Delivery partner resource

Horticulture Impact Assessment Program

AV16007 – Improving Avocado Orchard Productivity through Disease Management – Impact Assessment

June 2025

Hort Innovation

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Executive Summary

The Australian avocado industry has experienced considerable growth in recent years, with production increasing by over 30% relative to 5 years ago. In the 5 years between 2019 and 2023 Australian growers produced roughly 97,750 tonnes of avocadoes per annum, with a gross production value of around $454 million per year.[1]

An increasing prevalence of yield limiting and tree damaging diseases are adversely impacting Australian avocado crops, including Phytophthora and anthracnose. This project was commissioned in acknowledgement of the need for improved knowledge regarding options for disease mitigation and farm management to help combat these issues.

This investment has a total nominal cost of $1,809,743, of this $1,207,553 was funded by Hort Innovation. This impact assessment identified a clear pathway to impact for the research undertaken. Three of the benefits identified were quantified to demonstrate the impacts of Hort Innovation's investment, these included:

— Increased crop yields – By assessing the efficacy of different fungicides through this research and enhancing knowledge of best practice amongst growers for disease management, this research can lead towards increased crop yields.

— Improved fruit quality – The research has identified treatments of post-harvest diseases such as stem end rot and anthracnose, reducing their prevalence in packing lines. These treatments lift the quality of fruit being sold and deliver a higher merchantable yield.

— Improved crop resilience – Researchers have helped to change nursery plant production practices to emphasise healthier root structures and tree health checks prior to planting. This increases the resilience of mature plants to adverse weather events, limiting crop loss, and reduces the incidence of diseased plants being planted.

Quantification of further benefits was hampered by data limitations. The research report had limited data pointing to observed yield improvements and disease reduction and would benefit from additional quantitative outcomes data. It was the view of a grower interviewed in relation to this project that were the benefits of adoption monetised and uplift in yields or profits spelled out more clearly, there would be likely be further increases in adoption.

There were additional benefits identified through the research that were not quantified, these include:

— Improved knowledge of strategies and best practice for crop management – This research is adding to the evidence base for best practice in disease management among Australian avocado growers. The distribution of this knowledge increases the efficiency of all domestic producers. These benefits are not quantified to avoid double counting, as any beneficial impacts would also improve crop yields, fruit quality, and crop resilience.

— Reduced prevalence of diseases – This research enhances the use of various disease management protocols. The uptake of such protocols reduces the prevalence and impact of disease among plants. Yield impacts are an already quantified benefit; these impacts are not quantified here to avoid double counting.

[1] Hort Innovation 2024, *Horticulture Statistics Handbook 2023*

— Earlier disease identification – Site visits by researchers, and training of producers, has led to earlier identification of diseased plants on farms. This enables swifter treatment and more effective management of the disease limiting its impact. These benefits were not quantified to avoid double counting, as they are already captured through the quantified yield and quality impacts.

— Substitution away from less effective pesticides – The research promotes more effective management practices of disease management with reduced reliance on pesticides with lower efficacy. The research may result in the uptake of methods which reduce the residual amount of pesticides ingested by end consumers. This is a particularly important implication for exports. This is an unquantified benefit, as there is no cost saving associated with this substitution and any yield implications are captured in the yield economic benefit.

The results show that, taking all quantified costs and benefits into account, the investment produced a positive net result. The investment has a net present value (NPV) of $3.72 million and a benefit-cost ratio (BCR) of 2.75 at 30 years after investment completion using a 5% discount rate. This shows that the investment delivers a net positive return to levy payers and the broader community, returning $2.75 for every $1 in investment. This project has been attributed with 13.4% of the impacts, as the projects investment accounts for 26.8% of the total investment to date and the research to date accounts for 50% of the assumed research required to realise these benefits.

Context, objective, and details of investment

In 2022-23, Australia produced slightly over 100,000 tonnes of avocadoes estimated at a gross value of $574 million.[2] Queensland and Western Australia contributed over 80% of Australia's avocado production in the 2023-24 financial year.[3] Hass and Shepard are the dominant avocado varieties in the Australian market, only around 3% of the market is made up of other varieties.[4] Avocado production value began to gradually rise during the 2021/22 financial year after experiencing a drastic fall in the financial year prior.[5] Australia currently has a small export market presence, but the industry is strategising on expanding export markets and volume. Currently, Hong Kong, Singapore and Malaysia are Australia's major avocado export destinations.[6]

Hort Innovation collaborated with the University of Queensland to undertake research into identifying key diseases that affect avocado and to evaluate options for mitigation and on-farm management. The increasing prevalence of diseases has negatively impacted avocado tree health and led to lower quality fruit yields. This has impacted the profitability of the industry. A compounding factor has been an oversupply of fruit leading to lower sale prices and increasing cost of all inputs. The necessity for disease management has been recognised as the industry has begun to expand its export markets and volume.

There have been numerous previous studies into pathology and disease management supported by Hort Innovation which are complemented by AV16007. Research within this project had raised the concern that key fungicides were exhibiting lower levels of effectiveness in protecting fruit crop. Additionally, there are limits on how much pesticide residue can be present on fruit, making exploring alternative candidates crucial to not simply increase the dosages of existing fungicide treatments. Additionally, a combination of previously studied and emerging diseases was included in this research project. One of the most prevalent diseases is

[2] Avocados Australia Limited. 2024. At a glance factsheet 2023-24.

[3] Ibid.

[4] Horticulture Innovation Australia. 2021. Avocado Strategic Investment Plan 2022-2026.

[5] Avocados Australia Limited. 2024. At a glance factsheet 2023-24.

[6]Department of Agriculture, Fisheries and Forestry [DAFF]. Analysis – Market access for Western Australian Hass avocados in Thailand. 2023. Australian Government.

root rot caused by the water mould Phytophthora which leads to the decay of roots and is commonly experienced in poorly drained soil. This in addition to other diseases such as anthracnose and stem end rot (which typically becomes apparent after harvest) has negatively affected both yields and profit for the Australian avocado industry.

Alignment with Strategic Investment Plan

Project AV16007 closely aligned with, and significantly contributed towards, the Avocado Industry Strategic Investment Plan (SIP) 2017-2021.[7] By improving industry knowledge and supporting adoption of best practice for disease management on farms, the project has contributed to improving the quality of fruit produced by the industry (Outcome 2) and has supported an increase in marketable yields without increasing costs of production (Outcome 4). Further, by supporting more effective and efficient use of pesticides on farms, the research helps to reduce chemical residue in fruit, which is a particularly important implication for exports and thereby supports Outcome 3 of the SIP.

A new SIP was developed during the project for 2022-2026, the project specifically aligns with Outcome 2: 'Industry supply, productivity and sustainability', and Strategy 4: 'Develop and optimise fit for purpose pest and disease management strategies.'

Overall, the project has supported improvement in farm productivity, by enabling improvements in yields and quality, which in turn supports the industry's exports.

Table 1 Project details of AV16007

Project code	AV16007
Title	Improving Avocado Orchard Productivity through Disease Management
Research organisation(s)	University of Queensland
Project leader	Assoc. Prof. Elizabeth Dann
Funding period	2017-18 to 2022-23
Objective	To identify and learn more about the key diseases affecting avocado, and evaluate options for management

Source: Hort Innovation

Related investments

The project was linked with 5 other investments, these are:

— AV10001: Improving yield and quality in avocado through disease management - phase 2 – This project aimed to optimise avocado yields, fruit quality and tree health by improving the management of diseases affecting fruits, roots and whole trees.

  AV10001 provided foundational knowledge on avocado fruit physiology, particularly in relation to the causes of skin disorders which cause spotting and blemishes. The findings of AV10001 informed the design of AV16007 which expanded on the prior project by investigating a broader range of disease and their impact on productivity. AV16007 applied the physiological understanding from AV10001 to develop integrated disease management strategies aimed at improving fruit quality and reducing losses across the

[7] Hort Innovation (2017). Avocado Strategic Investment Plan 2017-2021.

supply chain.

— AV14012: Investigating tree mortality during early field establishment – This project set out to investigate the species of fungi associated with black root rot and their relative ability to cause disease, with a view to developing a diagnostic test and some insights on how this disease may be managed.

  The findings of AV14012 directly informed AV16007, which extended the scope to include broader disease management strategies across the entire orchard life cycle.

— AV13021: Exploring alternatives for managing Phytophthora root rot in avocados – This project sought to find out if 2 treatments, mandipropamid and potassium silicate, reduce Phytophthora root rot in avocados.

  The outcomes of AV13021 provided a research base and potential treatment options that AV16007 could assess, validate, and incorporate into integrated disease management strategies. AV16007 built on this work by applying and extending promising approaches in commercial orchard settings, with a broader focus on improving overall orchard productivity through more effective disease control across multiple pathogens and production stages.

— AV08000: Rootstock improvement for the Australian avocado industry - phase 3 – This project was sought to address a number of key issues important to the long-term sustainability of Australian avocado production.

  The insights and promising rootstock selections from AV08000 provided a foundation for the integrated disease management approaches explored in AV16007. Subsequently, AV16007 considered the role of rootstock selection as a component of broader orchard disease management strategies, aiming to reduce losses and improve productivity across different growing environments

— AV19005: Understanding the mode of action of phosphite in avocado for enhanced management of Phytophthora root rot – This project sought to improve the avocado industry's understanding of how the fungicide phosphite is metabolised by trees infected with Phytophthora root rot. The research aimed to enable more targeted applications of phosphite to improve tree health and productivity.

  AV19005 is directly linked to AV16007, as both projects addressed the challenge of managing phytophthora. While AV16007 focused on developing and promoting integrated disease management strategies to improve overall orchard productivity, AV19005 delved deeper into the mechanisms by which phosphite (phosphonate) suppresses Phytophthora root rot.

Governance

The governance structure of AV16007 was designed to ensure strategic alignment, scientific integrity, and effective industry engagement. Hort Innovation provided oversight to ensure the project met its objectives and aligned with industry priorities. The project was funded through the avocado research and development levy, with contributions from the Australian Government. The University of Queensland was the delivery partner, with Associate Professor Elizabeth Dann as the project lead. Throughout the project regular steering committee meetings were held where researchers provided updates on the research, ensured the research aligned with the needs of industry and that it conformed with the Avocado SIP.

Additionally, the project incorporated extensive stakeholder engagement. This included collaboration with avocado growers, agronomists, and industry bodies such as Avocados Australia. The research team conducted field trials across multiple commercial orchards and engaged directly with growers through workshops, field days, and diagnostic support services.

The governance structure enabled the ongoing alignment of research activities with the needs of industry, facilitated comprehensive stakeholder engagement ensuring the collation of diverse perspectives and dissemination of information, and ensured research findings were practical and applicable to improve avocado orchard productivity through enhanced disease management.

Impact pathway

A clear pathway from input to impacts can be identified. Overall, the investment produced 7 impactful benefits for both levy payers and the broader communities. Table 2 shows the logical pathway to impact of the investment.

Table 2 Impact pathway of AV16007

Pathway	Description
Inputs and activities	**Staffing** The project was supported by a range of project staff, students and visiting researchers. **Identification of key diseases adversely impacting growers** The project team worked with growers to identify diseases that are adversely affecting crops across growing regions to enable targeted research. **Access to orchards and establishment of field trial sites** Researchers were granted access to orchards and growers in growing regions, and established field trial sites in these existing orchards. Throughout the project regular site visits were conducted by the project team to collect samples for lab analysis. **Trialling of a range of disease treatment and disease management processes** Throughout the project the team conducted three field trials of disease management and treatments to combat diseases such as stem end rot and anthracnose.
Outputs	**Publication and dissemination of results** The project team developed a guide for optimal timing of phosphonate application and disseminated it to growers. A report was produced on causal organisms of diseases and the efficacy of identified treatments. Further a report was prepared covering the efficacy of tested soil amendments for their ability to sustain tree health and support tree productivity **Collection of fungal isolates** The project team established a collection of 1,500 fungal isolates for future study. **Supported industry** Throughout the project the project team provided industry support, education, and extension activities to growers. Site visits enabled the early identification and treatment of disease in some farms. While the number of activities were not quantified, support activities were estimated to account for 48 days of project personnel time between October 2018 and May 2019. **Creation of a literature review** Published scientific literature in peer-reviewed journals and both domestic and international publications. As of May 2023, 3 publications arose directly from this project or the previous project (AV14012), and 2 more were submitted for publication. **Provided information on best practice to growers** Communicated the benefits and importance of adopting recommended activities and strategies to growers, assisting them to make informed decisions regarding disease treatment and management. Further researchers helped growers identify activities, products and strategies to limit the impacts of disease and maximise crop productivity.
Outcomes	**Enhanced disease prevention practices** The research has enabled earlier identification and diagnoses of disease through the services provided and training administered. **Identification of additional research pathways** Findings led to the creation of AV19005 to further study phosphorous application in disease management **Increased awareness of best practice among growers**

Pathway	Description
	The research increased the awareness of best practice strategies to minimise impacts of disease and pathogens on crops, and to support improvements in fruit quality and orchard productivity. It has also identified activities, products and strategies to limit the impacts of disease and maximise productivity **Strengthened industry relationships** The research has strengthened relationships and networks within industry.
Impacts	**Increased crop yields** Through its assessment of the efficacy of different fungicides, this research has enhanced knowledge of best practice amongst growers for disease management, supporting growers to increase their merchantable crop yields. **Improved fruit quality** The research has identified treatments of post-harvest diseases such as stem end rot and anthracnose, reducing their prevalence in packing lines. These treatments lift the quality of fruit being sold and deliver a higher merchantable yield of high-quality fruit. **Improved knowledge of strategies and best practice for crop management** This research is adding to the evidence base for best practice in disease management among Australian avocado growers. The distribution of this knowledge increases the efficiency of all domestic producers. **Improved crop resilience** Researchers have helped to change nursery plant production practices to emphasise healthier root structures and tree health checks prior to planting. This increases the resilience of mature plants to adverse weather events. **Reduced prevalence of diseases** This research enhances the use of various disease management protocols. **Earlier disease identification** Site visits by researchers, and training of producers, has led to earlier identification of diseased plants on farms. **Substitution away from less effective pesticides** The research promotes more effective management practices of disease management with reduced reliance on pesticides with lower efficacy.

Source: ACIL Allen

Cost and benefits

Costs

Cost of the investment

The investment was a collaboration of Hort Innovation and the University of Queensland. Hort Innovation contributed roughly $1.05 million in cash and $160,000 through overheads, while the University of Queensland contributed $602,000 through in-kind contributions (ex. GST). Table 3 below shows the total nominal cash and in-kind contributions from each partner.

Table 3 Nominal costs of the investment by contributing partners of AV16007

Organisation	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	Total
Hort Innovation - Cash	$266,333	$130,036	$140,536	$200,656	$209,800	$100,000	$1,047,361
Hort Innovation - Overheads	$43,083	$22,829	$21,962	$28,039	$29,283	$14,995	$160,192
Partner Organisation - In-kind	$100,365	$100,365	$100,365	$100,365	$100,365	$100,365	$602,190
Total	$409,781	$253,230	$262,863	$329,060	$339,448	$215,360	$1,809,743

Source: Hort Innovation

The total nominal investment of $1.81 million is adjusted for inflation to represent the real value of investment. Adjustment for inflation is meant to present historical costs in today's dollars, by making periods comparable by converting nominal values to real values (adjusted for changes in purchasing power due to inflation).

Costs of the investment, in nominal term and real term, are provided in Table 4 below.

Table 4 Real costs of the investment AV16007

Organisation	Hort Innovation	Partners	Total
Nominal costs	$1,207,553	$602,190	$1,809,743
Real costs ($2024 financial year)	$1,425,149	$702,566	$2,127,715

Source: ACIL Allen, modelled using ABS's CPI data

After converting to real terms, the cost of the investment is $2.13 million, and Hort Innovation's portion (both cash and in-kind) of all investments is $1.43 million.

Benefits

Table 5 below summarises the potential benefits of the investment and categorised them into 3 categories: economic, environmental and social impact. It provides a description of the benefits and how the investment could achieve them. The table also shows the assessment method that was used for each benefit.

Table 5 Summary of potential impacts of AV16007

Type of impact	Assessment	Description
Economic impact	Quantified	**Increased crop yields** – Diseases are an economic constraint on the avocado industry's output. By assessing the efficacy of different fungicides through this research and enhancing knowledge of best practice amongst growers for disease management, this research can lead towards increased crop yields. The research aligns with an industry outcome targeting a 15% increase in crop yields without increased production costs per kilogram.
	Quantified	**Improved fruit quality** – Post harvest diseases are an economic constraint on the avocado industry's output. The research has identified treatments of post-harvest diseases such as stem end rot and anthracnose, reducing their prevalence in packing lines. These

		treatments lift the quality of fruit being sold and deliver a higher merchantable yield.
	Unquantified	**Improved knowledge of strategies and best practice for crop management** – This research is adding to the evidence base for best practice in disease management among Australian avocado growers. The distribution of this knowledge increases the efficiency of all domestic producers. These benefits are not quantified to avoid double counting.
	Quantified	**Improved crop resilience** – Researchers have helped to change nursery plant production practices to emphasise healthier root structures and tree health checks prior to planting. This increases the resilience of mature plants to adverse weather events, limiting crop loss, and reduces the incidence of diseased plants being planted.
Environmental impact	Unquantified	**Reduced prevalence of diseases** – This research enhances the use of various disease management protocols. The uptake of such protocols reduces the prevalence and impact of disease among plants. Yield impacts are already captured through the economic yield increases, so these are not counted here to avoid double counting.
	Unquantified	**Earlier disease identification** – Site visits by researchers, and training of producers, has led to earlier identification of diseased plants on farms. This enables swifter treatment and more effective management of the disease limiting its impact. These benefits are not quantified to avoid double counting.
	Unquantified	**Substitution away from less effective pesticides** – The research promotes more effective management practices of disease management with reduced reliance on pesticides with lower efficacy. The research may result in the uptake of methods which reduce the residual amount of pesticides ingested by end consumers, this is a particularly important implication for exports. This is an unquantified benefit, as there is no cost saving associated with this substitution and any yield implications are captured in the yield economic benefit.
Social impact	N/A	No social impact was identified for the investment.

Source: ACIL Allen

Data and assumptions

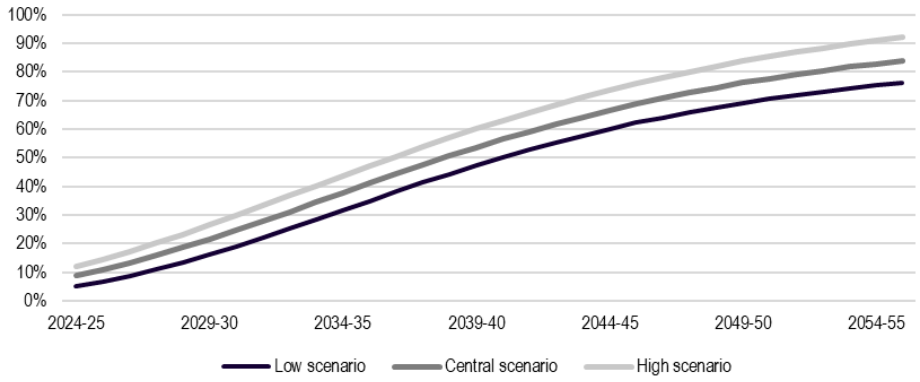
The required data, assumptions and calculations used to estimate the impacts of the investment are presented in Table 6 below. The data were sourced from project data, external sources through literature review, industry data provided by Hort Innovation and other publicly available databases.

Assumptions were informed by stakeholder consultations and are designed to be conservative considering the uncertainties underlying the magnitude of the impacts. These uncertainties include the rate and extent of industry uptake and variability in the application of recommendations by growers. Further, the scale of the investment's impact on crop yields and fruit quality were not quantified through the project, impacts are therefore assumption driven with low certainty. As many projects have a long-term focus and benefits may take years to fully emerge, using conservative assumptions helps avoid overstating expected returns. This cautious approach reflects best practice in economic evaluation where future adoption patterns and external influences cannot be predicted with high confidence.

Table 6 Data and assumptions used for AV16007

Data	Source and rationale
Data	
Average production (tonnes) between 2018 and 2023	94,298 FY 23 Horticulture Statistics Handbook
Average price per kilogram ($/kg) between 2018 and 2023	$5.13/kg FY 23 Horticulture Statistics Handbook
Target increase in crop yield by end of 2021	15% The report (AV16007)
Target increased in quality of fruit	15% The report (AV16007). This target is an objective of the research, however, at the time of analysis, there is not enough information to determine whether this will be achieved by industry or not. The following assumption is set more conservatively than 15%.
Assumed potential impacts on crop yields	5% The data from the research is insufficient to estimate improved yield. This assumption is set by the analyst as a conversative means of estimating impacts.
Assumed potential impacts on fruit quality	5% The data from the research is insufficient to estimate improved quality. This assumption is set by the analyst as a conservative mean of estimating impacts.
Assumed crop loss due to diseases	5% The data from the research is insufficient to estimate crop loss due to disease. This assumption is set by the analyst as a conservative mean of estimating impacts.
Trees lost due to freak weather events	500 per year This figure is based on consultation with the researcher.
Value of fruit trays per tree	$1,000 This figure is based on consultation with the researcher.
Value of replacement trees	$50 This figure is based on consultation with the researcher.
Assumption	
Attribution	Hort Innovation funding accounts for 26.8% of total funding in this chain of research[8], further following this research further testing and studies are required to fully realise the potential benefits of this research project. Thus, this analysis assumes that research to date accounts for 50% of the total research required to achieve the identified benefits. Therefore, attribution of 13.4% is assumed for this project.
Counterfactual	Due to industry size and research costs, the outcomes of this project are unlikely to be achieved by organisations other than Hort Innovation and the University of Queensland. The counterfactual scenario can be assessed as there is a very low likelihood the project would be undertaken without funding from Hort Innovation.

[8] ACIL Allen's estimates from provided data.

Data	Source and rationale
Adoption	The researchers identified some instances of growers changing practices as a result of the research findings. Thus, it is assumed that adoption of research recommendations commences at around 5% immediately following the research project (2022-23). Given initial findings point to improved outcomes for growers it is assumed that adoption will rise to 80% over a 30 year time horizon, before plateauing. **Figure 1 Adoption curve**  *Source: ACIL Allen*
Confidence level	At the time of assessment, there are many uncertainties regarding the impacts of the project as future research is required for the practice changes to be adopted by the industry. Further the research does not quantify observed impacts to yield and fruit quality resulting from the field trials, so improvements used in calculations are assumption driven with low certainty. This analysis has quantified the potential impacts with a low level of confidence of 25%.
Calculation	
Increased crop yields	*Increase in crop yields x Average production quantity x Average per kilo price of avocadoes*
Total crop produced including non-merchantable fruit	*(Average production quantity / (1 - Crop loss due to diseases))*
Total crop lost to diseases	*Total crop produced including non-merchantable fruit - Average production quantity*
Improvements in fruit quality (reduction in crop losses)	*Total crop lost to diseases x improved disease management*
Lost revenue due to crop loss	*Trees lost due to freak weather events x value of fruit trays lost per tree*
Increased costs due to tree replacement	*Trees lost due to freak weather events x value of each replacement tree*
Savings due to improved crop resilience	*Lost revenue due to crop loss x Increased costs due to tree replacement*

Source: ACIL Allen

Net impact

A summary of the net impact of the investment is presented in Table 7. The results show that, taking all quantified costs and benefits into account, the investment produced a positive net result. The investment has an NPV of $3.72 million and a BCR of 2.75 at 30 years after investment completion.

When taking only costs and benefits attributable to Hort Innovation into account, the investment generated an NPV of $2.16 million and a BCR of 2.75 at 30 years after investment completion. The benefits attributed to Hort Innovation were in proportion to the nominal costs.

Table 7 Net impact results of AV16007

	Years after investment completion						
	0	5	10	15	20	25	30
Whole investment							
PV of Costs ($m)	$2.13	$2.13	$2.13	$2.13	$2.13	$2.13	$2.13
Benefits ($m)	$0.07	$0.74	$2.04	$4.02	$6.59	$9.62	$12.28
PV of Benefits ($m)	$0.08	$0.71	$1.67	$2.82	$4.00	$5.08	$5.85
NPV ($m)	-$2.05	-$1.42	-$0.46	$0.69	$1.87	$2.96	$3.72
BCR	0.04	0.33	0.78	1.33	1.88	2.39	2.75
IRR	Negative	Negative	0.8%	9.3%	12.4%	13.6%	14.0%
MIRR	Negative	Negative	2.4%	7.4%	8.8%	9.0%	8.7%
Attributable to Hort Innovation							
PV of Costs ($m)	$1.24	$1.24	$1.24	$1.24	$1.24	$1.24	$1.24
Benefits ($m)	$0.04	$0.43	$1.18	$2.33	$3.83	$5.58	$7.13
PV of Benefits ($m)	$0.05	$0.41	$0.97	$1.64	$2.32	$2.95	$3.40
NPV ($m)	-$1.19	-$0.83	-$0.27	$0.40	$1.09	$1.72	$2.16
BCR	0.04	0.33	0.78	1.33	1.88	2.39	2.75
IRR	Negative	Negative	0.7%	9.3%	12.3%	13.6%	14.0%
MIRR	Negative	Negative	2.3%	7.4%	8.7%	9.0%	8.7%

Sensitivity analysis

Sensitivity analysis was conducted to test the robustness of susceptibility of the analysis to key assumptions and parameters. Given the uncertainty of a number of assumptions used in this CBA, sensitivity testing is important to determine the appropriateness of underlying assumptions.

The results of the sensitivity analysis are presented in Table 8 below.

Table 8 Sensitivity analysis results of AV16007

	NPV	BCR	IRR	MIRR
Under standard assumptions (Central case scenario and 5% discount rate)	$3.72	2.75	14.0%	8.7%
3% discount rate	$5.58	3.62	14.0%	8.7%
7% discount rate	$2.44	2.15	14.0%	8.7%
Low adoption (starts at 5% and reaches 13% in 5 years)	$3.77	2.77	13.7%	8.8%
High adoption (starts at 12% and reaches 20% in 5 years)	$4.57	3.15	16.0%	9.3%
Lower increase in crop yields (Central scenario, -20%)	$2.59	2.22	11.6%	7.9%
Higher increase in crop yields (Central scenario, +20%)	$4.86	3.28	16.2%	9.4%
Lower increase in fruit quality (Central scenario, -50%)	$3.69	2.74	13.9%	8.7%
Higher increase in fruit quality (Central scenario, +50%)	$3.75	2.76	14.1%	8.8%
Lower confidence (20%)	$2.55	2.20	11.6%	7.9%
Higher confidence (30%)	$4.89	3.30	16.3%	9.5%

Source: ACIL Allen

Key findings

The following key findings have been identified for this assessment:

- The research aligns with the avocado industry's Strategic Investment Plan Outcome 4, with findings facilitating potential increases in crop yields and fruit quality, without increasing production costs per kilogram.
    - By assessing the efficacy of different fungicides and enhancing knowledge of best practice for disease management amongst growers, this research can lead towards increased crop yields.
    - The research identified treatments for post-harvest diseases such as stem end rot and anthracnose, reducing their prevalence in packing lines. These treatments can lift the quality of fruit moving through packhouses and deliver a higher merchantable yield.
    - Further the research has supported changes to nursery plant production practices, emphasising healthier root structures and improved tree health checks prior to planting. These practices can increase the resilience of mature plants to adverse weather events and limit fruit, and tree, losses during these events.
- There are considerable benefits associated with this research that have not been quantified due to data and methodology limitations, for instance, there were no cost savings associated with substitution away from less effective pesticides therefore no quantified benefit could be estimated. Were these additional benefits quantified they would enhance the research's BCR. This further highlights the significant positive returns to industry resulting from the investment. The unquantified benefits associated with this research include:
    - information generation

    - improved biosecurity practices
    - a reduction in the use of ineffective pesticides.
- At the time of assessment, there are many uncertainties regarding the impacts of the project as future research is required for many of the recommended practice changes to be adopted.
- A limitation of the research was the data collected and reported upon. The research report would benefit from recording and demonstrating the observed quantitative outcomes in terms of yield improvements and reductions in the incidence of disease against a baseline. This would also help increase adoption. Growers pointed to the need for costs and benefits associated with the research to be clearly recorded to assist with decision making regarding adoption. If benefits are monetised and the uplift in yield or profits are spelled out, grower adoption becomes more likely.

Consultations

The following stakeholders were consulted on this assessment:

- Andrea Magiafoglou, Hort Innovation
- Dr Elizabeth Dann, University of Queensland
- Clayton Lynch, Australian Producer Partners.

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