

# Industry-specific impact assessment program: Citrus

## Impact assessment report for project *Driving citrus industry success through a coordinated market development program - Stage 2 (CT13022)*

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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 *CT13022: Driving citrus industry success through a coordinated market development program Stage 2*. The project was funded by Hort Innovation over the period 9 July 2013 to 31 December 2015.\

In 2013 while much of Australian citrus production was consumed within Australia, export markets were starting to expand. The Australian industry was facing a number of challenges on both its domestic and export markets including meeting market requirements, agrichemical usage for both domestic and importing country requirements, and information assembly and timely dissemination to assist marketing decisions.

It was recognised that technical and market support was required to address these issues and a coordinated and focused market development efforts were required to ensure synergies and coordination between projects and activities were maximised. The project followed on from an earlier citrus market development project CT09055.

### 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 coordinating and integrating industry efforts across the supply chain regarding critical domestic issues such as agrichemical use, and market access. The project facilitated information dissemination and associated decision making across the supply chain and has contributed significantly to export market expansion.

### Investment Criteria

Total funding from all sources for the project was \$1.90 million (present value terms). The investment produced estimated total expected benefits of \$6.61 million (present value terms). This gave a net present value of \$4.71 million, an estimated benefit-cost ratio of 3.48 to 1, an internal rate of return of 40.5% and a modified internal rate of return of 10.0%. However, as number of other impacts identified were not valued in monetary terms, the investment criteria as provided by the valued benefits are likely to be underestimated.

### Conclusions

Project CT13002 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 in an increase in a further profitability gains.

## Keywords

Impact assessment, cos-benefit analysis, CT13022, citrus industry, market development, citrus exports, 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 CT13022: *Driving citrus industry success through a coordinated market development program Stage 2* was randomly selected as one of the 25 unique MT19012 investments 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 following provides some recent descriptive production and supply statistics for the Australian citrus industry over the past three years. 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	1,520.1
2018	747,032	258,192	427.7	1,656.5
2019	744,354	252,250	457.1	1,812.1
Average	735,375	242,884	405.5	1,669.5

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.

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### Project Rationale

In 2013 while much of Australian citrus production was consumed within Australia, export markets were expanding. The industry was facing a number of opportunities and challenges on both its domestic and export. Some of these issues included:

- pest and disease pressures and an ongoing review of agrichemical usage
- ensuring fruit supply that met the quality, sweetness and appearance desired by consumers
- ensuring fruit supply that met importing country regulatory requirements (e.g. phytosanitary, food safety, grading, packaging and labelling)
- ensuring citrus exporters have timely access to data to inform marketing decisions
- ensuring key markets remain open
- ensuring services delivered along the supply chain are timely, efficient and effective.

It was recognised that technical and market support was required to address these issues and a coordinated and focused market development program was required to ensure synergies and coordination between projects and activities were maximised. The project followed on from an earlier citrus market development project CT09055.

## Project Details

### Summary

Project Code: CT13022

Title: *Driving citrus industry success through a coordinated market development program Stage 2*

Research Organisation: Citrus Australia Limited

Project Leader: Andrew Harty

Period of Funding: 9 July 2013 to 31 December 2015

### Objectives

The objectives of the project investment were:

- To oversee a suite of existing and new market development projects associated with quality standards, market access, agricultural residue monitoring, and new projects associated with market information and biosecurity.

- To oversee and develop industry linkages and consultation processes, including advisory committees, regional advisory committees, regional extension, reference groups and communication activities.
- To support the effectiveness of the levy investment in research and development.
- To carry out export enhancement activities including in areas of market development, market supply coordination, agrichemical development and usage, and fruit fly management.

### Logical Framework

Table 4 provides a description of Project CT13022 in a logical framework format, organised by project activities, outputs, outcomes and impacts within each of five broad components. The five components were: project management via a steering committee, oversight of market development projects, industry linkages and consultation, R&D implementation, and specific services.

Table 4: Logical Framework for Project CT13022

<p>Activities</p>	<p><u>Project management</u></p> <ul style="list-style-type: none"> <li>• Establishment of a steering committee to assess annual operating plans, review project progress and changes needed, and participate in project evaluation.</li> </ul> <p><u>Oversight of market development projects</u></p> <ul style="list-style-type: none"> <li>• The market development projects that were oversighted included projects addressing market access (CT12005), quality improvement (CT12004), market intelligence (CT13037), a national planting database (CT14010) and the citrus agrichemical residue monitoring program (CT11011).</li> </ul> <p><u>Industry linkages and consultation</u></p> <ul style="list-style-type: none"> <li>• Industry linkages and consultation included activities regarding: <ul style="list-style-type: none"> <li>○ the maintenance of linkages with regional citrus Industry Development Officers.</li> <li>○ communications with industry via print and electronic media.</li> </ul> </li> </ul> <p><u>R&amp;D implementation</u></p> <ul style="list-style-type: none"> <li>• R&amp;D implementation included activities regarding: <ul style="list-style-type: none"> <li>○ both formal and informal interaction with researchers undertaking citrus projects.</li> <li>○ organisation of workshops to bring researchers and industry experts together to focus on priority areas, such as quality improvement and agrichemical management.</li> </ul> </li> </ul> <p><u>Specific services</u></p> <ul style="list-style-type: none"> <li>• Specific service activities included: <ul style="list-style-type: none"> <li>○ export market development, via trade missions and other trade development activities.</li> <li>○ export market supply coordination via seasonal teleconferences of exporter groups.</li> <li>○ coordination of the industry’s agrichemicals framework.</li> <li>○ support for regional fruit fly management.</li> </ul> </li> </ul>
<p>Outputs</p>	<p><u>Project management</u></p> <ul style="list-style-type: none"> <li>• Ongoing contribution with advice to evaluating plans progress and directional change where appropriate.</li> </ul> <p><u>Oversight of market development projects</u></p> <ul style="list-style-type: none"> <li>• The oversight role added value to individual projects by ensuring any synergies were exploited and cohesion took place with other citrus R&amp;D projects.</li> <li>• This was achieved with respect to quality standards, market access, chemical residue monitoring, information delivery, and addressing readiness for preparing for biosecurity threats.</li> </ul> <p><u>Industry linkages and consultation</u></p> <ul style="list-style-type: none"> <li>• Three committees were established addressing:</li> </ul>



<ul style="list-style-type: none"><li>○ Export market</li><li>○ Domestic market</li><li>○ Varieties</li><li>● Regional Advisory Committee were established.</li><li>● Industry Development Officers (or equivalent) were established in each citrus region.</li><li>● Regional forums were organised and held in each of the main producing areas.</li><li>● The market development team were involved in various communication products such as Australian Citrus News.</li></ul> <p><u>R&amp;D implementation</u></p> <ul style="list-style-type: none"><li>● A research reference group was established to conduct evaluations.</li><li>● The group provided ranking of project proposals, prior to funding decisions being made by the industry advisory committees.</li><li>● A workshop held to formulate a research program to improve eating quality of Australian citrus.</li><li>● A workshop and a series of teleconferences were held with an international postharvest infestation group and Australian agencies resulting in information exchange and adjustments to trial work.</li></ul> <p><u>Specific services</u></p> <ul style="list-style-type: none"><li>● Value added to trade missions.</li><li>● Coordination of Australian presence at the China Fruit and Vegetable Fairs in 2013, 2014 and 2015.</li><li>● Export market supply coordination under an exemption agreement with Australian authorities.</li><li>● Establishment of a dedicated Queensland Citrus exporter Group.</li><li>● Update of the Citrus Strategic Agrichemical Review Process.</li><li>● Contribution to fruit fly campaign in the Riverland region.</li></ul> <p><u>Summary of Key Project Outputs</u></p> <ul style="list-style-type: none"><li>● Contribution to the development of the citrus export trade to China.</li><li>● Development of agrichemicals management framework.</li><li>● Establishment of a citrus agrichemical residue monitoring program.</li><li>● Resolution of Japan agrichemical issues.</li><li>● Postharvest fungicide labelling.</li><li>● Export market coordination.</li><li>● Improvement to industry consultation and communication processes.</li><li>● Organisation and coordination of effective national events for the citrus industry.</li><li>● Driving a quality culture in the industry.</li><li>● Improving delivery of market intelligence to industry.</li><li>● Establishment of an effective market development team.</li></ul> <p><u>Recommendations for the next stage of the citrus market development program</u></p> <ul style="list-style-type: none"><li>● The market development project should be continued in any Stage 3.</li><li>● An ongoing revision of project directions should be included.</li><li>● There needs to be flexibility to respond to new issues in any new market development program.</li><li>● Ongoing input into the development of R&amp;D programs should be built into any Stage 3 project.</li><li>● Industry management of agrichemicals is vital in any new program and expansion of residue monitoring needs to be an objective.</li><li>● The R&amp;D program on Ultra-low residue citrus and the sweeter citrus program should be initiated as a matter of urgency.</li><li>● The biosecurity threat from of Huanglongbing (Citrus Greening should be monitored.</li><li>● A risk mitigation study of potential trade closures should be included in any Stage 3.</li></ul>
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	<ul style="list-style-type: none"> <li>• The network of various consultation groups should be maintained and strengthened.</li> <li>• The Season Update communication activity should be refreshed.</li> <li>• Building skills capacity for the industry needs to be given some priority.</li> <li>• A goal of doubling the citrus industry export value between 2015 and 2025 should direct the activities of any future stage of the project.</li> </ul>
Outcomes	<p><i>Recommendations</i></p> <ul style="list-style-type: none"> <li>• Almost all of the recommendations have been incorporated into future iterations of the project (namely CT15012 and CT18002). The agrichemicals component has been incorporated into a new project specifically on agrichemicals (CT18001) but the ‘ultra-low residue’ component has been challenging to execute (David Daniels, pers. comm., 2020).</li> <li>• The goal of doubling export value between 2015 and 2025 has almost been achieved five years ahead of schedule. In this time the value of the export trade has gone from \$A291 million to \$A549 million. This is largely due to increased trade volumes into high value markets such as China. CT13022 laid the foundations for that trade and without those foundations, the expansion above would not likely to have taken place.</li> <li>• A potential increase in export market development achievements from improved synergies and interactions between market development projects, specifically relating to quality standards, market access, and chemical residue monitoring.</li> <li>• Some changes have occurred in the prioritisation of research investment driven by new issues relating to market development.</li> <li>• There have been a large number of minor market access improvements since due to the CT13022 investment; however, these improvements do lead to material differences for citrus business in the form of increased efficiencies and reduced costs.</li> <li>• The agrichemical program (monitoring and risk management) that was established under CT13022 continues to advance the industry. Exporters have timely access to importing country maximum residue limits (MRLs) and an efficient and effective program for residue testing prior to export. This has been critical to managing MRL risks in Japan, Thailand Taiwan and Indonesia (David Daniels, pers. comm., 2020).</li> <li>• A potential strengthening of the delivery and communication of information to citrus growers through the facilitation of industry linkages leading to an increase in grower productivity, profitability and environmental sustainability.</li> <li>• The extensive networks formed during CT13022 have remained strong and are a legacy to the project leader (Andrew Harty). There are currently regionally-based and ‘issues related’ committees across Australia which provide a valuable linkage between levy payers and Hort Innovation. Currently, the new project leaders are coordinating meetings between Hort Innovation and the committees to provide industry input into Hort Innovation’s next 5-year Strategic Investment plan for the citrus industry (David Daniels, pers. comm., 2020).</li> </ul>
Impacts	<ul style="list-style-type: none"> <li>• An increase in the rate of export market expansion with reduced pressure on quantities placed on the domestic market.</li> <li>• Contribution to increased profitability of Australian citrus exports through price increases.</li> <li>• An increase in grower profitability due to cost reductions of growers and exporters.</li> <li>• Improved efficiency and effectiveness of Australian citrus RD&amp;E investment</li> <li>• Contribution to improved environmental management of Australian citrus producers via improved agrichemical management</li> <li>• Regional community spill-over impacts driven by increased profits by citrus growers and their supply chains.</li> </ul>

## Project Investment

### Nominal Investment

Table 5 shows the annual investment in project CT13022 by Hort Innovation. There were no ‘other’ investors in this project.

Table 5: Annual Investment in Project CT13022 (nominal \$)

Year ended 30 June	Hort Innovation (\$)	Total (\$)
2014	388,472	388,472
2015	392,373	392,373
2016	160,913	160,913
2017	235,439	235,439
<b>Totals</b>	<b>1,177,197</b>	<b>1,177,197</b>

### 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 CT13022

Economic	<ul style="list-style-type: none"> <li>An increase in the rate of export market expansion with a consequent reduced pressure on domestic market returns.</li> <li>Contribution to increased profitability of Australian citrus exports through price increases.</li> <li>An increase in grower profitability due to cost reductions of growers and exporters.</li> <li>A more effective and efficient allocation of citrus research resources</li> </ul>
Environmental	<ul style="list-style-type: none"> <li>An increase in attention to environmental sustainability and improved environmental management via use of agrichemicals.</li> </ul>
Social	<ul style="list-style-type: none"> <li>Regional community spill-over impacts driven by increased productivity and profitability by citrus growers and their supply chains.</li> </ul>

### Public versus Private Impacts

Predominantly private industry impacts to Australian citrus supply chains were identified as emanating from the investment. Some public impacts have been delivered as a result of improved environmental management and spinoffs to regional communities in citrus growing areas from the citrus profitability increase.

### 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 and associated agents.

### Impacts on Other Australian Industries

Impacts on industries other than the citrus industry are not anticipated from the CT13002 investment.

### Impacts Overseas

No direct overseas impacts of CT13022 were identified. However, some overseas citrus growers and exporters may indirectly lose some export market profitability as the Australian industry has expanded its export markets.

### 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	1. Food
2. Biosecurity	2. Soil and Water
3. Soil, water and managing natural resources	3. Transport
4. Adoption of R&D	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<sup>1</sup> (2017). Project CT13022 is directly relevant to all of the desired outcomes in the SIP. For example, the project directly addresses Outcome 1: “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 CT13022 through the embedded strategies 1.1, and 1.3. Outcome 2 is addressed via strategy 2.2. In addition, the project addresses Outcome 4 via strategy 4.2 (Ensure growers and other members of the value chain are fully aware of industry developments).

## Valuation of Impacts

### Impacts Valued

The impacts valued in the assessment of CT13022 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.

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

### Impacts Not Valued

increased profitability of Australian citrus production (the third impact in Table 6) 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 impact valued (avoidance of a potential price decrease on the domestic market) would implicitly include this impact.

The fourth impact in Table 6, 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 spill-overs) 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:

Impact 1: the contribution the project investment made to increased exports so reducing domestic market supply so reducing price decreases.

Impact 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 CT13002

Variable	Assumption	Source/Comment
<b>Impact 1: Industry gain due to avoided domestic citrus price fall by expanding export markets</b>		
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 CT13002	7.5%	Analyst assumption
Additional exports due to Project CT13002	1,162.5 tonnes per annum	15,500 tonnes x 7.5%
Period of additional exports due to project	4 years (2017/18 to 2020/21)	Analyst assumption
Fresh wholesale value domestic market with CT13002	\$1830.0 per tonne	Table 1
Impact of CT13002 on domestic market price	Avoided price reduction of 0.4% 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	

<b>Impact 2: Increased price for exported citrus due to market development impact of CT13022</b>		
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 tonnes per annum	Data analysis (See Figure 2)
Increase in export price attributable to new market developments driven by CT15012	2.5%	Analyst assumption
Increased revenue from exports	\$m 0.89 per annum	242,884 tonnes x \$146 x 5%
First year of impact	2017/18	Analyst assumptions
Number of years of impact	4	
Year of final impact	2020/2021	
<b>Risk and attribution factors</b>		
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: Australian Citrus Export Growth (tonnes)

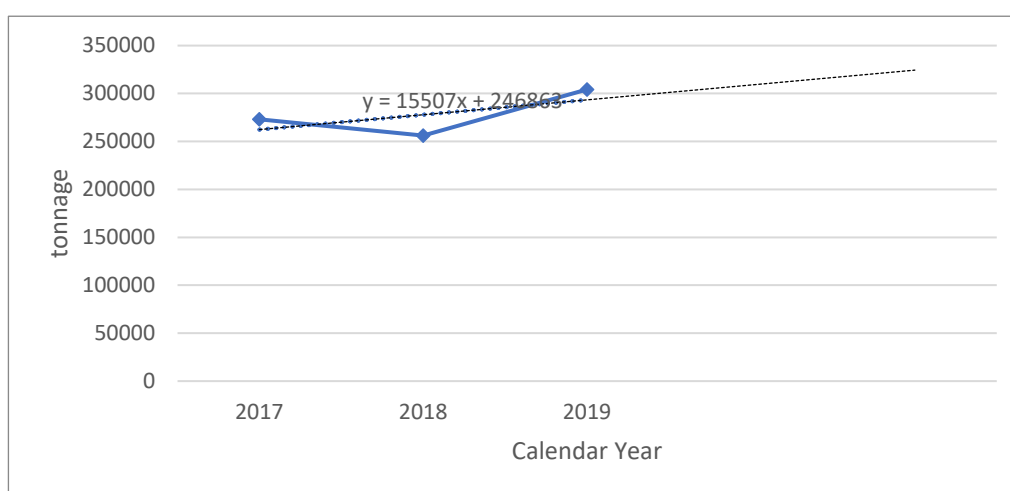
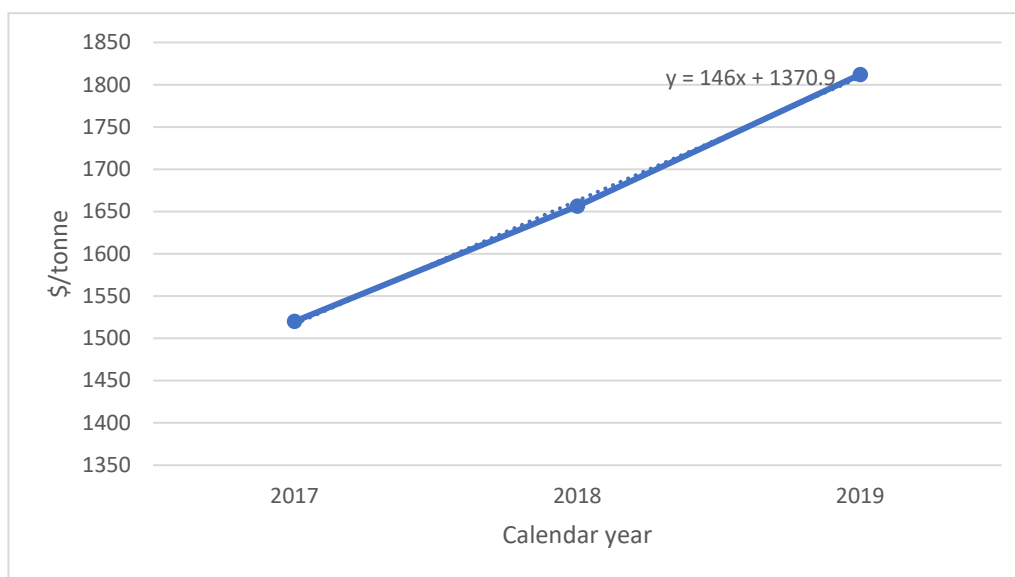


Figure 2: Australian Citrus Export Price Growth (\$/tonne)



## 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 CT13022

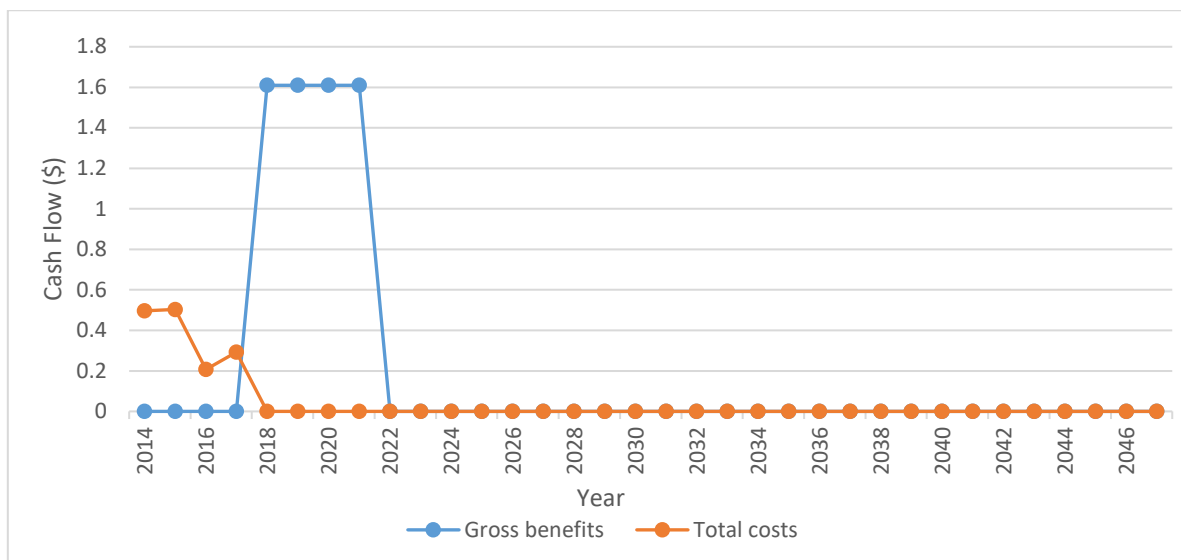
Investment Criteria	Years after Last Year of Investment						
	0	5	10	15	20	25	30
Present Value of Benefits (\$m)	0.00	6.61	6.61	6.61	6.61	6.61	6.61
Present Value of Costs (\$m)	1.90	1.90	1.90	1.90	1.90	1.90	1.90
Net Present Value (\$m)	-1.90	4.71	4.71	4.71	4.71	4.71	4.71
Benefit-Cost Ratio	0.00	3.48	3.48	3.48	3.48	3.48	3.48
Internal Rate of Return (%)	negative	40.52	40.52	40.52	40.52	40.52	40.52
MIRR (%)	negative	95.91	25.48	16.50	12.99	11.13	9.96

Table 10: Investment Criteria for Hort Innovation Investment in Project CT13022

Investment Criteria	Years after Last Year of Investment						
	0	5	10	15	20	25	30
Present Value of Benefits (\$m)	0.00	6.61	6.61	6.61	6.61	6.61	6.61
Present Value of Costs (\$m)	1.90	1.90	1.90	1.90	1.90	1.90	1.90
Net Present Value (\$m)	-1.90	4.71	4.71	4.71	4.71	4.71	4.71
Benefit-Cost Ratio	0.00	3.48	3.48	3.48	3.48	3.48	3.48
Internal Rate of Return (%)	negative	40.52	40.52	40.52	40.52	40.52	40.52
MIRR (%)	negative	95.91	25.48	16.50	12.99	11.13	9.96

The annual undiscounted benefit and cost cash flows for the total investment for the duration of the CT13022 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



### Source of Benefits

The respective contributions of the two impacts valued are provided in Table 12.

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	4.561	69.0
Benefit 2: Increased value of citrus exports	2.047	31.0
Total	6.61	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 moderately 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)	6.44	6.61	6.79
Present Value of Costs (\$m)	1.50	1.90	2.38
Net Present Value (\$m)	4.94	4.71	4.41
Benefit-cost ratio	4.29	3.48	2.85

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 CT13022 (Total investment, 30 years)

Investment Criteria	Pessimistic	Base	Optimistic
	Reduction in domestic market price of 0.2% and a contribution of 1.5% of the increase in export prices	Reduction in domestic market price of 0.4% and a contribution of 2.5% of the increase in export prices	Reduction in domestic market price of 1% and a contribution of 5% of the increase in export prices
Present Value of Benefits (\$m)	3.51	6.61	15.43
Present Value of Costs (\$m)	1.90	1.90	1.90
Net Present Value (\$m)	1.62	4.71	13.53
Benefit-cost ratio	1.85	3.48	8.13

### 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
Medium	Low-Medium

Coverage of benefits was assessed as Medium. The two most important impacts from the investment were valued, although four other impacts identified were not valued.

Confidence in assumptions for monetary valuation was rated as Low-Medium as some of the assumptions made relating to the contribution of the project to the impacts valued were difficult to support with data available and relied on the use of subjective but conservative assumptions.

## Conclusions

The investment in Project CT13002 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 in an increase in a further profitability increase along the citrus supply chain.

Total funding from all sources for the project was \$1.90 million (present value terms). The investment produced estimated total expected benefits of \$6.61 million (present value terms). This gave a net present value of \$4.71 million, an estimated benefit-cost ratio of 3.48 to 1, an internal rate of return of 40.5% and a modified internal rate of return of 10.0%.

However, as number of other impacts identified were not valued in monetary terms, 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