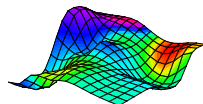


Report to

Cotton Research and Development Corporation

**Triple Bottom Line Evaluation of
Cotton Research and Development Corporation
Investment over the 2003-2008 Planning Period**

18 December 2008



BDA Group
Economics and Environment

BDA MELBOURNE
PO Box 6009
Hawthorn West, VIC 3122
Ph (03) 9852 8969

BDA CANBERRA
PO Box 4022
Manuka ACT 2603
Ph (02) 6282 1443

FOREWORD

The Australian cotton industry has benefited from many technological advancements that can be attributed to research and development activities both in Australia and internationally. The Cotton Research and Development Corporation (CRDC) is an initiative of the Federal government, and it has a unique role in the overall research and development landscape, bridging both private and public interests.

While there is ample evidence of the economic pay off from cotton research and development investment in Australia, it has only been in more recent times that investors have looked at the wide range of environmental and social benefits that can be attributed to research and development activities, and to the CRDC in particular. This study examines the triple bottom line impacts that can be attributed to the CRDC's investment over the period 2003 to 2008.

It is also recognised in this study that the CRDC works in partnership with a wide range of both private and public investors. These partnerships are fundamental to the achievement of returns that maximise benefits to cotton growers and Australia more broadly.

In undertaking this study considerable support was provided by CRDC staff, and in particular Bruce Pyke and Karen Larsen. Their assistance and support is gratefully acknowledged.

David Collins
Director
BDA Group

Disclaimer: All surveys, forecasts, projections and recommendations made in reports or studies associated with the project are made in good faith on the basis of information available at the time; and achievement of objectives, projections or forecasts set out in such reports or studies will depend among other things on the actions of the Cotton Research and Development Corporation and their partners, over which we have no control. Notwithstanding anything contained therein, neither BDA Group nor its servants or agents will, except as the law may require, be liable for any loss or other consequences arising out of the project.

EXECUTIVE SUMMARY

Between 2003 and 2008 the CRDC invested over \$60m in R&D activities to deliver economic, environmental and social returns to Australian cotton growers and the wider community. BDA Group was commissioned by the CRDC to undertake a triple bottom line evaluation of this investment.

In completing this assignment BDA Group examined three aspects of CRDC's R&D investment to determine whether or not the investment represented "value for money" for both cotton growers and Australia at large. The first issue was **attribution** - or what industry and community impacts could sensibly be attributed to the CRDC investment. The second issue was **value** - that is, was the value of benefits generated as a result of identified impacts greater than the costs incurred. The final issue was **additionality** - or what value does the CRDC structure deliver given its place in the total cotton R&D landscape in Australia.

Attribution The CRDC accounts for some 20% of total cotton R&D in Australia, with over 50% being undertaken by public R&D organisations. Through R&D partnerships the CRDC is financially involved with around 60% of all cotton R&D undertaken in Australia.

One in four R&D investments have resulted in a major industry impact – a success rate that is high compared to other rural R&D in Australia. Major impacts from CRDC's investment included developments in BMP, Water Use Efficiency, Fusarium Wilt Management, Bt Resistance Management, Cotton Breeding and EMS Pathways. Thirteen minor impacts were also identified.

A number of other new technologies developed by other agencies both in Australia and overseas were identified, including Bollgard®, GPS and variable rate fertilisers.

Value There are a wide range of economic, environmental and social benefits from CRDC's R&D investment. Although many environmental and social benefits can be identified, considerable difficulties remain in deriving robust quantitative estimates of these benefits.

It was estimated that CRDC's R&D investment between 2003 and 2008 has delivered a minimum return of \$431m to cotton growers, \$292m to other sectors, \$24m in environmental benefits and \$68m in social benefits. This represents a return of \$7 to Australian cotton growers and \$14 to Australia at large for every dollar invested by the CRDC over this period.

Additionality The CRDC plays a unique role in cotton R&D, bridging both private and public interests. Through the negotiation of different cost sharing arrangements for individual R&D investments, the CRDC can assist public agencies to undertake the socially desirable level of cotton R&D in Australia and ensure that there is adequate investment made by cotton growers.

TABLE OF CONTENTS

EXECUTIVE SUMMARY	2
1 INTRODUCTION	4
2 ATTRIBUTION	6
2.1 Investment to Impact Logic	6
2.2 CRDC R&D Investment	8
2.3 Total Cotton R&D Investment	9
2.4 R&D Impacts	10
2.5 Key Points	13
3 VALUE	14
3.1 Choosing the Investment Period	14
3.2 Quantifying Benefits	15
3.3 Accounting for Co-Investment with R&D Partners	17
3.4 Pay Off From CRDC's R&D Investment	18
3.5 Key Points	21
4 ADDITIONALITY	22
4.1 Does the Levy Mechanism Alone Ensure Appropriate Cotton R&D Investment?	22
4.2 Cost Sharing promotes appropriate level of Cotton R&D Investment	24
4.3 Implications for CRDC Performance Evaluation	26
5 CONCLUSIONS AND RECOMMENDATIONS	29
REFERENCES	31

1 INTRODUCTION

The Cotton Research and Development Corporation (CRDC) is required by the Federal government to develop and implement a Strategic Research and Development Plan every five years. In July 2008 a new five year plan was implemented following the conclusion of a development cycle that commenced in February 2007. Over the life of the 2003 to 2008 Strategic Planning Cycle the CRDC has delivered considerable benefits to both the cotton industry and Australia more broadly. While some of these benefits have been assessed as part of a wider review of Rural Research and Development (R&D) outcomes¹, the CRDC has recognised the need to undertake a more comprehensive triple bottom line (TBL) evaluation of R&D impacts that can be attributed to past R&D investments². BDA Group was engaged by the CRDC to undertake this evaluation.

In completing the TBL evaluation three broad issues need to be considered.

1. **Attribution** – what industry and community impacts can sensibly be attributed to the CRDC investment over the period 2003 to 2008?

The aim of CRDC's R&D investment is to develop technologies (product, processes or information) that are used by members of the cotton industry or the wider community and in doing so delivers beneficial impacts to them.

2. **Value** – was the value of benefits generated as a result of identified impacts greater than the costs incurred?

Demonstrating value has typically been undertaken through a number of cost benefit analyses of impacts that can be attributed to CRDC investments. This is useful in demonstrating the "payoff" from particular investments as well as the minimum return on the portfolio as a whole.

These evaluations, however, have more relevance at the portfolio level as they do not typically consider what opportunities are foregone by the CRDC from investing funds in an alternative endeavour. That is, the counterfactual is assumed to include changes that might occur without funds invested in the specific project, and no consideration is given to how the CRDC might have otherwise used such funds. This is less of an issue when looking at a minimum portfolio payoff as the use of funds in alternative investments is implicitly accounted for.

¹ Council of Rural Research and Development Corporations Chairs 2008

² CRDC 2008.

The “portfolio” assessment approach provides a better indication of CRDC’s value than the evaluation of returns to individual investments. This approach is also supported by the Productivity Commission (2007 p.151) who note - *for more insights into the returns from public research it is useful to offset highly successful projects against less successful ones, and to also count the resources used in projects that failed to produce any apparent social or economic return.*

Caution is advised in drawing conclusions between a high portfolio return and whether or not more funds should be allocated to R&D investments. Again, as noted by the Productivity Commission (2007 p. 186) – *The case studies and qualitative evidence are strongly supportive of sizeable benefits from publicly supported R&D, but the evidence relates to average returns, not returns at the margin. It is these {latter} returns that are relevant for funding adjustments.* In addition, funding adjustment should be made on the basis of expected future returns not on historical performance.

3. **Additionality** – what impacts would have otherwise been generated without the CRDC or support provided through matching funds?

Additionality is the fundamental issue concerning whether or not the CRDC structure, and how it is funded, delivers value to Australia. Demonstrating value as discussed above only shows that, given the R&D landscape in Australia, benefits may exceed costs. While the R&D investment may be of value, if other R&D providers simply increased their investment in areas where the CRDC might not have invested then there would be no value from the CRDC structure. Likewise, matching funds could only be justified on cost sharing grounds (equity) if any reduction in matching funds were simply replaced through an increase in the cotton R&D levy. However, even if CRDC funds were simply “replaced” by other R&D providers, if the effectiveness of the investment (benefits generated) were diminished then there would be value in maintaining the CRDC structure.

Consequently, the additionally issue can only be assessed by considering the CRDC’s role in the R&D landscape and what other R&D providers would do if the CRDC structure did not exist. The lower order additionality issue is how cotton farmers would react to any change in matching funds provided by the federal government.

This report examines the issues of attribution, value and additionality and provides an overview of TBL impacts from CRDC funded R&D. The report concludes with recommendations that might assist the CRDC to strengthen their monitoring and evaluation processes in the future.

2 ATTRIBUTION

Successful R&D is one means by which the Australian cotton industry can improve its profitability and competitiveness in global markets. However, changes are always occurring and R&D will only contribute to some of the changes that occur across the cotton industry and community more broadly through time. The **attribution** issue is concerned with identifying the impacts that can be sensibly attributed to CRDC's R&D investment.

In this section the impacts that can be attributed to CRDC's R&D investment between 2003 and 2008 is examined. In the following section an *investment to impact logic* is presented and then, in turn, each component of this logic is described.

2.1 Investment to Impact Logic

It is important to recognise that the CRDC investment is part of a total R&D investment made by public and private organisations, targeted directly and indirectly at cotton production, harvesting, processing and marketing. The CRDC contribution is shown graphically in Figure 1.

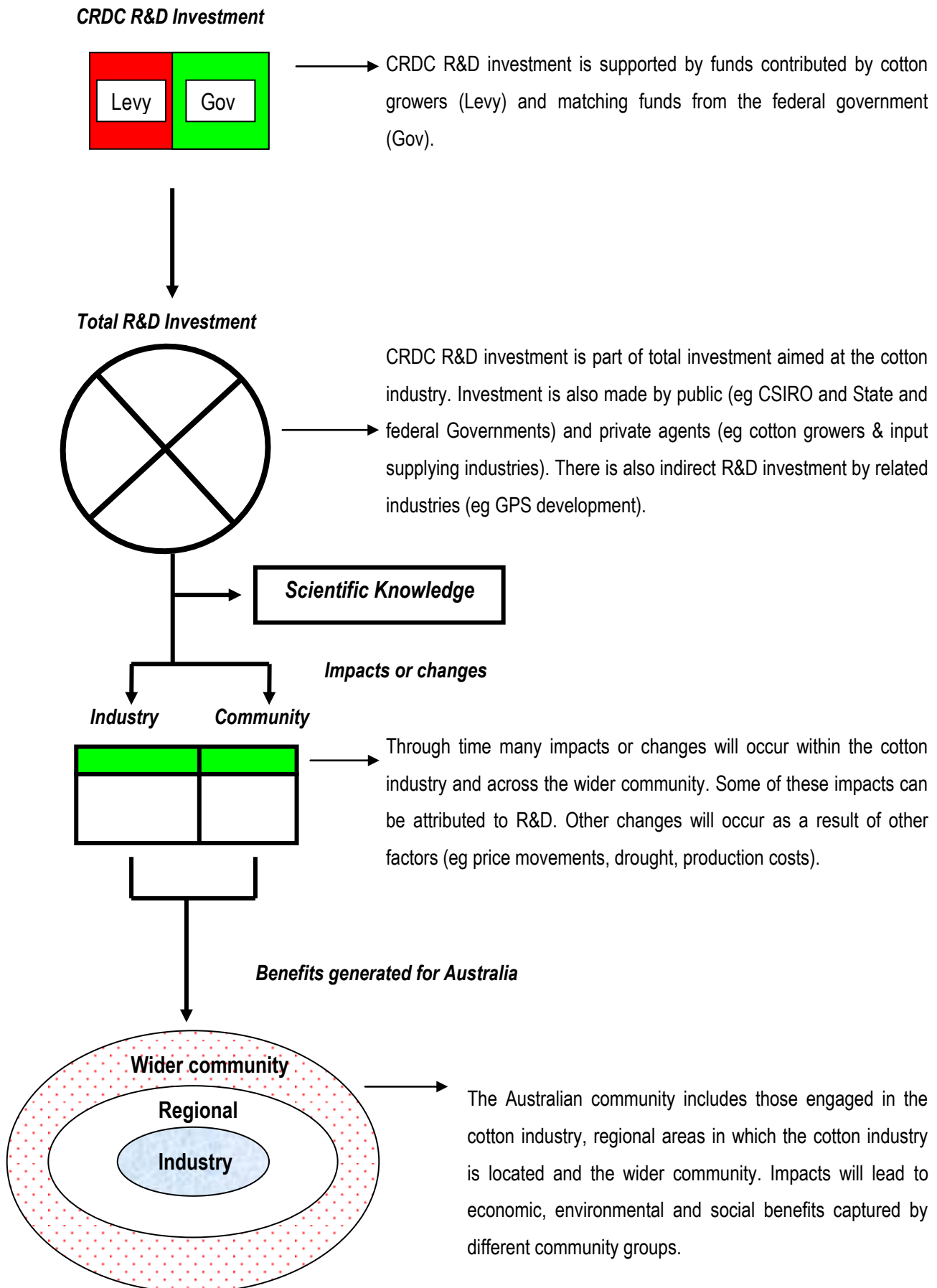
The CRDC is funded through a levy on cotton production and supporting funds provided through the Federal governments matching contributions. CRDC funding arrangements were implemented (through regulation) to address a perceived market failure in the investment in R&D by the cotton industry. Over the 2003 to 2008 Strategic Plan investment was made in a number of projects across six programs and 31 strategies. Investments made were not differentiated on the basis of funding source (levy or matching funds).

The CRDC was not the sole funder of R&D aimed specifically at Australia's cotton industry over the period 2003 to 2008. The CRDC typically enters into a partnership agreement with individual research providers with each agreement specifying each party's contribution to the project and the R&D outcome sought. Individual research providers (private and public) also carry out R&D activities independent of the CRDC investment.

R&D Investment outcomes will result in either an increase in scientific knowledge or a technology (product, process or information) that is used by industry or community members. As a result of the latter changes will be made by industry and community members that deliver a beneficial impact to them. For the former, R&D might have no immediate or direct application and hence serves only to increase scientific knowledge, which might then be used for future technology development.

The final part of the investment to impact logic is the magnitude of benefits realised from changes made by industry and community members. This underlies the **Value** of CRDC's R&D investment and is examined in Section 3.

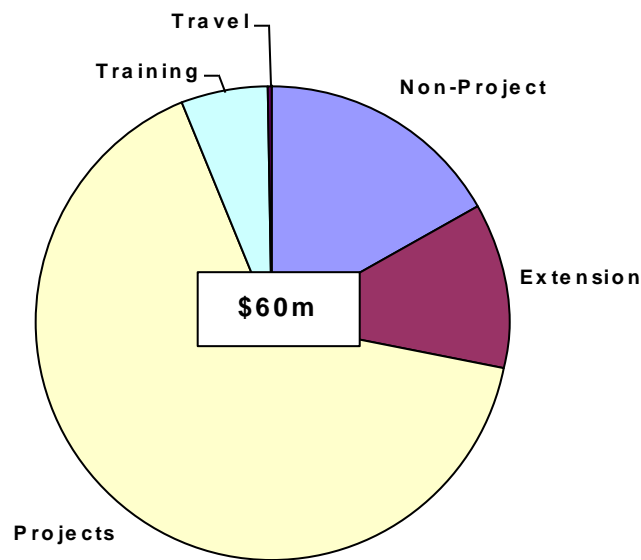
Figure 1: CRDC Investment to Impacts Logic



2.2 CRDC R&D Investment

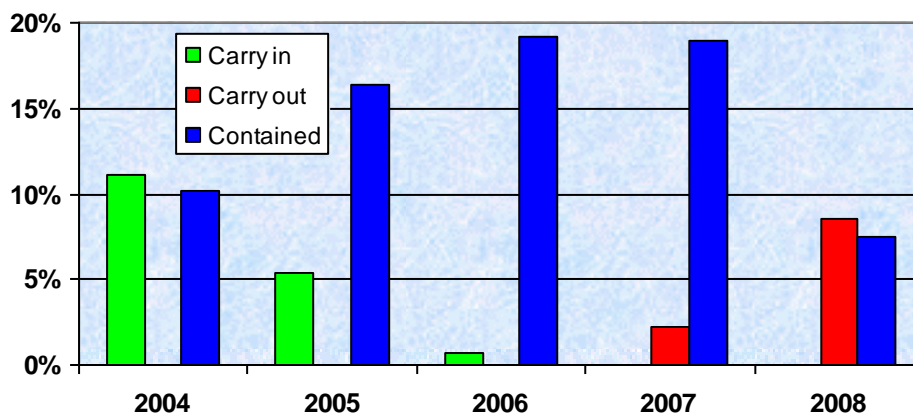
Over the life of the 2003 to 2008 Strategic plan the CRDC invested a total of just over \$60m in a range of R&D activities and administrative support. A breakdown of investment activities is shown in Figure 2. Most of the investment was allocated to project specific investments (66%). Investment was also made in dedicated extension activities (11%), travel support for researchers (<1%) and non-project specific investments (17%) such as ACRC contributions, untied contributions and administration.

Figure 2: Breakdown of CRDC R&D Investment: 2003 to 2008



For project specific investments there was found to be a sizeable *carry in* (projects that had commenced prior to the planning period) and *carry out* (projects that will be completed in the next planning period). In Figure 3 the distribution of total portfolio project specific costs by planning period is provided.

Figure 3: Share of Total Portfolio Cost: Project Specific Investments: By Planning Period: %



The important point from the distribution of investment by the planning period in which projects either commence or will conclude is that some impacts over the planning period under consideration can be attributed in part to prior investment and that some current investment may deliver impacts in the following planning period. The median project length was 3 years with the maximum length reaching nearly six years.

2.3 Total Cotton R&D Investment

Total R&D investment in cotton growing and processing in Australia is not readily available. Partial information was available for a number of years from different sources, and this data was used to derive an estimate of total R&D funding by the CRDC, public agencies and private organisations. This information is shown in Table 1. It was estimated that the CRDC accounts for around 20% of total R&D expenditure, but through funding partnerships is financially involved with around 60% of all R&D carried out. Public agencies account for the greatest share of cotton R&D, estimated at around 50%. Considerable cotton R&D is also undertaken overseas in major cotton producing countries, notably the United States.

Table 1: Total Cotton R&D Funding: By source and Research Provider: \$m 2006/2007

<i>Source</i>	<i>Research Provider</i>				<i>Total</i>
	<i>Cotton CRC</i>	<i>CRDC Partner</i>	<i>Public Other</i>	<i>Private Other</i>	
CRDC	\$6.5m	\$4.2m		\$1.2m	\$11.9m
Public	\$18.9m	\$2.8m	\$10.0m		\$31.7m
Federal	\$7.6m	\$1.4m			
State	\$6.0m	\$0.9m			
Higher Education	\$5.3m	\$0.5m			
Private	\$2.6m	\$1.4m		\$14.0m	\$18.0m
	\$28.0m	\$8.4m	\$10.0m	\$15.2m	\$61.6m

Note: Cotton CRC figures were sourced from the 2006/07 Annual Report. CRDC partner figures were estimated assuming an average 59% (by value) CRDC contribution to projects. This data was provided by the CRDC for the period 2003 to 2011. CRDC figure includes operational and overhead costs. Other public R&D was estimated by BDA Group and Private R&D was sourced from ABS Business R&D Expenditure tables for 2005/06.

2.4 R&D Impacts

Information on R&D impacts across the cotton industry that can be attributed to the CRDC investment has been derived in two ways, and relate more to the cotton industry than to community impacts more broadly.

- The first method was through a qualitative examination of CRDC impacts associated with individual R&D projects, excluding extension, training and travel³. These impacts can be attributed to CRDC and partner investment and individual projects have been categorised as either contributing to scientific *knowledge* (with no observable industry impact), a *minor impact* (because of low adoption or benefits) or a *major impact*, where industry impacts were deemed to be significant.
- The second method was through industry surveys that examined technological advances in the cotton industry more broadly. Survey results were used as a cross check for the assessment of individual CRDC projects and to assess impacts that could be attributed to non-CRDC R&D investments.

CRDC Project Impacts

Over the 2003 to 2008 period CRDC invested nearly \$39m in 224 R&D projects. Summary details for these projects are presented in Table 2.

Table 2: Portfolio Project Summary: By impact Category

Measure	Impact			All Projects
	Knowledge	Major	Minor	
Number	175	23	28	224
Expenditure	\$24.3m	\$9.7m	\$4.9m	\$38.9m
Portfolio Share	62%	25%	13%	100%
<i>Smallest Project</i>	\$1,200	\$3,000	\$10,000	
<i>Largest project</i>	\$0.8m	\$2.4m	\$0.8m	
<i>Median Project</i>	\$100,000	\$276,000	\$99,285	

³ Extension was excluded as it was deemed that many of the other observed impacts and resultant industry changes would depend on the extension network supported by the CRDC. As such, extension impacts would largely be accounted for in the examination of other projects.

Of all R&D projects supported by CRDC over the 2003 to 2008 Strategic Plan nearly 40% by value were deemed to have had an observable industry or community impact, with 25% or one in four deemed to have had a major impact. The majority of projects, by value were found to contribute to scientific knowledge, as either foundation blocks for future work or terminated because of limited industry potential. On balance this would appear to be a relatively high performance rate from the total portfolio. As a comparison, the Productivity Commission⁴ reported that on their assessment of rural R&D 12% of projects delivered 66% of total benefits and 20% of projects delivered 80% of benefits. The Productivity Commission also reported results from a CSIRO Division of Wool Technology study that found just over 7% of projects resulted in industry impacts.

Another interesting finding was that R&D projects that were deemed to have had a major impact were typically larger, by value, than other projects. This suggests that more resources were diverted to projects that had a greater likelihood of success or were in the early stages of industry take-up. It is also worth noting that R&D impacts do not typically come as a surprise at the conclusion of the investment. Rather, projects are continually reviewed and changes made across the portfolio to ensure that major impacts are realised and excessive investment is not made in *dry holes*. For the latter, projects that were deemed to have knowledge impacts tended to be small, by value, compared to projects that ultimately lead to industry impacts. The key point here is that R&D investments require continual review and adjustment to ensure that maximum benefits are realised.

A summary of the Major and Minor impacts are provided in Table 3.

Table 3: Summary of Major and Minor Impacts

Major Impacts	Minor Impacts
1. Best Management Practices	1. Women in Cotton (WINCOTT)
2. Water Use Efficiency	3. OH&S improvements
3. Fusarium Wilt Management	4. Salinity management on-farm
4. Bt Resistance Management	5. Area Wide Management (Emerald)
5. Cotton Breeding	6. Centre and Lateral Pivots
6. EMS Pathways	7. Semio-chemicals
	8. IPM management in Bollgard®
	9. Aphid / Mites Management
	10. Weed management
	11. Silver Leaf Whitefly Management
	12. Nitrogen Use Efficiency
	13. Pesticide Remediation

⁴ Productivity Commission 2007, p 151

Industry Survey

In 2008 the CRDC and Cotton CRC commissioned Cotton Consultants Australia Inc (CCA) to carry out two industry surveys⁵. Survey work was undertaken by the Western Research Institute. The first was a survey of growers and the second was a survey of CCA Consultants. One of the areas covered in the survey was growers views on the most valuable new technology, equipment if change that occurred over the previous five years. Details of these changes are summarised in Table 4.

Table 4: Main New Technologies, Equipment or Changes over last Five years

Change	Public R&D	Private R&D
Bollgard®	Mainly in managing resistance	Main developer (USA)
GPS	Some application work	Main developer
Water Use Efficiency	Main developer	Involved at commercialisation
Roundup Ready / Flex	Broader weed management	Main developer
GM Technology	Limited contribution	Main developer
Minimum Till	Main developer	Limited contribution
Travelling Irrigator	Adaptation for Australia	Main developer (USA)
Nutrition	Main developer	Some product development
Variety Development	Main developer	Limited contribution
IPM	Main developer	Some commercialisation input
Variable Rate Fertilisers	Main developer	Limited contribution
BMP	Main developer	Limited contribution

Survey results indicate that four of the major impacts that were attributed to CRDC's R&D investment over 2003 and 2008, as reported in the previous section, were also viewed by cotton growers as areas of major value to them. While management of Fusarium Wilt may not provide a direct benefit to individual growers, limiting the rate of spread of the disease should deliver significant industry benefits through time. Management of this disease was given a high priority by growers that participated in the survey. Impacts associated with the EMS Pathways R&D was focussed on achieving environmental outcomes and changes in cotton processing rather than maximising economic gains to growers. Consequently, it was not surprising that cotton growers did not list EMS Pathways impacts as valuable to them.

⁵ Western Research Institute 2008 (a) and Western Research Institute 2008 (b)

For each of the main new technologies an assessment was also made as to who was the main technology developer, be it private or public. Two observations are relevant for public R&D investment in the cotton industry.

1. Some technologies are developed outside of the cotton industry (such as GPS) but can have significant industry impacts. Consequently, cotton specific R&D will only account for a proportion of new technologies that are taken up across the industry.
2. New Technologies / changes are developed independently by both private and public interests with some co-investment as appropriate. For example, the development of Bollgard® was by private interests, but the management of potential pest resistance was undertaken by public interests (through the CRDC). The development of travelling irrigators was carried out overseas, but public R&D agencies were involved in the adaptation of this technology to Australian production systems.

2.5 Key Points

The CRDC is only part of the total investment in cotton R&D in Australia which is characterised by public support and to a lesser extent private investment. While not always the major funder of R&D, the CRDC is financially involved with around 60% of all the cotton R&D undertaken in Australia. This involvement is through partnerships with public and to a lesser extent private agents.

It was recognised that there are difficulties in assigning R&D impacts to any given time period because many observed impacts can be attributed to investment in previous periods and many impacts may not be generated until future periods.

Over the period 2003 and to 2008 25% of investments made were deemed to have resulted in a major industry impact. Six impacts were identified and an industry survey confirmed that many of these impacts were highly valued by cotton growers. The observed *success* rate of 25% was found to be higher than for many other rural industries. Typical of most R&D portfolios, a large proportion for investments (62%) will have no immediate value to industry, serving only to contribute to scientific knowledge and capability.

3 VALUE

In the previous section the impacts that could be attributed to CRDC's R&D investment was examined. Impacts were defined on the basis of observed industry or community changes that could sensibly be linked to the R&D investment by CRDC and its partners (either public or private agents). The benefits generated from these impacts provide the basis upon which value for money can be determined. That is, benefits can be assessed and compared to the investment cost to determine whether or not the investment represented value for money. However, several issues arise in attributing ultimate industry and community benefits to R&D investment by CRDC alone. These issues are examined in this section along with a quantitative evaluation of value or payoff from CRDC's investment portfolio.

3.1 Choosing the Investment Period

The first issue that is relevant is selecting an appropriate period of investment for evaluation. No matter what period is chosen there will typically be outcomes achieved (with observable industry impacts) that can in part be attributed to R&D investment prior to the period and there will be R&D investments made that deliver no observable impacts but may indeed lead to major impacts beyond the period chosen. Further, because R&D investments need to be made over many years a short time period might not be representative of impacts realised.

In this study a five year period was chosen as this corresponds to the CRDC's most recently completed five year strategic plan. Although this period is likely to be long enough to ensure that a number of impacts can be observed the selection of this period for assessing investment performance remains problematic because of the temporal dislocation between some R&D investments and their observed impacts.⁶ To address this problem two evaluation methods have been used.

- The first method is based on a detailed evaluation of major impacts observed over the five-year investment period. The purpose of these evaluations is to demonstrate that the major impacts identified have delivered significant benefits to cotton growers and Australia at large and to determine the relevant R&D investment pathway and costs incurred.
- The second method is based on a comparison of benefits from major impacts compared against the total R&D investment over the chosen investment period to derive an estimated minimum portfolio return or pay off. This method would provide a reasonable estimate if benefits are discounted by the average number of years that it takes from initial R&D investment and the realisation of industry

⁶ This issue was also recognised by ACIL Tasman in their 2006 evaluation of the Cotton breeding program in which they state that "sensible matching of the timing of costs against benefits in a strictly ex-post sense is virtually impossible".

impacts. In effect, the method assumes that benefits realised in the current period are representative of benefits that might be generated from investment in the current period.

3.2 Quantifying Benefits

The CRDC is a partnership between private (levy payers) and public (matching funds) interests. Consequently benefits that should be considered in any evaluation should include both private benefits captured by levy payers as well as benefits generated across the wider community. This however does not imply that only private benefits should be compared against private costs (levy payments) and public benefits net of private benefits should be compared against public costs (matching funds). The payoff to levy payers should be based on private benefits compared to the total CRDC portfolio cost and the payoff to the public, or Australia at large, should be based on all benefits compared to the total CRDC portfolio cost.

- From a levy payer's perspective matching funds should not be excluded because they are provided for the specific purpose of generating productivity gains across the cotton industry⁷ and as such have the same opportunity cost to cotton growers as levies paid.
- From the government's perspective the payoff must consider all costs and all benefits as public expenditure is concerned with gains across the whole of society, including levy payers.

Benefits can be described in terms of triple bottom line impacts

Economic – R&D impacts that increase product quality, create new products or features, improve market access, reduce processing risk or increase product use efficiency will stimulate the demand for cotton products. In turn, this leads to an increase in the prices cotton growers receive for their cotton.

Impacts that improve the efficiency of cotton production or associated transport or marketing expenses will decrease unit costs of production (including increasing yields) and increase industry profitability.

Environmental – Impacts that protect the natural resource base from degradation will decrease the unit costs of production in the future. Impacts that reduce the environmental impacts caused by cotton production and processing may increase the profitability of other industries or the environmental value of Australian landscapes. Environmental gains can also be achieved if market share changes between natural and synthetic fibres create a positive change in the net carbon balance or levels of other pollutants.

⁷ The rationale for government support through matching funds is examined further in Section 4.

Social – Impacts that increase scientific knowledge or industry understanding of social and occupational health and safety issues will improve the effectiveness of future R&D and overall social well being. Investment and benefit generation in disadvantaged areas will also create value to Australia as a whole through promoting national regional economic development objectives. Lower prices for rural commodities also benefits Australian consumers.

Quantifying economic benefits has proven to be more straight forward than quantifying environmental and social benefits because impacts in existing markets (both inputs and outputs) can be measured in terms of cotton prices and input costs. A number of studies have reported and in some case quantified TBL impacts from Cotton R&D. These impacts are described in the Table below.

Table 5: Range of Reported Impacts from Cotton R&D

R&D Investment	Economic	Environmental	Social
Bt Resistance Management ^a	<ul style="list-style-type: none"> Longer shelf life for Bollgard® Lower refuge cost 	<ul style="list-style-type: none"> Reduced pesticide loss off farm Increased on-farm biodiversity 	<ul style="list-style-type: none"> OH&S benefits from reduced pesticide use Increased economic activity in rural areas Increased scientific capability
Water Use Efficiency ^a	<ul style="list-style-type: none"> Lower costs of production 	<ul style="list-style-type: none"> Water savings Reduced deep drainage 	<ul style="list-style-type: none"> Increased economic activity in rural areas Increased scientific capability
Women in cotton network ^b			<ul style="list-style-type: none"> Greater engagement of women in the cotton industry
Nitrogen Use Efficiency ^b	<ul style="list-style-type: none"> Lower cost of production 	<ul style="list-style-type: none"> Reduced greenhouse gas emission 	<ul style="list-style-type: none"> Increased economic activity in rural areas Increased scientific capability
Objective Fibre Measurement ^b	<ul style="list-style-type: none"> Higher price for cotton Royalty on technology sales 		<ul style="list-style-type: none"> Increased economic activity in rural areas Increased scientific capability
Fusarium Wilt management ^c	<ul style="list-style-type: none"> Prevent yield loss Access to Californian stock feed market 		
Cotton Breeding ^d	<ul style="list-style-type: none"> Lower costs of production Increased crop yield Royalties earned 	<ul style="list-style-type: none"> Reduced water use Reduced insecticide use 	<ul style="list-style-type: none"> Expansion of cotton production Job creation in Rural communities

(a) BDA Group, 2008 (b) BDA Group, 2007 (c) BDA Group 2004, (d) CIE 2004.

In some of the studies reported in Table 5 attempts were made to quantify many of the environmental and social benefits from cotton R&D. However, most studies reported significant limitations in deriving robust estimates of these benefits. Further, cost benefit analyses completed as part of the Council of Rural Research and Development Corporation Chairs (CRRDCC)⁸ evaluation of the returns from Rural R&D noted that while many environmental and social benefits were generated there was difficulty in deriving consistent and robust estimates. The CRRDCC has also indicated that they will continue to develop appropriate evaluation methods that can be used more widely across Rural Research Corporations.

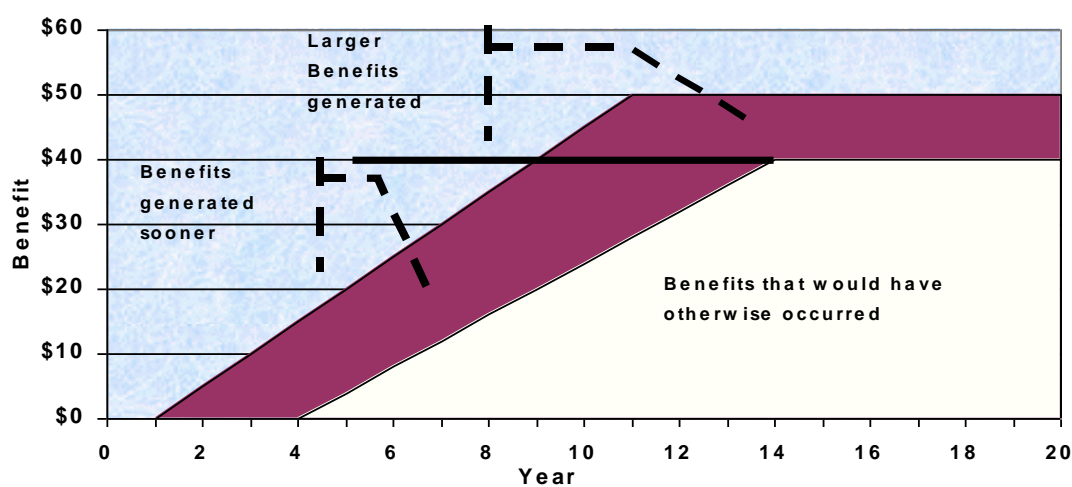
3.3 Accounting for Co-Investment with R&D Partners

The CRDC is a partnership between the Australian government and Australian cotton growers. Funds are used⁹ *to enhance the ecological, social and economic values associated with cotton production systems and to increase benefit to cotton industry participants, regional communities and the Australian people.* Investment funds are used to support R&D projects across a wide range of public and to a lesser extent private organisations. When projects are supported by the CRDC there is typically co-investment by the relevant R&D provider(s). Therefore, when benefits are estimated they need to be distributed appropriately between the CRDC and partner level of investment - otherwise it would not be possible to determine the pay off on CRDC funds alone. This can be done in one of two ways.

- (1) Allocating benefits in proportion to each organisation's share of total R&D costs. This approach is preferred for larger R&D investments where specific activities can not be assigned to one source of funding or another. For example, this approach would be sensible when evaluating cotton breeding R&D.
- (2) Determining the investment leverage that is obtained by the CRDC, or what impacts would have otherwise occurred without the CRDC investment. This has been addressed in this study by determining what research lead time (RLT) or competitive advantage CRDC funded researchers enjoy over other organisations (including current partners working independently of the CRDC). The RLT is specified in terms of how much sooner impacts have been realised and the magnitude of benefits. Benefits that can be attributed to the CRDC investment under this approach is shown in Figure 4.

⁸ CRRDCC 2008

⁹ CRDC 2007, Cotton Research and Development Corporation Annual Report 2006-07, Narrabri, P.17

Figure 4: RESEARCH LEAD TIME DESCRIBES THE ADDITIONAL BENEFITS FROM CRDC INVESTMENT

3.4 Pay Off From CRDC's R&D Investment

In this section the payoff from CRDC's R&D investment is considered.

Pay Off from Major Impacts

Of the six major impacts identified from CRDC investment between 2003 and 2008, four have been evaluated using cost benefits analysis techniques. In addition, one minor impact has also been evaluated. A summary of these evaluations is provided in Table 6. As shown, each of these projects were estimated to have delivered large benefits to cotton growers and Australia more broadly, and on a project basis were found to have generated a high rate of return on funds invested.

The two other major impacts – BMP and EMS Pathways have not been evaluated using cost benefit analysis and therefore no estimates of pay off are available. However, while it is expected that economic gains to cotton growers are likely to be modest, the benefits to Australia at large are expected to be large as most of the benefits will be environmental or social in nature.

Table 6: Estimated Pay Off from Cotton R&D: 2008 dollars

Impact	Change	Pay Off
<i>Cotton Breeding</i>	Release of new varieties	\$6b or \$51 for every dollar invested. (a) \$66m a year and \$11m in royalties (b)
<i>Fusarium Wilt</i>	Management to limit rate of spread across farms	\$187m to growers and \$5m to cotton seed industry (c)
<i>Water Use Efficiency</i>	Adoption of water saving technologies like Irrimate®	\$51m to Australia and \$36m to growers – a return of \$22 to industry for every dollar invested(d)
<i>Bt Resistance management</i>	Planting restriction on Ingard® and refuge specification	\$270m to growers and \$634m to Australia a return of \$87 to the industry on every dollar invested (d)
<i>Nitrogen Use Efficiency</i>	Better matching of fertiliser application to crop demand	\$25m to growers and \$36m to Australia – a return of \$26 to growers for every dollar invested (e)

(a) CIE 2002 (b) ACIL Tasman 2006 (c) BDA Group 2004 (d) BDA Group 2007 (e) BDA Group 2008.

Portfolio Pay Off

Portfolio returns from cotton R&D have been estimated in the past by comparing benefits from projects that have delivered major impacts against a representative period of total R&D expenditure. BDA Group (2007) reported that the returns to levy payers, industry and Australia at large were \$13, \$12 and \$30 respectively for every dollar invested by CRDC in R&D between 1997 and 2001. An evaluation method developed by ACIL Tasman for the CRRDCC was followed, but as discussed in section 3.2 benefits should be compared against total CRDC R&D expenditures not just the funds collected from cotton growers through the levy. On this basis, the pay off would still be high, estimated at \$6.40 to growers for every dollar invested and nearly \$15 to Australia at large on every dollar invested.

An evaluation of the Australian Cotton CRC (BDA Group 2004) also reported high returns from cotton R&D, with a pay off of just over \$7 to growers for every dollar invested. It was also reported that additional benefits were captured by other sectors of the Australia economy. The investment period considered in this evaluation was 1999 to 2004.

To derive an estimate of the minimum pay off on the 2003 to 2008 CRDC R&D investment portfolio BDA Group considered the returns from three R&D projects that were deemed to have had a major impact over this period. Returns from the water use efficiency investment was not included because benefits from R&D commenced prior to the 2004 and returns from Nitrogen Use Efficiency R&D was also excluded

because these impacts will largely be generated beyond 2008. Benefits are summarised in Table 7 and discussed in more detail below.

Table 7: Benefits Attributable to CRDC R&D Investment between 2003 and 2008.

Impact	Economic		Environmental	Social
	Cotton Growers	Others		
Cotton Breeding	\$105m	\$18m		
Fusarium Wilt	\$56m	\$2m		
Bt Resistance management	\$270m	\$272m	\$24m	\$68m
Total	\$431m	\$292m	\$24m	\$68m

Note: All figures are in 2008 dollars.

Cotton Breeding R&D benefits were estimated at \$66m a year for growers and \$77m a year for Australia as a whole. Over five years R&D, benefits would total \$330m for cotton growers and \$385m for Australia as a whole. The ACII Tasman (2006) study reported that CRDC investment accounted for 32% of total R&D costs.

Fusarium Wilt R&D benefits were estimated at \$187m for growers and \$192m for Australia as a whole. CRDC's cost share was around 30%.

Bt Resistance R&D benefits were estimated at \$270m a year for growers and \$634m a year for Australia as a whole. These estimates reflect the benefit attributable to CRDC's contribution as estimates were derived using a research lead time approach.

Environmental and social benefits that can be attributed to the Bt resistance management R&D includes reduced pesticide run-off from cotton farms and greater economic activity in regional areas as a result of increased cotton production. Although no environmental or social benefits are reported against the other two major impacts such benefits would have been realised but have not been quantified. For example, the cotton breeding work has led to the development of varieties that require less application of pesticides and water. Further, all three areas of R&D have resulted in a significant build up in scientific capability that will continue to serve the cotton industry and support other rural based industries well into the future.

The estimated benefits from the three major impacts reported in Table 7 can be taken as representative of the returns on R&D if they are discounted by the average lag between initial R&D investment and when benefits are generated. However, this was only necessary for cotton breeding benefits as the benefits for the other two major impacts already accounted for the lag in the derivation of investment benefits. The estimated portfolio pay off is reported in Table 8.

Table 8: Estimated Portfolio Pay Off: Present Value Terms: 2008 dollars

Sector	Benefits	Costs	Pay Off
Cotton Growers	\$426m	\$58m	\$368m or \$7 for every dollar invested.
Australia	\$809m	\$58m	\$751m or \$14 for every dollar invested

Clearly, investment in cotton R&D has been shown to deliver solid returns to cotton growers and Australia at large. While the impacts of CRDC's R&D investment over the 2003 to 2008 Strategic Planning period will not be fully known for many years, current and past impacts suggest that the pay off is likely to be high.

3.5 Key Points

Drawing on previous evaluations of cotton R&D it is evident that a wide range of economic, environmental and social benefits have been generated. On a portfolio level, it was estimated that the minimum return to cotton growers was around \$7 for every dollar invested and when gains to non-cotton growers are included the pay off increase to \$14 on every dollar invested.

Typical of most R&D portfolios most of the benefits generated can be attributed to a small number of successful projects that result in significant industry impacts. These impacts should be readily recognised by industry and this was found to be the case for the three major impacts considered here. These were impacts associated with R&D in cotton breeding, Fusarium Wilt management and Bt Resistance Management.

Successful R&D can also generate considerable environmental and social benefits. Most of the environmental benefits delivered result from lower levels of chemical use in cotton production, water savings and reduced greenhouse gas emissions. Social benefits are also generated in a number of areas including improved health and welfare outcomes for cotton farmers, greater economic activity in regional areas and the build up of scientific capability in priority areas for industry and government .

4 ADDITIONALITY

Demonstrating the value of CRDC's R&D investment in the previous section has shown that benefits exceed costs and therefore is attractive from an investment perspective. Methods used to estimate investment value are based on a consideration of the "with and without" funding scenarios (the counterfactual) assuming that the overall R&D infrastructure (capability) that exists would otherwise remain. That is, funds would simply be diverted to other areas of investment. Therefore, such evaluations provide little insight into the value of the CRDC as a structure and the funding model itself.

CRDC is only part of the overall R&D that is undertaken specifically to increase the profitability of cotton production. R&D is also undertaken by private groups such as cotton growers themselves and input supplying industries – that benefit from increased demand for the goods and services they provide to cotton growers. R&D is also undertaken by public organisations, primarily from an efficiency perspective where investment is made to address the possible under-provision of cotton R&D that delivers benefits to Australian cotton growers. This is the market failure argument. Public investment is also made to deliver changes in the cotton industry that generates benefits to both regional groups and the wider community¹⁰. These benefits are typically classified as economic gains to non-cotton growers but also include many environmental and social benefits that are captured by Australians more broadly. The key point here is that the market failure in R&D investment by cotton growers is addressed through both the provision of R&D funds by the CRDC as well as public organisations more broadly. This is the **additionality** issue – and CRDC investment needs to be considered as part of the broader R&D landscape rather than as a separate activity.

4.1 Does the Levy Mechanism Alone Ensure Appropriate Cotton R&D Investment?

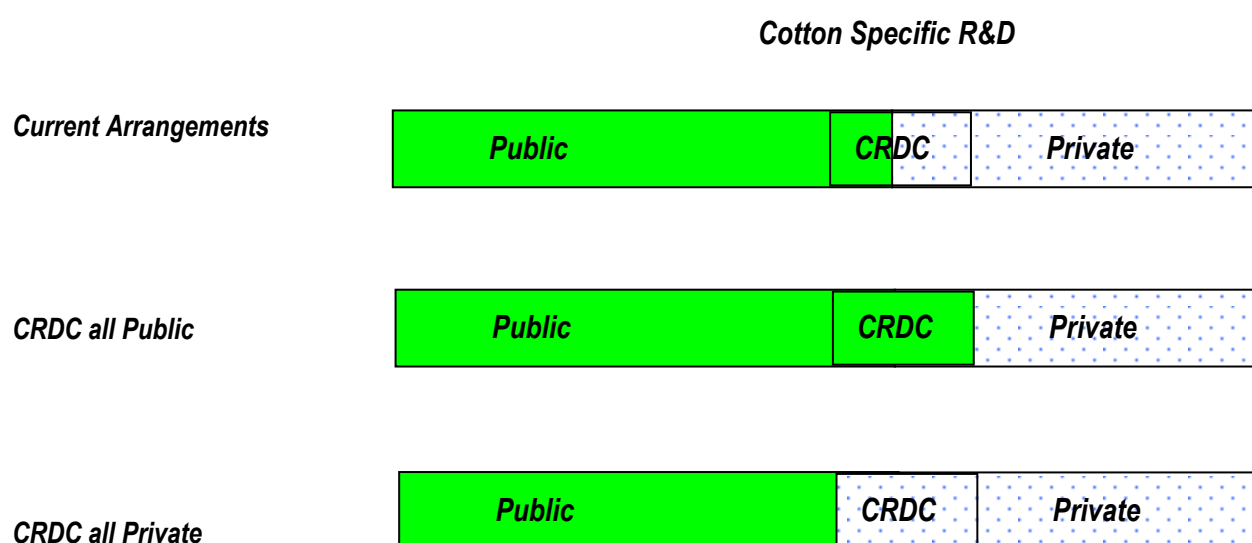
The Productivity Commission¹¹ has defined additionality as a measure of *the extent to which a research project is genuinely new or has crowded out a project that would have taken place under the counterfactual. --- Where complete crowding out occurs, a publicly funded project elicits no benefit (nor involves direct costs) because it merely displaces those associated with a crowded-out private project.* The corollary of course is that complete crowding out also occurs when a private project merely displaces those associated with a crowded out public project.

¹⁰ As part of this assignment feedback was sought from major public funders of cotton R&D. It was clear that public agencies undertook cotton R&D both in partnership with the CRDC and also independently. Most agencies undertook R&D to promote the productivity and sustainability of cotton production in Australia. Some organisations had shifted their focus to cotton R&D that delivered an environmental dividend as well as increasing the productivity of cotton production.

¹¹ Productivity Commission 2007, page 659

For the operation of the CRDC the additionality issue at the boundaries can be represented by the two scenarios shown in Figure 5. Cotton specific R&D in Australia can be described as either public or private. The CRDC occupies a space where its activities are funded by a combination of both private and public funds, and its investment objective is to invest in R&D to deliver economic, environmental and social benefits for cotton growers and Australians more broadly.

Figure 5: CRDC Boundary Funding options



At the moment there is investment in R&D specifically for the cotton industry by private and public agents. Private investment occurs because the benefits from the investment can be captured by the private agents who put forward investment funds. (Public benefits may also free ride private investment – such as increased economic activity in rural areas or reduced health costs through improved OH&S on cotton farms). Likewise, there is public investment to ensure that a wide range of economic, environmental and social benefits are realised. (Private benefits may also free ride public investment – such as lower fertiliser costs through improved practices that reduce nutrient run off from farms). There is limited justification for public investment to generate private benefits and there is limited justification for private investment to generate a wide range of social benefits. The purpose of the CRDC is primarily to address a perceived market failure where without the public investment there would be an under investment in R&D by private agents. As such, the CRDC invests funds to generate private returns that would not otherwise be realised and to generate benefits as appropriate for the wider Australian community. However, both private and public agents can either increase or decrease their level of investment in cotton R&D outside of the CRDC and independent of other agents. Further, the amount of levy paid by

cotton farmers is their collective decision, with government support provided up to a predetermined level. A combination of both public and private funds through the CRDC implies that some market failure might be addressed by the levy (and hence paid by cotton growers) while the remainder still requires public funds.

At one boundary is the case where the CRDC, with its role to address the perceived under investment in cotton R&D, is solely funded by the public. This might occur when the levy mechanism fails to bring forward any private investment. That is, the levy does not address the market failure to any extent. Obviously this is not the case because the industry has voted to impose a levy on cotton production.

At the other boundary is the case where the CRDC is funded solely through contributions from private agents. In this situation the levy arrangement would be deemed as an effective means of overcoming the market failure problem. The levy could be set at the appropriate level to ensure adequate R&D investment. The CRDC would then purchase R&D services from different providers ensuring that all intellectual property generated (and benefits that flow) is captured by cotton growers to the extent that the R&D investment is worthwhile.

In reality it is unlikely that the appropriate levy rate would be known for any given time period, and it would be coincidental if the current levy and matching funds was indeed the appropriate level of funding required to address the perceived market failure. Cotton growers can currently decide what levy to pay and the fact that they may not decide to increase the levy does not mean that no additional R&D investment is justified from a social perspective, but rather that the levy mechanism does not in itself overcome the market failure problem completely. This issue has also been examined by ABARE (2006) who concluded that the levy mechanism may only serve to overcome some of the under-investment problem in rural R&D in Australia.

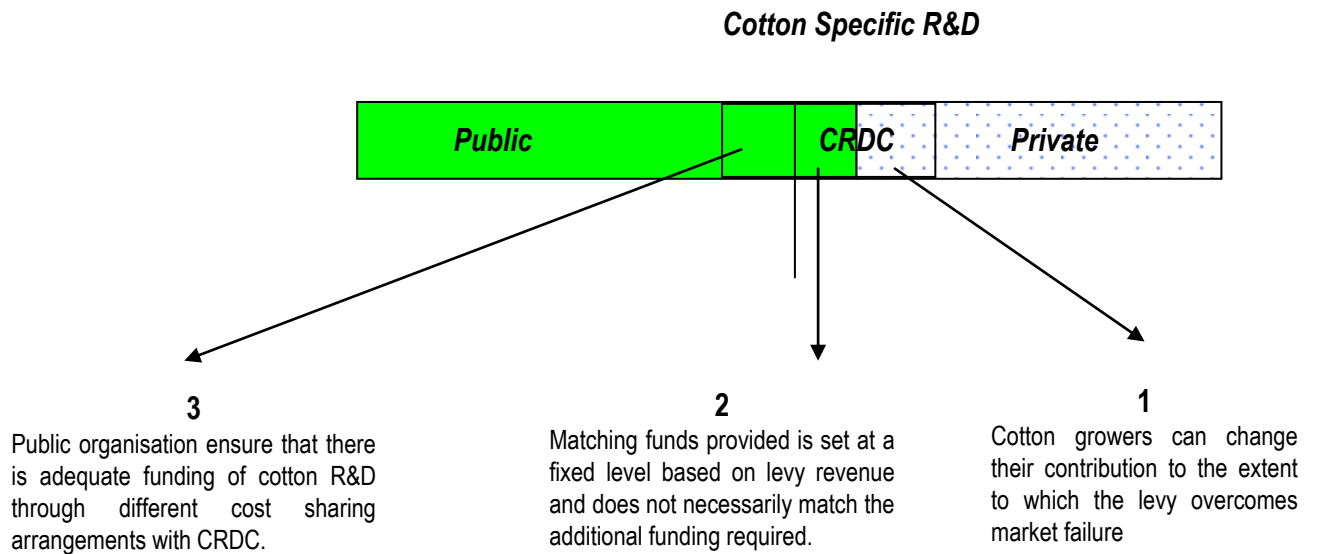
4.2 Cost Sharing promotes appropriate level of Cotton R&D Investment

There are two key points from the discussion above, The first is that the levy mechanism alone will not ensure that there is an appropriate level of funding of cotton R&D that is aimed at generating economic benefits for cotton growers. Second, the level of public support for cotton R&D is unlikely to be the amount collected through the matching fund arrangement under the levy scheme. A more complete representation of current arrangements is shown in Figure 6 below. There are three sources of funding to correct the under investment in cotton R&D.

1. Cotton growers, through the levy, provide funds to the CRDC for subsequent investment in R&D activities that would not normally be funded by the private sector.

2. The Commonwealth government provides matching funds, up to a maximum expressed as a share of total revenue from cotton sales by farmers. These funds are combined with funds collected through the levy as well as additional funds through royalties and interest earned to invest in R&D. The amount of funds available to the CRDC is determined by external factors.
3. The third source of funds is through other public investment in cotton R&D.

Figure 6: Funding Under Investment in Cotton R&D



In an ideal situation the level of under investment in cotton R&D would be determined by public agents and investment made in excess of CRDC’s expenditure as appropriate. However, the level of under investment is unknown and likely to vary from year to year depending on specific investment opportunities and external economic conditions. In practice what happens is that the CRDC enters into investment partnerships with public agencies, taking an agreed cost sharing position for individual R&D projects. Through cost sharing public R&D agents can adjust their total level of support for cotton R&D in line with their expectation of under investment by the private sector. Further, if public agents hold the view that the total level of support for cotton R&D is accounted for by the levy alone, public agents can then enter into cost sharing arrangements with the CRDC where generated benefits accrue largely to non-cotton growers. In effect the matching funds are diverted away from R&D that delivers economic gains to cotton growers.

The capacity to enter into different cost sharing arrangements for different cotton R&D projects also provides scope for public agents to achieve an efficiency dividend on cotton R&D that is primarily aimed

at generating benefits for the wider Australian community. This is done by leveraging investment through the CRDC with the CRDC investment also aimed at generating economic returns to cotton growers.

4.3 Implications for CRDC Performance Evaluation

It is wrong to assume that the use of matching funds and the levy collected from cotton growers provides the level of investment in cotton R&D that is socially desirable. Further, some commentators have argued that the levy mechanism in itself provides a mechanism for cotton growers to collectively decide on the socially desirable level of cotton R&D investment in Australia. As discussed above, there is no evidence to suggest that these views are valid, and it is argued that the socially desirable level of cotton R&D investment in Australia can be addressed in part by the levy as well as with continued public support. To ensure optimal levels of investment cotton growers are able to increase or decrease their contribution and public agencies are also able to change their level of support. For the latter this is done in an efficient manner through adjustments to cost sharing arrangements for individual cotton R&D projects undertaken in partnership with the CRDC as well as undertaking cotton R&D independently¹². The level of matching funds provided does not need continual adjustment and serves only as an incentive to the cotton industry to participate in R&D partnerships through the CRDC structure.

Of primary importance to the CRDC's performance evaluation will be the value to cotton growers from the total CRDC investment. However, this provides no insight into whether or not the total investment in cotton R&D (public and private) is at a desirable level and whether or not the grower levy should be changed. This can only be determined through the continual review and subsequent negotiation of appropriate cost sharing arrangements between the CRDC and its partners. This is currently achieved through individual project funding agreements. To work effectively however, in the first instance, an understanding of the share of benefits captured by cotton growers and non-cotton growers on all funds invested would be required. This has not been done to date as evaluations have largely focussed on incremental gains from the CRDC contribution alone.

While it is not possible to comment on how effective CRDC's cost sharing positions have been three of the identified major impacts over the 2003 to 2008 planning period and one project that delivered only knowledge have been examined to illustrate differences in cost sharing arrangements and why different positions are held.

¹² Feedback from public agencies suggested that cost sharing arrangements were negotiated on a project by project basis and changes made through time depending on the expected benefits that different agencies sought to generate.

1 Bt Resistance Management

Total Bt Resistance Management R&D costs were \$6.5m and total benefits were estimated at \$634m (BDA Group 2007). It was estimated that cotton growers captured 42% of the benefits and through the CRDC met 43% of total costs. The major non-cotton grower benefit was an economic gain to private interests involved in the production, sale and distribution of transgenic cotton. However, it is unlikely that these private interests would have invested in the required R&D as was assumed in the counterfactual¹³. In terms of cost sharing the proportion paid by the CRDC was roughly in line with benefits captured, and on the surface would suggest that the cost sharing arrangement was appropriate. The levy mechanism was an appropriate means of securing cotton grower R&D investment given that market failure was clearly evident and cotton growers stood to gain significant benefits.

2 Cotton Breeding

Total cotton breeding R&D costs were \$19m a year and total benefits were estimated at \$75m (ACIL Tasman 2006). It was estimated that cotton growers captured 87% of the benefits and through the CRDC met 32% of total costs. The major public funder of this R&D was the CSIRO and again market failure is clearly evident as individual growers would have little incentive to invest. At first inspection there would appear to be a major imbalance between the level of grower support and the share of benefit they receive. While the support from CSIRO may be for other reasons, it is likely that cost sharing with cotton growers can be achieved through royalties paid on developed varieties. Indeed, the CRDC has recently decided to withdraw support for cotton breeding as the market failure can be addressed through royalties charged to growers rather than through the levy mechanism.

3 EMS Pathways

Total EMS pathways R&D costs were \$629,000 and benefits have not been quantified. The EMS Pathways project was largely funded through DAFF(83%) as part of a \$11.9m initiative aimed at increasing the adoption of profitable and sustainable farming practices and improved environmental outcomes. Although benefits have been realised by cotton growers it is unlikely that this work would have been funded by growers themselves or through the CRDC. There was however a clear rationale for public support for the DAFF investment and the cost sharing arrangement demonstrates how matching funds can be diverted away from their primary use to achieve other public goals.

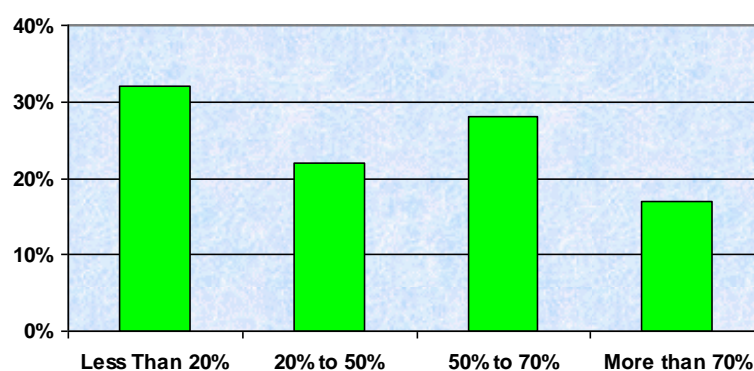
4 Soil Health

¹³ As an aside, the investment of public funds to generate economic benefits for non cotton growers was sound as under investment would have occurred.

Part of the R&D support in the area of soil health was towards projects looking at rhizosphere biological function, Total R&D costs were \$1.2m with the CRDC accounting for just over 60%. While this work delivered no impact across the cotton industry it contributed to knowledge in the area of soil health. This work was deemed as long term R&D and very basic in nature with little incentive for private support, even through the levy mechanism. However, this work was identified by ACGRA as being an area of interest to growers and where public organisations did not allocate adequate resources. The project was a good demonstration of how the CRDC can increase the effectiveness of public R&D by better linking basic R&D to industry priorities.

The cost sharing arrangements for four areas of R&D supported by the CRDC demonstrates that cost sharing is an important lever in allocating public and private funds to R&D activities in line with market failure in the provision of cotton R&D by private agents. It is also clear that there is no fixed rule for cost sharing as any agreed position will depend on expected benefits to both public and private (CRDC) investors and the appropriateness of the levy mechanism as a means of addressing the perceived under-investment in cotton R&D. Feedback obtained from CRDC's major public research partners indicated that cost sharing arrangements entered into should reflect perceived benefits to different parties, with the CRDC representing the interest of Australia cotton growers. The range of different cost sharing positions taken by the CRDC for the period 2003/04 to 20010/11 is illustrated in Figure 7.

Figure 7: Partner Contribution to Total Project Cost: % of Projects



Through negotiation of different cost sharing arrangements the CRDC can assist public agencies to undertake the socially desirable level of cotton R&D in Australia. It is clear that this process is being undertaken in a collaborative manner with major public agencies, but without a better appreciation of the distribution of R&D benefits and cost shares no conclusion can be made on the effectiveness of this process.

5 CONCLUSIONS AND RECOMMENDATIONS

BDA Group was commissioned by the CRDC to undertake a triple bottom line evaluation of their R&D investment over the period 2003 to 2008. The evaluation completed here has demonstrated that the CRDC has been able to deliver substantial economic, environmental and social benefits to Australian cotton growers and Australians more broadly. It was estimated that the return on investment for cotton growers was \$7 for every dollar invested and the return to Australia at large was \$14 on every dollar invested by the CRDC over the evaluation period. As these returns are based on benefits realised from a small number of major impacts that could be attributed to the CRDC investment, they represent the minimum pay off to cotton growers and Australia at large. However, some important observations were made.

- R&D is an inherently risky and long term investment with most projects delivering impacts that contribute to scientific knowledge and capability rather than technologies that are taken up and used by either cotton growers or other community members. Therefore, while the estimated return on investment is a measure of the minimum return it is unlikely that inclusion of other projects that have delivered more marginal impacts would result in a significantly higher return.
- The estimated return is only representative of the return that is likely to be achieved on the 2003 to 2008 R&D portfolio because there is a considerable temporal separation between investment and impact. Some observed impacts between 2003 and 2008 can be attributed to, in part, investment made prior to this period while some investments will only deliver impacts well past 2008.
- R&D investments made by the CRDC will deliver economic, environmental and social benefits. The estimation of economic benefits to cotton growers and other sectors is relatively straight forward, and market surveys and other means of feedback obtained by the CRDC enables impacts to be measured in terms of extent (adoption) and profitability. However, many of the environmental and social benefits are difficult to quantify and therefore the estimated return will under-state investment performance to Australia at large.

The issue of additionality was also examined in this study. While evidence of solid triple bottom line benefits on CRDC's R&D investment demonstrates that the investment was "worthwhile" such returns do not indicate whether or not CRDC should change its level of investment in R&D in the future. This is not solely because investment decisions should be made on prospective returns, but rather that the CRDC through its R&D partnerships and cost sharing arrangements can influence the total level of investment made by public and private agencies to achieve benefits to cotton growers and the wider community. The appropriate level of cost sharing will vary from project to project depending on the effectiveness of the

levy mechanism to address market failure in the level of investment in R&D by the private sector and the distribution of public and private benefits (including potential efficiency dividends to public agencies).

BDA Group was also asked to put forward recommendations that might assist the CRDC to strengthen their performance and reporting process in the future. These are provided below.

1. Through time any major impact that can be attributed to the CRDC's investment should be monitored and economic, environmental and social benefits generated determined and quantified where possible. These impacts will largely determine the returns that are delivered to cotton growers and Australia at large and hence the performance of CRDC's investment.
2. CRDC's project management system should be expanded to include for each project whether or not it was completed, and if completed, if the project contributed towards an observed major or minor impact or to scientific knowledge. This should be done well past a project's completion. The cost sharing arrangement entered into should also be recorded.
3. Prospective evaluation could be strengthened by undertaking an assessment of the anticipated triple bottom line impacts from the major outcomes that are targeted by the CRDC. This evaluation should be simple and utilise expertise and experience within CRDC and ACGRA to derive estimates of potential benefits that could be attributed to the CRDC, R&D time lags, levels of risk faced and the appropriateness of the CRDC structure to address the perceived market failure. This would assist in setting priority areas of investment and also the level of cost sharing that would be appropriate from CRDC's perspective.
4. Consideration should be given to developing suitable reporting metrics for environmental and social benefits that are not easily quantified in monetary terms. This should be done as part of the CRRDCC evaluation program, which is seeking to develop appropriate TBL reporting metrics that can be used consistently across all rural research corporations.
5. If the CRDC commits to on-going evaluation of randomly selected projects as suggested by the CRRDCC consideration should be given to:
 - stratification and sampling that recognises that only a small number of impacts will deliver the majority of benefits;
 - stratification that might be used to better illustrate non-levy payer benefits or cost sharing arrangements; and
 - population specification based on prospective evaluation of anticipated TBL impacts from major outcomes targeted by the CRDC rather than "work in progress".

REFERENCES

ABARE 2006, Analysis of the Productivity Commission Draft Research Report Public Support for Science and Innovation, Prepared for Rural Policy and Innovation Division, Department of Agriculture, Fisheries and Forestry.

ACIL Tasman 2006, CSIRO's R&D investment in cotton breeding & decision support systems; Benefits delivered since 2002, Prepared for CSIRO, October.

BDA Group, 2008, Cost benefit analyses of research funded by the Cotton Research and Development Corporation, Commissioned Study by CRDC, September.

BDA Group, 2007, Cost benefit analyses of randomly selected research funded by the Cotton Research and Development Corporation, Commissioned Study by CRDC, March.

BDA Group 2004, Economic Evaluation of the Research & Development outcomes of the Australian Cotton CRC, March.

CIE 2004, Net benefits from CSIRO Plant Industry Research.

Council of Rural Research and Development Corporations Chairs 2008, Measuring economic, environmental and social returns from Rural Research and Development Corporations' investment, November.

CRDC 2008, Strategic R&D Plan 2008-13, Outline of emerging R&D strategies 2008-2013, Moree, February.

Productivity Commission 2007, Public Support for Science and Innovation, research report, Productivity Commission, Canberra.

Western Research Institute 2008(a), 2008 Grower Feedback Report: Cotton Growers Survey, Prepared for Cotton Consultants Australia Inc., August.

Western Research Institute 2008(b), 2008 Cotton Consultant Report CCA Consultants, Prepared for Cotton Consultants Australia Inc., August.