

COTTON RESEARCH AND DEVELOPMENT CORPORATION

An Economic Analysis of Investment in Research to Improve Water Use Efficiency on Farms using Existing and New Infrastructure, New Tool and Technologies

Background

The Cotton Research and Development Corporation (CRDC) commissioned BDA Group in July 2009 to undertake a benefit cost analysis of three randomly selected sub-programs across their 2003/04 to 2007/08 research and development portfolio. These analyses form part of a wider assessment of the return from rural research that is being conducted by the Council of Rural Research and Development Corporation Chairs.

Over the period 2003/04 to 2007/08 one of CRDC's main investment programs was "Farming Systems". The objective of this program was to develop integrated farm management practices that enhance the sustainability and profitability of cotton farming in Australia. Over this period the CRDC placed a greater emphasis on improving and integrating a better understanding of soil health, crop nutrition, sodicity / salinity management, crop rotations and improving water use efficiency. Within that program five sub-programs were designed, with sub-program 1 aimed at improving water use efficiency on farms using existing and new infrastructure, new tools and technologies. This sub-program, 4.1, is the focus of this evaluation.

The Projects

There were 18 projects funded in sub-program 4.1 between July 2003 and June 2008. Research partners included the Australian Cotton Cooperative Research Centre, Land and Water Australia, CSIRO, the National Centre for Engineering in Agriculture, University of Technology Sydney, University of South Australia and the University of Southern Queensland.

Between 2003/04 and 2007/98 CRDC and partners invested \$4.5m in total, as reported in Table 1. Across the 18 projects CRDC has contributed 29% of funds in nominal terms. Investment projects all commenced in 2003/04 with no projects carried in from previous

years. Most of the investment was made from 2006/07 onwards with 21% of project funding being invested in projects with a planned completion date beyond June 2008.

Table 1: CRDC and Partner Investment (nominal \$)

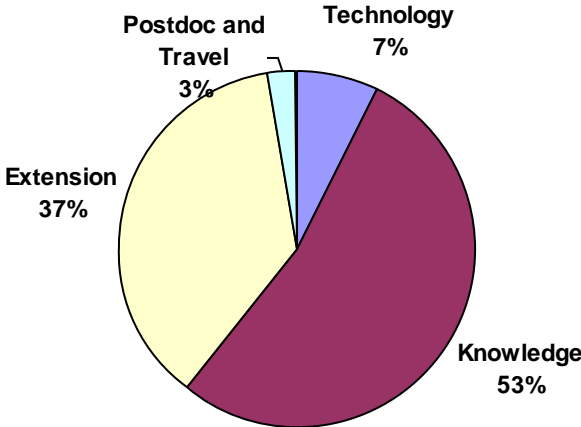
Year	CRDC Investment	Partner Investment	Total
2004	\$248,200	\$466,099	\$714,299
2005	\$21,110	\$46,485	\$67,595
2006	\$440,759	\$382,731	\$823,490
2007	\$552,244	\$874,778	\$1,427,022
2008	\$440,385	\$1,423,315	\$1,863,700
Total	\$1,702,698	\$3,193,408	\$4,896,106

Note: Year refers to year ending June.

Outputs and Outcomes

Outputs from sub-program 4.1 have been described as either technology based (product, process or information on a specific aspect of cotton production that has resulted in a beneficial impact across the industry), extension (outputs designed to convey information to cotton farmers across a number of technologies related to water use), knowledge (projects designed to increase scientific understanding which underpins future technology development) and post doctoral and travel (which is aimed at increasing scientific capability in water use on cotton farms). A breakdown of investment across these groups is provided in Figure 1.

Figure 1: Breakdown of Outputs from Sub-Program 4.1



The breakdown of investments by output group demonstrates the broad nature of research, development and extension investments made by CRDC. While some projects will lead to specific technological outputs such investment is typically supported by a number of knowledge based investments as well as extension efforts across a wide range of associated technologies, including the use of lateral moves and centre pivots (LMCP)¹.

Technology outputs from sub-program 4.1 are largely based around the use of LMCP, overhead irrigation systems that can be used as an alternative to furrow irrigation. Specific outputs included:

- An irrigation management tool that cotton farmers can use to map movement positions, timing of irrigation and to better understand soil moisture variation across a field.
- Sprinkler guidelines for cotton soils.
- Information packages including articles and grower case studies in Australian Cotton Grower, presentations at the 13th Australian Cotton Conference and training package through the Cooperative Research Centre for Irrigation Futures.
- Detailed cost comparisons of LMCP against drip and furrow irrigation systems.

The main outcome associated with investment outputs has been the increased adoption of LMCP as well as use of other irrigation systems in areas where soil types are inappropriate for LMCP. In 2000/01 around 5,300 ha of cotton was irrigated using LMCP systems². Adoption had increased by a further 2,000 in 2001/02 and was around 10% or 19,000 ha in 2007/08³. The potential area where LMCP might be used has been estimated at around 30% of the total cotton growing area.

The counterfactual can also be described in terms of the likely rate of adoption through time of LMCP irrigation systems. It was evident in 2001/02 that the cotton industry had started to adopt LMCP systems, although at a modest rate. The prolonged drought conditions over the past 6 years will have limited the take up of new systems as (1) farm cash flows have been low and (2) replacement of irrigation systems are mainly carried out at the end of the their

¹ Some of the extension and knowledge generated under this sub-program has contributed to water use efficiency gains in flood irrigation. These gains have been evaluated under other sub-programs and not included in this evaluation.

² NEC9 Final report

³ Western Research Institute 2008 Survey of Australian Cotton growers

economic life – which is around 15 years. Adoption rates have also been impacted by the uncertainty surrounding government water reforms and increasing energy costs to run the pressurised systems.

A breakdown of annual LMCP adoption as a result of the CRDC investment as well as under an assumed counterfactual is provided in Table 2.

Table 2: Assumed Adoption of LMCP Technology: ‘000 ha

Year	With CRDC	Without CRDC	Difference
2001	5.3	5.3	0.0
2002	7.3	7.3	0.0
2003	9.3	8.3	1.0
2004	11.3	9.3	2.0
2005	13.3	10.3	3.0
2006	15.3	11.3	4.0
2007	17.3	12.3	5.0
2008	19.3	14.3	5.0
2009	23.3	16.3	7.0
2010	27.3	18.3	9.0
2011	31.3	20.3	11.0
2012	35.3	22.3	13.0
2013	39.3	26.3	13.0
2014	43.3	30.3	13.0
2015	47.3	34.3	13.0
2016	51.3	38.3	13.0
2017	55.3	42.3	13.0
2018	59.3	46.3	13.0
2019	63.3	50.3	13.0
2020	67.3	54.3	13.0
2021	71.3	58.3	13.0
2022	75.3	62.3	13.0
2023	79.3	66.3	13.0
2024	83.3	70.3	13.0
2025	87.3	74.3	13.0
2026	91.3	78.3	13.0
2027	95.3	82.3	13.0
2028	99.3	86.3	13.0

The adoption rates provided in Table 2 have been based on the following assumptions.

- (1) Take up past 2008 is based on a return to more normal season conditions from 2012 and an area planted of 356,000 ha⁴.
- (2) Adoption with CRDC investment from 2008 was assumed to be at the rate of an additional 4,000 ha a year. Under a 15 year replacement rate for irrigation infrastructure some 25,000 ha would be up-graded each year. Under the assumed “with CRDC” adoption of 4,000 ha a year this would represent around 16% of the industry adopting LMCP. A more conservative assumption than the expected 30% was used in this study. As this assumption is the main determinant of the pay off on CRDC funds the assumption is tested with sensitivity analysis in the final section of this report.
- (3) Under the “without CRDC” investment scenario it was assumed that adoption would occur past 2008 at 2,000 ha a year. This estimated was based on adoption rates prior to CRDC outcomes.
- (4) It was also assumed that there would be a five year lag under the assumed counterfactual as it is likely that other parties would have evaluated LMCP technology as there was growing interest from industry.

Benefits

- **Economic**

Economic benefits from adoption of LMCP systems on soil types and climate that are appropriate include lower operating costs, reduced water requirements and increased crop yields compared to furrow irrigation systems. These benefits are however, offset to some extent from higher initial capital costs.

⇒ Operating costs⁵ - Operating cost savings have been estimated at around \$140 per ha. The main saving is in reduced irrigation labour costs and channel maintenance. These saving are offset to some extent by the increased system pumping cost. The estimated \$140 per ha was adjusted down to reflect water use efficiencies that have been

⁴ BDA Group 2008 Evaluation of randomly selected CRDC programs

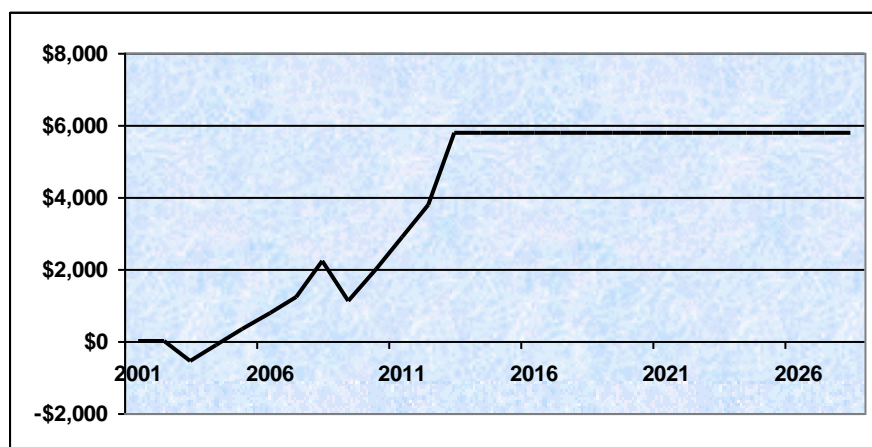
⁵ Sourced from WATERpak – p169

achieved in recent years. WATERpak reports a water saving of nearly 3 ML per ha. A 1ML per ha saving was deemed more appropriate and water application cost was reduced accordingly (around \$18 per ML applied). The operating cost saving used in this evaluation was taken as \$110 per ha.

- ⇒ Water Saving – As noted above, it was assumed that water application rates would be some 1 ML per ha lower. This represents a water saving of \$200⁶ per ha.
- ⇒ Crop Yield⁵ – CMLP systems achieve a more uniform watering pattern and reduce yield losses from application variation (including water logging). This saving was estimated at 0.3 bales per ha. Using an average price of \$450 per bale the increased yield would deliver a benefit of \$135 per ha.
- ⇒ Capital Cost – CMLP systems, depending on the site⁷, involve a higher capital cost than furrow systems. WATERpak reports this cost difference at around \$250 per ha. Alternatively, NSW Department of Industry and Development report the cost difference at up to \$2,000 per ha higher or on average \$1,000 per ha. While it is appreciated that the capital cost of CMLP and furrow systems will vary depending on size and location the higher estimate of \$1,000 per ha was used in this evaluation.

The economic benefits through time from CRDC’s investment in program 4.1 are shown in Figure 2. Benefits are negative in the first few years as capital costs exceed operating cost savings.

Figure 2: Estimated Economic Benefits Through Time; \$’000



⁶ Based on BDA Group (2007) evaluation of highly successful CRDC investments. The capital cost of water is around \$1,500 per ML or \$200 on an annualised basis.

⁷ Greenfield or redeveloped flood layout.

- **Environmental**

Environmental benefits are twofold. The first benefit is a water saving of 1 ML per ha which can then be used for other consumptive uses⁸. The second is a reduction in herbicide use, typically used in furrow systems to maintain clear channels and the associated reduction in potential run-off and greenhouse gas emissions. No attempt was made in this evaluation to quantify these benefits in monetary terms⁹. However, the water saving was estimated to reach 13 GL a year by 2013.

- **Social**

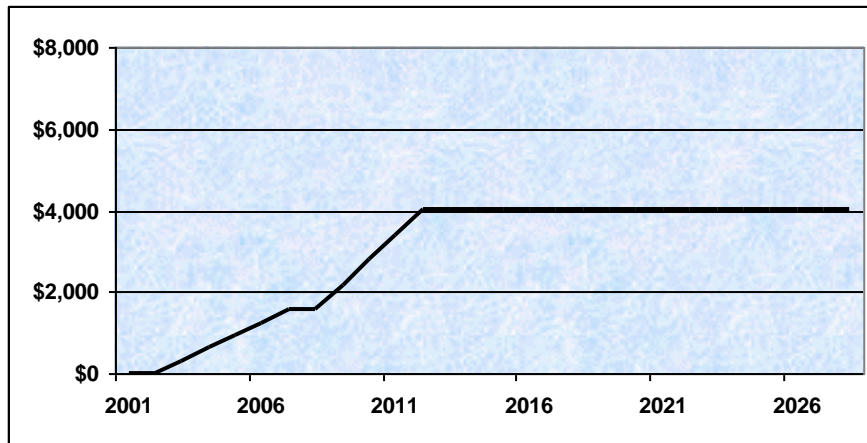
Social benefits include spillover benefits to other irrigated crops, increased economic activity in rural areas as a result of greater industry profitability and increased capability as a result of (1) increased industry awareness of irrigation system productivity and (2) increased scientific capability. Again, no attempt was made to quantify the latter two benefits.

Benefits to other irrigated crops will occur as cotton farms employ LMCP systems for use on non-cotton crops. The saving in other crops was estimated at \$310 per ha. Capital costs were excluded as these have been accounted for as a cost to cotton production. Also, possible yield gains were ignored. The area of irrigated non-cotton crops on cotton farms will vary depending on water availability. Grower surveys indicate that under full water allocations cotton crops account for 67% of all crops irrigated. With lower allocations, such as in 2008/09 cotton accounts for less than 50%. For the purpose of this evaluation it was assumed that irrigated cotton and non-cotton areas are the same. Benefits through time to non-cotton crops are shown in Figure 3. These benefits were estimated to reach \$4m a year by 2012.

⁸ Cotton production might increase in response to higher profits, but water might also be transferred to other consumptive users. It is important to recognise that the value of water savings is included in economic benefits as water is a traded commodity.

⁹ In the 2008 random evaluations these benefits were quantified for CRDC supported technologies that have resulted in reduced fertiliser applications.

Figure 3: Estimated Social Benefits Through Time; \$'000



Results

All costs and benefits were expressed in current dollars using the CPI. A discount rate of 5% was used from the commencement of the CRDC investment in 2003/04.

Investment criteria were estimated for both the total investment and CRDC investment alone¹⁰. Results are presented in Table 3.

Table 3: Investment Criteria for Total Investment

Criterion	0 years	5 years	10 years	15 years	20 years
Present value of benefits (\$m)	\$5.51	\$18.61	\$33.31	\$44.82	\$52.21
Present value of costs (\$m)	\$4.33	\$4.33	\$4.33	\$4.33	\$4.33
Net present value (\$m)	\$1.18	\$14.28	\$28.98	\$40.49	\$47.88
Benefit cost ratio	1.34	4.51	8.07	10.86	12.65
Internal rate of return	40%	65%	67%	67%	67%

¹⁰ Following ACIL evaluation guidelines, benefits to CRDC were taken as the returns to cotton growers adjusted in proportion to their share of total investment across all partners.

Table 4: Investment Criteria for CRDC Investment

Criterion	0 years	5 years	10 years	15 years	20 years
Present value of benefits (\$m)	\$1.31	\$5.60	\$10.51	\$14.37	\$16.84
Present value of costs (\$m)	\$1.46	\$1.46	\$1.46	\$1.46	\$1.46
Net present value (\$m)	-\$0.14	\$4.14	\$9.06	\$12.91	\$15.39
Benefit cost ratio	0.90	3.85	7.23	9.87	11.57
Internal rate of return	-1%	38%	42%	42%	42%

The results show that the return to cotton growers on CRDC's investment has been modest to date and will require additional take-up of the LMCP technology in the future if positive returns are to be generated. When benefits to non-cotton crops are included the return to date has been more attractive.

Sensitivity Analysis

Sensitivity analysis was carried out on the increased rate of adoption through time that could be attributed to the CRDC and partner investment and reported in Table 5. Results are reported for the CRDC investment over the life of the investment plus 20 years. Two scenarios were considered from 2009 (1) a more modest take up of LMCP at 1,000 extra ha a year and (2) a higher level of take up at 3,000 ha a year. Results show that the impact of the CRDC investment on adoption rates will influence the returns that are generated. However, even at a lower level of adoption than that assumed in this study the investment was estimated to still deliver a positive return.

Table 5: Sensitivity to Assumptions regarding Adoption of LMCP Systems for CRDC Investment (20 years)

Criterion	1,000 ha	2,000 ha Base	3,000 ha
Present value of benefits (\$m)	\$12.59	\$16.84	\$21.10
Present value of costs (\$m)	\$1.46	\$1.46	\$1.46
Net present value (\$m)	\$11.13	\$15.39	\$19.64
Benefit cost ratio	8.65	11.57	14.50
Internal rate of return	40%	42%	44%

Conclusion

CRDC investment in Sub-Program 4.1 was mainly aimed at supporting R&D and extension into the use of CMLP irrigation systems in cotton production. These systems, while requiring a higher up-front capital expenditure, are expected to deliver cost and water savings when used instead of furrow irrigation systems on appropriate soil types and production regions. Using benefit cost analysis it was estimated that the investment by CRDC and all parties would ultimately deliver a positive economic return to cotton growers and Australia more broadly.