	800
2001	1350	750
2002	1200	850
2003	1750	750
2004	1300	700
2005	2300	1500
2006	1700	450

Source: Boyce Cotton Comparative Analysis 2006

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PROGRAM FIVE

Plant Breeding and Biotechnology

Objective

World-leading cotton varieties displaying continuous improvement in cotton yield, quality and agronomic performance through plant breeding and biotechnology innovations.

Outcome

Continually improving cotton varieties.

Overview

After eighteen years, the major investment CRDC has made to the CSIRO cotton plant breeding and biotechnology program effectively ceased. In September 2007 CSIRO Plant Industry and Cotton Seed Distributors Ltd (CSD) announced the Cotton Breeding Australia joint venture, which will fund cotton breeding and targeted research for an initial ten-year term. Both parties in the new venture will co-contribute for research.

CRDC is proud to have been the major investor on behalf of the cotton industry in this highly successful, multiple award-winning breeding program up until September 2007.

CSIRO-bred cotton varieties currently represent over 90 per cent of the Australian market and are well represented around the world. The fact that this research program has reached a point where it can be funded by industry more directly without additional grower levy is also a measure of its success. CSD is a grower owned enterprise that has worked with CSIRO Plant Industry since the 1980s to develop and deliver the varieties developed by the CRDC-supported research.

Strategy One

Develop regionally adapted cotton varieties exhibiting improved yield, quality, insect and disease resistance and herbicide tolerance

In early 2004, CRDC engaged three leading international scientists, aided by Glenn Fresser (at the time, Chair of the Australian Cotton Growers' Research Association and now a CRDC Director) to undertake a major review of this program. Arising from their recommendations, CRDC enhanced its investment in the Fusarium wilt resistance breeding and CSIRO's regional cotton variety testing.

Although CRDC only invested directly in the CSIRO breeding program for the first three years of the strategic plan, the benefits of these investments continue to be felt. Two new varieties commercially released for the 2007–08 season were products of previous CRDC investments. These new varieties incorporate key transgenic traits, with one containing Bollgard II® and Roundup Ready FLEX® and the other containing Roundup Ready FLEX® technology alone.

During the Strategic Plan's operations, over 30 new varieties developed with the assistance of CRDC investments were released, offering many new features, including improved fibre quality, disease resistance, growth habit, maturity and regional adaptability. Breeding for improved yield tended to produce a negative correlation with fibre quality, so combining the two attributes became a major focus for the breeding program.

Sicot 71BR dominated the first three seasons of Bollgard II® release, offering significant yield improvements combined with fibre quality similar to previous varieties.

Sicala 350B provided a 10 to 15 per cent quality premium over conventional varieties in the 2006–07 season, albeit with an impact on yield. This variety offered the possibility of blending with Pima cotton to achieve a high quality and unique product in the global marketplace.

The 2007 release of the broadly adapted variety Sicot 75 provided a similar yield potential to Sicot 71BR but with much improved staple length. Cotton Breeding Australia will continue the task of breeding varieties offering the holy grail of high quality combined with high yield cotton to provide Australian growers with a competitive advantage.

Strategy Two

Targeted, innovative biotechnology focused on solving production and quality constraints confronting the Australian cotton industry

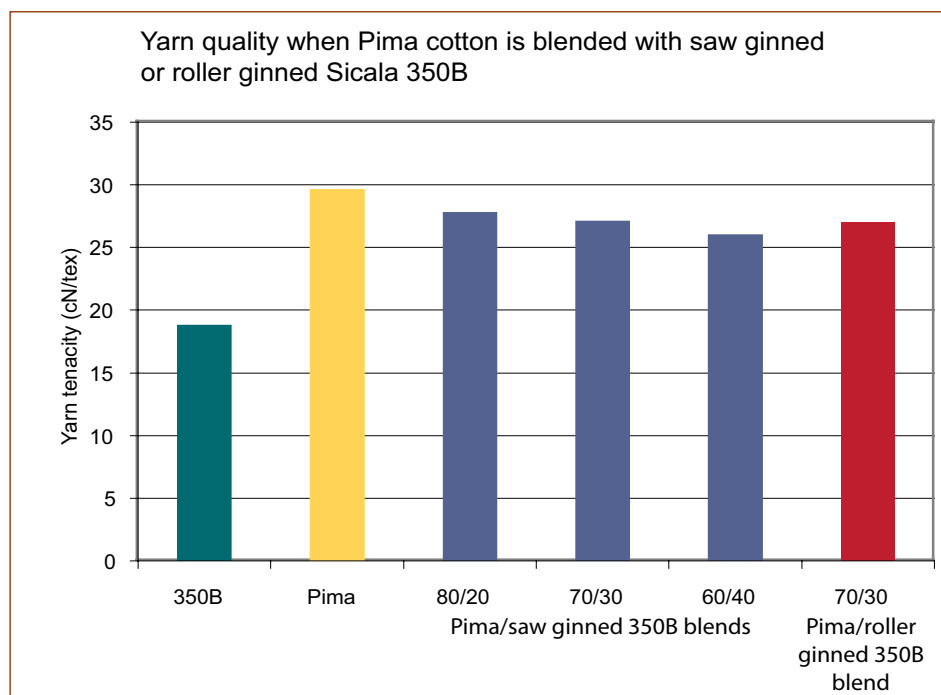
CRDC investments in biotechnology over the period of the 2003–2008 Strategic R&D Plan have enabled new varieties with Bollgard II® and Roundup Ready FLEX® technology to reach the Australian cotton market ahead of most international competitors.

In 2007–08, CRDC continued to invest in biotechnology to target yield and fibre quality, disease tolerance and agronomic performance such as tolerance to waterlogging. It is expected, however, that key biotechnology research conducted by CSIRO will no longer require funding from CRDC. This does not mean that CRDC will no longer invest in breeding and biotechnology. Instead CRDC aims to establish new priorities that focus on opportunities to develop traits that add value to Australian cotton fibre and cottonseed.

Strategy Three

Reduction in time required to introduce improved or novel genes into elite cotton varieties through the development of frontier technologies, without compromising scientific rigour

In what is a worldwide problem for researchers, CRDC continues to support research to reduce the time needed to transfer genes into elite varieties. In 2005–06 CRDC, CSIRO Plant Industry and Cotton Seed Distributors Ltd launched CottTech. This was a new and innovative research approach aimed at building on the existing capacity of the CSIRO cotton breeding team to generate commercial outcomes for the cotton industry. Researchers





In early 2004 CRDC engaged three leading international scientists to undertake a review of Program Five: (left to right) Dr Robert Wright, Associate Professor of Crop Genetics, Department of Plant and Soil Science, Texas Tech University; Mr Rob Jarvis, Regional Director of The Cotton Company of Zimbabwe, Dr Lloyd May, Assistant Professor, Cotton Genetics Crop and Soil Sciences (Coastal), University of Georgia, and. They were joined by Glenn Fresser (on the right) who was Chair of ACGRA at the time and is now a CRDC Director.

The chief outcomes from the review were an enhanced emphasis on Fusarium wilt resistance breeding and the capacity of the CSIRO breeding program to conduct its regional cotton variety testing.

working within the CottTech program have undertaken a suite of cotton biotechnology projects aimed at removing constraints on production and ultimately delivering beneficial traits faster through improved breeding techniques.

Cotton is a desert plant, so does not tolerate waterlogging for any extended period. It has been estimated that up to ten per cent of crop yield may be lost each year because of the effects of waterlogging from irrigation. This level of yield loss can increase significantly during a year where significant rainfall occurs immediately after irrigation. To help overcome this problem, genes that reduce the impact of waterlogging continue to be investigated within the CottTech initiative. A number of genes have been isolated and the first small plot field trial was conducted in 2008. Refining the technology will occur after assessment of the 2007–08 yield results. More efficient methodology has been developed to screen breeding material for the presence of desired transgenic traits.

A new short-term project under investigation through CottTech was established to determine whether the genome for the Australian strains of Fusarium wilt fungus could be sequenced. Recent advances in genomics may allow the genome of this important disease to be mapped. Such information would provide significant advantages, not only in the development of new varieties or its control, but also in fundamental ecology and biology assessment of the disease and its interaction with cotton.

Strategy Four

Continuous monitoring of the signals from cotton textile and oilseed marketplace to ensure Australian varieties maintain a place at the high quality end of the market

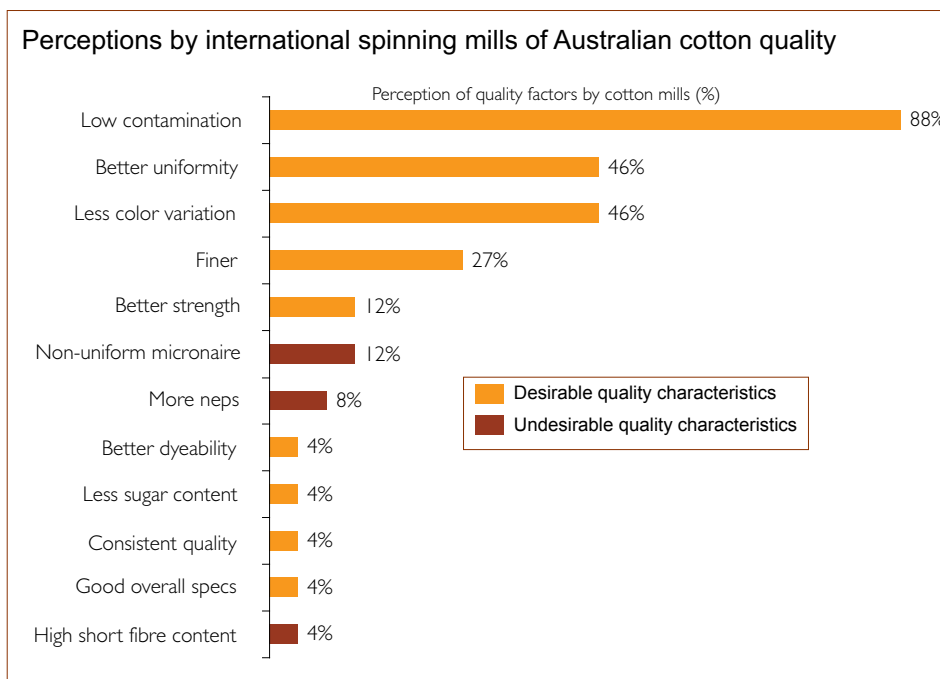
The benchmark for Australian cotton on the world market is acala type cotton from the San Joaquin Valley in California: that is, SJV cotton.

Despite the severe impact of the drought on production during the plan's period, Australian cotton was overwhelmingly quoted as an equal of SJV. Australian cotton continued among the top prices listed for the highest category of upland cotton on the Liverpool Cotton Outlook 'A' index over the five years.

World competition in the cotton export market for is eve- increasing and it is important for Australia to develop strategies to continue to improve its advantage in the market place. International surveys conducted in collaboration with Cotton Australia and Australian Cotton Shippers Association (ACSA) indicate that world demand for premium cotton types will increase by some 20 per cent over the next five years.

To understand this opportunity for Australian cotton, a project was commissioned to assess the capacity to blend Australian premium cotton types with Pima cotton and determine what blend ratios could be achieved without affecting final yarn quality. Following these small-scale trials, the objective over the next two to three years is to work with international spinners who specialise in the production of fine count yarns to determine the final value of any commercial advantage that can be achieved. This could provide an opportunity for higher premiums to be passed back to growers.

CRDC continues to support ACSA to monitor quality requirements of spinning mills to ensure Australian cotton meets international market demands. This includes maintaining levels of support into the assessment of aspects such as contamination levels: an attribute that gives Australian cotton a strong advantage in comparison to our trading competitors, as can be seen by its excellent rating in the graph below.



PROGRAM SIX

Value Chain

Objective

To produce high quality consumer-preferred cotton and develop new international and domestic market opportunities.

Outcome

High quality consumer-preferred Australian cotton in the world marketplace.

Overview

Australian cotton continues to compete at the premium end of the world market. It has achieved and maintained this market advantage with the aid of CRDC investments in Australian-bred varieties that produce cotton fibre with the strength, length, fineness and maturity sought by spinners, combined with excellent R&D-driven agronomic practices producing consistent high quality and efficient ginning and shipping systems that deliver cotton on time.

A survey of international spinning mills in 2004, supported by CRDC, provided valuable information for future R&D. The graph on page 33, represents the information gathered by the survey. It shows that Australian cotton is generally rated highly, particularly in regard to contamination, grade, colour, spinning ability, staple length, trash content and elongation but also revealed the need to reduce nep counts (tangles of immature fibres that result in processing inefficiency) and short fibre content.

The major emphasis of this program over the period of the Strategic R&D Plan 2003–2008 has been on preserving and enhancing quality right through the value chain – ‘from field to fabric’. The past five years have seen the industry embrace this concept and much has been achieved. ‘Value Chain’ forms one of the three R&D programs in the new Strategic R&D Plan 2003–2008, emphasising its importance to the industry’s future.

Strategy One

A breeding program that releases varieties with high quality fibre characteristics which satisfy consumer demand trends. To investigate the use of biotechnology to enhance other traits, for example, nutritionally improved cottonseed oil

As reported in Program Five, the establishment of the new Cotton Breeding Australia joint

venture meant that CRDC’s investment in the CSIRO cotton plant breeding and biotechnology program declined significantly; nevertheless, the key aims of this strategy remain highly relevant to the Australian cotton industry.

During the course of 2007–08, CRDC considered its future role in value chain R&D thoroughly as it developed a new strategic plan for 2008–2013. As a consequence of the inquiry and consultation surrounding the development of the new plan, the concept of improving our understanding, and enhancing the competitive advantage, of Australia’s cotton fibre and cottonseed products has emerged as a key driver for CRDC’s value chain investment. Healthier cottonseed oil was developed over the period of the Strategic Plan, using gene silencing to produce oil with a much higher ratio of oleic and stearic acid to the saturated fatty acids, palmitic and cycloproenoic. During the 2007–08 year, CRDC continued to work with CSIRO to explore an effective commercial pathway for the resulting oil. With commercialisation dependent on acceptance of a genetically altered foodstuff, CRDC is seeking a response from interested parties on the international commercial opportunities before committing scarce funds to further significant commercialisation.

Strategy Two

To promote agronomic and management practices, including the Cotton BMP program, which preserve and protect optimal fibre quality characteristics

The major initiative during this period was the EMS Fibre Pathways joint initiative between CRDC and the National Heritage Trust, which has helped to define how fibre quality can be maintained through the processing chain and led to the development of post-farm gate BMPs.

Although the EMS Fibre Pathways project was finalised in 2006–07, post-farm gate initiatives developed under this program have continued. In particular, the industry was encouraged to consider establishing BMP guidelines for the ginning, classing, storage and handling sectors. Accordingly, draft Classing BMPs were completed in 2005–06, with most classing facilities participating on a voluntary basis in the 2007–08 season to test the BMPs and the individual classing facilities’ levels of compliance. The 2008–09 season has seen the start of the classing BMP audit and certification process.

In addition, Ginning BMPs are under development and interest from the industry on establishing BMPs for cotton bale storage, handling and shipping is also under consideration.

A series of Field to Fabric Quality workshops held in 2005 was accompanied by development



The CSIRO Cotton Field to Fabric Training Course: Managing for Quality through the Production Chain course is aligned to national training competencies and covers global perspectives of the market and distribution, yarn manufacture, fabric formation, marketing, dyeing and finishing, fibre properties, quality assurance, agronomy impacts, picking, ginning and classing. Fifty industry personnel completed the full-booked Cotton Field to Fabric Training Course in 2007–08. Strong demand for the course reflects an industry-wide acceptance of the importance of maximising fibre quality right through the production chain

of a CRDC-supported CSIRO *Cotton Field to Fabric Training Course: Managing for Quality through the Production Chain*, which has proved enormously popular. Much of the information contained in the course is based on the outputs of CRDC investments in research, development and extension work.

The Field to Fabric cotton quality initiative was enhanced by improved integration of research on the impact of different management practices at the farm level on fibre quality, with research investigating cotton 'spinnability' and resulting yarn quality. To assist in this research, a miniature spinning protocol was successfully established to allow assessment of spinning efficiency and subsequent yarn properties using small-scale cotton samples.

Trials have successfully assessed the impact of harvest aid timing on fibre quality and textile performance. Yield was found to be significantly affected by early defoliation; that is, when less than 60 per cent of bolls were open. Micronaire and fibre linear density were significantly less if defoliation occurred at the 40 per cent open boll stage. Surprisingly, neps counts were generally not affected by early defoliation; however, most of the cotton on the plants in these trials was mature at the time of defoliation. A higher neps count would be expected in a situation where a greater proportion of bolls contain immature fibres at harvest.

No significant differences between timing of harvest aid treatments were noted for the yarn performance attributes, yarn irregularities and strength for carded 20 tex ring spun yarns. There was, however, a significant relationship between fabric colour intensity and time of harvest aid treatment, with the earlier treatments taking up less dye.

Strategy Three

Ginning improvements resulting from research to reduce neps generation and to preserve desirable fibre qualities

Ginning has a significant impact on fibre and subsequent yarn quality, as it can reduce fibre length and increase neps levels significantly. CRDC's investment in ginning research has continued to target the development of gin modifications and/or practice change, particularly moisture management and improved quality parameters throughout the ginning process to ensure fibre quality is maintained.

During 2007–08, a scoping study was completed on current technologies and practices used to manage moisture throughout the processing and storage of cotton post-harvest and highlighted a number of priority areas for future investment. A key recommendation encourages the development of more effective techniques to measure moisture in the ginning process. With respect to individual fibre properties, the report recommended that assessing the period of fibre glass transition (that is, the relationship between temperature and moisture and the physical characteristics of a cotton fibre) may enable the development of new management strategies for cotton processing. CRDC seeks opportunities to further investigate this new area of research under the Strategic R&D Plan 2003–2008, in conjunction with the Cotton Catchment Communities CRC.

With the aim of improving the management of moisture through the ginning process, a prototype capacitance moisture sensor has been developed and an industrial scale sensor built and fitted to a commercial gin for further evaluation. New ginning point inserts that improve lint removal and, possibly, gin productivity and fibre

quality and reduce seed damage have been successfully trialed in commercial gins.

The issue of neps may become more important as mills push for higher efficiency and the cotton industry strives to gain higher price premiums. While mechanical picking and the ginning process are recognised as key factors causing development of neps within the fibre, CRDC has in conjunction with the Cotton Catchment Communities CRC investigated agronomic factors that affect fibre quality and development of neps subsequently. Initial research indicates that the link between fibre factors affecting neps development may be harder to assess than initially thought.

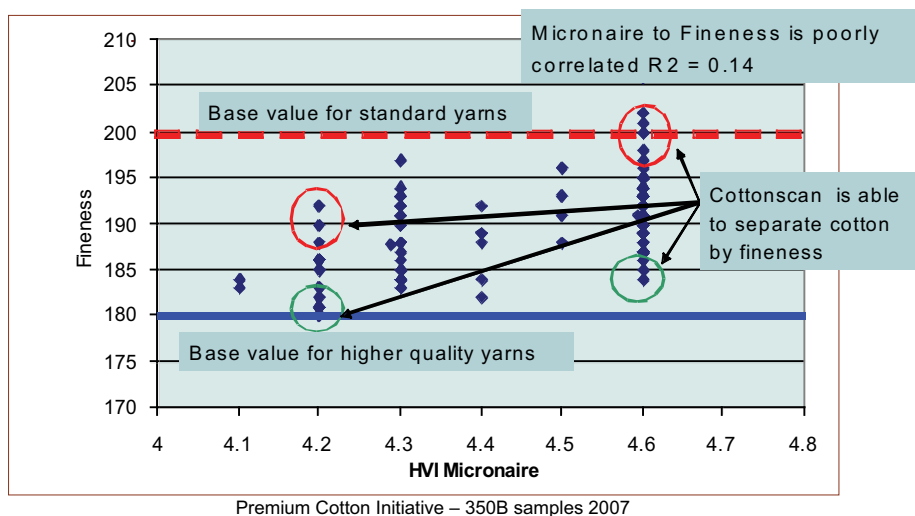
In order to understand the level of neps present in Australian cotton, CRDC invested in a general neps survey across the 2007–08 Australian cotton crop. This investment is expected for the first time to provide an important benchmark that would allow traceability back to farms, fields and practices.

Strategy Four

The development of more accurate and repeatable technology of fibre measurement for neps, fineness, maturity and other fibre characteristics; and support changes to the traditional classing system, which better identifies and rewards superior fibre characteristics

Aided by CRDC investments, the Textile and Fibre Technology program in Geelong (part of CSIRO Materials Science and Engineering after 30 June 2008) has developed two instruments for improving the measurement of fibre maturity and fineness: attributes currently measured by a less reliable composite measure known as micronaire. Cotton growers are penalised for

The Relationship between fibre micronaire as measured by commercial HVI instruments and fineness as measurement by new CSIRO Cottonscan technology



Source: CSIRO Textile and Fibre Technology Program





CRDC Directors and program management staff visited the CSIRO Textile and Fibre Technology Program in Geelong for a first-hand view of important Program Six research.

In the foreground are Dr Stuart Gordon, Research Team Leader at CSIRO Materials Science and Engineering, and Dr Ian Taylor, former CRDC R&D Program Manager

cotton with micronaire that is too high (that is, assumed to be coarse) or too low (that is, assumed to be immature). One of these instruments, SiroMat, utilises an automated polarised light microscopy to measure fibres as a test for fibre maturity. The advantage of this technology is that it is able to directly measure the fibre maturity distribution in a sample. According to spinners, this is important from the perspective of predicting textile problems such as neps formation and dye uptake variation. The speed of the SiroMat test means that it has potential for use as a stand-alone instrument in mill and merchant laboratories and as a tool to aid cotton breeders to select improved varieties.

The second instrument, Cottonscan, is an innovative and fast instrument giving average maturity and fineness values. Extensive trials with the prototype instrument in Australia and the US have confirmed that it gives consistent and highly repeatable results, which are independently validated. Further development continued in 2007–08 to determine whether Cottonscan could be used to reliably determine average fibre linear density, or fineness. Cottonscan measurements have been shown to offer a significant improvement over traditional HVI (High Volume Instrument) measurements, which would, when applied commercially, potentially allow spinners to more effectively differentiate fibre quality and improve efficiency.

Business cases have been preparing for both instruments and opportunities for commercialisation are being investigated. SiroMat could be commercialised as early as 2009 if commercialisation partners can be found.

Strategy Five

To support efforts to develop new markets and high premiums for Australian raw cotton as well as value adding cotton in Australia

The EMS Fibre Pathways project, discussed above, encouraged the industry to investigate the opportunity to develop a brand-based on fibre quality and then determine whether this could be further strengthened in sectors of the marketplace by linking environmental best practices through a BMP program, to a differentiated fibre.

International surveys supported by CRDC in 2007 showed that the term 'BMP' is not well recognised by the immediate consumers (the spinners) of Australian cotton. While 35 per cent and 29 per cent, respectively, of those surveyed stated that the buyers of their processed yarn and fabrics do pay attention to 'eco-friendly' and 'ethical growing standards' practices, only six per cent stated that their buyers have knowledge of, or pay attention to, best management practices.

The EMS Fibre Pathways project also highlighted the need to develop an agreed set of indicators for environmental performance on cotton farms and better identify practices that are relevant to improving or sustaining those indicators and the specific benefits that accrue to the farm and the environment from their adoption. This recommendation was a key driver for CRDC to apply successfully for funding from the Australian Government through the Department of Agriculture, Fisheries and Forestry, in 2007–08 for a short-term project under the *EMS Pathways to Sustainable Agriculture* program. The resulting project on Environmental Performance Indicators for cotton, grains and beef is reported under Program Two, Strategy Two.

Executives from IZUMIYA, a Japanese chain with 86 department stores, with Cotton Australia CEO (and former CRDC Director), Adam Kay (second from right). IZUMIYA continues to successfully market garments made exclusively from Australian BMP cotton under their environmentally branded in-house 'Good-I' label – a vote of confidence in the Australian product and an encouraging sign for future differentiation of environmentally-produced Australian cotton in the marketplace



CRDC Roll-Call 2003–2008

AUSTRALIAN GOVERNMENT

Ministers

Up to 2005: The Hon Warren Truss MP
2005–2007: The Hon Peter McGauran MP
From 2007: The Hon Tony Burke MP

Parliamentary Secretaries

Up to 2004: Senator the Hon Judith Troeth
2004–2005: Senator the Hon Richard Colbeck
2005–2007: The Hon Sussan Ley MP

Board of Directors

Chairs

Up to December 2006: Bridget Jackson
Acting, 2007: Dick Browne
From August 2007: Mike Logan

Vice-Chair

Dick Browne

Executive Directors

Up to August 2004: Ralph Schulzé
From August 2004: Bruce Finney

Non-executive Directors

2003–08: TJ Higgins; Dick Browne
2003–2005: Kathryn Adams; Jeff Bidstrup;
Neil Forrester; Adam Kay
From 2005: Leith Bouly; David Conners;
Glenn Fresser; Lisa Wilson

Government Directors

2003–2005: Graeme Hamilton
2005–2006: Simon Smalley
2006: Ian Robinson

ACGRA

Chairs

Up to 2005: Glenn Fresser
2005–2007: Hamish Millar
From 2007: Ben Stephens

Committee Members over the period

W Moffatt; A Heckendorf; G Armstrong; C Humphries;
P Morrison; G Fresser; P O'Brien; Mrs L-A Melbourne; G
Kauter; C Hogendyk; S Henggeler; G Cherry; B Finney; P
Cross; K Harris; C Turner; S Bodiam; J Fritsch; R Collins; J
Moore; A Cush; J Bennett; A McGown; R Browne; R Eveleigh;
H Bligh; D Campbell; J Fergusson; A May; M McCosker; J
Watson; N Burnett; M Abbo; H Ball; M Beeston; A Blair; G
Brownlie; N Morawitz; J Cameron; B Dall'Alba; D Erbacher;
A Greste; J Hamparsum; D Kelly; R Lowe; H McIntyre; P
McVeigh; H Millar; M Mitchell; G Morris L Mulligan; A Parkes;
T Richards; J Robinson; C Rogan; B Stephens; T Taylor; T
Thompson; B Tyrwhitt; N Walton; M Ward

CRDC

Staff

Program Management Team

General Manager – Research and Extension: Bruce Pyke

Program staff:

Helen Dugdale

2003–2005: Greg Kauter

Up to 2003: Guy Roth

2005–2008: Ian Taylor

Up to 2005: Jodi McLean

From 2005: Dallas Gibb

Up to 2006: Rachel Holloway

Administrative Assistant: Karen Larsen

Communication Managers

Up to 2005: Elizabeth Tout

2005–2006: Julie Burt

From 2006: Rohan Boehm

Administration Team

General Manager – Business and Finance:

Up to 2007: Robin Logan

From 2008: David Coleman

Administrative staff:

Dianne Purcell

Margaret Wheeler

Kara Taylor

2005–2008: Bernie Robertson

From 2008: Lee-anne Melbourne





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