Horticulture Impact Assessment Program:

Appendix 1: Managing almond production in a variable and changing climate (AL14006 Impact Assessment)

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Delivery partner:

AgEconPlus and Agtrans Research

Project code:

MT18011

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Executive Summary

What the report is about

This report presents the results of an impact assessment of a Horticulture Innovation Australia Limited (Hort Innovation) investment in *VG14006: Managing Almond Production in a Variable and Changing Climate.* The project was funded by Hort Innovation over the period March 2015 to May 2019.

Methodology

The investment was first analysed qualitatively within a logical framework that included activities and outputs, outcomes, and impacts. Actual and/or potential impacts then were categorised into a triple bottom line framework. Principal impacts identified were then considered for valuation in monetary terms (quantitative assessment). Past and future cash flows were expressed in 2019/20 dollar terms and were discounted to the year 2019/20 using a discount rate of 5% to estimate the investment criteria and a 5% reinvestment rate to estimate the modified internal rate of return (MIRR).

Results/key findings

Investment in this research project has improved almond industry knowledge of the impact of weather and climate on tree physiology and phenology and generated information on appropriate farm management responses. The impact that was valued was progress toward the industry goal, expressed through the Almond Industry Strategic Investment Plan 2017-21, of increasing average kernel yield from 3 to 4 t/ha.

Investment Criteria

Total funding from all sources for the project was $1.35 million (present value terms). The investment produced estimated total expected benefits of $5.28 million (present value terms). This gave a net present value of $3.94 million, an estimated benefit-cost ratio of 3.93 to 1, an internal rate of return of 14.3% and a MIRR of 9.4%.

Conclusions

The Hort Innovation investment in Project AL14006 has generated new knowledge of the impact of weather and climate on tree physiology and phenology and information on appropriate farm management responses. Several social impacts identified were not valued as the impacts were considered uncertain and difficult to value with credible assumptions. Hence, investment criteria provided by the valuation may be underestimates of the actual performance of the investment.

Keywords

Impact assessment, cost-benefit analysis, almond production, managing production, variable climate, changing climate, weather, phenology, crop development

Introduction

Horticulture Innovation Australia Limited (Hort Innovation) required a series of impact assessments to be carried out annually on a number of investments in the Hort Innovation research, development, and extension (RD&E) portfolio. The assessments were required to meet the following Hort Innovation evaluation reporting requirements:

- Reporting against the Hort Innovation's current Strategic Plan and the Evaluation Framework associated with Hort Innovation's Statutory Funding Agreement with the Commonwealth Government.
- Annual Reporting to Hort Innovation stakeholders.
- Reporting to the Council of Rural Research and Development Corporations (CRRDC).

Under impact assessment program MT18011, the first series of impact assessments were conducted in 2019 and included 15 randomly selected Hort Innovation RD&E investments (projects). The second series of impact assessments (current series), undertaken in 2020, also included 15 randomly selected projects worth a total of approximately $7.11 million (nominal Hort Innovation investment). The second series of projects were selected from an overall population of 85 Hort Innovation investments worth an estimated $44.64 million (nominal Hort Innovation investment) where a final deliverable had been submitted in the 2018/19 financial year.

The 15 investments were selected through a stratified, random sampling process such that investments chosen represented at least 10% of the total Hort Innovation RD&E investment in the overall population (in nominal terms) and was representative of the Hort Innovation investment across six, pre-defined project size classes.

Project *VG14006: Managing Almond Production in a Variable and Changing Climate* was randomly selected as one of the 15 investments under MT18011 and was analysed in this report.

General Method

The impact assessment follows general evaluation guidelines that are now well entrenched within the Australian primary industry research sector including Research and Development Corporations, Cooperative Research Centres, State Departments of Agriculture, and some universities. The approach includes both qualitative and quantitative descriptions that are in accord with the impact assessment guidelines of the CRRDC (CRRDC, 2018).

The evaluation process involved identifying and briefly describing project objectives, activities and outputs, outcomes, and impacts. The principal economic, environmental, and social impacts were then summarised in a triple bottom line framework.

Some, but not all, of the impacts identified were then valued in monetary terms. Where impact valuation was exercised, the impact assessment uses cost-benefit analysis as its principal tool. The decision not to value certain impacts was due either to a shortage of necessary evidence/data, a high degree of uncertainty surrounding the potential impact, or the likely low relative significance of the impact compared to those that were valued. The impacts valued are therefore deemed to represent the principal benefits delivered by the project. However, as not all impacts were valued, the investment criteria reported for individual investments potentially represent an underestimate of the performance of that investment.

Background & Rationale

Background

The Australian almond industry is a significant horticultural sector with a five year estimated production value of $626.2 million and a production volume of 78,033 tonnes kernel weight equivalent – Table 1.

Table 1: Almond Industry Performance 2014-2018

Year Ended 30 June	Production – Kernel Weight Equivalent (t)	Gross Value of Production ($m)	Farmgate Value of Production ($m)	Export Value ($m)
2014	65,060	465.6	442.3	463.1
2015	82,509	707.5	672.1	521.8
2016	82,333	854.1	811.4	616.2
2017	80,800	553.6	525.9	461.2
2018	79,461	550.1	522.6	440.3
Average	78,033	626.2	594.9	500.5

Source: Australian Horticulture Statistics Handbook 2014/15 and 2017/18 (farmgate value estimated by AgEconPlus)

Almonds are Australia's most valuable horticultural export crop accounting for 20% of the value of fresh horticulture exports. Almonds are grown in the south of Australia, with the majority of production occurring along the Murray River. Key production areas include the North Adelaide Plains (South Australia), Riverland (South Australia), Sunraysia (Victoria) and the Riverina (NSW). Together these four areas account for 97% of production. Australia's almond growing season commences with the almond blossom in July and August each year. Harvest takes place in February and March, with produce ready for the market in April and May. Over 90% of almonds consumed in Australia are grown and produced by Australian farmers.

Almond research and development (R&D) activity is guided by the Almond industry's Strategic Investment Plan (SIP). The activities are funded by levies payable on almonds produced in Australia; and the R&D levy funds are managed by Hort Innovation. The current SIP has been driven by levy payers and addresses the Australian Almond industry's needs from 2017 to 2021. Strategies and priorities in the Plan have been driven by a set of five desired outcomes (Hort Innovation, 2017):

1. Pest and disease damage to almonds has been reduced through enhanced integrated pest management and integrated disease management.
2. A major productivity gain in almond pollination by 2022 through a 25% reduction in honey bee stocking rate with no loss in pollination efficiency (nut set).
3. Improvements in the crop production system have lifted average industry kernel yield from 3 to 4 t/ha, 4ML of irrigation water generates a tonne of almond kernel yield and proven 'shake and catch' harvesting / processing technology is in place.

4. Australian almonds are an informed industry that adopts R&D outcomes and has the capacity to support current and future industry needs.
5. Increased domestic almond consumption up from 16,000 t in 2016 to 27,500 t in 2022. Increased export sales up from 64,000 t in 2016 to 110,000 t in 2022.

Rationale

High quality almond production is sensitive to weather and climate risks including insufficient chill units, heat waves, drought, and untimely rainfall. Consequently, this project was to:

(i) Conduct a detailed analysis of climate across Australian almond growing regions to identify and prioritise weather/climate risks.
(ii) Assess whether the risks are changing from the recent past and what climate science is suggesting about the future.
(iii) Suggest gaps in industry understanding of climate risks and alternative ways to manage these risks.

The project was to conduct field trials to gain a better understanding of the role of climate in crop development and yield.

Project Details

Summary

Project Code: AL14006
Title: *Managing Almond Production in a Variable and Changing Climate*
Research Organisation: South Australian Research and Development Institute (SARDI)
Project Leader: Dane Thomas
Period of Funding: March 2015 to May 2019

Objectives

Specific objectives of project AL14006 were:

1. Identify and assess risks of weather and climate events and management options.
2. Determine the impact of weather and climate on tree physiology.
3. Review and validate predictive phenology (tree life cycle) models.

Logical Framework

Table 2 provides a detailed description of the project in a logical framework.

Table 2: Logical Framework for Project AL14006

Activities	Weather/climate event and management option activities included: • Half day workshops and follow-up grower surveys completed in four major growing areas (North Adelaide Plains, Riverland, Sunraysia and Riverina) to identify and rank weather and climate risks according to chance of occurrence and economic loss. • Literature review to identify management options to address weather and climate risks. • A desktop analysis of weather and climate risks to almond production completed via the preparation of a series of agro-climate indices. Agro-climatic indices were calculated using historic climate records for locations in each almond growing region. • The influence of climate drivers such as El Nino Southern Oscillation (ENSO) and the Indian Ocean Dipole (IOD) on expected changes from the long-term average of the agro-climatic indices was examined.

	• Agro-climatic indices in a future climate were modelled assuming 1°C warmer, 2°C warmer, 20% drier, 10% wetter and 20% wetter seasonal scenarios. • The impacts of weather and climate on almond production under current, extreme event (e.g. ENSO) and future climate scenarios were communicated to industry via web downloadable booklets and conference proceedings. Tree physiology activities included: • Field data was collected on crop development and yield and associated weather on a meso-site (localised) basis. Crop development data included flowering, fruit maturity, hull split, yield, and yield quality. • Potted trials were also used to collect data on crop performance under different weather conditions and trials covered the two major Australian almond varieties (Nonpareil and Carmel), climatic conditions were varied using solar heated chambers. • All crop development data (commercial orchards and potted plant trial) was utilised to explore the impact of climate on crop development and yield, and to assess the almond predictive phenology model. Phenology model development and testing activities included: • Literature review to determine the presence, extent, and applicability of phenology models for almonds grown in Australia and evaluation of the reliability of these models. • Models predicting almond flowering, almond fruit growth, and hull split were reviewed. An excel based program for almond phenology was developed for growers. The model allows growers to input local temperature observations and therefore produce predictions of local phenology for use by almond growers in management decisions. • Two fact sheets that describe how to evaluate phenology were developed for growers. Assistance was also provided to the Almond Board of Australia (ABA) for their development of a grower tool for recording crop phenology development.
Outputs	The important outputs of the project included: • Detailed local crop development calendars for each cropping region. • A literature review of tree response to climatic variation. • An analysis of climate risks using historical weather data. • Geographic comparison of climate risks - Australia and overseas growing regions. • Assessment of how climate risks change with extreme events (e.g. ENSO). • Identification of knowledge gaps and potential management options to deal climate risks • A simple benefit-cost framework for assessing the payback from mitigating climate risk. • Report on phenology models and a combined ‘best practice’ model. • A description of phenology under Australian conditions. • Best practice model that allows growers to adjust production practice for climate variability. • An assessment of meso-climates in the Australian almond growing regions. • Information on the impact on phenology and yield of meso-climates. • Impact of temperature, critical temperature thresholds and damage functions for specific phenological and development processes. • Impact assessment and cost benefit analysis of management options. • Extension materials including ‘grower facing’ cop production information communicated through relevant industry events. Philosopher
Outcomes	The outcomes driven by the project included: • Growers with improved understanding of weather and climate risks and appropriate management responses. • Reduction in production losses caused by weather/climate events such as rain at harvest, heatwaves, warmer spring and summer temperatures, changes in the quality and quantity of irrigation water, inadequate winter rain to fill profile and

	leach salts, temperature too cold for pollination, insufficient chill accumulation to satisfy flowering, non-synchronised flowering, frost, and rain and humidity leading to disease.
Impacts	• Economic – progress toward industry goal of increasing average yield from 3 to 4 t/ha. Increased yield achieved through avoided crop loss as a result of improved weather / climate risk management. • Capacity – increased almond grower skills in managing weather/climate risk. • Capacity – increased researcher skills in climate, phenology, and tree physiology. • Social - contribution to improved regional community wellbeing from spill-over benefits as a result of increased crop yield and grower income - North Adelaide Plains, Riverland, Sunraysia and Riverina.

Project Investment

Nominal Investment

Table 3 shows the annual investment made in Project AL14006 by Hort Innovation.

Table 3: Annual Investment in Project AL14006 (nominal $)

Year ended 30 June	HORT INNOVATION ($)	SARDI ($)	TOTAL ($)
2015	20,000	28,511	48,511
2016	95,000	135,426	230,426
2017	109,000	155,384	264,384
2018	105,000	149,682	254,682
2019	109,000	155,384	264,384
Total	**438,000**	**624,386**	**1,062,386**

Source: AL14006 Executed Research Agreement

Program Management Costs

For the Hort Innovation investment the cost of managing the Hort Innovation funding was added to the Hort Innovation contribution for the project via a management cost multiplier (1.162). This multiplier was estimated based on the share of ‘payments to suppliers and employees’ in total Hort Innovation expenditure (3-year average) reported in the Hort Innovation’s Statement of Cash Flows (Hort Innovation Annual Report, various years). This multiplier was then applied to the nominal investment by Hort Innovation shown in Table 3.

Real Investment and Extension Costs

For purposes of the investment analysis, the investment costs of all parties were expressed in 2019/20 dollar terms using the Implicit Price Deflator for Gross Domestic Product (ABS, 2019). No additional extension costs were incurred.

Impacts

Table 4 provides a summary of the principal types of impacts delivered by the project, based on the logical framework. Impacts have been categorised into economic, environmental, and social impacts.

Table 4: Triple Bottom Line Categories of Principal Impacts from Project AL14006

Economic	• Progress towards the industry goal of increasing average yield from 3 to 4 t/ha. Increased yield achieved through avoided crop loss as a result of improved weather / climate risk management.
Environmental	• Nil
Social	• Increased almond grower skills in managing weather/climate risk. • Increased researcher skills in climate, phenology, and tree physiology. • Contribution to improved regional community wellbeing from spill-over benefits as a result of increased crop yield and grower income - North Adelaide Plains, Riverland, Sunraysia and Riverina.

Public versus Private Impacts

The impacts identified from the investment are predominantly private impacts accruing to almond growers. However, some public benefits also have been produced in the form of capacity built and spill-overs to regional communities from enhanced grower yield and income.

Distribution of Private Impacts

The private impacts will have been distributed between growers, processor/packers, wholesalers, exporters, and retailers. The share of impact realised by each link in the supply chain will depend on both short- and long-term supply and demand elasticities in the almond market.

Impacts on Other Australian Industries

Findings from the project may also be relevant to growers of other Prunus species including cherry, peach, nectarine, plum, apricot, and prunes.

Impacts Overseas

While relationships between Australian climatic conditions and grower management response, tree phenology and physiology will be Australian site specific, general principles and models may have relevance to other almond growing areas such as Spain and California.

Match with National Priorities

The Australian Government's Science and Research Priorities and Rural RD&E priorities are reproduced in Table 5. The project outcomes and related impacts will contribute to Rural RD&E Priority 1 and 4, and to Science and Research Priority 1.

Table 5: Australian Government Research Priorities

Australian Government	
Rural RD&E Priorities (est. 2015)	**Science and Research Priorities (est. 2015)**
1. Advanced technology 2. Biosecurity 3. Soil, water and managing natural resources 4. Adoption of R&D	1. Food 2. Soil and Water 3. Transport 4. Cybersecurity 5. Energy and Resources 6. Manufacturing 7. Environmental Change 8. Health

Sources: (DAWR, 2015) and (OCS, 2015)

Alignment with the Almond Strategic Investment Plan 2017-2021

The strategic outcomes and strategies of the almond industry are outlined in the Almond Industry's Strategic Investment Plan 2017-2021[1] (Hort Innovation, 2017). Project AL14006 primarily addressed Outcome 3, Strategy 3.8 'Support further efficiencies in Horizon 1 (current production system) orchards and the development of Horizon 3 orchards (new production system designed for Australian conditions) to better understand how the combination of soil health, nutrition, tree architecture, plant physiology and orchard design is integrated'.

[1] For further information, see: https://www.horticulture.com.au/hort-innovation/funding-consultation-and-investing/investment-documents/strategic-investment-plans/

Valuation of Impacts

Impacts Valued

Analyses were undertaken for total benefits that included future expected benefits. A degree of conservatism was used when finalising assumptions, particularly when some uncertainty was involved. Sensitivity analyses were undertaken for those variables where there was greatest uncertainty or for those that were identified as key drivers of the investment criteria.

The impact that was valued was progress toward the industry goal of increasing average kernel yield from 3 to 4 t/ha. Increased yield achieved through avoided crop loss as a result of improved weather / climate risk management.

Impacts Not Valued

Not all of the impacts identified in Table 4 could be valued in the assessment. Those not valued included:

- Increased almond grower skills in managing weather/climate risk.
- Increased researcher skills in climate, phenology, and tree physiology.
- Contribution to improved regional community wellbeing from spill-over benefits as a result of increased crop yield and grower income - North Adelaide Plains, Riverland, Sunraysia and Riverina.

These impacts were not valued due to lack of data to support credible assumptions.

Summary of Assumptions

A summary of the key assumptions made for valuation of progress toward the industry goal of increasing average kernel yield from 3 to 4 t/ha is provided in Table 6.

Table 6: Summary of Assumptions for Impact Valuation

Variable	Assumption	Source/Comment
Area of almond production.	48,000 ha.	45,088 ha in 2018 with additional orders from nurseries for trees in 2019 (ABA, 2019).
Share of crop adopting project findings.	50%.	AgEconPlus estimate made after considering that the project focussed on the main production areas and included the industry's major growers.
Yield increase as a result of the project. Increased yield achieved through avoided crop loss as a result of improved weather / climate risk management.	1% i.e. average yield increases from 3 to 3.03 t/ha.	AgEconPlus estimated made after review of the final project report.
Farmgate price of increased yield.	$7,577/tonne	Five year average 2014 to 2018 adapted from the Horticulture Statistics Handbook 2014/15 and 2017/18.
Cost to growers of implementing climate management practices.	$2,000/tonne	AgEconPlus estimate after considering the need heat wave, drought, and untimely rainfall mitigation measures.
Farmgate value of increased yield.	$5,577/tonne	$7,577/tonne less $2,000/tonne.
Year in which yield improvement commences.	2022	AgEconPlus – three years after project completion and management changes start to impact production.
Year in which maximum adoption	2032	AgEconPlus – 50% of industry

reached.		production has now adopted.
Attribution of impacts to this project.	50%	The project built on literature and models sourced from the Californian and Spanish almond industries.
Risk factors		
Probability of the project generating useful outputs that increase almond yield.	100%	AgEconPlus – outputs have been communicated to growers.
Probability of impact (assuming successful outcome)	50%	AgEconPlus – there is a reasonable probability that growers will not successfully implement recommendations.
Counterfactual		
If Project AL14006 had not been funded there is a 50% chance that another source of funding or another research organisation would have completed the research.		
Proportion of benefits estimated that would have been delivered without Project AL14006.	50%	AgEconPlus.

Results

All costs and benefits were discounted to 2019/20 using a discount rate of 5%. A reinvestment rate of 5% was used for estimating the Modified Internal Rate of Return (MIRR). The base analysis used the best available estimates for each variable, notwithstanding a level of uncertainty for many of the estimates. All analyses ran for the length of the project investment period plus 30 years from the last year of investment (2018/19) as per the CRRDC Impact Assessment Guidelines (CRRDC, 2018).

Investment Criteria

Tables 7 and 8 show the investment criteria estimated for different periods of benefits for the total investment and the Hort Innovation investment alone.

Table 7: Investment Criteria for Total Investment in Project AL14006

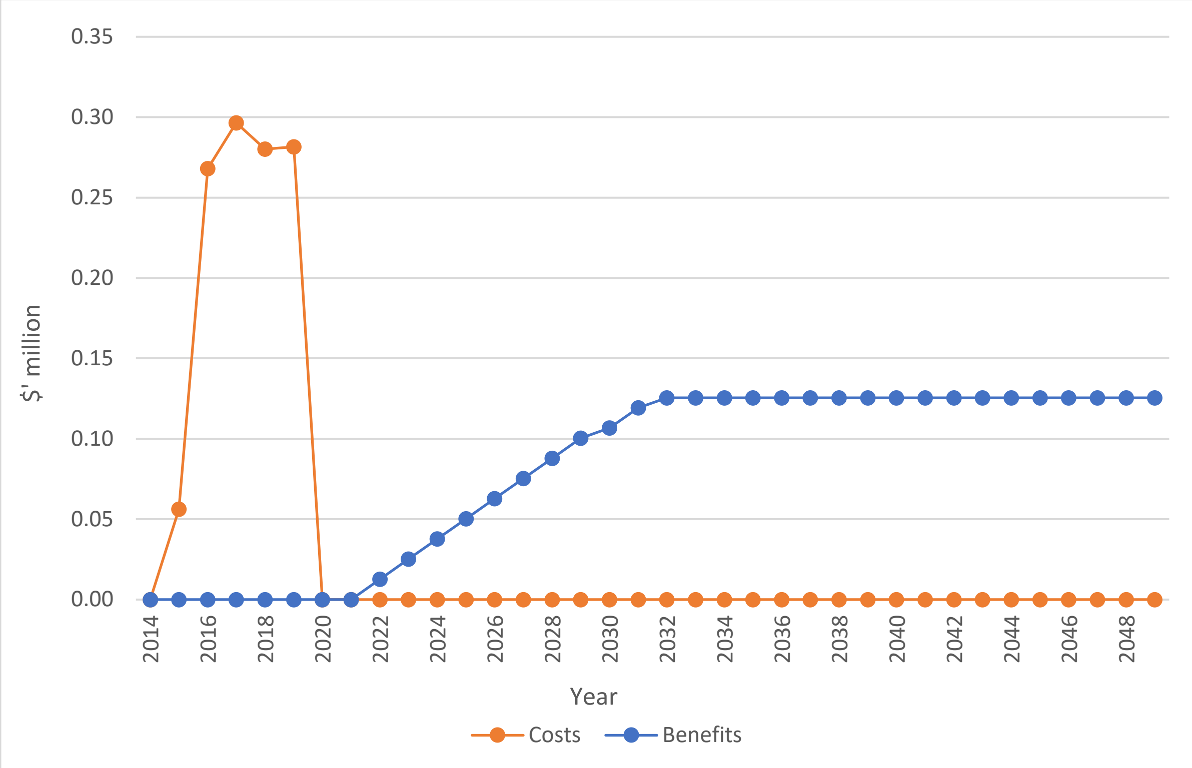
Investment Criteria	Years after Last Year of Investment						
	0	5	10	15	20	25	30
Present Value of Benefits ($m)	0.00	0.26	1.31	2.65	3.75	4.61	5.28
Present Value of Costs ($m)	1.35	1.35	1.35	1.35	1.35	1.35	1.35
Net Present Value ($m)	-1.35	-1.09	-0.03	1.31	2.40	3.26	3.94
Benefit-Cost Ratio	0.00	0.19	0.97	1.97	2.79	3.43	3.93
Internal Rate of Return (%)	negative	negative	4.2	11.0	13.1	13.9	14.3
MIRR (%)	negative	negative	4.4	9.0	9.8	9.7	9.4

Table 8: Investment Criteria for Hort Innovation Investment in Project AL14006

Investment Criteria	Years after Last Year of Investment						
	0	5	10	15	20	25	30
Present Value of Benefits ($m)	0.00	0.11	0.58	1.16	1.65	2.02	2.32
Present Value of Costs ($m)	0.59	0.59	0.59	0.59	0.59	0.59	0.59
Net Present Value ($m)	-0.59	-0.48	-0.01	0.57	1.06	1.43	1.73
Benefit-Cost Ratio	0.00	0.19	0.97	1.97	2.79	3.43	3.93
Internal Rate of Return (%)	negative	negative	4.2	11.0	13.1	13.9	14.3
MIRR (%)	negative	negative	4.4	9.0	9.8	9.7	9.4

The annual undiscounted benefit and cost cash flows for the total investment for the duration of the AL14006 investment plus 30 years from the last year of investment are shown in Figure 1.

Figure 1: Annual Cash Flow of Undiscounted Total Benefits and Total Investment Costs



Sensitivity Analyses

A sensitivity analysis was carried out on the discount rate. The analysis was performed for the total investment and with benefits taken over the life of the investment plus 30 years from the last year of investment. All other parameters were held at their base values. Table 9 presents the results. The results show sensitivity to the discount rate reflecting the lag between project cost and the generation of maximum project benefits.

Table 9: Sensitivity to Discount Rate (Total investment, 30 years)

Investment Criteria	**Discount rate**		
	0%	**5% (base)**	**10%**
Present Value of Benefits ($m)	11.75	5.28	2.75
Present Value of Costs ($m)	1.18	1.35	1.53
Net Present Value ($m)	10.56	3.94	1.22
Benefit-cost ratio	9.93	3.93	1.80

A sensitivity analysis was then undertaken for the share of almond crop adopting AL14006 findings. Results are provided in Table 10. Even when share of crop adopting project findings is reduced to a maximum of 20%, and given all other assumptions remaining unchanged, the project returns an acceptable benefit cost ratio.

Table 10: Sensitivity to Share of Almond Crop Adopting AL14006 Project Findings (Total investment, 30 years)

Investment Criteria	**Share of Almond Crop Adopting Project Findings**		
	20%	**50% (base)**	**80%**
Present Value of Benefits ($m)	2.12	5.28	8.12
Present Value of Costs ($m)	1.32	1.35	1.32
Net Present Value ($m)	0.80	3.94	6.80
Benefit-cost ratio	1.60	3.93	6.14

A final sensitivity analysis tested the sensitivity of the investment criteria to yield increase attributable to the project. The results (Table 11) show that even if yield increase is as low as 0.25%, the project investment would breakeven.

Table 11: Sensitivity to Yield Increase as a Result of AL14006 (Total investment, 30 years)

Investment Criteria	**Yield Increase**		
	0.25%	**0.5%**	**1% (base)**
Present Value of Benefits ($m)	1.32	2.64	5.28
Present Value of Costs ($m)	1.35	1.35	1.35
Net Present Value ($m)	-0.02	1.30	3.94
Benefit-cost ratio	0.98	1.96	3.93

Confidence Rating

The results produced are highly dependent on the assumptions made, some of which are uncertain. There are two factors that warrant recognition. The first factor is the coverage of benefits. Where there are multiple types of benefits it is often not possible to quantify all the benefits that may be linked to the investment. The second factor involves uncertainty regarding the assumptions made, including the linkage between the research and the assumed outcomes.

A confidence rating based on these two factors has been given to the results of the investment analysis (Table 12). The rating categories used are High, Medium and Low, where:

High: denotes a good coverage of benefits or reasonable confidence in the assumptions made

Medium: denotes only a reasonable coverage of benefits or some uncertainties in assumptions made

Low: denotes a poor coverage of benefits or many uncertainties in assumptions made

Table 12: Confidence in Analysis of Project

Coverage of Benefits	**Confidence in Assumptions**
High	Medium-Low

Coverage of benefits valued was assessed as High as the key impact, increase in average industry yield due to improved response to weather and climate variation, was valued. Confidence in assumptions was rated as Medium-Low, key data was estimated by the analyst.

Conclusion

The investment in AL14006 has provided almond growers with information and tools to improve production response to a variable and changing climate.

Total funding from all sources for the project was $1.35 million (present value terms). The investment produced estimated total expected benefits of $5.28 million (present value terms). This gave a net present value of $3.94 million, an estimated benefit-cost ratio of 3.93 to 1, an internal rate of return of 14.3% and a modified internal rate of return of 9.4%.

As several social impacts identified were not valued, the investment criteria estimated by the evaluation may be underestimates of the actual performance of the investment.

Glossary of Economic Terms

Cost-benefit analysis:	A conceptual framework for the economic evaluation of projects and programs in the public sector. It differs from a financial appraisal or evaluation in that it considers all gains (benefits) and losses (costs), regardless of to whom they accrue.
Benefit-cost ratio:	The ratio of the present value of investment benefits to the present value of investment costs.
Discounting:	The process of relating the costs and benefits of an investment to a base year using a stated discount rate.
Internal rate of return:	The discount rate at which an investment has a net present value of zero, i.e. where present value of benefits = present value of costs.
Investment criteria:	Measures of the economic worth of an investment such as Net Present Value, Benefit-Cost Ratio, and Internal Rate of Return.
Modified internal rate of return:	The internal rate of return of an investment that is modified so that the cash inflows from an investment are re-invested at the rate of the cost of capital (the re-investment rate).
Net present value:	The discounted value of the benefits of an investment less the discounted value of the costs, i.e. present value of benefits - present value of costs.
Present value of benefits:	The discounted value of benefits.
Present value of costs:	The discounted value of investment costs.

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Dane Thomas, Principal Investigator, SARDI

Abbreviations

ABA	Almond Board of Australia
CRRDC	Council of Research and Development Corporations
DAWR	Department of Agriculture and Water Resources (Australian Government)
ENSO	El Nino Southern Oscillation
GDP	Gross Domestic Product
GVP	Gross Value of Production
IOD	Indian Ocean Dipole
IRR	Internal Rate of Return
MIRR	Modified Internal Rate of Return
OCS	Office of Chief Scientist Queensland
PVB	Present Value of Benefits
RD&E	Research, Development and Extension
SARDI	South Australia Research and Development Institute