Horticulture Impact Assessment Program:

Appendix 5: Implementing brown sugar flotation for assuring freedom of fruit from fruit fly (CY16011 Impact Assessment)

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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 *CY16011: Implementing brown sugar flotation for assuring freedom of fruit from fruit fly.* The project was funded by Hort Innovation over the period February 2017 to February 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

The investment in CY16011 is likely to have contributed to improved monitoring and detection of fruit fly in Australian cherries using brown sugar flotation. Consequently, CY16011 is may contribute to future reductions in costs associated with testing cherry products for fruit fly, reduced risk of the spread of fruit fly through cherries, and maintained market access for Australian export cherries (through reduced risk of spread to domestic pest free areas).

Investment Criteria

Total funding from all sources for the project was $0.14 million (present value terms). The investment produced estimated total expected benefits of $0.41 million (present value terms). This gave a net present value of $0.27 million, an estimated benefit-cost ratio of 3.0 to 1, an internal rate of return of 15.1% and a MIRR of 6.5%.

Conclusions

Several other economic impacts were also identified but not valued as part of the current assessment. Given the impacts not valued, combined with conservative assumptions made for the principal economic impact valued, it is reasonable to conclude that the investment criteria reported may be an underestimate of the actual performance of the CY16011 investment.

Keywords

Impact assessment, cost-benefit analysis, CY16011, fruit, fruit fly, sugar flotation, BSF, cherry, market access

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 *CY16011: Implementing brown sugar flotation for assuring freedom of fruit from fruit fly* 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 actual and/or potential 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 used 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 Cherry Industry

Cherries are a fleshy stone fruit from the plants of the genus *Prunus*. The main species cultivated for edible fruit are sweet, or 'wild', cherries (*Prunus avium*) and sour cherries (*Prunus cerasus*) (AgriFutures Australia, 2017). There are approximately 485 cherry growers across Australia with around 2,845 hectares under planting (Cherry Growers Australia Inc., 2019). Cherries are produced in six states, with New South Wales, Victoria and Tasmania being the largest producers.

In 2018/19 Australia produced approximately 20,148 tonnes of cherries worth an estimated $189.3 million (Hort Innovation, 2020). The Australian cherries seasons generally starts in late October/early November and peaks in the weeks leading up to Christmas (December). Approximately 70% of Australian cherry production is sold to the domestic market with the remained exported to around 30 different countries around the world (AgriFutures Australia, 2017).

Fruit Fly in Australian Cherries

International demand has been driving expansion for the Australian cherry industry. However, as with most agricultural industries, industry productivity and growth may be constrained by pest and disease pressure. Queensland fruit fly (Qfly) and Mediterranean fruit fly (MedFly) are two of the most destructive agricultural pests for fruit and vegetables in Australia. Fruit fly larvae feed within the fruit and cause significant crop losses in terms of yield and quality. Fruit flies are generally spread through the movement of maggot-infested produce, making domestic and international biosecurity especially important (Plant Health Australia, 2013).

Sweet cherries are a host fruit of Qfly and MedFly. However, while readily infested in a laboratory, it is extremely rare to find cherry fruit naturally infested in the field as cherries tend to be grown in areas with cold winters and are harvested early in summary before the major build-up of fruit fly populations. Despite this, protocols for cherries going to fruit fly sensitive markets are based on extremely high levels of field infestation and stringent treatments are mandated to reduce the risk to negligible levels (Ekman, 2019). The presence of fruit fly precludes Australian cherries from entry to a number of interstate and international markets, limiting industry growth.

Rationale

The Australian cherry industry has been developing a systems approach for managing the risk of Qfly/ MedFly infestation of fresh fruit. Testing for the presence/ absence of fruit fly larvae forms a key part of the approach. However, the testing process is destructive and labour intensive as the fruit must be

dissected and examined for larvae. Further, the current process is unlikely to detect fruit fly eggs. A previous Hort Innovation project, CY14009, demonstrated that brown sugar flotation (BSF) can be used to detect and quantify the eggs and/or larvae in cherry fruit. Project CY16011 (*Implementing brown sugar flotation for assuring freedom of fruit from fruit fly*) was funded to adapt and refine the the BSF method developed in project CY14009 for commercial operations.

Project Details

Summary

Project Code: CY16011

Title: *Implementing brown sugar flotation for assuring freedom of fruit from fruit fly*

Research Organisation: Applied Horticulture Research Pty Ltd (AHR)

Principal Investigator: Jenny Ekman

Period of Funding: February 2017 to February 2019

Objectives

The objectives of the investment were to:

1. Develop a standardised protocol for BSF of cherries
2. Conduct workshops and develop training materials on use of BSF
3. Trial implementation of BSF as part of a sytems approach for market access

Logical Framework

Table 1 provides a description of CY16011 in a logical framework.

Table 1: Logical Framework for Project CY16011

Activities	• Risk under the systems approach was being quantified under project AM17001.
	• Work undertaken by New South Wales Department of Primary Industries (NSW DPI) as part of project CY14009 had already developed the basic procedure for BSF of cherries. Key findings from the project were:
	  ○ Breaking the cherries open using a mechanical crusher instead of by hand improved the detection of fruit fly eggs.
	  ○ As long as there were more than five eggs inside an infested cherry the probability of detecting at least one egg was 87%-100%.
	  ○ There was 100% probability of detecting at least one larva from an infested cherry fruit, even if less than five were present.
	  ○ Including 80 or more cherries within a crush slightly reduced detections of larvae.
	• Trials were conducted to further optimise the method. The trials examined:
	  ○ The effect of different sugar concentrations (brix) on detection of fruit fly eggs,
	  ○ Whether making the sugar solution several weeks in advance altered its effectiveness,
	  ○ Whether increasing the settling time improved detection of floating eggs, and
	  ○ The effect of changing the gap settings inside the cherry crusher on the percentage of eggs floating free.
	• Project partner NSW DPI conducted the trials at the Ourimbah laboratory using a mechanical cherry crusher and each trial was replicated three times.
	• Training materials were prepared and tested at industry workshops. The materials then were re-drafted based on comments received from workshop participants.
	• A short video was developed to demonstrate the BSF process.
	• The approach combined in-field monitoring using a trapping grid and post-harvest inspection using BSF and two lots of 600 reject fruit were sampled during the harvest season.

	• In December 2018 and January 2019 the BSF procedure was conducted on fruit from orchards in Orange and Young (NSW). • 15 businesses submitted samples for testing and 17,135 cherries were examined. • 30 samples of suspect objects were submitted to the NSW DPI collections unit for identification.

Outputs	• The project confirmed that the BSF method was representative. Results of the BSF trials showed that:
	  ○ Brix levels less than approximately 16.5% were ineffective at floating fruit fly eggs.
	  ○ Brix of brown sugar solutions did not change during up to 19 days storage at 4oC and the percentage of eggs that floated was the same for fresh solutions and solutions that were up to eight days old.
	  ○ Settling times of ten minutes, one or two hours similarly made no difference to the percentage of eggs that could be seen floating on the solution surface.
	  ○ There was no significant difference in recovery rates when cherries were crushed between a 5mm or 3mm crusher gap. However, there was a trend to dislodging more eggs as the cherries were more finely crushed.
	• A standardised BSF procedure was developed and distributed to members of the cherry industry. The procedure also has been made available on the Cherry Growers Association (CGA) website as a downloadable document. https://www.cherrygrowers.org.au/assets/PASE_Brown_Sugar_Floatation.pdf
	• The procedure includes identification sheets to assist growers and processors with identification of fruit fly eggs and larvae and distinguishing them from vinegar fly.
	• A video demonstrating the standard procedure was created and published on the CGA website and on YouTube: https://www.cherrygrowers.org.au/assets/PASE_Brown_Sugar_Floatation.pdf
	• Project results were presented to members of the cherry industry in June and September of 2018.
	• An article on the project was published in the cherry industry newsletter in November 2017.

Outcomes	• Once the method was confirmed as representative, the method was incorporated into a pilot trade run to validate the systems approach. The trial for cherries produced in fruit fly endemic areas was conducted in South Australia. The trial also served to demonstrate to the international community that the method worked and was being used domestically. • At least three NSW businesses used the BSF procedure to export to South Australia during the 2018/19 season. • Some Australian cherry producers have adopted the procedure but adoption by primary producers has been limited. • On the other hand, there has been evidence of strong adoption of the BSF procedure at the state biosecurity level. • This has resulted in improved biosecurity data for cherries showing that Qfly rarely infests cherries. The data are being used to improve exporter and importer understanding of the risk involved in exporting cherries from Qfly (and MedFly) endemic areas. • Collaboration between project CY16011, NSW Biosecurity and the CSIRO “Systems Approach for Market Access” project (Project AM17001) has enabled the development and testing of BSF as part of an Interstate Certification Assurance program for domestic marketing.
Impacts	• Reduced costs associated with testing of cherry fruit for fruit fly eggs and/or larvae. • Maintained or increased market access (currently domestic only) for Australian cherries contributing to the current expansion of the Australian cherry industry. • Potentially, reduced future costs of quarantine treatments for Australian export cherries supported through use of the process domestically.

	• Reduced risk of the spread of fruit fly through cherry fruit because of improved detection and biosecurity.

Project Investment

Nominal Investment

Table 2 shows the annual investment (cash and in-kind) in project CY16011 by Hort Innovation. There were no other investors in this project.

Table 2: Annual Investment in the Project CY16011 (nominal $)

Year ended 30 June	Hort Innovation ($)	Others ($)	Total ($)
2017	22,163	0	22,163
2018	49,610	0	49,610
2019	31,028	0	31,028
Totals	102,801	0	102,801

Source: CY16011 Project Agreement and Variation documents supplied by Hort Innovation 2020

Program Management Costs

For the Hort Innovation investment the cost of managing and administrating 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, various years). This multiplier was then applied to the nominal investment by Hort Innovation shown in Table 2.

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 Gross Domestic Product deflator index (ABS, 2020). No additional costs associated with project extension were incorporated as the project included a number of extension and communication activities that included industry and government stakeholders.

Impacts

Table 3 provides a summary of the principal types of impacts delivered by the project. Impacts have been categorised into economic, environmental, and social impacts.

Table 3: Triple Bottom Line Categories of Principal Impacts from Project CY16011

Economic	• Reduced costs associated with testing of cherry fruit for fruit fly eggs and/or larvae. • Maintained or increased market access (currently domestic only) for Australian cherries contributing to the current expansion of the Australian cherry industry. • Potentially, reduced future costs of quarantine treatments for Australian export cherries supported through use of the process domestically. • Reduced risk of the spread of fruit fly through cherry fruit because of improved detection and biosecurity.
Environmental	• Nil
Social	• Nil

Public versus Private Impacts

Impacts identified in this evaluation are predominantly private in nature. Private benefits are likely to be realised by Australian cherry packers/processors through reduction in costs associated with testing for fruit fly from the adoption of BSF, maintained/improved market access and a reduced risk of the spread of fruit fly. Some public benefits may occur and include potentially reduced costs of quarantine treatments for Australian state governments for export cherries.

Distribution of Private Impacts

The impacts on the Australian cherry industry from investment in project CY16011 will be shared along the cherry supply chain with input suppliers, growers, processors, transporters, wholesalers, retailers, and consumers all sharing impacts produced by the project. 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 cherry market.

Impacts on Other Australian Industries

No direct impacts on industries other than the Australian cherry industry were identified. However, potential gains to other fruit and/or berry tree industries may occur via potential future spill-overs from the increase in knowledge and scientific capacity associated with BSF testing techniques.

Impacts Overseas

No significant or direct overseas impacts were identified. However, the knowledge created by the project and shared through international scientific and industry networks may results in some positive impacts for cherry industries overseas where similar pest detection issues are relevant.

Match with National Priorities

The Australian Government's Science and Research Priorities and Rural RD&E priorities are reproduced in Table 4. The project findings and related impacts will contribute to Rural RD&E Priority 2, with some contribution to Priority 1, and to Science and Research Priority 1.

Table 4: 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 6. Resources 7. Advanced Manufacturing 8. Environmental Change 9. Health

Sources: (Commonwealth of Australia, 2015) and (Australian Government, 2015)

Alignment with the Cherry Strategic Investment Plan 2017-2021

The strategic outcomes and strategies of the cherry industry are outlined in the Cherry Strategic Investment Plan 2017-2021[1] (Hort Innovation, 2017). Project CY16011 primarily addressed Outcome 2 through Strategy 3.6.

[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.

One impact was valued. The impact was the maintenance of market access for Australian export cherries through the adoption of BSF for fruit fly detection and biosecurity management.

Impacts Not Valued

Not all of the impacts identified in Table 3 could be valued in the assessment. The following impacts were not valued due to lack of evidence/data on which to base credible assumptions, difficulty in quantifying the causal relationship and pathway between CY16011 and the impact and the complexity of assigning magnitudes and monetary values to the impact.

The economic impacts identified but not valued were:

- Reduced costs associated with testing of cherry fruit for fruit fly eggs and/or larvae.
- Potentially, reduced future costs of quarantine treatments for Australian export cherries.
- Reduced risk of the spread of fruit fly through cherry fruit because of improved detection and biosecurity.

More specifically, current quarantine requirements are for an authorized officer to cut open 600 (packed) cherries. This process takes up to a day and equates to the destruction of at least 20kg of fruit which may be worth up to $10/kg in the early season. As BSF could be carried out with reject fruit, and by a person already employed at the cherry packing facility, the cost would likely be half a day for that employee (Jenny Ekman, pers. comm., 2020). Further information on the adoption of BSF and cost data associated with fruit fly testing/quarantine treatments was sought from the CGA but were not received during the evaluation. Further, it was not possible to determine the current level of risk of the spread of fruit fly through cherry fruit nor the change in risk that may be attributable to the adoption of BSF as a means of improved detection and biosecurity.

Valuation of Impact 1: Maintained market access for Australian export cherries

Outcome 2 of the Cherry Strategic Industry Plan 2017-2021 is to '*Grow export markets to leverage the forecast increase in production over the next five years*'. The Australian cherry industry operates under a Biosecurity Management Programme developed by the CGA to ensure Australian cherries are free from pests and diseases of quarantine concern. Further, in partnership with Plant Health Australia, the CGA also has developed the Cherry Growers' Biosecurity Manual that outlines the appropriate measures and guidelines that can be implemented within cherry growing businesses to minimise risk of exotic and endemic pests (Cherry Growers' Australia Inc., n.d.). The quality assurance of Australian cherries is crucial to ongoing export trade profitability and future export market development.

Australia exported approximately 5,000 tonnes of fresh cherries worth an estimated $79.5 million in 2018/19 (Hort Innovation, 2020). The majority of Australia's cherry exports are from Tasmania (42%), Victoria (29%) and NSW (27%) (CGA, 2020). Tasmania still is a fruit fly free zone (Barnett, 2019) and the parts of the growing areas in South Australia and parts of NSW and Victoria are managed through the Fruit Fly Exclusion Zone that includes the Greater Sunraysia Pest Free Area (shown in Figure 1).

Figure 1: The Australian Fruit Fly Exclusion Zone

Source: (Florec, White, Dominiak, & Sadler, 2013)

It was assumed that the investment in CY16011 has led to adoption of BSF by cherry packers/processors and some state government quarantine facilities to improve monitoring and detection of Qfly and Medfly thereby reducing the risk transmission of fruit fly between domestic trading partners, therefore preventing and/or mitigating the changes of a loss of market access (and associated loss of value) to key export markets from pest free areas such as Tasmania.

Specific assumptions for the valuation of the market access impact are described in Table 5.

Attribution

Project CY16011 is just one of a number of cherry RD&E investments aimed at the maintenance or improvement of access to key export markets for Australian cherries. Therefore, an attribution factor of 20% was applied to the benefits estimated.

Counterfactual

It was assumed that, in the absence of Hort Innovation investment in CY16011, some alternative investments in cherry industry biosecurity would have occurred (e.g. through NSW DPI and other co-investors such as CSIRO) as Qfly and Medfly are an ongoing and major threat to Australian export trade. However, it is likely that the level of investment would have been less, and the RD&E would have less efficient and/or effective. For this reason, 80% of the impacts were considered driven by to the CY16011 investment.

Summary of Assumptions

A summary of the key assumptions made for valuation of the impacts is shown in Table 5.

Table 5: Summary of Assumptions

Variable	Assumption	Source/Comment
Baseline Data		
Annual volume of fresh cherries exported	5,000 tonnes	Based on 5,035 tonnes exported in 2018/19 (Hort Innovation, 2020)
Annual value of fresh cherry exports	$79.5 million	
Impact 1: Maintained market access for Australian export cherries		
Valuation Assumptions		
Proportion of cherry export value at risk of loss due to biosecurity concerns associated with Qfly and Medfly	50% of total exports	Analyst assumption – based on cherry exports from authorised 'pest free areas' in Tasmania and SA at risk of fruit fly through domestic fruit trade.
Producer profit as a percentage of export value	10%	
Reduction in risk of market access loss due to adoption of BSF for improved Qfly and Medfly monitoring and detection	5% p.a. (i.e. if current risk of market loss were 25% each year, improved biosecurity processes for the monitoring and detection of fruit fly would reduce the risk to 20% per annum)	
First year of impact	2019/20	Consistent with publication of final CY16011 outputs in 2018/19
Year of maximum impact	2023/24	5 years after first year of impact
Risk Factors and Other Variables		
Attribution of maintained market access to investment in CY16011	20%	See above
Counterfactual – proportion of benefits relevant to CY16011	80%	See above
Probability of Output	100%	Analyst assumption – based on successful completion of CY16011
Probability of Outcome	100%	Analyst assumption – based on evidence of adoption of BSF by NSW businesses in the 2018/19 season and incorporation of BSF as part of the CGA Biosecurity Management Programme (Cherry Growers' Association Inc., 2015)
Probability of Impact	90%	Analyst assumption – accommodates the risk that exogenous factors may prevent the predicted impact from being achieved

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

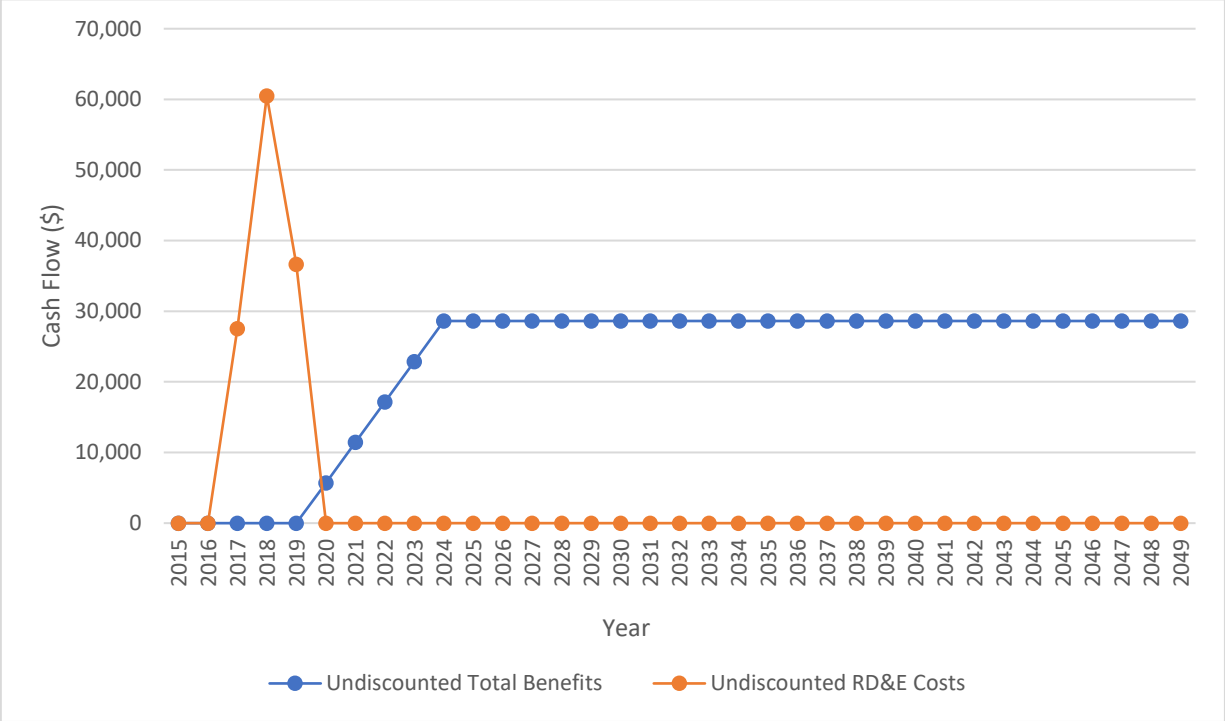
Table 6 shows the investment criteria estimated for different periods of benefit for the total investment. Hort Innovation contributed 100% of the total investment.

Table 6: Investment Criteria for Total Investment in Project CY16011

Investment Criteria	Years after Last Year of Investment						
	0	5	10	15	20	25	30
Present Value of Benefits ($m)	0.00	0.08	0.18	0.26	0.32	0.37	0.41
Present Value of Costs ($m)	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Net Present Value ($m)	-0.14	-0.06	0.04	0.12	0.18	0.23	0.27
Benefit-Cost Ratio	0.00	0.55	1.29	1.88	2.33	2.69	2.97
Internal Rate of Return (%)	negative	negative	8.98	12.96	14.30	14.82	15.12
MIRR (%)	negative	negative	6.44	7.77	7.49	6.97	6.46

The annual undiscounted benefit and cost cash flows for the total investment for the duration of CY16011 investment plus 30 years from the last year of investment are shown in Figure 2.

Figure 2: 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 7 present the results. The results showed a moderate to low sensitivity to the discount rate.

Table 7: Sensitivity to Discount Rate (Total investment, 30 years)

Investment Criteria	**Discount rate**		
	0%	**5%**	**10%**
Present Value of Benefits ($m)	0.80	0.41	0.24
Present Value of Costs ($m)	0.12	0.14	0.15
Net Present Value ($m)	0.68	0.27	0.09
Benefit-cost ratio	6.43	2.97	1.63

A sensitivity analysis was then undertaken for the assumed proportion of cherry export value at risk of loss from biosecurity concerns. The results are presented in Table 8 and show a moderate sensitivity to the proportion of the value of cherry exports at risk.

Table 8: Sensitivity to Proportion of Export Value at Risk (Total investment, 30 years)

Investment Criteria	**Proportion of Export Value at Risk of Loss**		
	10%	**50% (base)**	**90%**
Present Value of Benefits ($m)	0.08	0.41	0.73
Present Value of Costs ($m)	0.14	0.14	0.14
Net Present Value ($m)	-0.06	0.27	0.60
Benefit-cost ratio	0.59	2.97	5.35

Finally, a sensitivity analysis was undertaken for the assumed reduction in risk of a loss of market access associated with improved monitoring and detection of fruit fly using BSF processes. The results are presented in Table 9 and show a moderate sensitivity to the assumed reduction in risk. A break-even analysis found that the investment criteria were positive at a reduction in the risk of loss of market access of 1.7%.

Table 9: Sensitivity to Assumed Reduction in Risk of Loss of Market Access (Total investment, 30 years)

Investment Criteria	**Proportion of Export Value at Risk of Loss**		
	2.5%	**5% (base)**	**7.5%**
Present Value of Benefits ($m)	0.20	0.41	0.61
Present Value of Costs ($m)	0.14	0.14	0.14
Net Present Value ($m)	0.07	0.27	0.47
Benefit-cost ratio	1.49	2.97	4.46

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 10). 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 10: Confidence in Analysis of Project

Coverage of Benefits	Confidence in Assumptions
Medium	Low

Coverage of benefits was assessed as Medium – one of four economic impacts was valued in monetary terms.

Confidence in assumptions was rated as Low. Though baseline data used in the analysis were largely drawn from published and/or credible sources such as Hort Innovation, the CGA and the ABS a number of the assumptions used in the valuation were uncertain.

Conclusion

The investment in CY16011 is likely to have contributed to improved monitoring and detection of fruit fly in Australian cherries using brown sugar flotation. Consequently, CY16011 is may contribute to future reductions in costs associated with testing cherry products for fruit fly, reduced risk of the spread of fruit fly through cherries, and maintained market access for Australian export cherries (through reduced risk of spread to domestic pest free areas).

Total funding from all sources for the project was $0.14 million (present value terms). The investment produced estimated total expected benefits of $0.41 million (present value terms). This gave a net present value of $0.27 million, an estimated benefit-cost ratio of 3.0 to 1, an internal rate of return of 15.1% and a modified internal rate of return of 6.5%.

Several other economic impacts were also identified but not valued as part of the current assessment. Given the impacts not valued, combined with conservative assumptions made for the principal economic impact valued, it is reasonable to conclude that the investment criteria reported may be an underestimate of the actual performance of the CY16011 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.

Reference List

AgriFutures Australia. (2017, May 24). *Cherries*. Retrieved April 2020, from AgriFutures Australia: https://www.agrifutures.com.au/farm-diversity/cherries/

Australian Bureau of Statistics. (2018, October 26). *5204.0 - Australian System of National Accounts, 2017-18.* Retrieved from Australian Bureau of Statistics: https://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/5204.02017-18?OpenDocument

Australian Bureau of Statistics. (2019a, June). *7121.0 - Agricultural Commodities, Australia*. Retrieved from https://www.abs.gov.au/ausstats/subscriber.nsf/log?openagent&71210do001_201718.xls&7121.0&Data%20Cubes&AF32A589689189F0CA2583EB0021EF49&0&2017-18&30.04.2019&Latest

Australian Bureau of Statistics. (2019b, April 30). *7503.0 - Value of Agricultural Commodities Producted, Australia*. Retrieved from Australian Bureau of Statistics: https://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/7503.02017-18?OpenDocument

Australian Government. (2015). *Science and Research Priorities.* Canberra: Department of Industry, Innovation and Science. Retrieved from https://www.industry.gov.au/sites/g/files/net3906/f/2018-10/science_and_research_priorities_2015.pdf

Barnett, G. (2019, January 9). *Fruit Fly Pest Free Area status reinstated for Mainland Tasmania*. Retrieved from Peter Gutwein Premier of Tasmania Tasmanian Government: http://www.premier.tas.gov.au/releases/fruit_fly_pest_free_area_status_reinstated_for_mainland_tasmania

Cherry Growers' Association Inc. (2015, May). Biosecurity Management Programme - A Status Update. Hobart TAS: Cherry Growers' Association Inc. Retrieved June 2020

Cherry Growers Australia Inc. (2019). *Australian cherry industry statistics*. Retrieved April 2020, from Cherry Growers Australia Inc.: https://www.cherrygrowers.org.au/industry-statistics/

Cherry Growers Australia Inc. (2020). *Export and Trade.* Retrieved August 2020, from Cherry Growers Australia Inc.: https://www.cherrygrowers.org.au/assets/australian_cherry_export_roadmap_2012_2017.pdf

Cherry Growers' Australia Inc. (n.d.). *Biosecurity*. Retrieved June 2020, from Cherry Growers' Association Inc.: https://www.cherrygrowers.org.au/biosecurity/

Commonwealth of Australia. (2015). *Agricultural Competitiveness White Paper.* Canberra: Commonwealth of Australia. Retrieved from https://agwhitepaper.agriculture.gov.au/sites/default/files/SiteCollectionDocuments/ag-competitiveness-white-paper.pdf

Council of Rural Research and Development Corporations. (2018). *Cross-RDC Impcat Assessment Program: Guidelines.* Canberra: Council of Rural Research and Development Corporations. Retrieved from http://www.ruralrdc.com.au/wp-content/uploads/2018/08/201804_RDC-IA-Guidelines-V.2.pdf

Ekman, J. (2019). *Implementing brown sugar flotation for assuring freedom from fruit fly.* Sydney NSW: Horticulture Innovation Australia Ltd. Retrieved April 2020, from https://www.horticulture.com.au/globalassets/laserfiche/assets/project-reports/cy16011/cy16011---final-report-complete.pdf

Florec, V., White, B., Dominiak, B. C., & Sadler, R. J. (2013, February). Choosing the battles: The economics of area wide pest management for Queensland fruit fly. *Food Policy, 38*(1), 203-213. Retrieved from https://www.researchgate.net/publication/257160869_Choosing_the_battles_The_economics_of_area_wide_pest_management_for_Queensland_fruit_fly#read

Horticulture Innovation Australia Ltd. (2016). *Annual Report 2015/16.* Sydney, NSW: Horticulture Innovation Australia Ltd.

Horticulture Innovation Australia Ltd. (2017). *Annual Report 2016/17.* Sydney, NSW: Horticulture

Innovation Australia Ltd.

Horticulture Innovation Australia Ltd. (2017). *Cherry Strategic Investment Plan 2017-2021.* Sydney NSW: Horticulture Innovation Australia Ltd. Retrieved April 2020, from https://www.cherrygrowers.org.au/assets/HortInnovation-cherry-SIP_at_a_glance.pdf

Horticulture Innovation Australia Ltd. (2018). *Annual Report 2017/18.* Sydney, NSW: Horticulture Innovation Australia Ltd.

Horticulture Innovation Australia Ltd. (2020). *Australian Horticulture Statistics Handbook 2018/19 - FRUIT.* Sydney NSW: Horticulture Innovation Australia Ltd.

Plant Health Australia. (2013). *Fact Sheet - Queensland and Mediterranean fruit flies.* Retrieved April 2020, from Plant Health Australia: https://www.planthealthaustralia.com.au/wp-content/uploads/2013/01/QFly-and-Medfly-FS.pdf

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Abbreviations

ABS	Australian Bureau of Statistics
AHR	Applied Horticulture Research Pty Ltd
BSF	Brown Sugar Flotation
CGA	Cherry Growers' Association
CRRDC	Council of Rural Research and Development Corporations
CSIRO	Commonwealth Scientific and Industrial Research Organisation
Hort Innovation	Horticulture Innovation Australia Ltd
MedFly	Mediterranean Fruit Fly
MIRR	Modified Internal Rate of Return
NSW DPI	New South Wales Department of Primary Industries
Qfly	Queensland Fruit Fly
RD&E	Research, Development and Extension