Delivery partner resource

Horticulture Impact Assessment Program

AP19003 - Advancing sustainable and technology driven apple orchard production systems – Impact Assessment

June 2025

Hort Innovation

AP19003 Advancing sustainable and technology driven apple orchard production systems

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AP19003 Advancing sustainable and technology driven apple orchard production systems

Executive Summary

The Australian apple industry was valued at $647 million for the year 2022-23 and is one of Australia's largest horticultural crop markets.[1] Latest statistics shows that in 2023-24, over 293,000 tonnes of apples were produced worth $680 million.[2] There are over 400 commercial apple and pear growers registered in Australia.[3]

Previous studies demonstrated that a high variability in fruit numbers (crop load) can translate to inconsistent fruit quality that negatively impact consumer satisfaction as consumers have a strong preference for apples with minimal skin blemishes and an overall consistent colour in addition to medium to large sized fruit.[4]

Currently, crop load management in apple orchards are done by taking one or a few samples per block, and pruning or thinning is applied to the whole block according to information gathered from the sample. This leads to some inefficiencies in optimising quality and yield because crop load per tree is variable and not uniform for each block.

Hort Innovation coordinated the production research program to investigate the physiological mechanisms and develop management tools to improve orchard design and crop load management so that apple orchards can more consistently produce high quality yields that meet market expectations through an uncertain climate. Crop load management is the practice of identifying and creating the ideal ratio of fruit to branch/tree. It involves considering how to appropriately balance the amount of fruit on a tree with the tree's natural resources to maximise the final crop yield without sacrificing quality based on several factors including tree size, age, and carbohydrate reserves.

Project AP19003 also aimed to explore new technologies that could support productivity which identified a commercial mobile sensing technology available to the industry to measure in situ fruit and tree parameters and establish orchard-specific crop load relationships. The Green Atlas Cartographer was trialled to test and measure factors such has fruit size, number and the light interception.

The investment has a total nominal cost of $848,421, funded by Hort Innovation ($397,646 in cash and $55,775 in overheads costs) The Department of Energy, Environment and Climate Action (DEECA). This impact assessment identified a clear pathway to impact for the investment. Two benefits were identified and quantified to demonstrate the impact of the investments, including:

— Increase in fruit yield and quality of apple from optimal crop load – The project has undertaken a number

[1] Apple and Pear Australia Limited [APAL]. 2024. *Industry Stats*. https://apal.org.au/programs/industry-data/industry-stats/

[2] Hort Innovation, Horticulture Statistic Handbook 2023.

[3] Apple and Pear Australia Limited [APAL]. 2024. *Industry Stats*. https://apal.org.au/programs/industry-data/industry-stats/

[4] Serra et al. 2016. Crop Load Influences Fruit Quality, Nutritional Balance, and Return Bloom in 'Honeycrisp' Apple. *HortScience*, 51(3), 236-244; Hueppe & Zander, 2023. Perfect apples or sustainable production? *Journal of Consumer Behaviour* 23(2), 698-710; Jaeger, 2018. Quality perceptions regarding external appearance of apples. *Postharvest Biology and Technology*, 146, 99-107; Drkenda, 2021. How do consumers perceive sensory attributes of apple? *Foods (Basel, Switzerland),* 10(11), 2667.

of trials and studies to determine the optimal crop load for apples. These results can be further interpreted and used to guide new project proposals to deepen knowledge and maximise strategies to produce premium fruit. Once adopted, growers can optimise their production of apples using this information. This is realisable using the mobile sensing technology Green Atlas Cartographer. When commercialised and adopted, this could reduce the orchard management cost for crop load by reducing the labour required to undertake the same crop load assessment activities. There would be an adoption in using the technology through consulting services for smaller orchards whereas larger orchards can adopt the technology in-house.

— Increase in fruit yield and quality of pear from optimal crop load – With some tuning, Green Atlas Cartographer can also be applied for the pear industry.

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 $1.29 million and a benefit-cost ratio (BCR) of 2.38 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 $2.38 for every $1 in investment. When taking only costs and benefits attributable to Hort Innovation into account, the investment generated an NPV of $695,593 and a BCR of 2.38 at 30 years after investment completion. The benefits attributed to Hort Innovation were in proportion to the nominal costs.

Context, objective, and details of investment

The Australian apple industry was valued at $647 million for the year 2023-23 and is one of Australia's largest horticultural crop markets.[5] Latest statistics shows that in 2023-24, over 293,000 tonnes of apples were produced worth $680 million.[6] There are over 400 commercial apple and pear growers registered in Australia.[7] Victoria accounted for over half of all apple production (over 130,000 tonnes) and was valued a $295 million, followed by New South Wales at about 39,000 tonnes (valued at $88 million).[8] The primary regions for apple production include Goulburn Valley and Yarra Valley in Victoria, Orange and Batlow in New South Wales, and Stanthorpe in Queensland.[9]

The apple market composition is primarily Pink Lady (Cripps Pink), Royal Gala, and Granny Smith.[10] Around 98% of the market sale of apples are consumed domestically.[11] In 2023-24, the fresh supply retail market was reported to have a wholesale value of $678 million.[12] The remaining apple production are exported with value of approximately $5 million.[13]

Previous studies demonstrated that a high variability in fruit numbers (crop load) can translate to inconsistent fruit quality that negatively impact consumer satisfaction as consumers have a strong preference for apples

[5] Apple and Pear Australia Limited [APAL]. 2024. *Industry Stats*. https://apal.org.au/programs/industry-data/industry-stats/

[6] Hort Innovation, Horticulture Statistic Handbook 2024.

[7] Apple and Pear Australia Limited [APAL]. 2024. *Industry Stats*. https://apal.org.au/programs/industry-data/industry-stats/

[8] Ibid.

[9] Hort Innovation, Horticulture Statistic Handbook 2024.

[10] Ibid.

[11] Tait, O., 2016, *Market Development for the Apple Industry*, p. 17

[12] Hort Innovation, Horticulture Statistic Handbook 2024.

[13] Hort Innovation, *Apple and pear annual investment plan 2022/23*, p.6

with minimal skin blemishes and an overall consistent colour in addition to medium to large sized fruit.[14]

Currently, crop load management in apple orchards are done by taking one or a few samples per block, and pruning or thinning is applied to the whole block according to information gathered from the sample. This leads to some inefficiencies in optimising quality and yield because crop load per tree is variable and not uniform for each block.

Hort Innovation coordinated the production research program to investigate the physiological mechanisms and develop management tools to improve orchard design and crop load management so that apple orchards can more consistently produce high quality yields that meet market expectations through an uncertain climate. Crop load management is the practice of identifying and creating the ideal ratio of fruit to branch/tree. It involves considering how to appropriately balance the amount of fruit on a tree with the tree's natural resources to maximise the final crop yield without sacrificing quality based on several factors including tree size, age, and carbohydrate reserves.

AP19003 also aimed to explore new technologies that could support productivity which identified a commercial mobile sensing technology available to the industry to measure in situ fruit and tree parameters and establish orchard-specific crop load relationships. The Green Atlas Cartographer was trialled to test and measure factors such has fruit size, number and light interception.

The aims of the investment were to support:

— investigating the dynamics of fruit position and light exposure on colour development, sunburn damage, fruit quality and floral initiation using the Sundial experimental orchard and technology such as LiDAR combined with solar position and light extinction models

— exploring the physiological mechanism (e.g. chemical signals) for observed impacts of high crop load on floral initiation and flower development, and the subsequent season(s) fruit size, assimilation, and translocation of carbohydrate to fruit

— developing a rapid orchard assessment tool using sensing technologies (e.g., proximal sensing of light interception, fruit number and fruit size) to determine crop load for optimum fruit size in apple orchards.

Alignment with Strategic Investment Plan

The project aligns with and supports the achievement of the objectives in the *Apple and Pear Strategic Investment Plan (SIP) 2017–2021*, [15] particularly Outcome 2: Demand and Outcome 3: Profitability.

It contributes to Outcome 2 by building export capability, strengthening international relationships, and addressing market access barriers—supporting the SIP strategies to *build export competitiveness and capability* and *develop an export market development plan*. The project's tailored export readiness programs, in-market insights, and industry training have directly helped improve Australia's export presence and grower preparedness, aligning with SIP efforts to increase the value of the marketable harvest.

It also contributes to Outcome 3 by aiming to increase the proportion of Class 1 fruit sold at premium prices in export markets, thereby improving industry profitability. By enabling growers and exporters to better understand international market requirements and improve quality standards, the project supports SIP strategies to *improve consistency and percentage of Class 1 fruit* and *increase industry knowledge of farm-to-*

[14] Serra et al. 2016. Crop Load Influences Fruit Quality, Nutritional Balance, and Return Bloom in 'Honeycrisp' Apple. *HortScience*, 51(3), 236-244; Hueppe & Zander, 2023. Perfect apples or sustainable production? *Journal of Consumer Behaviour* 23(2), 698-710; Jaeger, 2018. Quality perceptions regarding external appearance of apples. *Postharvest Biology and Technology*, 146, 99-107; Drkenda, 2021. How do consumers perceive sensory attributes of apple? *Foods (Basel, Switzerland),* 10(11), 2667.

[15] Hort Innovation 2022, Apple and Pear Strategic Investment Plan 2017-2021 Performance Report

plate supply chains

Table 1 Project details of AP19003

Project code	AP19003
Title	Advancing sustainable and technology driven apple orchard production systems
Research organisation(s)	The Department of Energy, Environment and Climate Action
Project leader	Dr Ian Goodwin
Funding period	2019-20 – 2023-24
Objective	To improve orchard design and crop load management in a variable climate.

Source: Hort Innovation

Related investments

The project has the following related investments:

- Proceeded by AP15002 and AP15013: Physiological, metabolic and molecular basis of biennial bearing in apple, consists of international component (AP15002) and Australian component (AP15013) – These 2 related projects aimed to increase the understanding of the mechanisms involved in biennial bearing and in turn why apple crops fail to develop sufficient flower numbers in the year after a high crop load. The outcomes of this research provided the basis for optimising crop load under AP19003.
- Followed by AP22004: Optimising apple production systems (PIPS 4 Profit) – This project aims to provide a national approach to developing profitable growing systems for apple production across Australia. The key aim of this research is to develop and evaluate strategies and technologies for efficient and reliable apple crop load management. This investment aligns with the objectives of AP19003 in improving the productivity and profitability of the industry.

Project governance

The governance of AP16002 was structured around a clear and methodical approach, ensuring annual national crop forecasts were delivered with consistency and integrity over the five-year project period. Governance was primarily overseen by Hort Innovation, which managed the project's funding and maintained communication with the apple and pear Strategic Investment Advisory Panel (SIAP) regarding any issues or risks. This oversight ensured that the project remained aligned with the apple and pear industry's Strategic Investment Plan (SIP) and continued to serve the interests of levy-paying growers.

Operationally, governance was supported by project delivery partners AgFirst (2017–2020) and Fruit Help (2020–2021), who were responsible for collecting and analysing crop data each year. A network of regional project advisors was engaged to ensure representation across Australia's major apple and pear growing regions. These advisors conducted local interviews and surveys, forming a vital link between growers and the central project team, and enabling the collection of detailed, region-specific information.

A draft review panel included growers and marketers who reviewed the preliminary estimate and provided input prior to the publication of the final estimate, ensuring transparency and rigour. This collaborative step helped to validate the findings and fine-tune the final outputs based on practical and market-informed feedback.

Overall, the governance model relied on collaboration between Hort Innovation, Apple and Pear Australia Limited (APAL), data delivery partners, and industry stakeholders to deliver a nationally coordinated

forecasting process. While the project was successful in producing consistent annual crop estimates, limitations in national baseline data, such as planted area and varietal mix, were repeatedly identified as barriers to greater accuracy. These limitations highlight an opportunity for future governance structures to incorporate national data infrastructure to improve the robustness and long-term forecasting capability of the crop estimation process.

Impact pathway

A clear pathway from input to impacts can be identified. Overall, the investment produced 2 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 AP19003

Pathway	Description
Inputs and Activities	**Results of other related investments.** The findings of both Project AP15013 and AP19003 on the impacts of crop load on return bloom, tree growth, yield, fruit quality and chemical signalling were used for this project. **Colour development, sunburn damage, fruit quality and floral initiation responses to fruit position and light exposure.** Carried out at the Sundial apple orchard at the Tatura SmartFarm. Trees were planted in a semicircle facing different orientations and were grafted onto different rootstalks in a randomised design. The findings were provided to shareholders. **Validation of a mobile sensorised platform to measure fruit number, size and colour, and light interception.** Green Atlas Cartographer was tested and evaluated during this project to examine the efficacy of the technology in orchard management.
Outputs	**Research findings published in industry articles, technical and summary reports, scientific journal papers, factsheets, technical videos, and news/online articles (4 published papers, 5 factsheets, 11 videos, 8 articles).** Established relationships of fruit position, light exposure and fruit quality will be fed into management systems to improve fruit quality consistency. **Presentations at industry events and science conferences, orchard walks and visitor engagement (10 presentations).** These activities demonstrate the potential benefits of the technology. **Commercial mobile sensing technology validated, producing 10 technical reports.** The Green Atlas Cartographer technology was trialled and validated in crop load management of apple orchards and demonstrated high precision.
Outcomes	**Improve industry knowledge.** Through the activities and outputs of the research, the industry now gained improved knowledge of the optimal crop load for apple trees to achieve better quality and yield. **Communication of research findings (4 published papers, 5 factsheets, 11 videos, 8 articles).** Results of the project were communicated to stakeholders through a variety of sources including industry articles, forums, regional roadshows, and scientific papers. **Crop load optimisation solution through mobile sensing technology.** The Green Atlas Cartographer technology could help growers optimise their crop load to achieve higher efficiency and yield in orchards.
Impacts	**Increase in fruit yield and quality from optimal crop load.** The results can be further interpreted and used to guide new project proposals to deepen knowledge and maximise strategies to produce premium fruit. **Reduction in orchard management cost.** The mobile sensing technology, when commercialised and adopted, could reduce the orchard management cost for crop load.

Source: ACIL Allen

Cost and benefits

Costs

The investment was a collaboration between Hort Innovation and the DEECA. Hort Innovation contributed $397,646 in cash and incurred $55,775 in overheads, while DEECA contributed $395,000 in kind (ex. GST amounts). 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 TG19004

Contribution	2019-20	2020-21	2021-22	2022-23	2023-24	Total
Hort Innovation – Cash	$65,834	$131,667	$82,499	$36,000	$81,646	**$397,646**
Hort Innovation – Overheads	$7,974	$18,399	$11,546	$5,515	$12,342	**$55,775**
DEECA – In-kind	$79,000	$79,000	$79,000	$79,000	$79,000	**$395,000**
Total	**$152,808**	**$229,066**	**$173,045**	**$120,515**	**$172,988**	**$848,421**

DEECA's in-kind contribution is assumed to spread evenly for each year of the funding duration.

Source: Hort Innovation

The total nominal investment of $848,421 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. After converting to real terms, the cost of the investment is $938,451.

Table 4 Real costs of the investment AP19003

Organisation	Hort Innovation	Partners	Total
Nominal costs	$453,421	$395,000	$848,421
Real costs ($2025 financial year)	$504,192	$434,259	$938,451

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

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 AP19003

Type of impact	Assessment	Description
Economic impact	Quantified	**Increase in fruit yield and quality of apple from optimal crop load.** The project has undertaken a number of trials and studies to determine the optimal crop load for apples. These results can be further interpreted and used to guide new project proposals to deepen knowledge and maximise strategies to produce premium fruit. Once adopted, growers can optimise their production of apples using this information.

Type of impact	Assessment	Description
		This is realisable using the mobile sensing technology Green Atlas Cartographer. When commercialised and adopted, this could reduce the orchard management cost for crop load by reducing the labour required to undertake the same crop load assessment activities. There would be an adoption in using the technology through consulting services for smaller orchards whereas larger orchards can adopt the technology in-house. It is worth noting that the technology already exists before the project, and the contribution of the project is through the validation for use in apple orchards.
	Quantified	**Increase in fruit yield and quality of pear from optimal crop load.** With some tuning, Green Atlas Cartographer can also be applied for the pear industry.
Environmental impact	N/A	No environmental impact was identified.
Social impact	N/A	No social impact was identified.

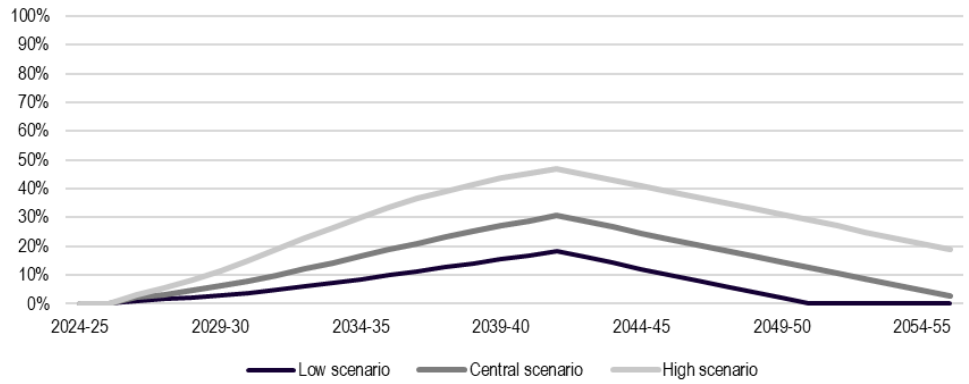
Source: ACIL Allen

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 where the level of certainty is low due to lack of informing evidence or reliance on other proxies and estimates that do not directly inform the calculation.

Table 6 Data and assumptions used for AP19003

Data/Assumption	Value, source and rationale
Data	
Apple industry production value	$585,300,000 (average from 2018-29 to 2022-23) Horticulture Statistics Handbook 2022-23
Pear industry production value	$128,700,000 (average from 2018-29 to 2022-23) Horticulture Statistics Handbook 2022-23
Number of orchards apple and/or pear	Approximately 400 APAL Industry stats https://apal.org.au/programs/industry-data/industry-stats/#:~:text=Industry%20at%20a%20glance:%20x%20For%20the,apple%20and/or%20pear%20growers%20in%20the%20country.
Planted area of apples	Approximately 9,625 ha https://apal.org.au/wp-content/uploads/2020/01/Apple-and-Pear-Crop-Estimate-2020-Final.pdf
Planted area of pears	Approximately 3,015 ha https://apal.org.au/wp-content/uploads/2020/01/Apple-and-Pear-Crop-Estimate-2020-Final.pdf

Data/Assumption	Value, source and rationale
Assumption	
Counterfactual	As the Green Atlas Cartographer technology already exists, stakeholders have informed that this technology would have been deployed regardless of whether the investment has been made or not. The value of the investment is in the validation of the technology to use in optimising crop load for apples and the information generated from the study on the optimal crop load for industry. It is assumed that due to the validation, the industry has more confidence in adopting the technology than otherwise would have been, and the yield improvement from optimised crop load is improved due to the investment.
Assumption	
Attribution	Proportion of impact attributable to the investment: 22%. Based on the proportion of nominal costs of the project in relation to related investments. Second attribution: 40%. The information regarding optimising crop load generated from the project is also not ready for large scale adoption in industry and further investments are needed for application, and Green Atlas Cartographer is not a product solely attributable to the project.
Adoption	While Green Atlas Cartographer technology already exists, the information regarding optimising crop load generated from the project is also not ready for large scale adoption in industry and further investments are needed for application. The industry is also currently facing constraints that would lead to difficulties for adopting new technology. It is assumed that adoption will start in 2026-27 at 2% of the industry with some small-scale trial and increases to approximately 38% of the industry after 15 years, it is then assumed to then slowly decrease at 1% per year due to new advancements. **Figure 1 Estimated adoption**  *Source: ACIL Allen*
Proportion of orchards that are suitable to adopt Green Atlas Cartographer	80% Some large orchards already have commercial ground-based or aerial platforms. Most apple growers (80%) have small holdings of less than 20 hectares; the remaining 20% farming in excess of 20 hectares. While some large orchards would still employ Green Atlas Cartographer. It is assumed approximately 80% of apple planting area would be suitable to adopt the technology. https://www.aussieapples.com.au/about/
Percentage of apple and pear currently unoptimised due to ineffective crop load	30-50% of spur and terminal buds fail to set fruit due to poor crop load management. This analysis uses 40%. https://apal.org.au/precision-crop-load-management-without-chemicals/

Data/Assumption	Value, source and rationale
Improvement in yield for current unoptimised crop load	10% for apple and 8% for pear. Assumptions set by analyst. These improvements only apply for a proportion of apple and pear that does not have optimised crop load due to current practices. Since the information and technology needs adjustments to be applied for pears, a lower assumption is used to reflect this uncertainty.
Average cost of adopting Green Atlas Cartographer	$400/ha/year Assumption informed by stakeholder.
Calculation	
Increase in yield in apple due to optimal crop load	*Production value of apple x Proportion of orchards that are suitable to adopt Green Atlas Cartographer x Percentage of apple and pear currently unoptimised due to ineffective crop load x Improvement in yield for apple for current unoptimised crop load*
Increase in yield in pear due to optimal crop load	*Production value of pear x Proportion of orchards that are suitable to adopt Green Atlas Cartographer x Percentage of apple and pear currently unoptimised due to ineffective crop load x Improvement in yield for pear for current unoptimised crop load*
Adoption costs for apple	*Average cost of adopting Green Atlas Cartographer x Proportion of orchards that are suitable to adopt Green Atlas Cartographer x Planted area of apples*
Adoption costs for pear	*Average cost of adopting Green Atlas Cartographer x Proportion of orchards that are suitable to adopt Green Atlas Cartographer x Planted area of pears*

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 a net present value (NPV) of $1.29 million and a benefit-cost ratio (BCR) of 2.38 at 30 years after investment completion.

When taking only costs and benefits attributable to Hort Innovation into account, the investment generated an NPV of $695,593 and a BCR of 2.38 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 AP19003

	Years after investment completion						
	0	5	10	15	20	25	30
Whole investment							
PV of Costs ($m)	$0.94	$0.94	$0.94	$0.94	$0.94	$0.94	$0.94
Benefits ($m)	$0.00	$0.11	$0.63	$1.72	$3.20	$4.28	$4.84
PV of Benefits ($m)	$0.00	$0.09	$0.46	$1.06	$1.71	$2.08	$2.23
NPV ($m)	-$0.94	-$0.85	-$0.48	$0.12	$0.77	$1.14	$1.29
BCR	0.00	0.10	0.49	1.13	1.82	2.22	2.38
IRR	Negative	Negative	3.3%	13.7%	16.9%	17.6%	17.8%
MIRR	Negative	Negative	3.8%	10.7%	11.9%	11.4%	10.5%

Attributable to Hort Innovation							
PV of Costs ($m)	$0.50	$0.50	$0.50	$0.50	$0.50	$0.50	$0.50
Benefits ($m)	$0.00	$0.06	$0.34	$0.93	$1.72	$2.30	$2.60
PV of Benefits ($m)	$0.00	$0.05	$0.25	$0.57	$0.92	$1.12	$1.20
NPV ($m)	-$0.50	-$0.46	-$0.26	$0.07	$0.41	$0.61	$0.70
BCR	0.00	0.10	0.49	1.13	1.82	2.22	2.38
IRR	Negative	Negative	3.3%	13.6%	16.8%	17.6%	17.7%
MIRR	Negative	Negative	3.7%	10.6%	11.9%	11.3%	10.5%

Source: ACIL Allen

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 AP19003

	NPV ($m)	BCR	IRR	MIRR
Under standard assumptions (Central case assumptions and 5% discount rate)	$1.29	2.38	17.8%	10.5%
3% discount rate	$2.06	3.19	17.8%	10.5%
7% discount rate	$0.76	1.81	17.8%	10.5%
Low increase in apple yield (8.5%)	$0.77	1.82	16.4%	10.0%
High increase in apple yield (11.5%)	$1.82	2.94	19.1%	11.0%
Low increase in pear yield (6%)	$1.14	2.22	17.4%	10.4%
High increase in pear yield (8%)	$1.45	2.54	18.2%	10.6%
Low attribution of impact to project (35%)	$0.78	1.83	16.4%	10.0%
High attribution of impact to project (45%)	$1.81	2.93	19.1%	11.0%
Low adoption costs ($300/ha)	$1.77	2.88	17.8%	10.5%
High adoption costs ($500/ha)	$0.82	1.87	17.8%	10.5%
Low adoption scenario (starts at 1% and max out at 18% of industry after 16 years and reduce to 0%).	$0.14	1.15	11.2%	7.8%
High adoption scenario (starts at 3% and max out at 47% of industry after 16 years and reduce to 19%).	$3.01	4.21	24.5%	12.7%

Source: ACIL Allen

Key findings

The following key findings has been identified for the investment:

— The investment returns a high BCR and NPV, demonstrating the real economic benefits for growers.

— With the industry facing challenges on profitability in recent years, adoption of the research outcomes is uncertain. Growers are typically conversative in adopting technology that are high tech like robotic processes and have large upfront capital investments. The potential benefit of adopting the technology needs to be clearly demonstrated and communicated to growers to encourage high adoption.

— A future potential of the technology is to use the ability to assess fruit size and quality for application in apple and pear grading, removing a step in the production to streamline the process of getting the commodities to market. However, additional sorting capability and capital investments are needed for this to be realised.

— There are tremendous opportunities for the Cartographer technology to be further developed and adjusted to apply to other commodities such as stone fruits, avocado, and almond. With the foundation ready, further research similar to this project can be undertaken to apply the technology to produce impact for these other industries.

— While the project was successful in producing consistent annual crop estimates, limitations in national baseline data, such as planted area and varietal mix, were repeatedly identified as barriers to greater accuracy. These limitations highlight an opportunity for future governance structures to incorporate national data infrastructure to improve the robustness and long-term forecasting capability of the crop estimation process.

Consultations

The following stakeholders were consulted on this assessment:

— Adrian Hunt, Hort Innovation

— Nic Finger, Fruit Help

— Ian Goodwin, Agriculture Victoria

— Kevin Sanders, Sanders Apple.

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