Industry-specific impact assessment program: Citrus

Impact assessment report for project *Australian citrus industry innovation and market development program* (CT15012)

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What the report is about

This report presents the results of an impact assessment of a Horticulture Innovation Australia Limited (Hort Innovation) investment in *CT15012: Australian Citrus Industry Innovation and Market Development Program.* The project was funded by Hort Innovation over the period January 2016 to December 2018. The project sought to increase the volume and value of citrus export trade via technology development, value chain training, and market intelligence to support access into high value markets such as China, South Korea and Japan.

Methodology

The investment was analysed qualitatively within a logical framework that included activities and outputs, outcomes and impacts. Impacts were categorised into a triple bottom line framework. Principal impacts identified were then considered for valuation. 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.

Results/key findings

The project investment focused on development of citrus market opportunities and their maintenance and included increasing product value and innovation and improving efficiency and sustainability. This has allowed export market expansion and reduced potential oversupply on the domestic citrus market.

As a result, the investment in CT15012 has provided the Australian citrus industry, including citrus growers, citrus supply chains and marketers, with information and support that has increased profitability across the value chain.

Investment Criteria

Total funding from all sources for the project was $3.17 million (present value terms). All project funding was provided by Hort Innovation. The total value of benefits was $13.31 million resulting in a net present value of $10.14 million (present value terms), a benefit cost ratio 4.20 to 1, an internal rate of return of 141.1% and a modified internal rate of return of 12.8%.

Conclusions

Project CT15012 was successful in that the investment has contributed to increasing the quantity of citrus exports via new market development as well as higher prices of exported product. In addition, this exporting success has been associated with a a potential gain to citrus growers and their supply chains with regard to the avoidance of a potential oversupply on the domestic market.

Keywords

Impact assessment, cost-benefit analysis, CT15012, citrus industry, innovation, market development, market access, market information, agrichemicals, Citrus Australia

Introduction

All research and development (R&D) and marketing levy investments undertaken by Horticulture Innovation Australia Limited (Hort Innovation) are guided and aligned to specific investment outcomes, defined through a Strategic Investment Plan (SIP). The SIP guides investment of the levy to achieve each industry's vision. The current industry SIPs apply for the financial years 2016/17 – 2020/21.

In accordance with the Organisational Evaluation Framework, Hort innovation has the obligation to evaluate the performance of its investment undertaken on behalf of industry.

This impact assessment program addresses this requirement through conducting a series of industry-specific ex-post independent impact assessments of the almond (AL), banana (BA), citrus (CT) and onion (VN) RD&E investment funds.

Twenty-nine RD&E investments (projects) were selected through a stratified, random sampling process. The industry samples were as follows:

- Nine AL projects were chosen worth $5.84 million (nominal Hort Innovation investment) from an overall population of 21 projects worth an estimated $10.78 million,
- Eight BA projects worth $3.02 million (nominal Hort Innovation investment) from an overall population of 24 projects worth approximately $16.72 million,
- Eight CT projects worth $5.40 million (nominal Hort Innovation investment) from a total population of 35 projects worth $15.78 million, and
- Four VN projects worth $2.40 million (nominal Hort Innovation investment) from an overall population of 8 projects worth $3.89 million.

The project population for each industry included projects where a final deliverable had been submitted in the five-year period from 1 July 2014 to 30 June 2019. The projects for each industry sample were chosen such that the investments represented (1) at least 10% of the total Hort Innovation RD&E investment expenditure for each industry, and (2) the SIP outcomes (proportionally) for each industry. Four projects had been randomly selected as part of a related Hort Innovation project (MT18011) and were included in the samples for the AL industry (AL14006 and AL16004) and the CT industry (CT15006 and CT15013). This left 25 unique projects randomly selected for evaluation under MT19012.

Project CT15012: *Australian Citrus Industry Innovation and Market Development Program* was randomly selected as one of the unique investments under MT19012 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

Citrus Industry

The Australian citrus industry is one of Australia's 'traditional' horticultural industries. A range of citrus types are produced in Australia. Oranges are the predominant citrus type grown by tonnage followed by mandarin, lemon/lime and grapefruit, in that order.

Table 1 illustrates some recent descriptive production and supply statistics for the Australian citrus industry. Table 2 illustrates the change in citrus exports (volume and value over the same period.

Table 1: Australian Citrus Production and Value for Years Ending June 2017 to 2019

Year ended June	Total Australian Production (tonnes)	Fresh Supply (tonnes)	Fresh Imports (tonnes)	Fresh Australian Supply (tonnes)	Fresh Supply Wholesale Value (m$)	Fresh Supply Wholesale Value ($/tonne)
2017	714,740	309,822	34,061	275,761	572.2	1,847
2018	747,032	294,956	27,749	267,207	534.7	1,813
2019	744,354	294,568	24,760	269,808	539.0	1,830
Average	735,375	299,782	28,857	270,925	548.6	1,830

Source: Australian Horticultural Statistics Handbook, 2018/19

Table 2: Australian Citrus Exports and Value for Years Ending June 2017 to 2019

Year ended June	Total Australian Production (tonnes)	Fresh Export Volume (tonnes)	Fresh Export Value ($m)	Fresh Export Value ($/tonne)
2017	714,740	218,211	331.7	1520.1
2018	747,032	258,192	427.7	1656.5
2019	744,354	252,250	457.1	1812.1
Average	735,375	242,884	405.5	1669.5

Source: Australian Horticultural Statistics Handbook, 2018/19

However, trend statistics for citrus presented by financial year as in Table 2 can be misleading. This is because the financial year captures a part of two different seasons. As citrus is a biennial bearing crop, there is a heavy crop one year and a light crop the following year. The financial year analysis can also misrepresent short term export trends. For instance, 2019 was another record season with 304 000 tonnes exported during the calendar year (see Table 3). The financial year presentation (Table 2) shows a decrease.

Table 3: Recent Australian Exports by Calendar Year

Year ended December	Fresh Export Volume (tonnes) By calendar year
2017	273,238
2018	256,140
2019	304 252
Average	277,877

Source: Trade Map data (courtesy of Citrus Australia)

Trade volumes have increased from 212,426 tonnes (in the 2015 calendar year) to 304 000 tonnes in calendar year 2019. In four years, trade volumes increased by nearly 100 000 tonnes (David Daniels, pers. comm., Citrus Australia).

Also, the volume increases have been into high returning markets such as China, Japan, Thailand, South Korea, and Viet-Nam (David Daniels, pers. comm., 2020). The value of the trade in calendar 2015 was A$291.9 million and this has increased to A$548.4 million in 2019 (an increase of 87 per cent). In other words, trade volumes have increased by 43 per cent but values have increased by 87 per cent. This is because the industry is now targeting high-returning markets which were previously considered too difficult to access due to a range of technical challenges (David Daniels, pers. comm., 2020).

The research and development activities of the citrus industry are guided by the industry's Strategic Investment Plan (SIP). The activities are funded by levies payable on citrus produced in Australia, as well as by matching government funds and voluntary contributions.

The process of preparing the latest SIP was managed by Hort Innovation in consultation with the Industry Representative Body (Citrus Australia) and the Strategic Investment Advisory Panel. The current citrus SIP has been driven by levy payers and addresses the Australian citrus industry's research and development (R&D) needs (and marketing specifically for the orange industry) from 2017 to 2021.

Project Rationale

Previous to the current SIP and when the project was funded in 2016, the citrus industry was operating under the Australian Citrus R&D Plan (2012-2017). This earlier plan had four key objectives that were pursued under Project CT15012:

1. To develop and maintain market opportunities
2. To increase product value
3. To improve efficiency and sustainability
4. To provide a supportive operating environment

Previous investments made by the citrus industry that were aligned with the same objectives as above included projects addressing market development, market access, market information and a citrus plantings database. During the investment in CT15012, there were also exchanges with other CT projects in the same space including residue monitoring, minimum residue analyses for major citrus export markets, and quality standards for major export markets.

The project set out to increase the volume and value of export trade via technology development, value chain training, and market intelligence to support access into high value markets such as China, South Korea and Japan. Maintaining and increasing trade was considered essential for the industry in order for the production base to remain economically viable.

Project Details

Summary

Project Code: CT15012

Title: *Australian Citrus Industry Innovation and Market Development Program.*

Research Organisation: Citrus Australia Limited

Project Leaders: Judith Damiani, Nathan Hancock (Citrus Australia)

Period of Funding: January 2016 to December 2018

Objectives

The overall aim of the investment was to develop a globally competitive and well informed Australian citrus industry that can reliably supply products that satisfy market requirements and take advantage of market opportunities.

Specific objectives were:

1) To develop and maintain market opportunities
2) To increase product value
3) To improve efficiency and sustainability
4) To provide a supporting operating environment

Logical Framework

Table 4 provides a description of Project CT15012 in a logical framework format, organised by project objectives.

Table 4: Logical Framework for Project CT15012

Activities	**Objective 1: Development/maintenance of market opportunities** • Definition of opportunities and challenges via regular meetings with industry • Coordination of exporter groups • Provision of regular updates to the Export Strategy Plan • Meeting with government and Hort Innovation to improve phytosanitary protocols • Maintenance of the on-line export registration system • Management of online management system • Update instructional manual for citrus exports • Advice to government to support Free Trade Agreements • Coordinate audits and pre-clearance programs by overseas authorities • Provide input into market access R&D program • Participation in the Hort Export Industry Consultative Committee • Participation in Hort Innovation's industry Trade Advisory Panel • Provide communication to industry on regulatory requirements • Coordinate meetings with exporter groups • Coordinate and participate in priority trade shows, inbound and outbound trade missions, and overseas consumer demand activities • Training of crop monitors • Disseminate data on shipping and market conditions • Coordinate crop forecasting and disseminate data on seasonal production • Manage the annual online citrus tree census • Collect and disseminate data on overseas competitor plantings **Objective 2: Increase product value** • Provide a conduit between the National Residue Survey (NRS) program and industry • Participate in and contribute to meetings of the Strategic Agrichemical Review Process • Participated in meetings with agrichemical companies to investigate replacement chemistry • Maintain a watching brief on overseas food safety requirements • Coordinate meetings with industry experts on variety and rootstock development **Objective 3: Improve efficiency and sustainability** • Participate in the AgVet Collaborative Forum • Engage with Integrated Pest Management experts regarding sustainable approaches to pest management • Participate in the citrus Biosecurity Reference Group • Participate in regular meetings of the citrus Pest and Disease Resistance Group • Participate in regular meetings of the citrus Postharvest Reference Group • Coordinate communication of the citrus Agrichemicals Leadership Group • Co-facilitate meetings of the citrus Production Leadership Group **Objective 4: Provide a Supportive Operating Environment** • Coordinate meetings with Industry Development Officers and other experts • Coordinate an International Working Group on citrus postharvest disinfestations • Coordinate a team of Australian researchers to participate in the 2016 International Citrus Congress • Make input into periodical Australian Citrus News

	• Provide input in to online publication Citrus e-News • Coordinate content of the monthly Season Update • Conduct annual forums/workshops in the major citrus growing regions • Coordinate/present at the National Technical Forum • Coordinate/present at the Market Outlook Forum • Coordinate regional committees in major growing regions • Contribute to the development of the next strategic investment plan (2017-2022)
Outputs	**Objective 1: Development/maintenance of market opportunities** • Development of market access priorities and advice to Hort Innovation on R&D for market access • Reports to citrus exporters on pricing and status of export markets • Updates to the citrus Export Strategy Plan • Reports on government meetings on phytosanitary protocols • Registered Crop Monitors trained • Advice to exporters on regulatory export requirements provided in print and electronic format • Commercial and technical advice to government • Audits and pre-clearance programs by overseas authorities completed • Contribution to Horticulture Export Industry Consultative Committee • Communication to industry regarding changes to regulatory requirements • Regular meetings held with exporter groups • Participated in priority trade shows and trade missions • Contribution to overseas market consumer demand studies • Dissemination of data on shipping and market conditions, crop forecasting and seasonal production • Provided an annual Australian citrus tree census report and report on overseas tree competitor plantings to industry participants **Objective 2: Increase product value** • Annual presentations provided on National Residue Survey • Report provided biannually on opportunities and threats with regard to agrichemical usage, pest management and trade compliance • Advice to agrichemical companies • Increased understanding of overseas food safety requirements, with results provided to industry • Communication to industry of rootstock opportunities **Objective 3: Improve efficiency and sustainability** • Ensured that 75% of citrus industry agrichemical priorities were included in the AgVet Forum A list • Technical advice to citrus industry regarding pest and disease management • Input into the citrus Biosecurity Reference Group • Input into the citrus Pest and Disease Reference Group • Input into the citrus Postharvest Reference Group • Input into the citrus Production Leadership Group. • Communication to industry of information on issues associated with biosecurity, pest and disease and postharvest management **Objective 4: Provide a Supportive Operating Environment** • An increase in effective communication channels to industry • Increase in useful information to growers on citrus postharvest disinfestation processes • More timely advice to growers on issues via the Australian Citrus News, Citrus e-News, and Season Updates

	• Coordination of an International Working Group on citrus postharvest disinfestations • Information exchanges made at National Technical Forum and the Market Outlook Forum • Information exchange via regional committees in major growing regions • Contribution to the development of the next citrus strategic investment plan (2017-2022)
Outcomes	• More informed decisions by growers on new area planting decisions • Growers and exporters more informed about export markets and other exporting country supplies, leading to improved selection of export target markets by grower and exporter groups • Improved management of phytosanitary protocols by growers and exporter groups • Some changes in citrus R&D priorities driven by the highlighting of critical constraints to exporting and market access • Increased access to export markets for Australian citrus • More informed growers regarding biosecurity, pest and disease control, agrichemical use and postharvest management • Increased area of citrus registered for export • Reduction in compliance (inspection and certification) costs for exporting citrus • The project leaders of CT15012 have assisted the industry in understanding and fulfilling technical market access requirements and the export trade results presented earlier in both volume and value terms support the success of those efforts. • All of these outcomes have occurred and will continue to occur under the future iteration of the project (CT18002) (David Daniels, pers. comm., 2020).
Impacts	• Increased exports of Australian citrus leading to potential avoidance of a general domestic price decrease to growers • increased profitability of Australian citrus exports through price increases • Increased profitability of Australian citrus production through cost reductions of growers and exporters • Contribution to improved environmental management of Australian citrus producers via improved agrichemical management • Improved efficiency and effectiveness of Australian citrus RD&E investment • Regional community spillover impacts driven by increased profits by citrus growers and their supply chains.

Project Investment

Nominal Investment

Table 5 shows the annual investment (cash and in-kind) in project CT15012 by Hort Innovation. There were no 'other' investors in this project.

Table 5: Annual Investment in the Project CT15012 (nominal $)

Year ended 30 June	Hort Innovation ($)	Total ($)
2016	320,000	320,000
2017	670,000	670,000
2018	691,115	691,115
2019	622,602	622,602
Totals	2,303,717	2 303 717

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 5.

Real Investment and Extension Costs

For the purposes of the investment analysis, investment costs of all parties were expressed in 2019/20 dollar terms using the GDP deflator index (ABS, 2020). There were no additional costs assumed associated with project extension. Results were communicated to the industry and others as part of the project.

Impacts

Table 6 provides a summary of the principal types of impacts delivered by the project. Impacts have been categorised into economic, environmental and social impacts.

Table 6: Triple Bottom Line Categories of Principal Impacts from Project CT15012

Economic	• Contribution to increased exports of Australian citrus leading to potential avoidance of a general price decrease on the domestic market • Contribution to increased profitability of Australian citrus exports • Potential cost reduction of growers and exporters • Improved efficiency and effectiveness of Australian citrus RD&E investment
Environmental	• Contribution to improved environmental management of Australian citrus producers
Social	• Regional community spillover impacts driven by increased profits by citrus growers and their supply chains.

Public versus Private Impacts

Predominantly private industry impacts were identified as emanating from the investment. Industry impacts have been realised by an avoidance of a price decline on the domestic market. This price decline has been avoided by an improvement in exporting decisions. Some public impacts have been delivered as a spin-off to regional communities in citrus growing areas. Also, there may be some public benefits delivered by more targeted and effective R&D investment by public funding agencies managed via Hort Innovation.

Distribution of Private Impacts

The positive impacts on the citrus industry from investment in this project are likely to be shared along the supply chain among growers, packers, wholesalers, and exporters.

Impacts on Other Australian Industries

Impacts on industries other than the citrus industry are not anticipated from the CT15012 investment.

Impacts Overseas

No direct overseas impacts of CT15012 were identified. However, some overseas citrus exporting countries may indirectly lose some market profitability as the Australian export performance improved due partly to the investment.

Match with National Priorities

The Australian Government's Science and Research Priorities and Rural RD&E priorities are reproduced in Table 7. The project findings and related impacts will contribute potentially to all Rural RD&E priorities and to Science and Research Priority 1.

Table 7: 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 Citrus Strategic Investment Plan 2017-2021

The current strategic outcomes and strategies of the citrus industry are outlined the Citrus Strategic Investment Plan 2017-2021[1] (2017). Project CT15012 is directly relevant to a number of the desired outcomes in the SIP. First the project directly addresses the first desired outcome: "Market opportunities in both domestic and especially export markets have been developed and maintained, leading to increased demand and support for citrus prices". This outcome is directly addressed by CT15012 through the embedded strategies 1.1, and 1.3.

In addition, the project addresses outcome 2 via both strategies 2.1 (Safeguard the Australian citrus industry from future biosecurity and phytosanitary risks throughout the value chain) and Strategy 2.2 "Safeguard the Australian citrus industry from injudicious use of agrichemicals throughout the value chain".

The project addressed also:

- Outcome 3: fruit quality and productivity, through some potential influence on R&D priorities (strategy 3.1).
- Outcome 4 increased skills, capacity and knowledge, through the involvement of industry in the project and its communication and extension activities.

It is not surprising that all four desired outcomes in the 2017-2021 Citrus Strategic Investment Plan were addressed by the project investment in CT15012 as one of the activities of CT15012 was to contribute to the development of the next strategic investment plan (2017-2022).

Valuation of Impacts

Impacts Valued

The impacts valued in the assessment of CT15012 were:

- the potential contribution to increased export volumes of Australian citrus leading to potential avoidance of a general price decrease on the domestic market.
- the potential contribution to an increased price for citrus exports due to the development of higher value markets.

Impacts Not Valued

Increased profitability of Australian citrus production (the third impact) was not valued as the changes in quantities and prices for each of domestic and export markets due to the project would need to be estimated, requiring data that were not readily available. Further, the simpler estimate of the first

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

impact valued (avoidance of a potential price decrease on the domestic market) would implicitly include this impact.

The fourth impact, the improved efficiency and effectiveness of R&D investment as influenced by the project would be difficult to value without further examples of how the R&D investment with and without the project may have changed.

The contribution of the project to improved environmental management (the fifth impact) was not valued as specific practices of changed environmental management would be required for credible assumptions to be made. Also, in part, this impact would be included in the valuation approach to the increased export value of Australian citrus.

The sixth impact (the regional community spillovers) were not valued due to the difficulty of making sound linkage assumptions between the project and the impact, the diversity of geographic locations involved, as well as a lack of time and resources.

Summary of Assumptions

The two impacts that were valued were:

1. the contribution the project investment made to increased exports so reducing domestic market supply so reducing price decreases.
2. the contribution the project investment made to the increased unit value of citrus exports

The assumptions that have been developed to value these two impacts are provided in Table 8.

Table 8: Summary of Assumptions for Impacts Valued for CT15012

Variable	Assumption	Source/Comment
Impact 1: Industry gain due to avoided domestic citrus price fall by expanding export markets		
Australian fresh citrus production sold on domestic market	270,925 tonnes per annum (excludes fresh imports, exports and juicing product)	Average for three years (2017-2019) from Table 1
Australian citrus exports	242,884 tonnes per annum	Average for three years (2017-2019) from Table 2
Short term trend in exports (2017-2019)	15,500 tonnes per annum	Data analysis (see Figure 1)
Increase in fresh exports attributed to CT15012	20%	Analyst assumption
Additional exports due to Project CT15012	3,100 tonnes per annum	15,500 tonnes x 20%
Period of additional exports due to project	4 years (2017/18 to 2020/21)	Analyst assumption
Fresh wholesale value domestic market with CT15012	1830.0 per tonne	Table 1
Impact of CT15012 on domestic market price	Increase of 0.5% due to reduction in domestic supply	Analyst assumption
First year of some impact from Stage 3 project (year ended June)	2017/18	
Number of years of impact	4	
Year of final impact	2020/21	
Impact 2: Increased price for exported citrus due to market development impact of CT15012		
Australian citrus exports	242,884 tonnes per annum	Average for three years (2017-2019) from Table 2

Short term trend in price increase	$146 per tonne per annum	Data analysis (See Figure 2)
Increase in export price attributable to new market developments driven by CT15012	10%	Analyst assumption
Increased revenue from exports	$m 3.55 per annum	242,884 tonnes x $146 x 10%
First year of impact	2017/18	Analyst assumptions
Number of years of impact	4	
Year of final impact	2020/2021	
Risk and attribution factors		
Probability of market outcomes (extent of additional exports and export price increases)	75%	Analyst assumptions
Probability of impacts (impact of Project CT15012 on domestic market prices via increased exports and on export price increases via new market development)	75%	
Attribution to Project CT15012	100%	Attribution to quantities and prices already accounted for in other assumptions relating to Impacts 1 and 2

Figure 1: Annual Increase in Australian Citrus Exports 2017-2019

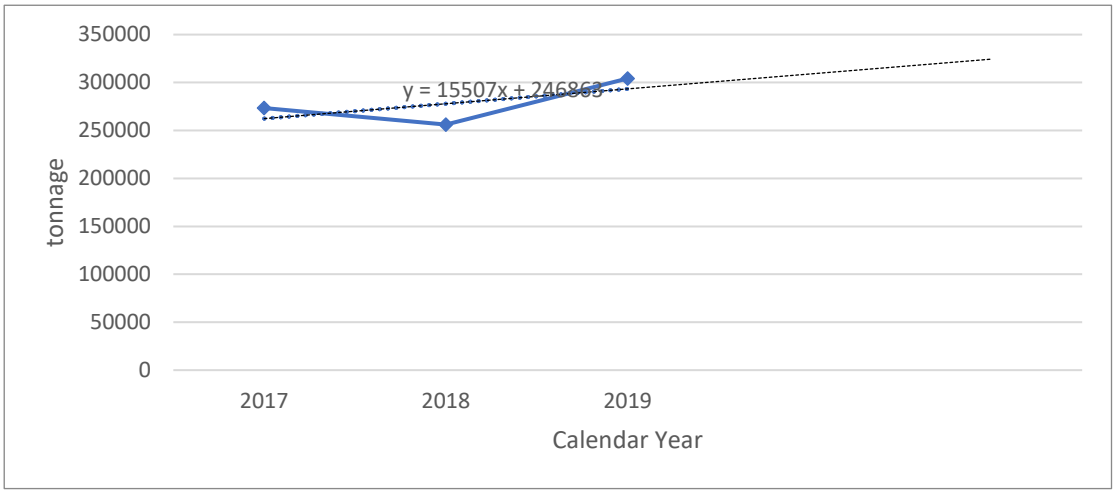
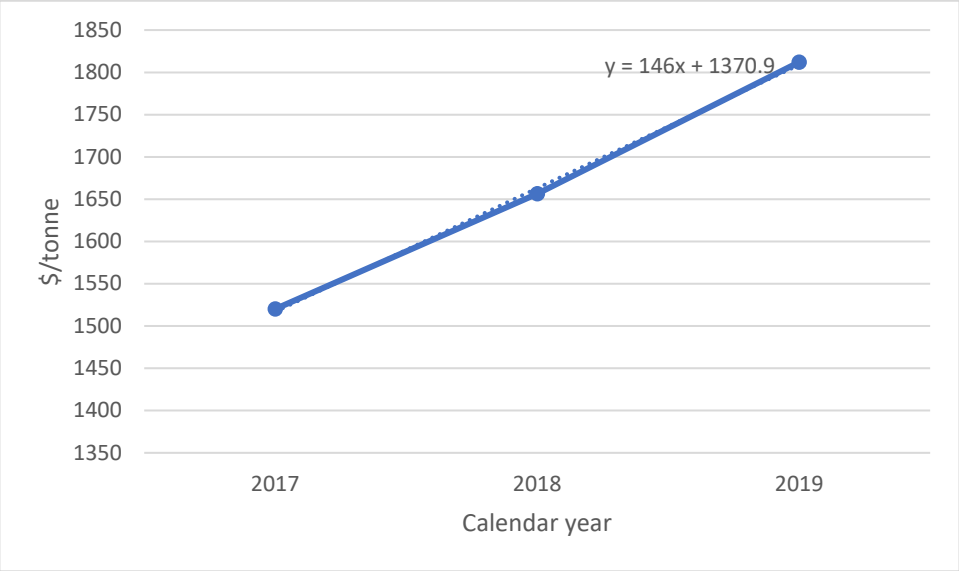


Figure 2: Australian Citrus Export Price Growth ($/tonne)



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 9 and 10 show the investment criteria estimated for different periods of benefits for the total investment and the Hort Innovation investment alone. As Hort Innovation was the only investor in the project, the investment criteria are the same for both tables.

Table 9: Investment Criteria for Total Investment in Project CT15012

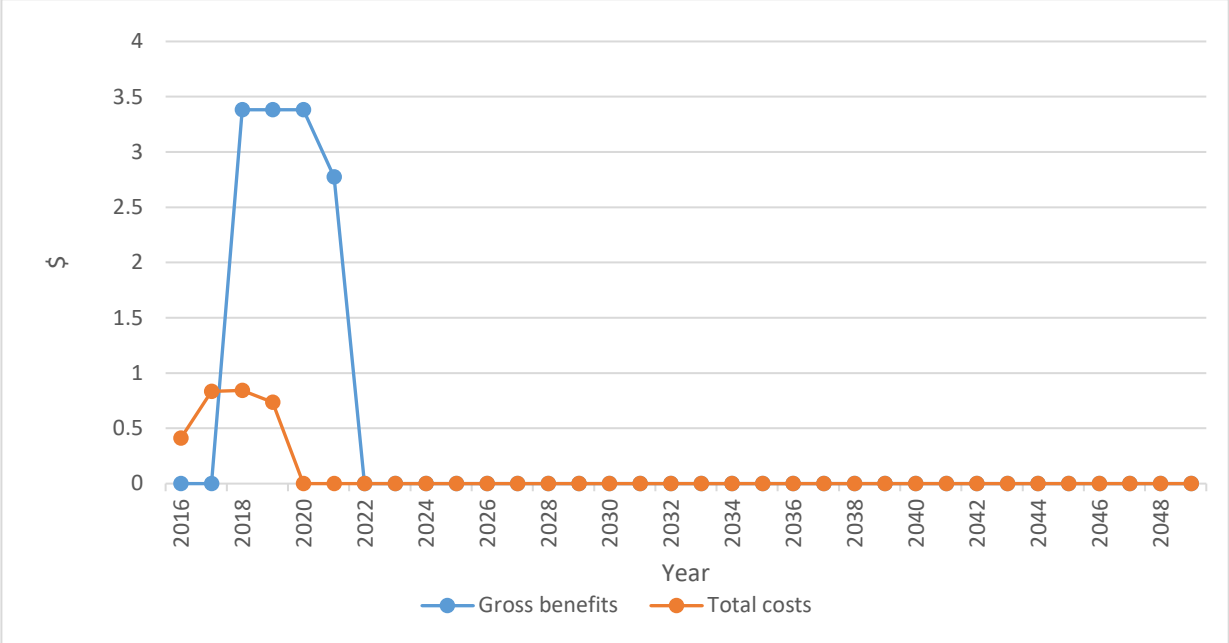
Investment Criteria	**Years after Last Year of Investment**						
	0	**5**	**10**	**15**	**20**	**25**	**30**
Present Value of Benefits ($m)	7.28	13.31	13.31	13.31	13.31	13.31	13.31
Present Value of Costs ($m)	3.17	3.17	3.17	3.17	3.17	3.17	3.17
Net Present Value ($m)	4.11	10.14	10.14	10.14	10.14	10.14	10.14
Benefit-Cost Ratio	2.30	4.20	4.20	4.20	4.20	4.20	4.20
Internal Rate of Return (%)	117.22	141.31	141.31	141.31	141.31	141.31	141.31
MIRR (%)	negative	76.08	32.13	21.72	17.08	14.45	12.76

Table 10: Investment Criteria for Hort Innovation Investment in Project CT15012

Investment Criteria	**Years after Last Year of Investment**						
	0	**5**	**10**	**15**	**20**	**25**	**30**
Present Value of Benefits ($m)	7.28	13.31	13.31	13.31	13.31	13.31	13.31
Present Value of Costs ($m)	3.17	3.17	3.17	3.17	3.17	3.17	3.17
Net Present Value ($m)	4.11	10.14	10.14	10.14	10.14	10.14	10.14
Benefit-Cost Ratio	2.30	4.20	4.20	4.20	4.20	4.20	4.20
Internal Rate of Return (%)	117.22	141.31	141.31	141.31	141.31	141.31	141.31
MIRR (%)	negative	76.08	32.13	21.72	17.08	14.45	12.76

The annual undiscounted benefit and cost cash flows for the total investment for the duration of the CT15012 investment plus 30 years from the last year of investment are shown in Figure 3.

Figure 3: Annual Cash Flow of Undiscounted Total Benefits and Total Investment Costs



Sources of Benefits

The respective contributions of the two impacts valued are provided in Table 11.

Table 11: Contribution of Source of Benefits to Present Value of Benefits (PVB)
(Total investment, 30 years)

Source of Benefit	PVB $m	PVB (%)
Benefit 1: Avoided losses on domestic citrus market	5.70	42.8
Benefit 2: Increased value of citrus exports	7.61	57.2
Total	13.31	100.0

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 12 presents the results that show a low sensitivity to the discount rate due to the limited time gap between the investment costs and the benefits (See Figure 3).

Table 12: Sensitivity to Discount Rate
(Total investment, 30 years)

Investment Criteria	Discount rate		
	0%	5%	10%
Present Value of Benefits ($m)	12.92	13.31	13.72
Present Value of Costs ($m)	2.82	3.17	3.54
Net Present Value ($m)	10.10	10.14	10.18
Benefit-cost ratio	4.57	4.20	3.87

A sensitivity analysis was then undertaken for a set of optimistic and pessimistic assumptions for the two impacts compared to the base assumptions. Results are provided in Table 13.

Table 13: Sensitivity to Optimistic and Pessimistic Assumptions of the Impact of CT15012 (Total investment, 30 years)

Investment Criteria	Pessimistic	Base	Optimistic
	Reduction in domestic market price of 0.25% and a contribution of 5% of the increase in export prices	Reduction in domestic market price of 0.5% and a contribution of 10% of the increase in export prices	Reduction in domestic market price of 1% and a contribution of 20% of the increase in export prices
Present Value of Benefits ($m)	6.66	13.31	26.54
Present Value of Costs ($m)	3.17	3.17	3.17
Net Present Value ($m)	3.49	10.14	23.37
Benefit-cost ratio	2.10	4.20	8.38

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 14). 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 14: Confidence in Analysis of Project

Coverage of Benefits	Confidence in Assumptions
High	Low-Medium

Coverage of benefits was assessed as High. The most important impacts from the investment were valued.

Confidence in assumptions for valuation was rated as Low-Medium as some of the assumptions made relating to the contribution of the project to the impacts valued were not supported by specific data and had to be made by the use of subjective but conservative assumptions.

Conclusions

The investment in CT15012 is likely to have contributed to increased citrus exports and values that have increased industry profitability, as well as reduced supply on the domestic citrus market, resulting an increase in a further profitability increase along the citrus supply chain.

Total funding from all sources for the project was $3.17 million (present value terms). The investment produced estimated total expected benefits of $13.31 million (present value terms). This gave a net present value of $10.14 million, an estimated benefit-cost ratio of 4.20 to 1, an internal rate of return of 141.3% and a modified internal rate of return of 12.8%.

However, a number of other impacts identified relating to, for example improved efficiency of RD&E investment or increased regional community spill-overs, were not valued in monetary terms. Consequently, the investment criteria as provided by the valued benefits are likely to be underestimated.

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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Abbreviations

CRRDC	Council of Research and Development Corporations
DAWR	Department of Agriculture and Water Resources (Australian Government)
GDP	Gross Domestic Product
OCS	Office of Chief Scientist Queensland
R&D	Research and Development
RD&E	Research, Development and Extension
SIP	Strategic Investment Plan